U.S. Department of Transportation
Federal Highway Administration

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 041024
Flagstaff, Arizona

Report No. FHWA-04-1024

May 1997

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LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 041024, Flagstaff, Arizona

Report No. FHWA-04-1-1024

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 041024 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 Interstate Highway 10, east of Flagstaff, Arizona. This section was instrumented on August 21, 1995. The instruments installed included TDR probes for moisture content, thermistor probes for subsurface temperature, electrical resistivity probe to record frost depth, tipping bucket rain gauge for precipitation, piezometer to monitor ground water table, and an on-site datalogger. Initial data was collected on August 22, 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.

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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 041024

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 041024 near Flagstaff, Arizona. The equipment installation activities were carried out on August 21, 1995 and initial data was collected on August 22, 1995.

Section Location

Section 041024 is a General Pavement Studies (GPS) section selected for SMP. This section is located on the outside lane of eastbound Interstate Route 40, a multi-lane highway facility in the State of Arizona. The closest city to the section is Flagstaff, Arizona. The beginning of the section is at milepost 106.95, 3.30 miles east of the Jolly Road structure and 0.7 miles west of Markham wash. This section is a GPS-1, "General Study of Flexible Pavements on Granular Bases," 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 292 mm of asphalt concrete (AC) with 165mm aggregate base (AB) over medium sand subgrade. The test section has a 3.70m travel lane with a 3.60m wide asphalt concrete shoulder. Additional details are summarized in table 1.

Table 1. Details of section 041024 in Arizona.

Functional Classification of Roadway	Interstate Highway, Rural, Arterial
Number of Lanes/Direction	Two
Pavement Type	Asphalt Concrete
Estimated Annual ESAL Applications on the Test Lane	936.7 KESALs
Climatic Classification	Dry, no-Freeze, SMP Cell #13

Pre-installation FWD testing was carried out on the test section on July 17, 1995. FWD data was analyzed using the FWDCheck program. 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 the appendix 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)	292*	165*	N/A
Proctor Dry Density (kg/m^3)	----	----	**
Proctor Moisture Content (%)	----	----	**
Field Measured Density (kg/m^3)	----	2388@4.7%MC***	1957@11.8%MC***
Laboratory Maximum Dry Density (kg/m^3)	----	2317@6%MC	1910@12.0%MC
Liquid Limit	----	28	NP
Plactic Limit	----	12	NP
Plastic Index	----	16	NP
Percent Passing #200	----	10.8%	29.5%

MC Moisture Content AB Aggregate Base
AC Asphalt Concrete NP Non-Plastic
* Layer thickness from construction records
** Proctor density tests were not carried out on the day of instrument installation due to rain
*** Density in the field was measured using Nuclear gauge

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

Freezing Index	:	116	No. of Days Below 0° C	:	139
Precipitation	:	355mm	No. of Wet Days	:	63
No. of Days Above 32° C	:	36	No. of Freeze/Thaw Cycles	:	147

Installation of instrumentation was carried out on August 21, 1995 and initial data collection was performed on August 22, 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.

William Nichols	:	NCE	Coby Rowe	:	NCE
Mark A. Potter	:	NCE	Michael E. Esposito	:	NCE
Michael Judd	:	Traffic Control	Clyde Ulrich	:	Traffic control
M. Mejia	:	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 inspected by Richard Smith on July 17, 1995. Distress survey and FWD testing of the section was also carried out on this date.

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 datalogger. 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 installed as the section was in the "Dry Freeze" region.

Table 3. Equipment installed.

Equipment	Quantity	Serial No.
Instrument Hole		
MRC Thermistor Probe	1	04C#2
TDR Sensors	10	04C01-04C10
Resistivity Probe	1	04#3R
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16510
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 datalogger 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 60 minutes and 91 tips to drain 473ml of water. The two screws at the bottom of the rain gauge were adjusted by one and one half turn (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 function 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 datalogger and battery unit were also checked. All instruments 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.

The resistivity probe was checked for continuity and conductivity using a digital multimeter. The probe was free of any problems. During the checkout procedure it was observed that the pin numbers and the resistance band numbers were opposite to each other (i.e., pin #1 corresponded to resistivity band #36 and vice versa). The spacing between each electrode was measured and recorded; these are given in table 5.

Instrument Installation

Analysis of pre-installation FWD data indicated uniformity of the section. The equipment installation followed the schedule given below.

0730	:	Depart from Flagstaff.
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.

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	0.016	Unit installed in base & subgrade
	5	0.094	
	6	0.174	
	7	0.243	
	8	0.319	
	9	0.471	
	10	0.624	
	11	0.778	
	12	0.929	
	13	1.081	
	14	1.234	
	15	1.386	
	16	1.540	
	17	1.691	
	18	1.841	

Table 5. Sensor spacing in the resistivity probe.

Connector Pin Number	Electrode Number	Distance from Top (m)			Continuity	Spacing (m) between Electrodes
		Line 1	Line 2	Average		
36	1	0.030	0.030	0.030	X	0.030
35	2	0.083	0.081	0.082	X	0.052
34	3	0.133	0.132	0.133	X	0.051
33	4	0.184	0.183	0.184	X	0.051
32	5	0.233	0.232	0.233	X	0.049
31	6	0.284	0.283	0.284	X	0.051
30	7	0.334	0.333	0.334	X	0.050
29	8	0.386	0.385	0.386	X	0.052
28	9	0.437	0.436	0.437	X	0.051
27	10	0.489	0.487	0.488	X	0.051
26	11	0.538	0.536	0.537	X	0.049
25	12	0.589	0.589	0.589	X	0.052
24	13	0.640	0.639	0.640	X	0.051
23	14	0.693	0.691	0692	X	0.052
22	15	0.741	0.741	0.741	X	0.049
21	16	0.792	0.791	0.791	X	0.050
20	17	0.842	0.842	0.842	X	0.051
19	18	0.893	0.893	0.893	X	0.051
18	19	0.944	0.941	0.943	X	0.050
17	20	0.996	0.994	0.945	X	0.052
16	21	1.046	1.045	1.046	X	0.051
15	22	1.097	1.095	1.096	X	0.050
14	23	1.146	1.145	1.146	X	0.050
13	24	1.198	1.197	1.198	X	0.052
12	25	1.249	1.248	1.249	X	0.051
11	26	1.300	1.298	1.299	X	0.050
10	27	1.351	1.350	1.351	X	0.052
9	28	1.400	1.399	1.400	X	0.051
8	29	1.451	1.450	1.451	X	0.051

Table 5. Sensor spacing in the resistivity probe (cont'd).

Connector Pin Number	Electrode Number	Distance from Top (m)			Continuity	Spacing (m) between Electrodes
		Line 1	Line 2	Average		
7	30	1.500	1.500	1.500	X	0.049
6	31	1.552	1.550	1.551	X	0.051
5	32	1.603	1.601	1.602	X	0.051
4	33	1.653	1.652	1.653	X	0.051
3	34	1.705	1.705	1.705	X	0.052
2	35	1.756	1.754	1.755	X	0.050
1	36	1.807	1.805	1.806	X	0.051
Bottom		1.828	1.829	1.829		

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.
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+15') from the section beginning, in a 0.30m diameter hole bored using a 252mm diameter flight auger after sawing out a 0.5m square block from the surface AC layer. 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 2.17m deep. Figure C1 in appendix C presents the site layout and instrument 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, resistivity, 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 9.30m 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 6. All instruments at this site were installed in adherence with FHWA LTPP SMP Guidelines, April 1994.

Moisture samples were collected at each TDR probe location. A representative Proctor sample was taken at a depth of 1.52m from pavement surface. The Proctor density test was not performed because of rain. TDR traces obtained during installation were later used to determine insitu 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 Installation Guidelines, April 1994.

Table 6. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
04C01	0.353	Base
04C02	0.505	Subgrade
04C03	0.655	
04C04	0.804	
04C05	0.960	
04C06	1.113	
04C07	1.265	
04C08	1.410	
04C09	1.721	
04C10	2.025	

A comparison of moisture contents determined from TDR traces obtained during installation with field measured moisture contents are presented in table 7.

Table 7. Measured moisture contents during installation.

Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by wt)	
			Field Measured[1]	TDR Installation[2]
04C01	0.353	Base	9.5	22.9
04C02	0.505	Subgrade	15.5	32.0
04C03	0.655		12.8	26.0
04C04	0.804		16.7	16.8
04C05	0.960		10.6	16.8
04C06	1.113		13.4	16.8
04C07	1.265		6.4	9.4
04C08	1.410		7.7	15.2
04C09	1.721		10.1	13.7
04C10	2.025		8.5	19.8

[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 is seen from the above data that, field measured moisture contents significantly varied from the moisture contents determined from the TDR traces obtained during installation. Variability observed in moisture contents at some sensor depths most likely was due to rainfall during installation and to some extent the field conditions, soil type, and limitations of the moisture determination method used.

The resistivity probe was installed in the unbound base and subgrade layers along with the thermistor unit #2 as per the SMP instrument installation guidelines. The resistivity probe leads were checked for continuity after backfilling of the instrumentation hole. Tables 8 and 9, respectively, present the installed locations of thermistor sensors and the resistivity probe with reference to the pavement surface.

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 5.1m to the right of 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 datalogger located in the equipment cabinet. The datalogger 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 equipments were functioning properly. The repair patch placed on the instrument hole performed well for most of the monitoring period. Some settlement of the patch was observed in the last three data collection visits.

INITIAL DATA COLLECTION

The second day (August 21, 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 datalogger, and TDR data collection using the mobile data acquisition system. Air temperature, rainfall, pavement, and subsurface temperature data monitored and stored by the onsite datalogger were examined. The equipment and datalogger were functioning correctly. The battery voltage was checked and found acceptable.

TDR data was not collected using the mobile data acquisition system. The mobile data acquisition box was damaged by rainwater during the seasonal instrumentation installation. However, mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors.

Table 8. Installed locations of MRC thermistor sensors.

Unit No.	Channel No.	Depth from Pavement Surface (m)	Remarks
1	1	0.013	AC
	2	0.125	
	3	0.248	
2	4	0.341	Base
	5	0.419	
	6	0.499	Subgrade
	7	0.568	
	8	0.644	
	9	0.796	
	10	0.949	
	11	1.103	
	12	1.254	
	13	1.406	
	14	1.559	
	15	1.711	
	16	1.865	
	17	2.016	
	18	2.166	

Table 9. Installed locations of resistivity sensors.

Connector Pin Number	Electrode Number	Depth from Pavement Surface
36	1	0.355
35	2	0.407
34	3	0.458
33	4	0.509
32	5	0.558
31	6	0.609
30	7	0.659
29	8	0.711
28	9	0.762
27	10	0.813
26	11	0.862
25	12	0.914
24	13	0.965
23	14	1.017
22	15	1.067
21	16	1.116
20	17	1.167
19	18	1.218
18	19	1.268
17	20	1.320
16	21	1.371
15	22	1.421
14	23	1.471
13	24	1.523
12	25	1.574
11	26	1.624
10	27	1.676
9	28	1.725

Table 9. Installed locations of resistivity sensors (cont'd).

Connector Pin Number	Electrode Number	Depth from Pavement Surface
8	29	1.776
7	30	1.825
6	31	1.876
5	32	1.927
4	33	1.978
3	34	2.030
2	35	2.080
1	36	2.130
Bottom		

Post installation FWD testing of the section was carried as per the LTPP guidelines. 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 at Section 041024 located in the State of Arizona. The section is located on the eastbound outside lane of Interstate Route 40 near the City of Flagstaff. The beginning of the section is at milepost 106.95, 3.30 miles east of Jolly Road structure and 0.7 miles west of Markham Wash. This is a GPS-1 section in the "Dry, Freeze" climatic zone, meeting the requirements of SMP cell #13.

