U.S. Department of Transportation
Federal Highway Administration

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 533813
Camas, Washington

Report No. FHWA-53-3813 May 1997

Notice

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 533813, Camas, Washington

Report No. FHWA-53-3813

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May 1997

Technical Report Documentation Page

1. Report No. FHWA-53-3813	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle LTPP Seasonal Monitoring Program Site Installation and Initial Data Collection Section 533813, Camas, Washington.		5. Report Date November 1996. 6. Performing Organization Code
7. Author(s) Srikanth S. Holikatti, Sirous H. Alavi, Douglas J. Frith, Mark A. Potter		8. Performing organization Report No.
9. Performing Agency Name and Address **Nichols Consulting Engineers, Chtd.** 1885 S. Arlington Avenue, Suite 111 Reno, Nevada 89503		10. Work Unit No. (TRAIS) N/A 11. Contract or Grant No. DTFH61-96-C-00010
12. Sponsoring Agency Name and Address Federal Highway Administration LTPP-Division, HNR-40 Turner Fairbanks Highway Research Center 6300 Georgetown Pike McLean, Virginia 22101		13. Type of Report and Period Covered. Final Report, July 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 533813 which is a part of the LTPP Core Seasonal Monitoring Program. This is a Jointed Portland Cement Concrete (JPCP) surfaced pavement test section, located on southbound outside lane of State Route 14, near Camas, Washington. The section was instrumented on July 17, 1995. The instruments installed included TDR probes for moisture content, thermistor probes for pavement and subsurface temperature, steel snap rings for joint opening measurements, tipping bucket rain gauge for precipitation, piezometer to monitor ground water table, and a CR10 datalogger. Initial data was collected on July 18, 1995. This included FWD and precipitation data, elevation , air and subsurface temperature, TDR measurements, joint opening and faulting measurements. This report also contains a description of site location, characteristics of installed equipment, 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 WASHINGTON SECTION 533813

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 533813 near Camas, Washington which is a part of the Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Seasonal Monitoring Program (SMP). The equipment installation activities were carried out on July 17, 1995 and initial data was collected on July 18, 1995.

Section Location

Section 533813 is a General Pavement Studies (GPS) section selected for SMP. This section is located on the outside lane of westbound State Highway Route 14, a multi-lane highway facility in the State of Washington. The closest city to the section is Camas, Washington. The beginning of the section is at milepost 11.03, 1.08 miles west of the off-ramp to northwest 6th Avenue and 0.61 miles west of the junction with Alpine Road . This is a GPS-3, "General Pavement Study of Jointed Plain Concrete Pavements"(JPCP) section meeting the requirements of SMP seasonal cell #18. Figure A1 in appendix A contains a map showing the location of the section.

Section Details

The pavement section consists of 203mm of JPCP with 38mm aggregate base and 975mm of soil aggregate mixture subbase over silty sand subgrade. The test section has a 3.70m traffic lane with 3.20m wide asphalt shoulder. Additional details are summarized in table 1.

Table 1. Details of section 533813 in Washington.

Functional Classification of Roadway	Rural State Highway
Number of Lanes/Direction	Two
Pavement Type	Jointed Plan Concrete
Estimated Annual ESAL Applications on the Test Lane	163.5 KESALs
Climatic Classification	Wet, No-Freeze, SMP Cell #18
Dowels	None

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

Table 2. Material properties.

Description	Surface Layer	Base Layer	Subbase	Subgrade
Material	PCC	AB	SAM	Silty Sand
Thickness (mm)	203	38*	975*	----
Proctor Dry Density (kg/m^3)	----	----	----	1490**
Proctor Moisture Content (%)	----	----	----	13**
Lab Max Dry Density (kg/m^3)	----	2337@8%MC	1885@14%MC	1821@16%MC
Field Measured Density	N/A	N/A	N/A	N/A
Liquid Limit	----	NP	26	NP
Plastic Limit	----	NP	18	NP
Plastic Index	----	NP	8	NP
Percent passing #200	----	15	57.9	31.0