The site was inspected on July 17, 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 21 and 22, 1995, respectively, in accordance with the LTPP SMP installation guidelines. Equipment to measure and record the following data was installed at site:

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

A resistivity probe was installed at this site as the site is in "Dry No-Freeze" zone. 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 9.3m to the right of the lane edge on almost level ground. Post installation checks indicated proper functioning of all installed equipment. Post installation FWD testing was performed as per LTPP guidelines.

TDR data was not collected using the mobile data acquisition system. The mobile data acquisition box was damaged by rainwater during the seasonal instrumentation installation. The Proctor desity test was not performed beause of rain during the instrument installation. The decision to continue with installation was made after carefully considering the additional expense, inconvenience and scheduling problems for the various agency personnel involved in the installation effort. However, mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors. Unfortunately, no pictures of the installation were taken because of camera malfunction. These were the exceptions or special conditions at this site.

APPENDIX A

Test Section Background Information

Appendix A includes the following supporting information:

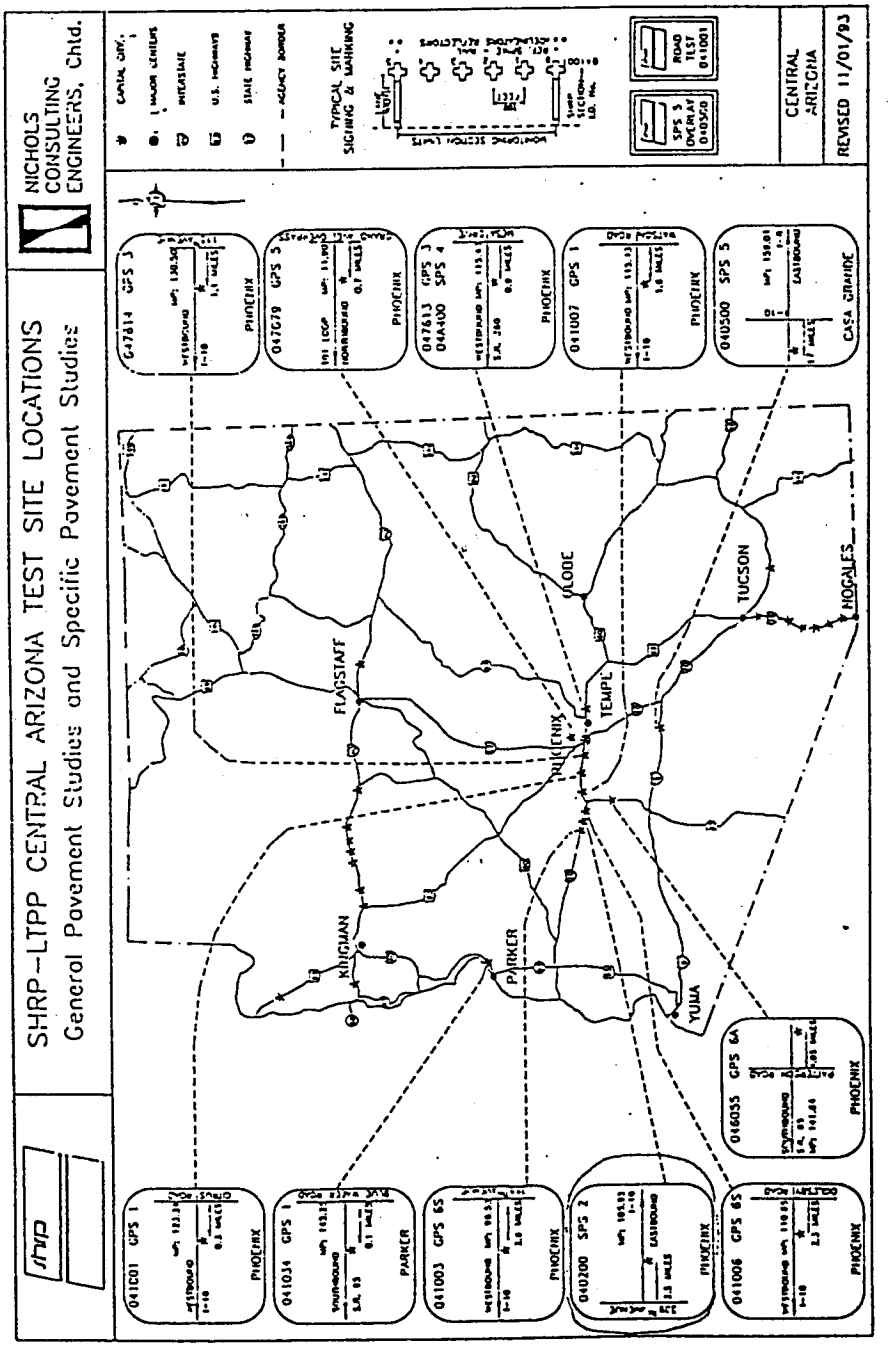


Figure A1. Site location map.

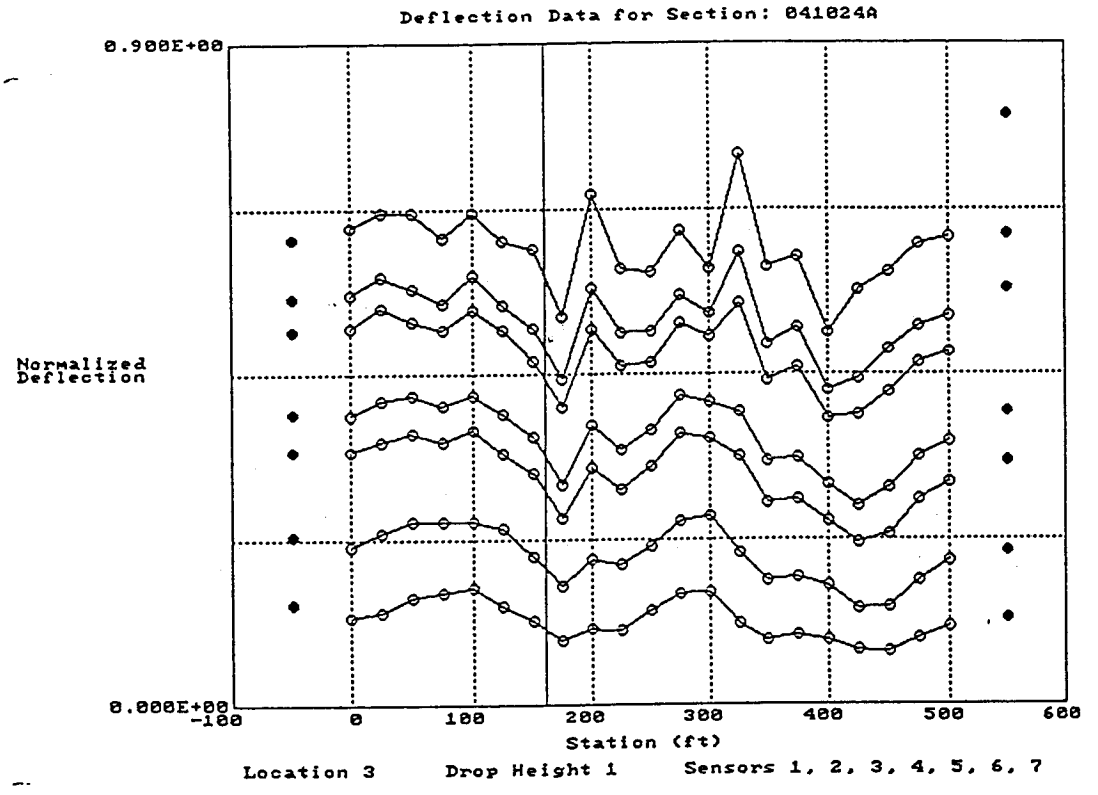
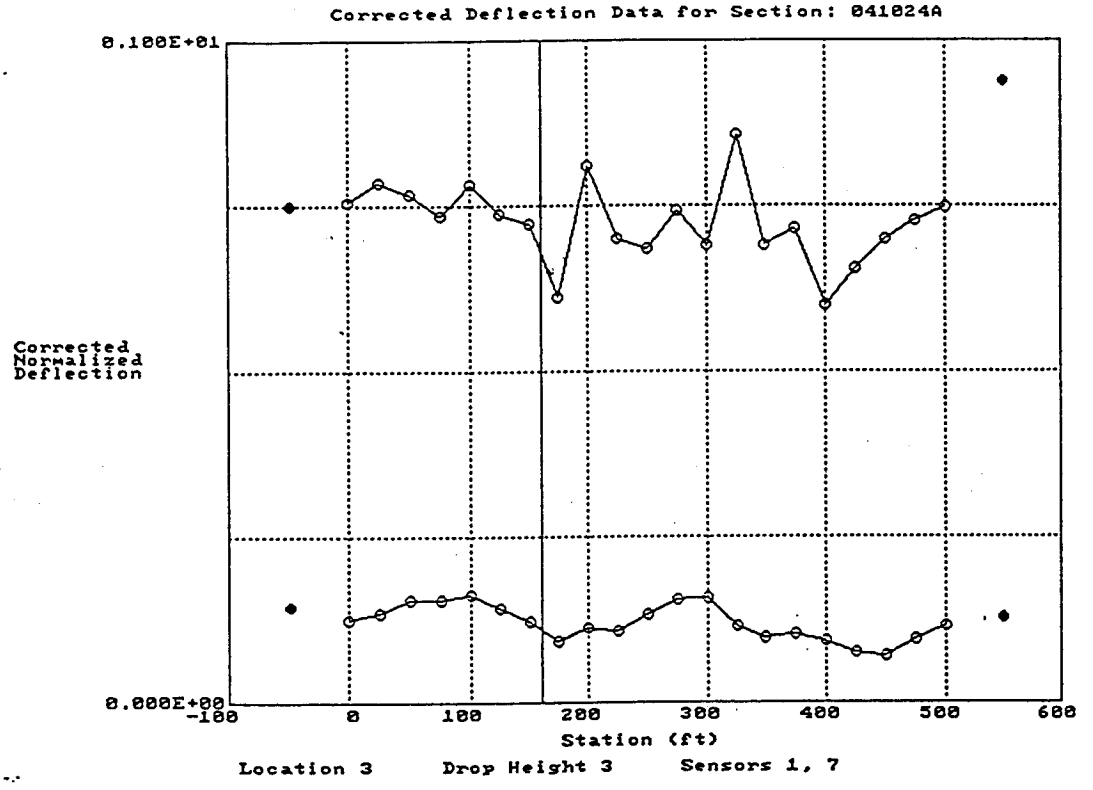


Figure A2. Normalized deflection profile from FWDCheck.



Corrected normalized deflection profile from FWDCheck.

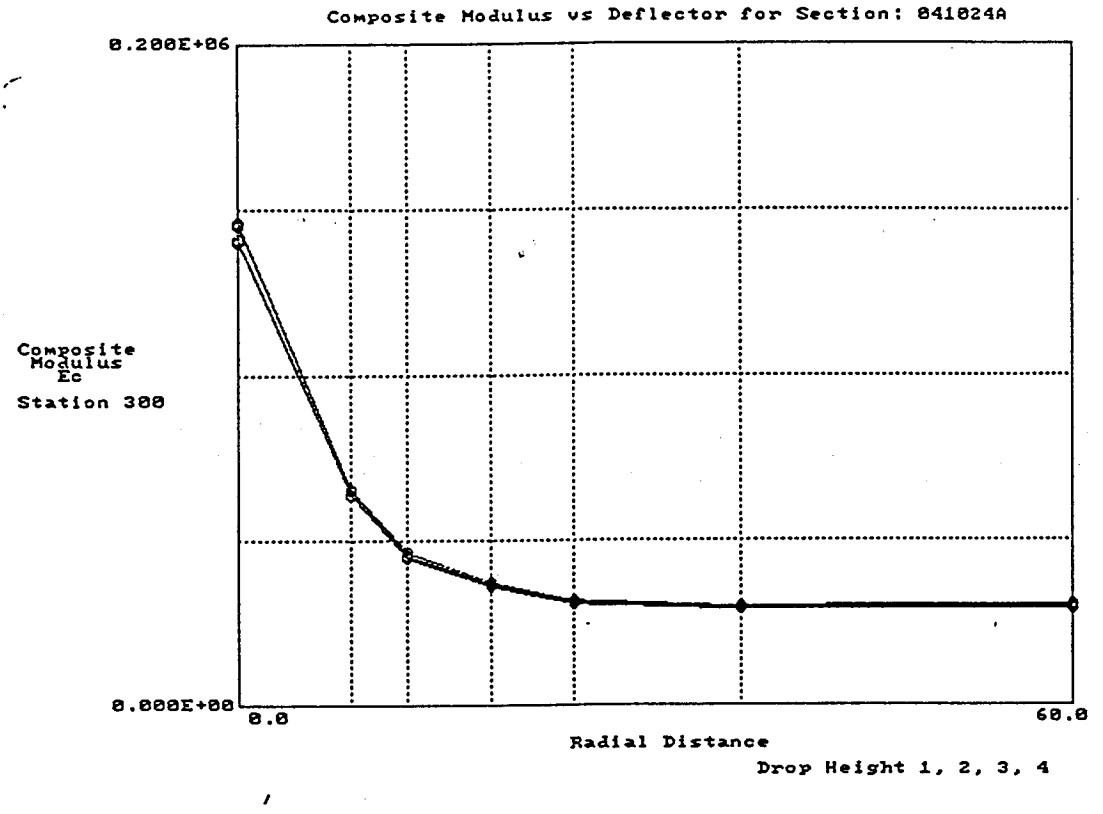


Figure A4. Composite modulus of section from FWDCheck.

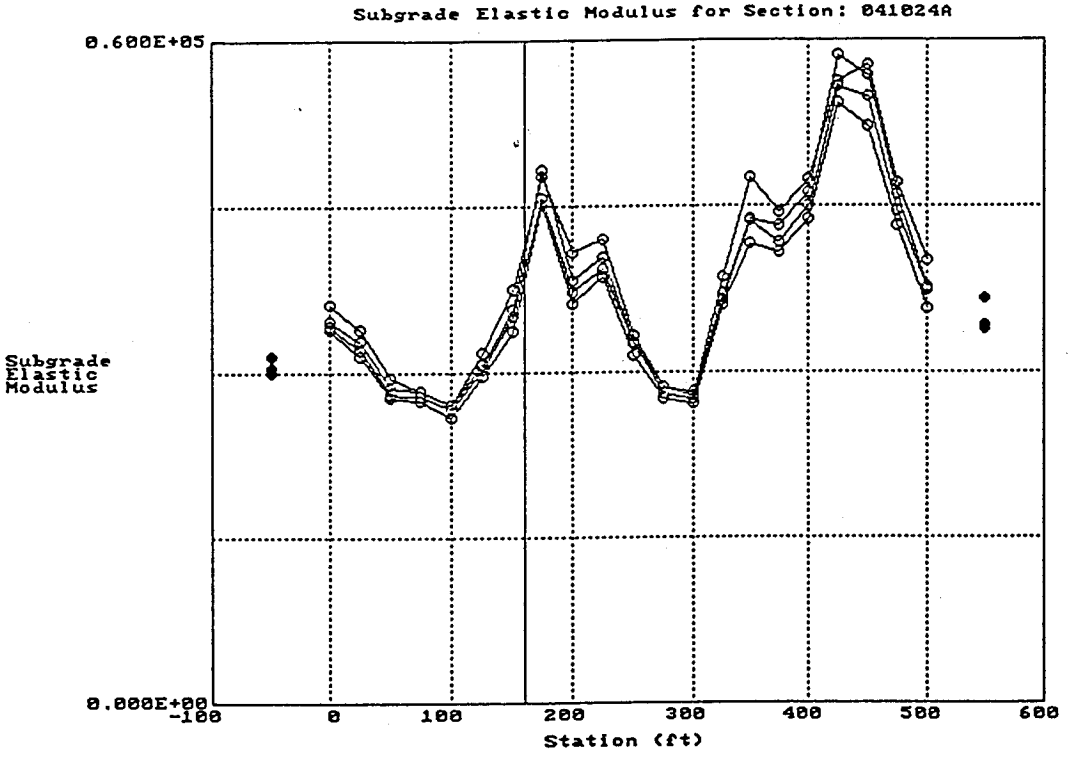


Figure A5. Elastic modulus of subgrade from FWDCheck.

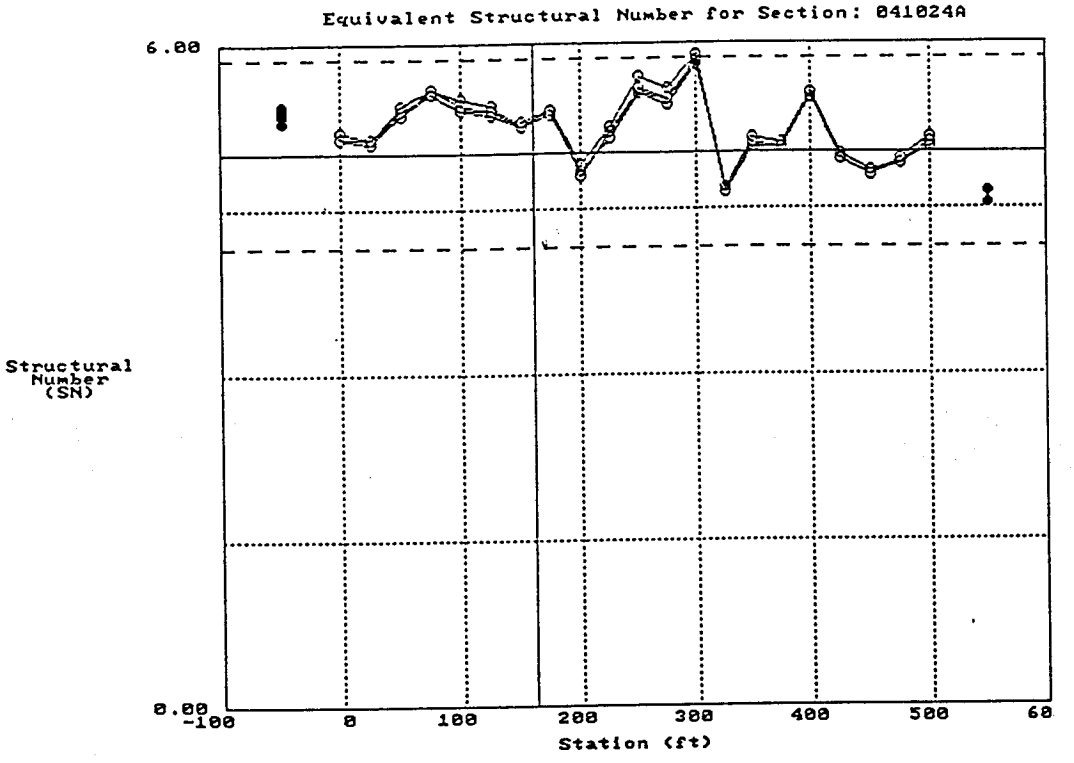


Figure A6. Equivalent structural number from FWDCheck.

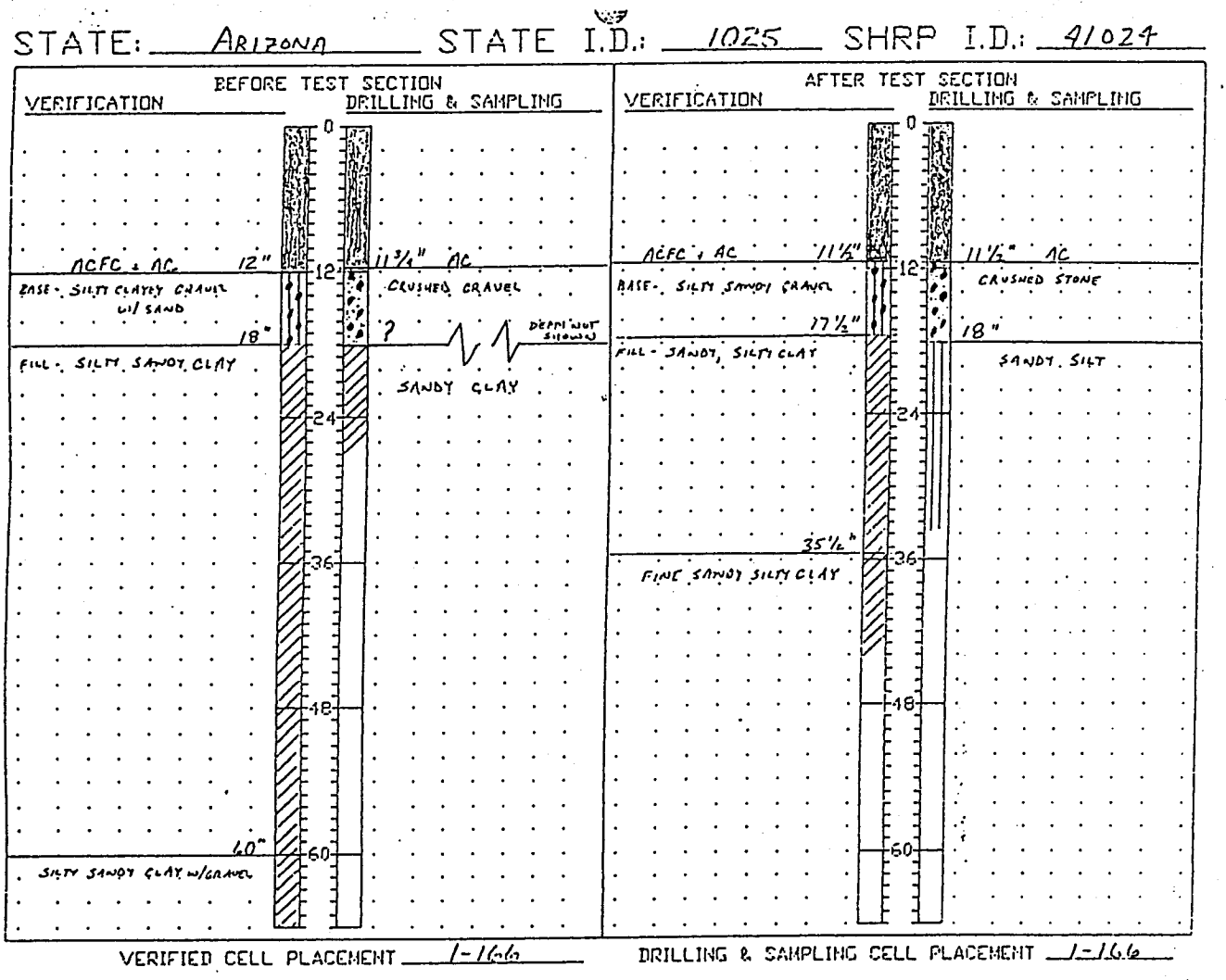
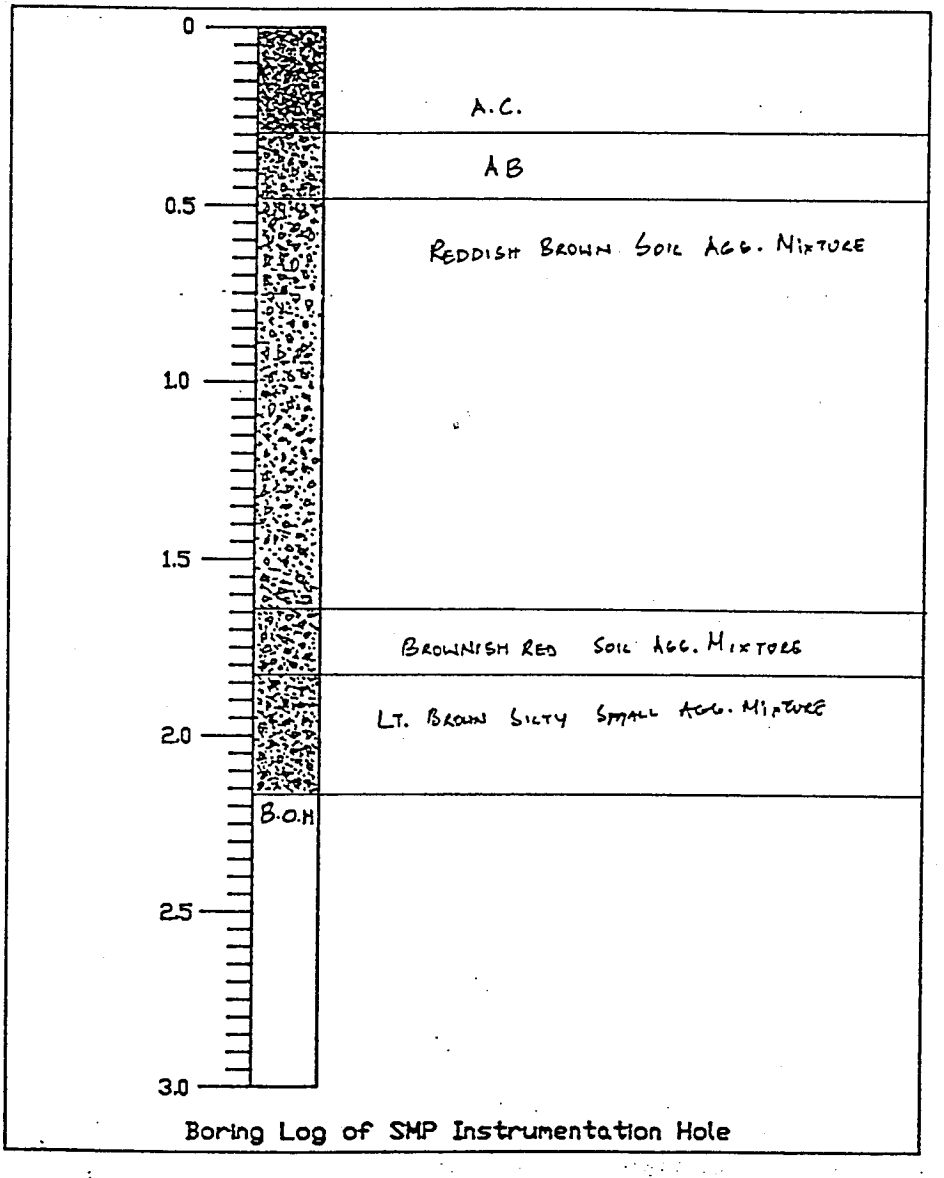