NP Non Plastic
MC Moisture Content
* Layer thickness from the coring/drilling records closest to the installation.
** Proctor density and moisture content as on the day of instrument installation.
PCC Portland Cement Concrete
AB Aggregate Base
SAM Soil Aggregate Mixture

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

Freezing Index	:	49	No. of Days Below 0° C	:	36
Precipitation	:	1041 mm	No. of Wet Days	:	186
No. of Days Above 32° C	:	9	No. of Freeze/Thaw Cycles	:	40

Installation of instrumentation was carried out on July 17, 1995 and initial data collection was performed on July 18, 1995. Instrument installation was a cooperative effort between Washington State Department of Transportation (WSDOT) and Nichols Consulting Engineers (NCE) LTPP Western Region Coordination Office staff. The following personnel participated in the installation:

Douglas J. Frith	:	NCE	Haiping Zhou	:	NCE
Mark A. Potter	:	NCE	Philip Friedman	:	NCE
Michael Esposito	:	NCE	Don Evans	:	WSDOT
Marvin Vowels	:	WSDOT	Tom Howell	:	WSDOT
Gloria Souvinir	:	WSDOT	Cleo Andrews	:	WSDOT Coring Crew
Bob Grandoff	:	WSDOT	Gary Allison	:	WSDOT Coring Crew

INSTRUMENT INSTALLATION

Meeting With Highway Agency

A planning meeting between NCE and WSDOT was held in Vancouver, Washington on June 27, 1995 to discuss SMP instrumentation, required equipment, the installation schedule, and installation team responsibilities. The site was also inspected by Douglas Frith and Haiping Zhou on this date. WSDOT provided traffic control, equipment, and personnel to achieve pavement sawing, instrument and piezometer hole auguring and also to carry out post installation patching and repair of instrumentation hole. NCE staff performed all the SMP equipment installation.

SMP Equipment Installation and Location Within the Section

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 not installed at this site as the section was in the "No Freeze" region. Instruments installed at the site were:

Table 3. Equipment installed.

Equipment	Quantity	Serial No.
Instrument Hole		
MRC Thermistor Probe	1	53A#1
TDR Moisture Sensors	10	53A01-53A10
13mm diameter Internal Snap Steel Rings	36	None
Equipment Cabinet		
Campbell CR10 Datalogger	1	16585
Battery Package	1	N/A
Weather Station		
TE 525 Tipping Bucket Rain Gauge	1	12102-693
Air Temperature Probe	1	N/A
Radiation Shield	1	N/A
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 insure they were functioning properly. The rain gauge was calibrated by recording the number of tips to drain 473ml of water in at least 45 minutes. This was found to be 95 tips and 45 minutes for the first trial. The two screws at the bottom of the rain gauge were adjusted by one quarter turn. This resulted in 100 ± 3 tips to drain out 473ml of water in 45 minutes, 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 thermistors within the clear plastic tube were measured and recorded. Descriptions of MRC thermistor probe and sensors are presented in table 4. The CR10 datalogger and battery unit were 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 shortened at the beginning of the sensor and the other not shortened. 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 changed frequently.

Instrument Installation

Pavement and subsurface instrumentation was installed at 6.80m (station 0-22' 3.5") before the approach end of section, in a 0.30m diameter hole bored in the subsurface layers after sawing a 0.50m square block from the PCC layer in the outer wheelpath. The decision to install the instrumentation at the approach end of the section was made in consultation with the FHWA SMP coordinator and Technical Assistance Contractor (TAC). The following site conditions necessitated the change in location of instrumentation.

- FWDCheck results of the section indicated that the two ends of the section were not representative of the section .
- The conduit from the instrumentation hole to the equipment cabinet had to cross a 0.60m deep drainage ditch.
- Steep ground beyond the ditch made locating the equipment cabinet quite difficult.

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	Installed in PCC
	2	0.152	
	3	0.305	
2	4	0.023	Installed in Subbase
	5	0.105	
	6	0.176	
	7	0.254	
	8	0.327	
	9	0.483	
	10	0.634	
	11	0.788	
	12	0.944	
	13	1.093	Installed in Subgrade
	14	1.243	
	15	1.396	
	16	1.550	
	17	1.701	
	18	1.851	

The equipment installation generally followed the schedule given below.