Figure A7. Profile of test section.

State ID. 04 SHRP ID. 1024

Station 5+15' Date(dd/mm/yy) 21/08/95



Boring Log of SMP Instrumentation Hole

Start Time — End Time —

Prepared By MARK A. POTTER Employed By N.C.E

Figure A8. Boring log of instrument hole.

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 0 4

SHRP SECTION ID 1 0 2 4

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/17/95

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

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (Square Meters)	0.0	0.0	0.0
2. BLOCK CRACKING (Square Meters)	0.0	0.0	0.0
3. EDGE CRACKING (Meters)	0.0	0.0	0.0
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	0.0	0.0	0.0
Length Sealed (Meters)	7.0	0.0	0.0
4b. Non-Wheel Path	21.6 ~~8.0~~ 7.6	4.1	~~9.0~~ 21.5
Length Sealed (Meters)	13.6	0.0	12.5
5. REFLECTION CRACKING AT JOINTS Number of Transverse Cracks	0	0	0
Transverse Cracking (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
Longitudinal Cracking (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
6. TRANSVERSE CRACKING Number of Cracks	0	0	0
Length (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
PATCHING AND POTHOLES			
7. PATCH/PATCH DETERIORATION (Number)	2	0	1
(Square Meters)	.4	0.0	.4
8. Potholes (Number)	0	0	0
(Square Meters)	0.0	0.0	0.0

ENTERED OCT 12 1995 By JW

Revised December 1, 1992

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 04

SHRP SECTION ID 1024

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/17/95

SURVEYORS: RPS, _ _ _

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)			00
(Square Meters)			00.0
SURFACE DEFECTS			
11. BLEEDING (Square Meters)	00.0	00.0	00.0
12. POLISHED AGGREGATE (Square Meters)			00.0
13. RAVELING (Square Meters)	00.0	00.0	00.0
MISCELLANEOUS DISTRESSES			
14. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 3			
15. WATER BLEEDING AND PUMPING (Number)			00
Length of Affected Pavement (Meters)			00.0

16. OTHER (Describe) _____

ENTERED
OCT 12 1995
BY LW

APPENDIX B

Installed Instrument Information

Appendix B includes the following supporting information:

Figure B1. TDR traces obtained for sensor 04C01 during calibration.
Figure B2. TDR traces obtained for sensor 04C02 during calibration.
Figure B3. TDR traces obtained for sensor 04C03 during calibration.
Figure B4. TDR traces obtained for sensor 04C04 during calibration.
Figure B5. TDR traces obtained for sensor 04C05 during calibration.
Figure B6. TDR traces obtained for sensor 04C06 during calibration.
Figure B7. TDR traces obtained for sensor 04C07 during calibration.
Figure B8. TDR traces obtained for sensor 04C08 during calibration.
Figure B9. TDR traces obtained for sensor 04C09 during calibration.
Figure B10. TDR traces obtained for sensor 04C010 during calibration.

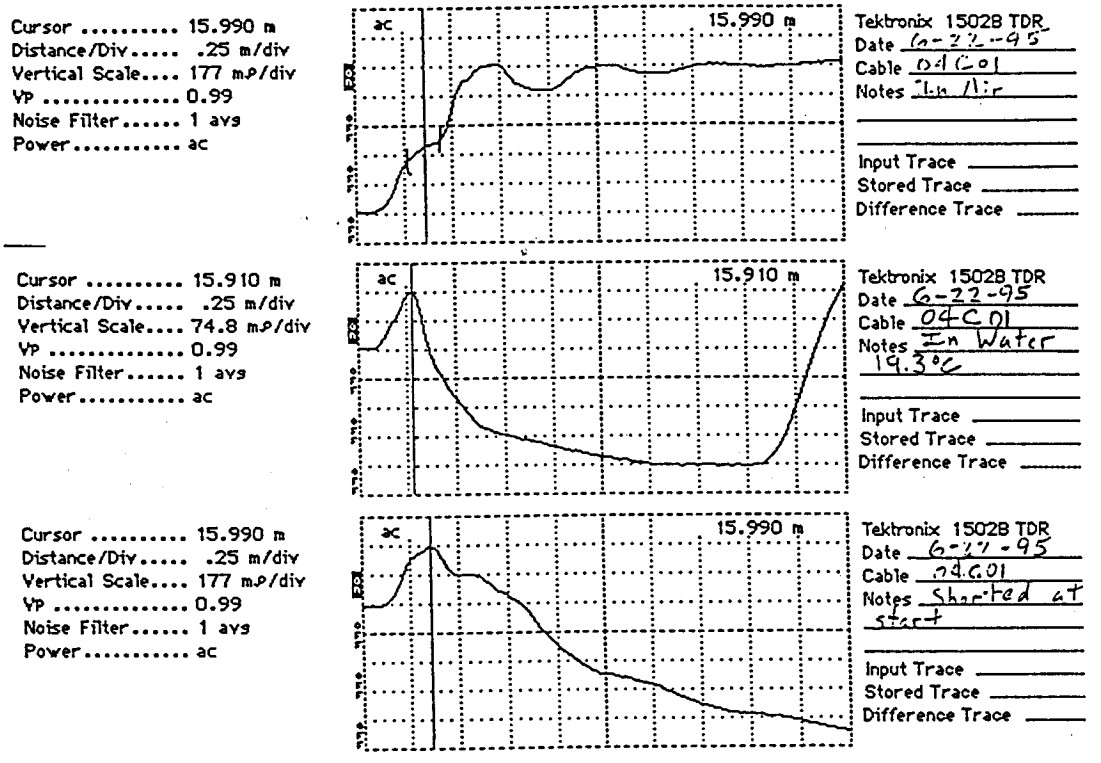


Figure B1. TDR traces obtained for sensor 04C01 during calibration.

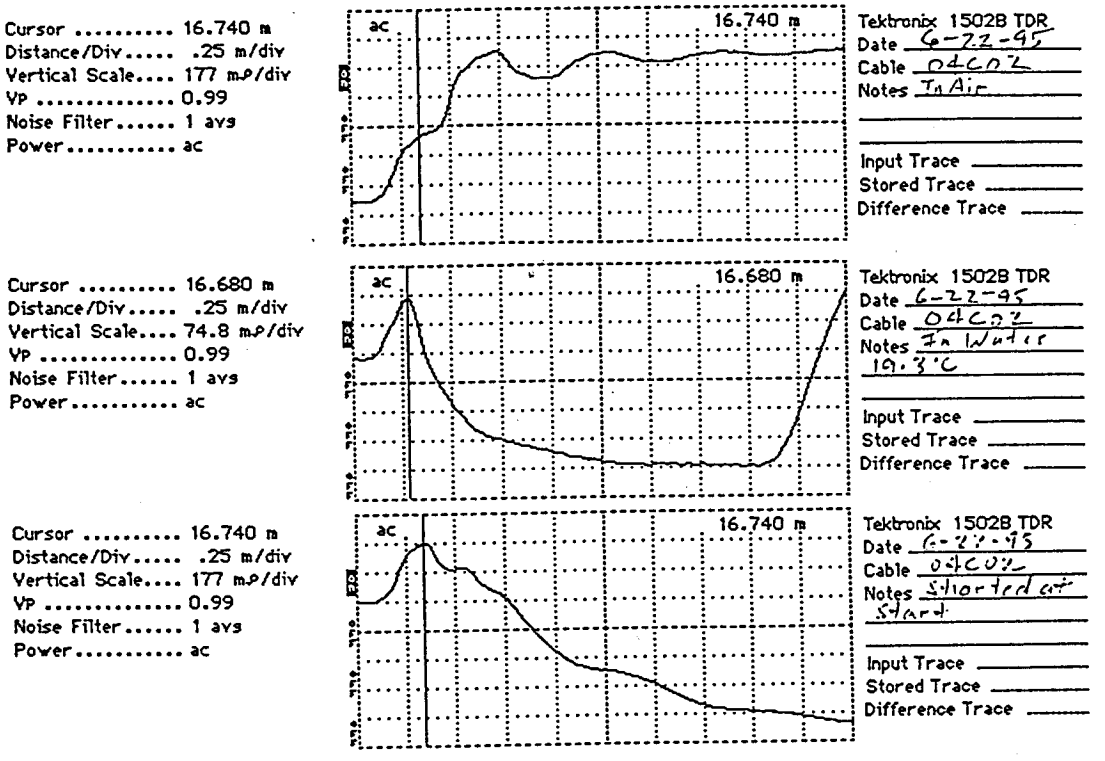


Figure B2. TDR traces obtained for sensor 04C02 during calibration.

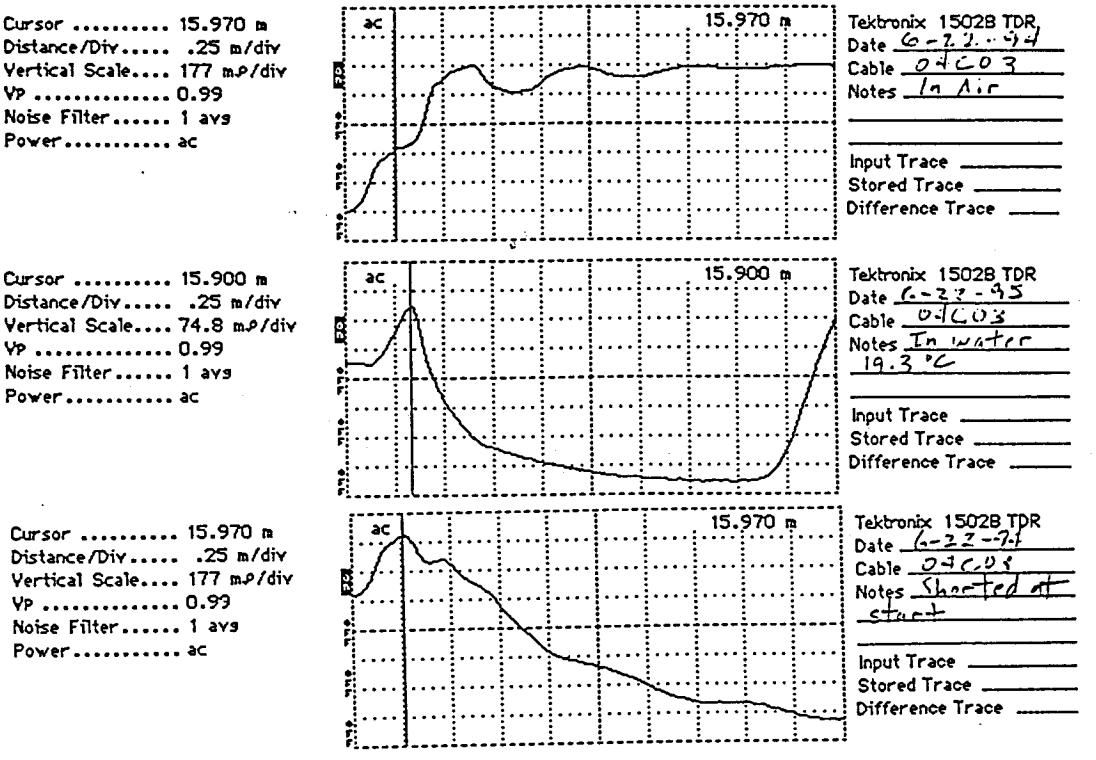


Figure B3. TDR traces obtained for sensor 04C03 during calibration.

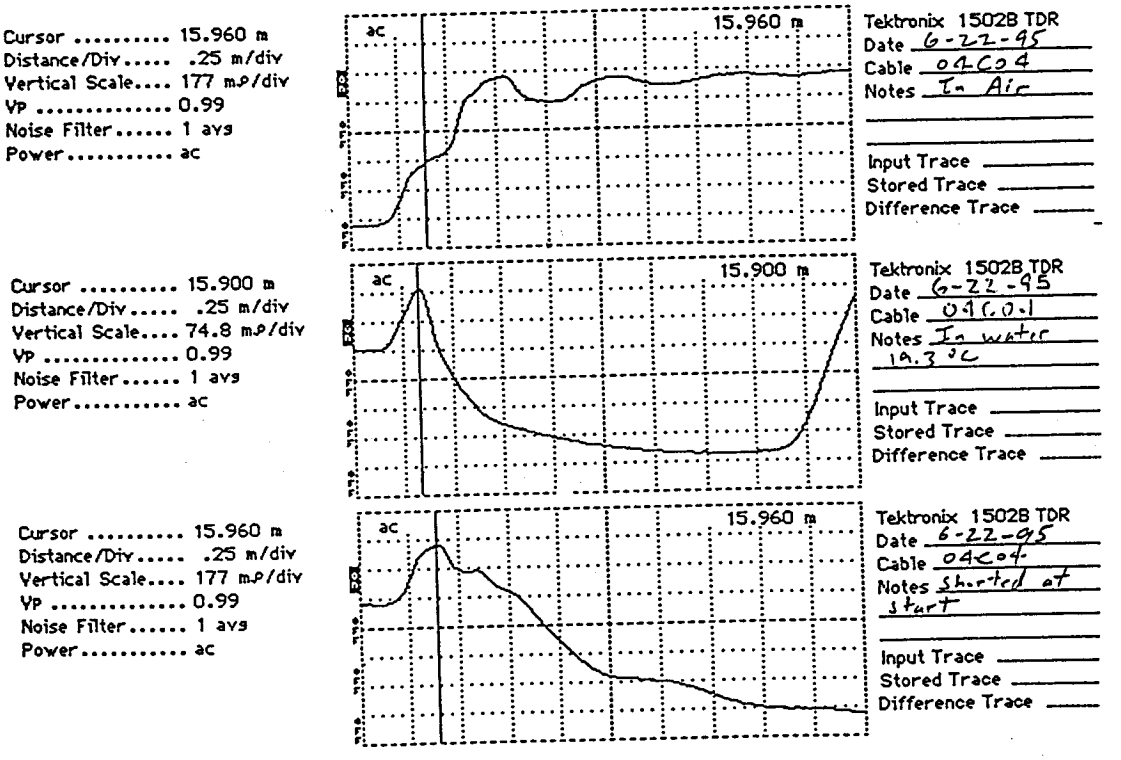


Figure B4. TDR traces obtained for sensor 04C04 during calibration.

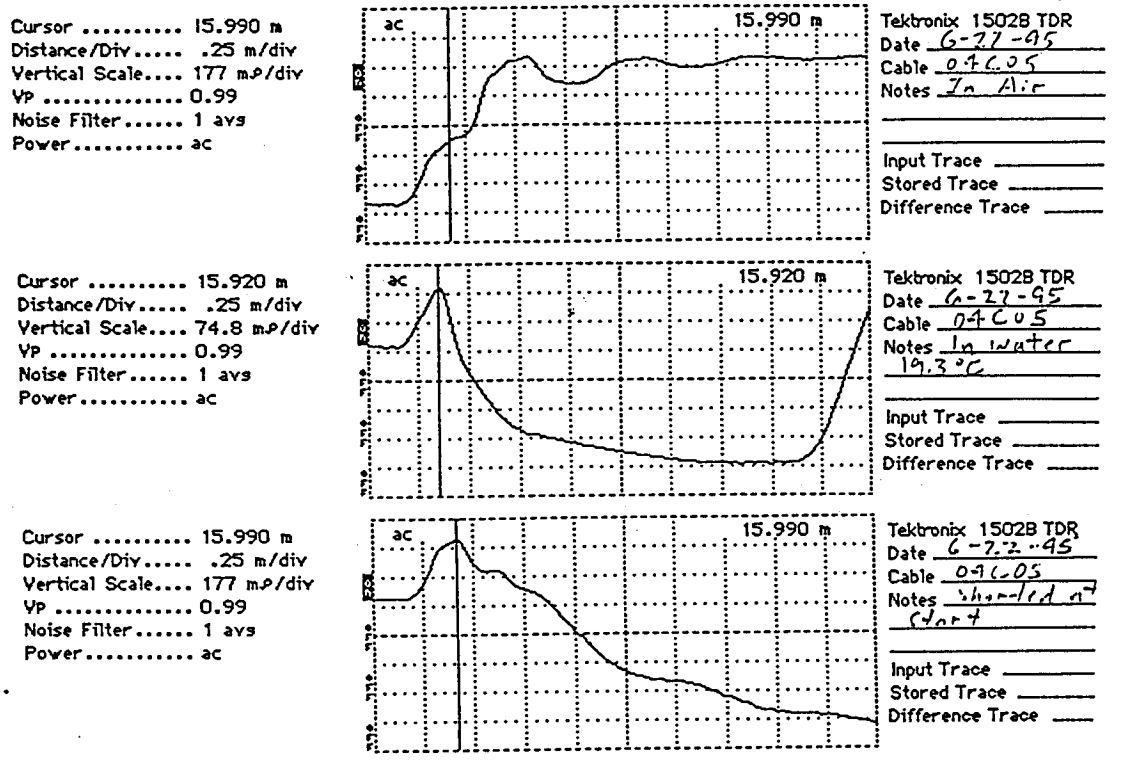


Figure B5. TDR traces obtained for sensor 04C05 during calibration.

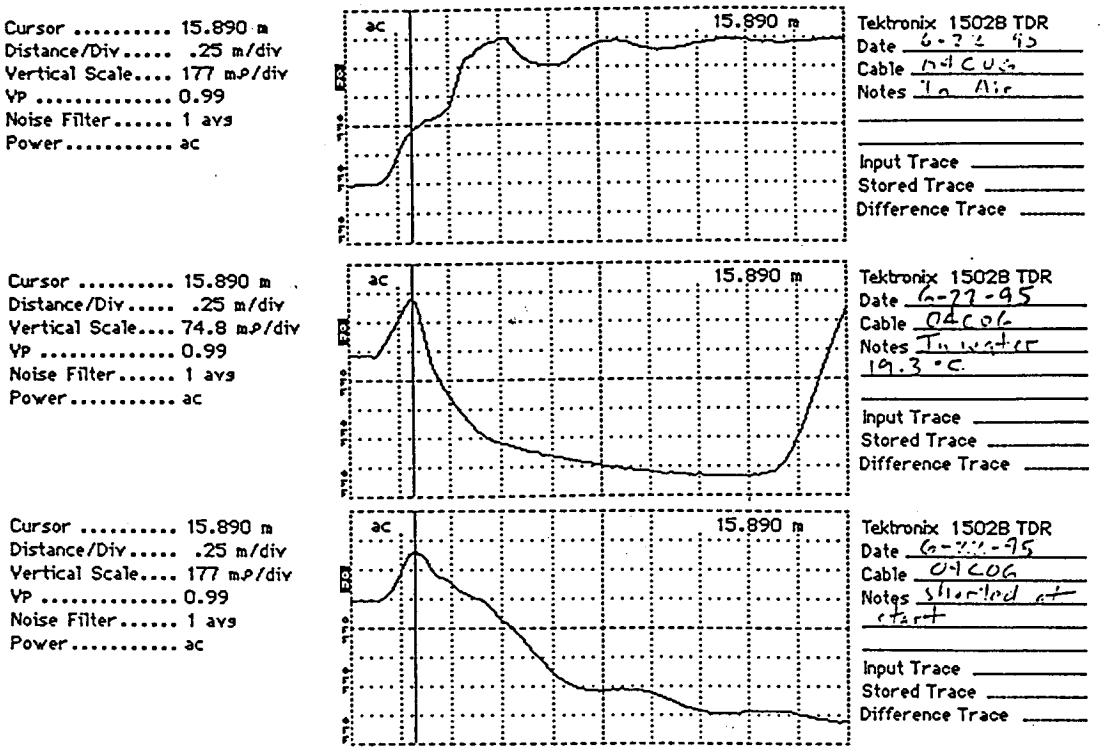


Figure B6. TDR traces obtained for sensor 04C06 during calibration.