0745	:	Depart from Camas.
0800	:	Arrive at site, start unpacking equipment in preparation for installation.
0830	:	Traffic control in place, instrumentation hole and piezometer located and marked, drill piezometer,
0900-1000	:	FWD testing of instrumentation hole, saw cutting of thermistor unit 1 slot, conduit trench, and instrument hole.
0845- 1030	:	Installation of piezometer, drill weather station pole hole, place pole and concrete the base.
0930-1000	:	Install equipment cabinet.
1030-1130	:	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.

The pavement temperature sensors (thermistor, unit #1) were installed in the PCC layer as per LTPP guidelines. TDR moisture probes and subsurface temperature sensors (thermistor, unit #2) were installed in the instrumentation hole which was bored using a 252mm diameter solid stem auger. The instrumentation hole was 2.11m deep. Figure C1 in appendix C presents the site layout and instrument location within the section. TDR probes were placed in an offset fan pattern such that the lead wires were on the hole side closest to the pavement edge. Each TDR probe lead wires had the "S" shaped stress relief loop made in them. TDR and thermistor probe lead wires were bundled and put through a 51mm diameter flexible electrical conduit buried in a 76mm wide trench, leading to the equipment cabinet. The equipment cabinet was located 6.10m away from the lane edge on a steep hillside. Each TDR probe was connected to the function generator and continuously monitored during back filling and compaction of instrumentation hole to ensure that the probe or the wiring was not damaged. Moisture samples were collected at each TDR probe location. A representative Proctor sample was taken at a depth of 1.68m from pavement surface. The installed depths of 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 1.68m from pavement surface. The TDR traces generated during installation are presented in figure C2 and C3 in appendix C. These traces were later used to determine insitu moisture content at each TDR probe depth. From the individual trace, apparent trace length was determined and used in the moisture content determination equations provided in the FHWA LTPP SMP Guidelines, April 1994. Comparison of moisture contents determined from TDR traces obtained during installation with field measured moisture contents are presented in table 6 and figure C4 in appendix C. Table 7 presents the installed depths of thermistor sensors.

It was observed that the field measured moisture contents were close to TDR measured moisture contents in most cases. Some variation in moisture contents at some sensor depths can be attributed to soil type and the field moisture determination method.

Table 5. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
53A01	0.357	Subbase
53A02	0.505	
53A03	0.660	
53A04	0.810	
53A05	0.962	
53A06	1.116	Subgrade
53A07	1.255	
53A08	1.415	
53A09	1.721	
53A10	2.020	

[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.

Table 6. Measured moisture contents during installation and initial data collection.

TDR Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by Wt)	
			Field Manual[1]	TDR Install[2]
53A01	0.357	Subbase	12.2	9.2
53A02	0.505		12.9	9.2
53A02	0.660		16.0	18.5
53A04	0.810		18.9	22.4
53A05	0.962		15.7	18.5
53A06	1.116	Subgrade	13.2	16.4
53A07	1.255		14.9	11.2
53A08	1.415		14.8	10.2
53A09	1.721		13.2	13.3
53A10	2.020		14.9	14.3

[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.

Table 7. Installed locations of MRC thermistor sensors.

Unit No.	Channel No.	Depth from Pavement Surface (m)	Remarks
1	1	0.013	Installed in PCC
	2	0.092	
	3	0.172	
2	4	0.282	Installed in Subbase
	5	0.364	
	6	0.435	
	7	0.513	
	8	0.586	
	9	0.742	
	10	0.893	
	11	1.047	
	12	1.203	
	13	1.352	Installed in Subgrade
	14	1.502	
	15	1.655	
	16	1.809	
	17	1.960	
	18	2.110	

A 152 mm diameter stem auger was used to bore the observation piezometer/benchmark at a distance of 30.49m (section station 1+00) from the beginning of section, 4.50m 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 "ON SITE" 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. A set of steel snap rings were installed on either side of the joints to measure joint opening movements in accordance with SMP Guidelines, April 1994.