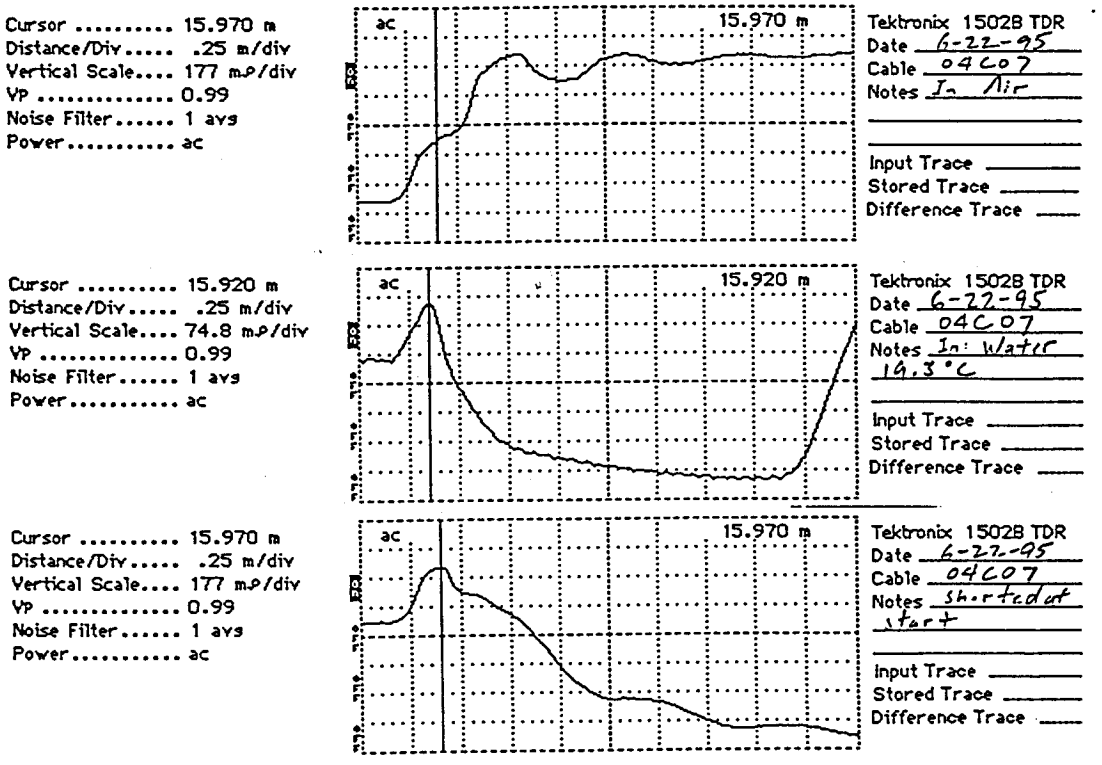


Figure B7. TDR traces obtained for sensor 04C07 during calibration.

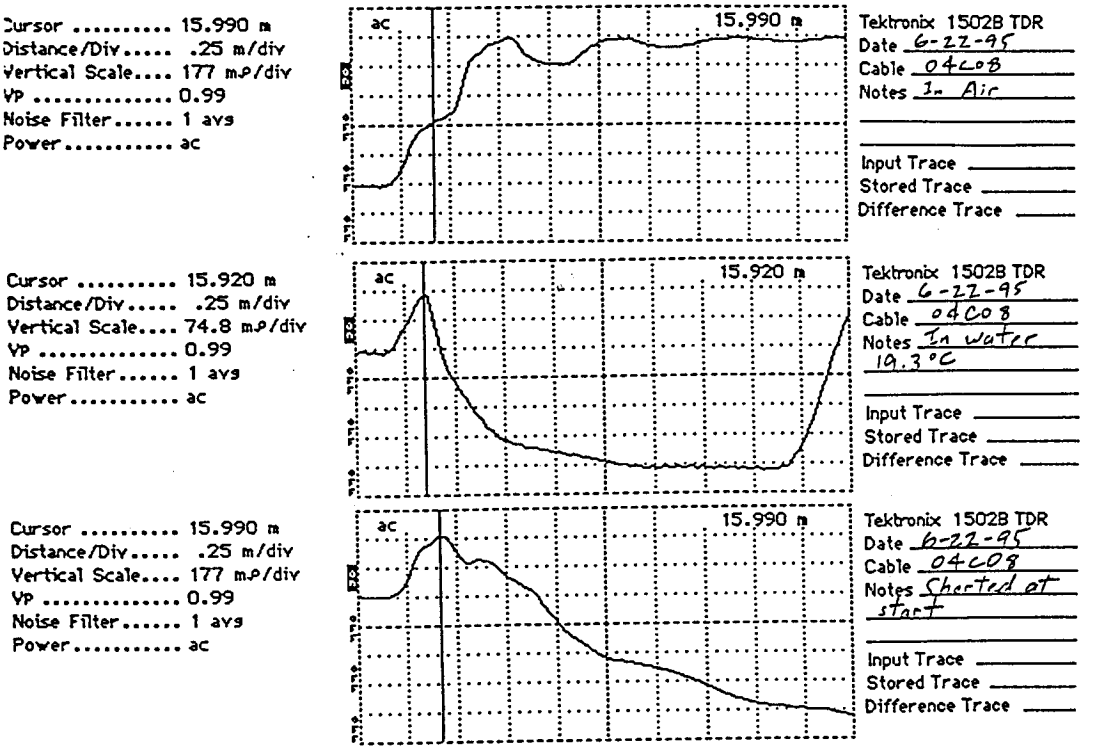


Figure B8. TDR traces obtained for sensor 04C08 during calibration.

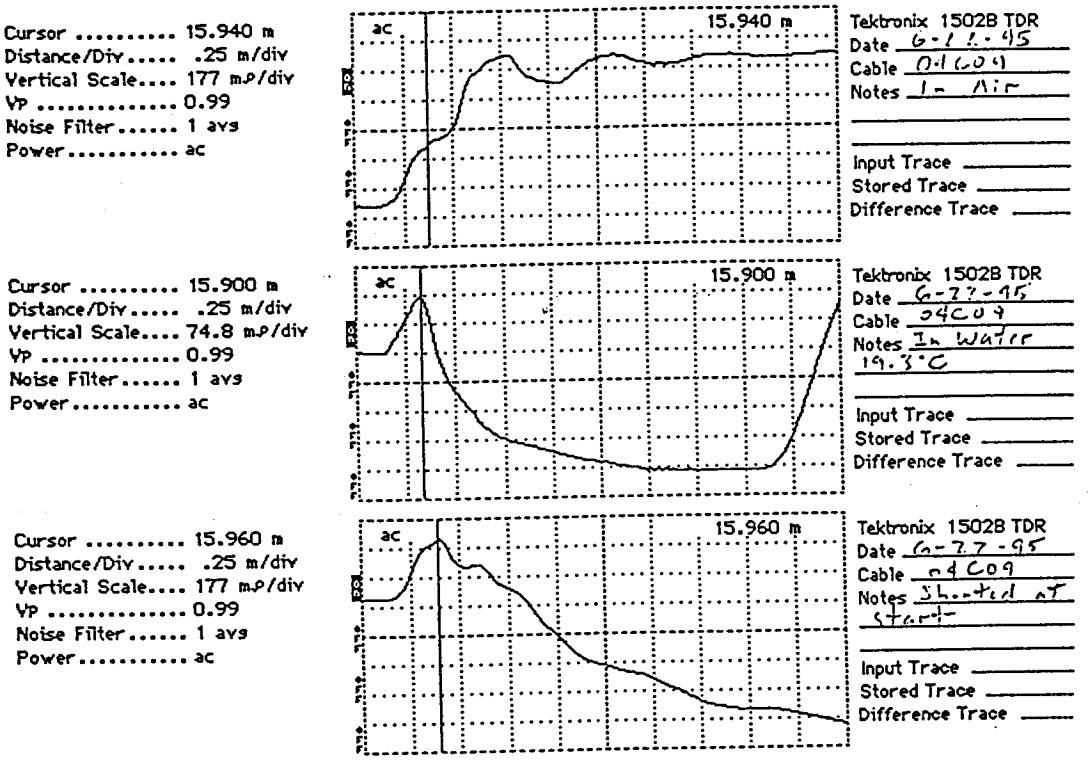


Figure B9. TDR traces obtained for sensor 04C09 during calibration.

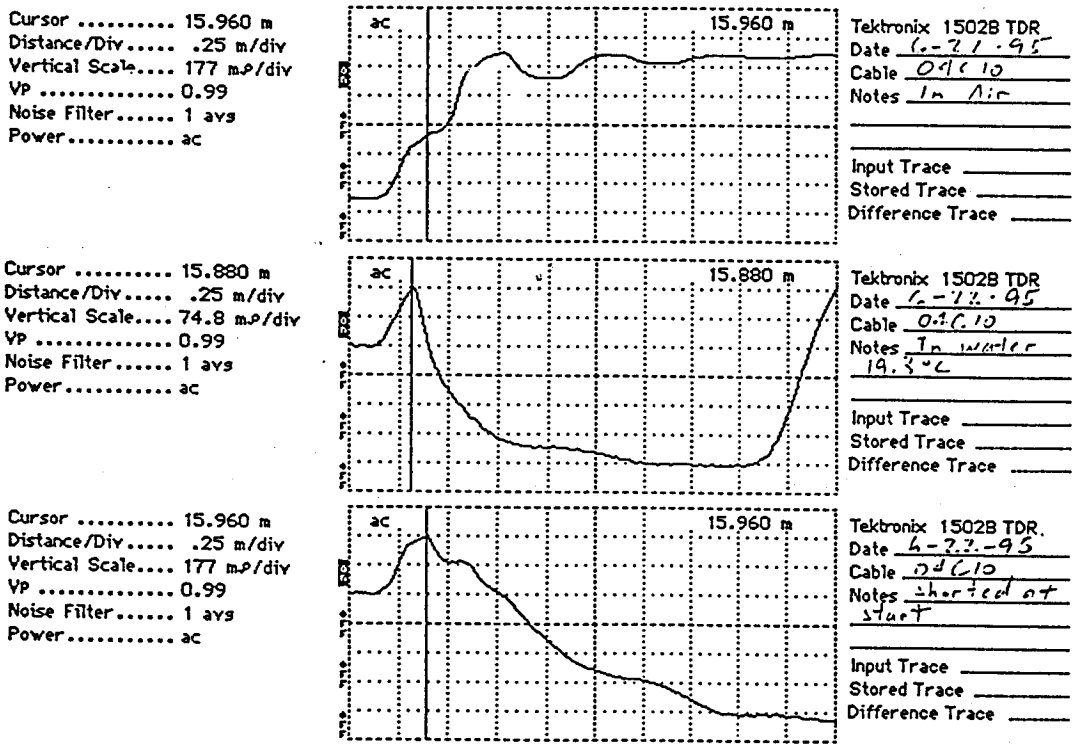


Figure B10. TDR traces obtained for sensor 04C010 during calibration.

APPENDIX C

Installation Information

Appendix C has the following supporting information:

Figure C1. Location of instrumentation within the section.
Figure C2. TDR traces measured during instrument installation.
Figure C3. TDR traces measured during instrumentation installation.
Figure C4. Measured moisture contents during installation.
Table C1. Field measured moisture contents during installation.

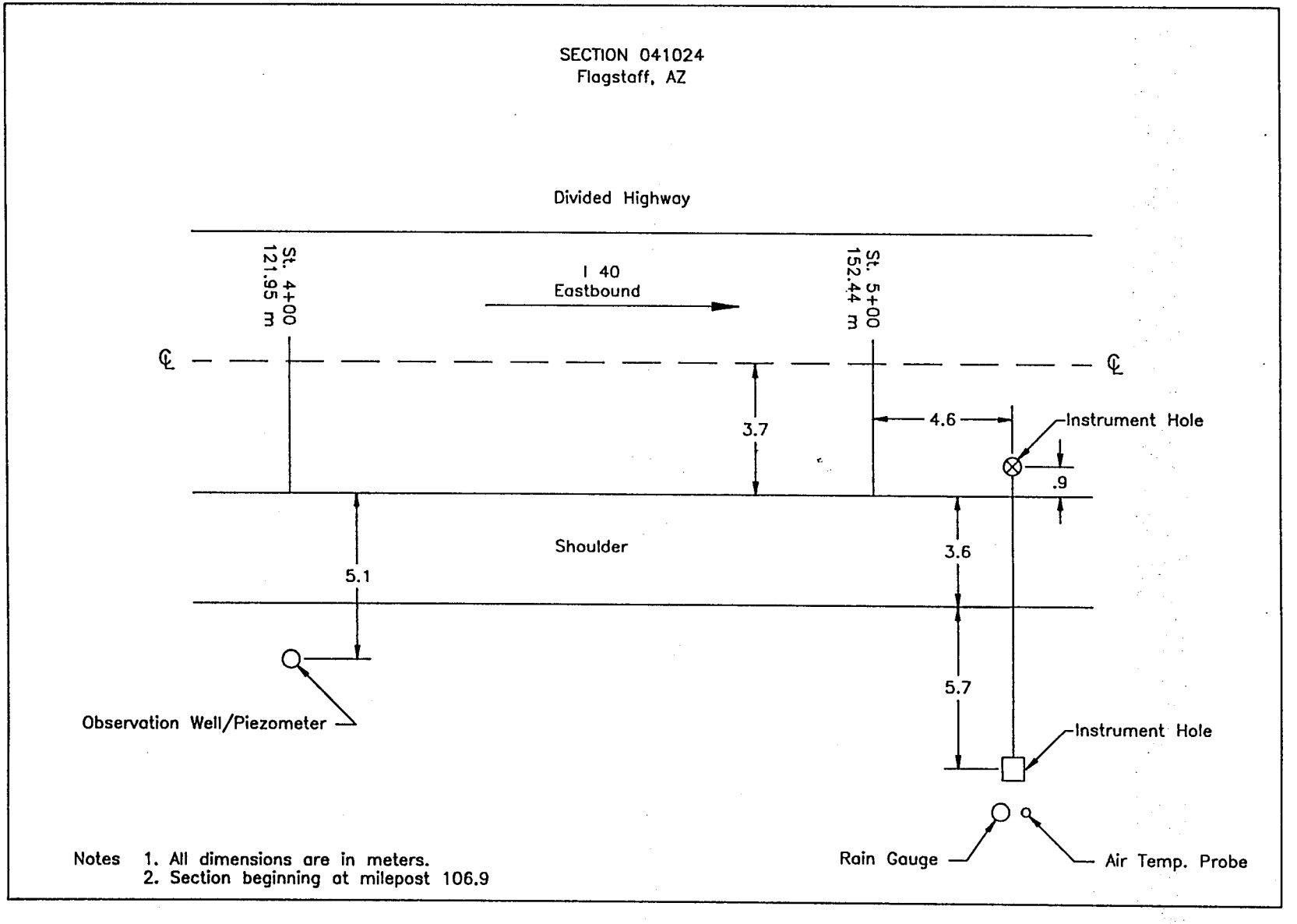


Figure C1. Location of instrumentation within the section.

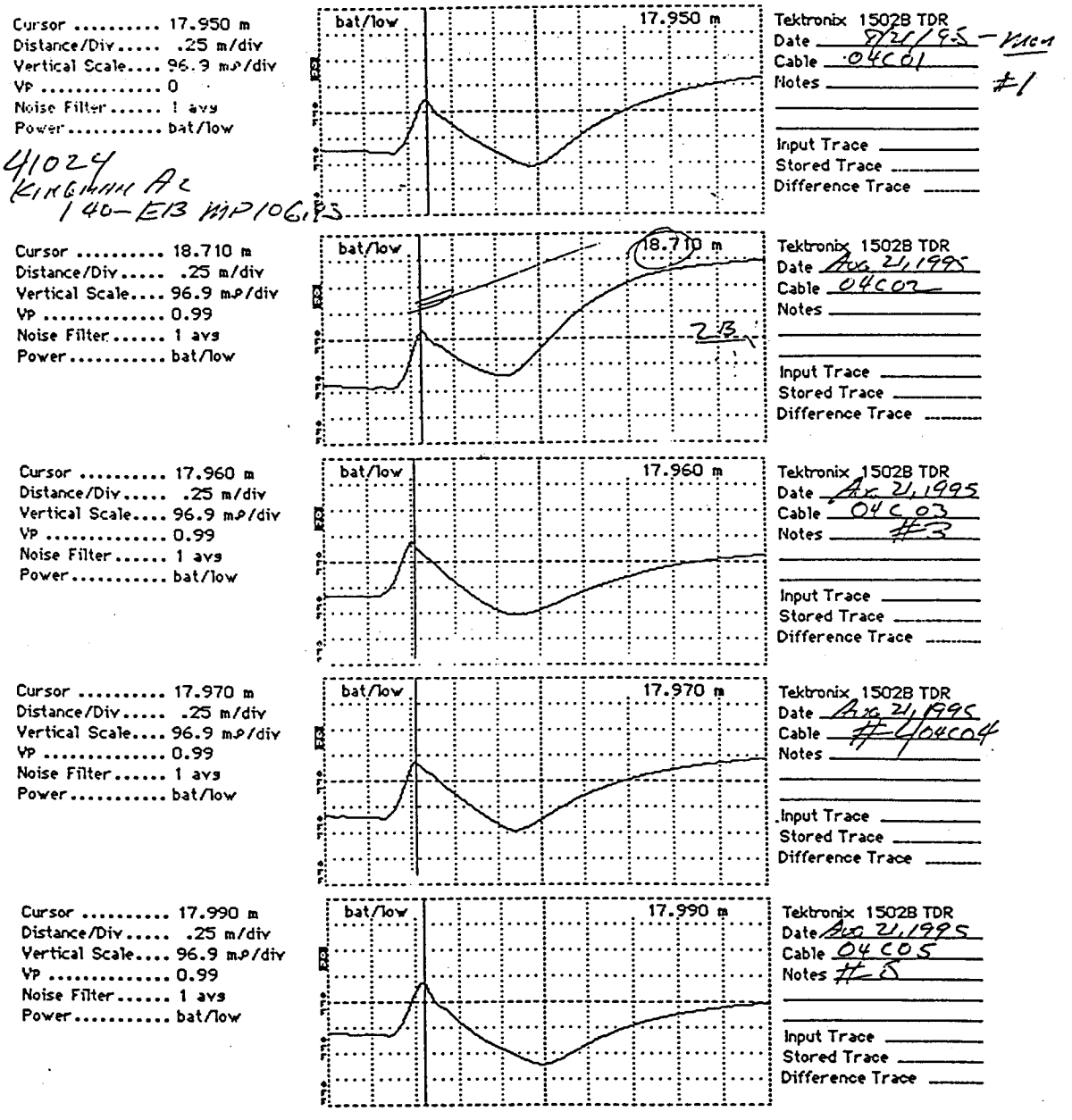


Figure C2. TDR traces measured during instrument installation.

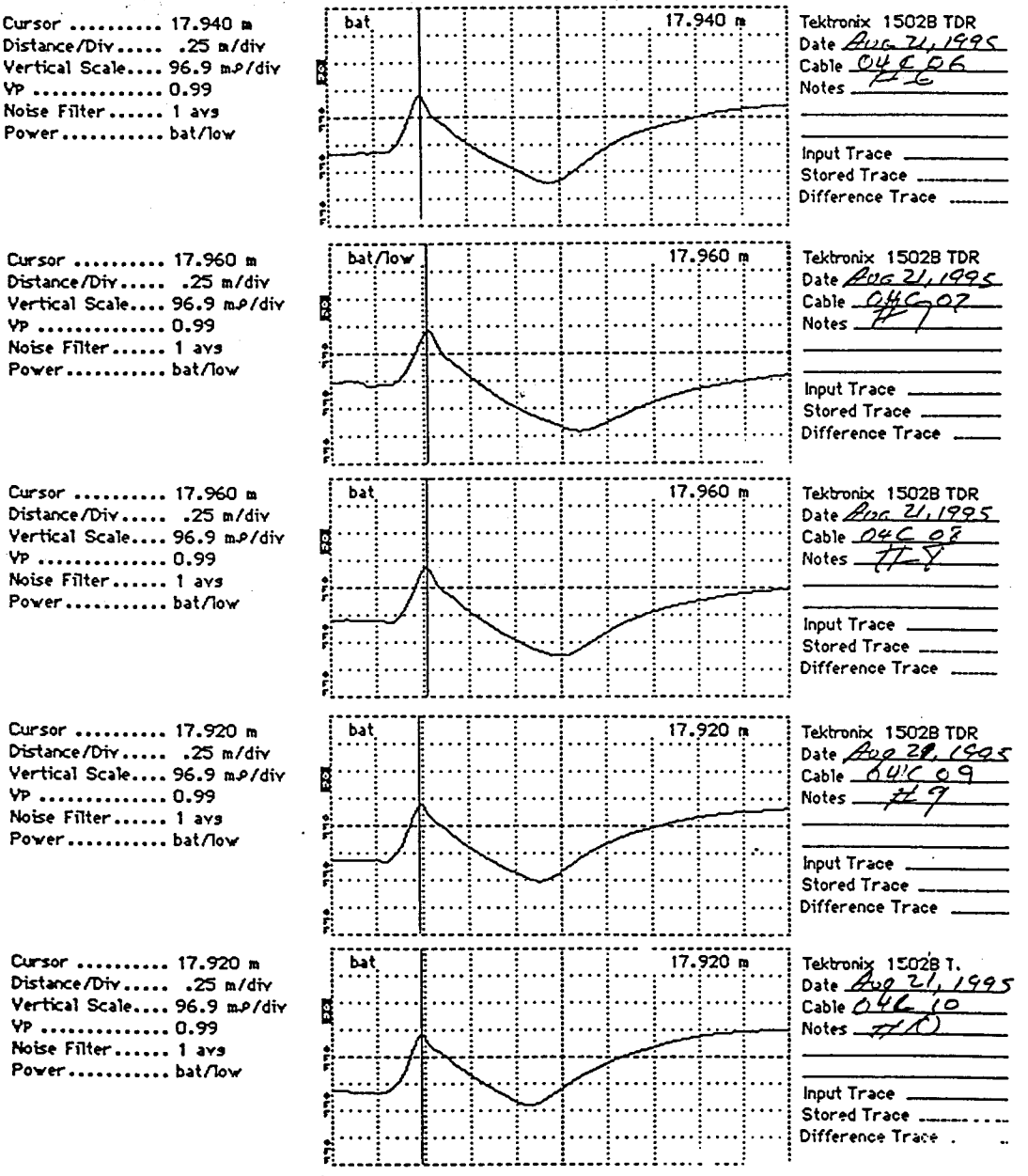


Figure C3. TDR traces measured during instrumentation installation.