Site Repair

The instrumentation hole and the conduit trench were patched and repaired by WSDOT personnel with quick setting readymix concrete. Care was exercised to prevent damage to all of the installed equipment and wires leading to the equipment cabinet. Subsequent tests confirmed that all installed equipment were functioning properly. The repair patch placed over the instrumentation hole did not perform well, cracks developed in the patch were sealed with silicone sealant. The patch was replaced on June 25, 1996.

INITIAL DATA COLLECTION

The second day (July 18, 1995) was spent collecting initial data, checking the functionality of installed equipment, elevation surveys of the section, examination of the overnight data collected by the onsite datalogger, and TDR and thermistor data collection using the mobile data acquisition system.

Air temperature, rainfall data, pavement and subsurface temperature monitored and stored by the onsite datalogger were examined. The equipment and datalogger were functioning correctly. The battery voltage was checked and found acceptable. Onsite raw data collected is presented in Table D1 in appendix D. Figures D1 through D10 present the TDR traces recorded by the mobile data acquisition system. Figure D11 shows the average hourly air and subsurface temperature profile for the top five sensors.

Post installation deflection testing of section, a set of elevation surveys, a set of joint opening, and a set of joint faulting measurements were carried out following the LTPP guidelines. The elevation of observation well top was assumed 1.0 meter. The elevation survey results are presented in table D1 in appendix D, the joint opening and joint faulting measurement data sheets are also enclosed in appendix D.

SUMMARY

This report describes the SMP equipment installation activities on section 533813 located in the State of Washington. The section is located on westbound outside lane of State Highway 14 near the City of Camas. The beginning of the section is 1.08 miles west of the off-ramp to northwest 6th Avenue and 0.61 miles west of the junction with Alpine Road. This is a GPS-3 section in "Wet, No Freeze" climatic zone meeting the requirements of SMP seasonal cell #18.

A planning meeting with WSDOT representatives was held at Vancouver on June 27, 1995 to discuss SMP equipment installation and work responsibilities. The section was also inspected to asses the field conditions at the site on this day by Douglas Frith and Haiping Zhou. Accordingly, successful installation of SMP equipment and initial data collection was carried out on July 17 and 18, respectively, in accordance with the LTPP SMP 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
- Pavement depth-moisture profile
- Ground water measurements
- Pavement joint movements

The equipment installation hole was located at the approach end of the section, the equipment cabinet was located 6.1m away from the lane edge on steeply sloping ground. The decision to install the equipment at the approach end of the section was made in consultation with the LTPP Technical Assistance Contractor (TAC) due to the following reasons:

- The leave end of the section was not representative of the section.
- The instrumentation cables had to cross a 0.60m deep drainage ditch.
- Steep sloping ground beyond the shoulder at the leave end made placement of equipment cabinet difficult.

A resistivity probe was not installed at this site as the site is in "Wet, No-Freeze" climatic zone. All equipment were installed in accordance with LTPP SMP guidelines, April 1994. Post installation deflection testing was also carried out. Post installation checks indicated proper functioning of all installed equipment.

APPENDIX A

Test Section Background Information

Appendix A includes the following supporting information:

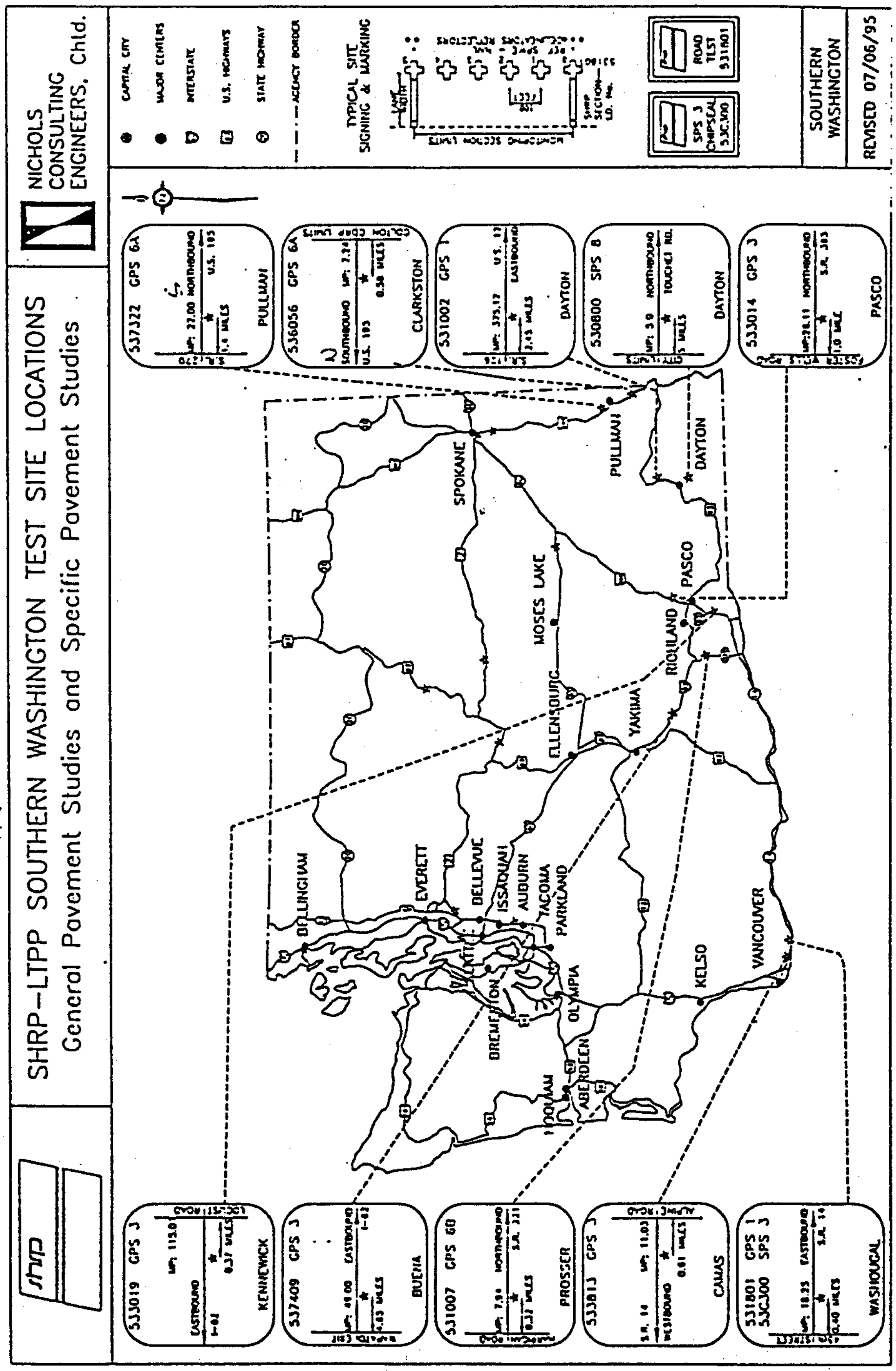


Figure A1. Site location map.