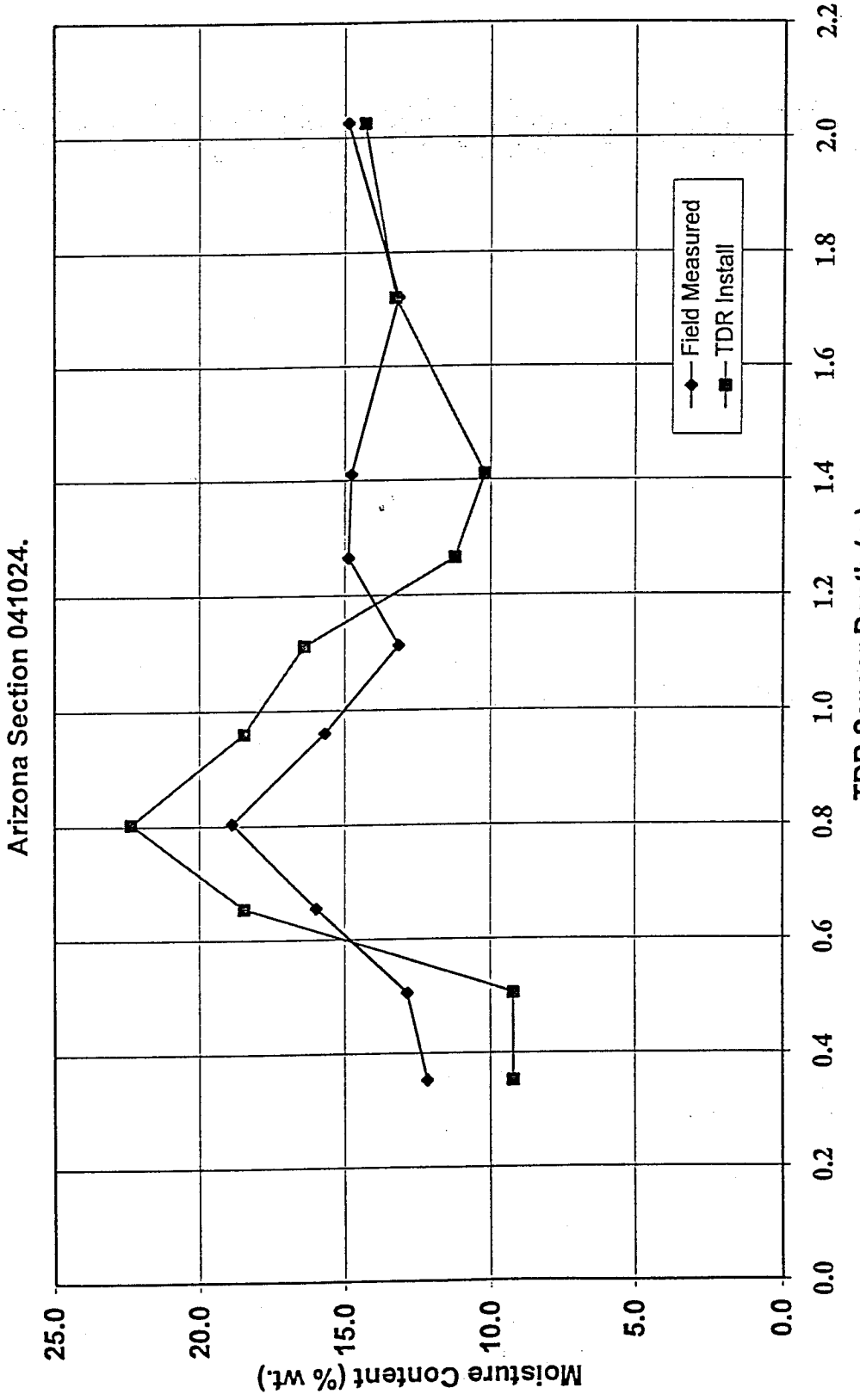


Figure C4. Measured moisture contents during installation.

Table C1. Field measured moisture contents during installation.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	* State Code [04] * Test Section Number [1024]

Personnel : Coby Rowe
Date : 8/21/95
Start Time : NA
Finish Time : NA
Surface Type : Asphalt Concrete
Weather Conditions : Cloudy & Rainy
Unusual Conditions : None

TDR Sensor Number	Field Measured Moisture Content %
10	9.5
9	15.5
8	12.8
7	16.7
6	10.6
5	13.4
4	6.4
3	7.7
2	10.1
1	8.5

APPENDIX D

Initial Data Collection

Appendix D includes the following supporting information:

Figure D1. Average hourly air and pavement temperature at top five sensors during initial data collection.
Table D1. Onsite data collected during initial data collection.

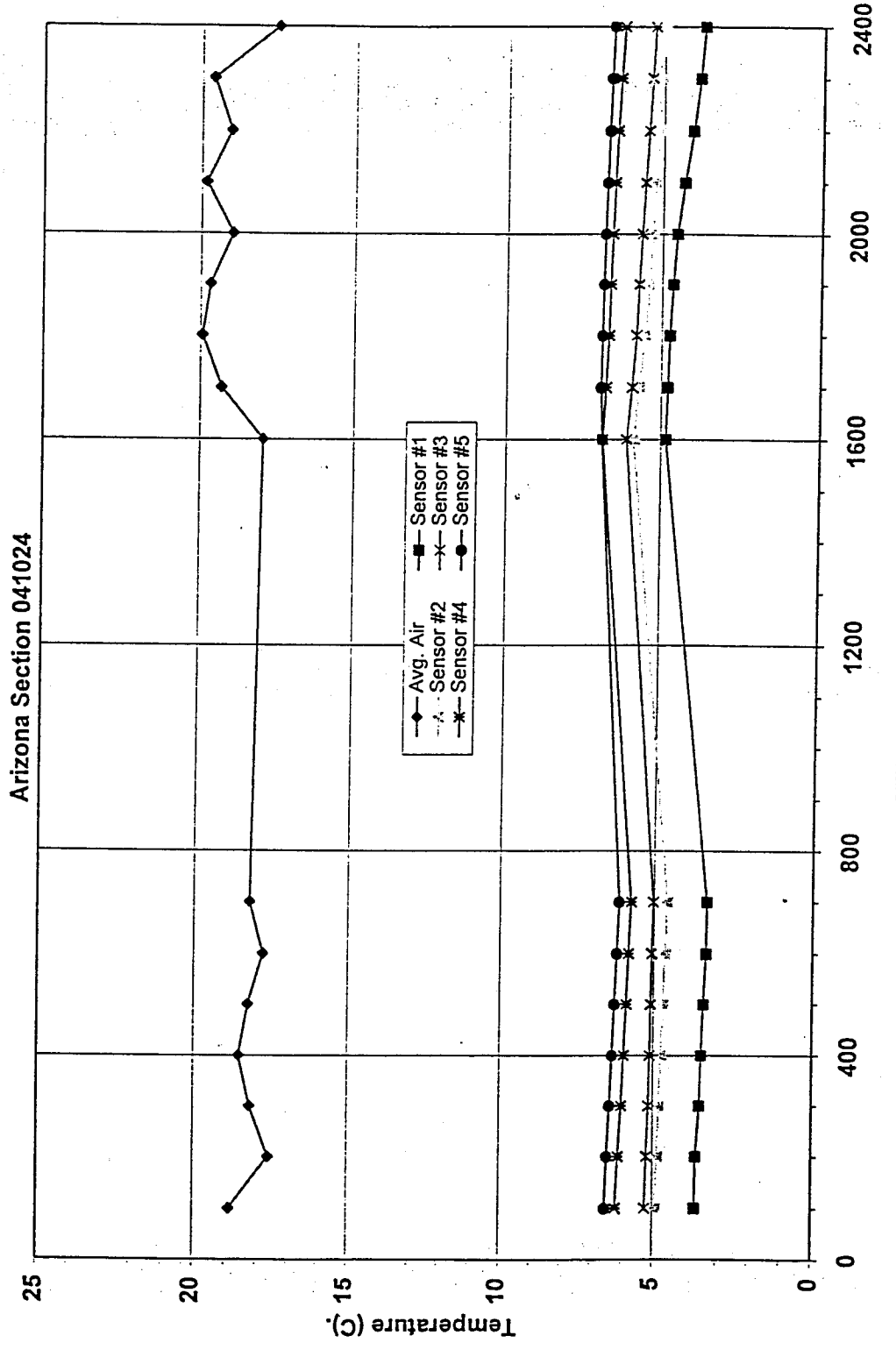


Figure D1. Average hourly air and pavement temperature at top five sensors during initial data collection.

Table D1. Onsite data collection during initial data collection.

Arizona Section 041024, Onsite Data.

5	1995	233	1600	12.27	17.99	1.5																			
6	1995	233	1600	4.843	5.874	6.101	6.855	6.873																	
5	1995	233	1700	12.27	19.33	0																			
6	1995	233	1700	4.797	5.722	5.944	6.761	6.922																	
5	1995	233	1800	12.26	19.94	0																			
6	1995	233	1800	4.755	5.529	5.821	6.683	6.891																	
5	1995	233	1900	12.26	19.7	0																			
6	1995	233	1900	4.656	5.407	5.747	6.645	6.855																	
5	1995	233	2000	12.26	19	0																			
6	1995	233	2000	4.552	5.311	5.668	6.59	6.827																	
5	1995	233	2100	12.26	19.85	0																			
6	1995	233	2100	4.34	5.233	5.586	6.534	6.778																	
5	1995	233	2200	12.26	19.07	0																			
6	1995	233	2200	4.084	5.14	5.484	6.466	6.727																	
5	1995	233	2300	12.25	19.63	0																			
6	1995	233	2300	3.874	5.071	5.389	6.379	6.67																	
1	1995	233	2400	12.26	12.27	1609	12.25	2353	19.21	20.17	1731	16.53	2345	1.5	4067										
2	1995	233	2400	4.37	5.323	5.637	6.556	6.788	6.821	7.08	7.3	7.36	12.42	12.67	13.21	13.38	13.21	12.83	8.11	7.9	7.7				
3	1995	233	2400	5	1541	5.914	1542	6.292	1542	6.883	1547	6.981	1543	7.07	1541	7.42	1541	7.88	1541	8.04	1542	13.1	1542	13.28	1541
4	1995	233	2400	3.682	2353	4.957	2354	5.123	2355	6.251	2358	5.466	1544	6.487	2335	6.912	2357	7.08	2353	6.952	2351	11.96	2353	12.23	2344
5	1995	233	2400	12.25	17.58	0																			
6	1995	233	2400	3.744	4.986	5.301	6.291	6.606																	
5	1995	234	100	12.25	18.86	0																			
6	1995	234	100	3.677	4.923	5.252	6.198	6.536																	
5	1995	234	200	12.25	17.61	0																			
6	1995	234	200	3.656	4.864	5.207	6.122	6.473																	
5	1995	234	300	12.25	18.21	0																			
6	1995	234	300	3.545	4.821	5.154	6.032	6.4																	
5	1995	234	400	12.24	18.57	0																			
6	1995	234	400	3.503	4.753	5.117	5.955	6.325																	
5	1995	234	500	12.24	18.28	0																			
6	1995	234	500	3.439	4.699	5.094	5.887	6.261																	
5	1995	234	600	12.24	17.81	0																			
6	1995	234	600	3.356	4.646	5.077	5.828	6.192																	
5	1995	234	700	12.24	18.24	0																			
6	1995	234	700	3.346	4.581	5.036	5.754	6.134																	