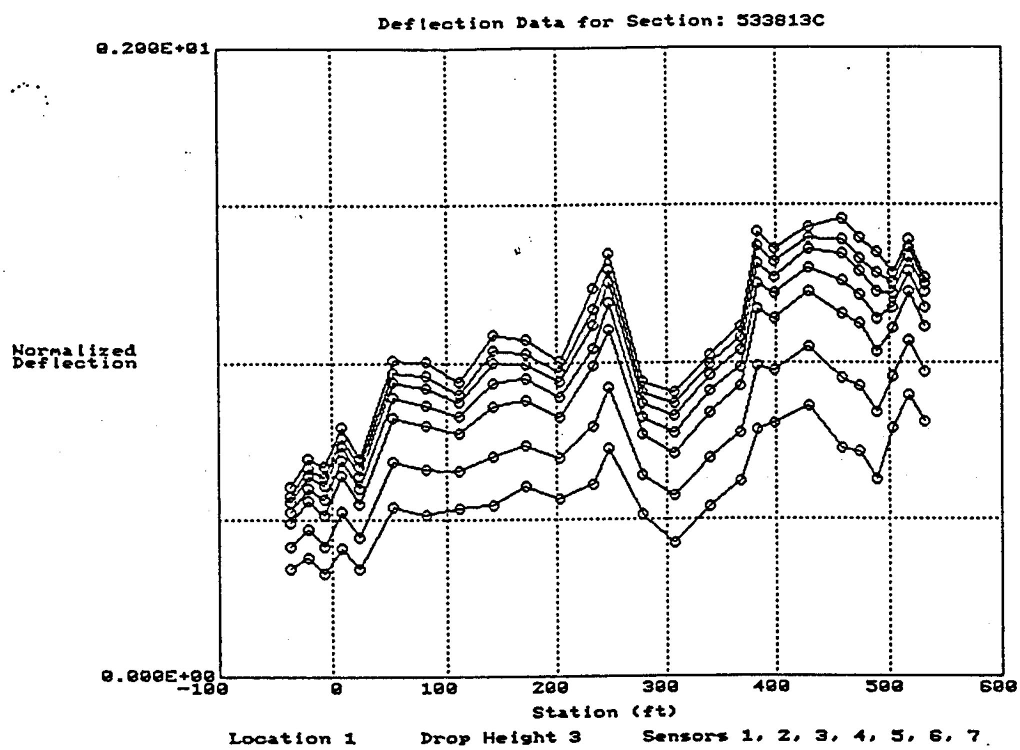


Figure A2. Normalized deflection profile from FWDCheck.

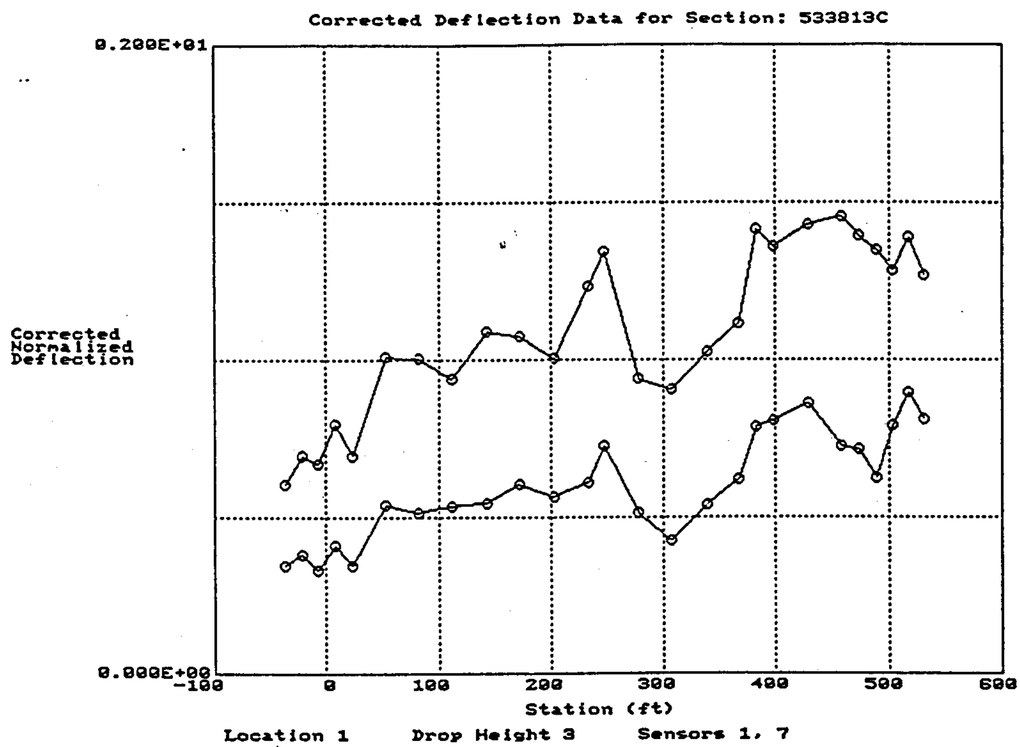


Figure A3. Corrected normalized deflection profile from FWDCheck.

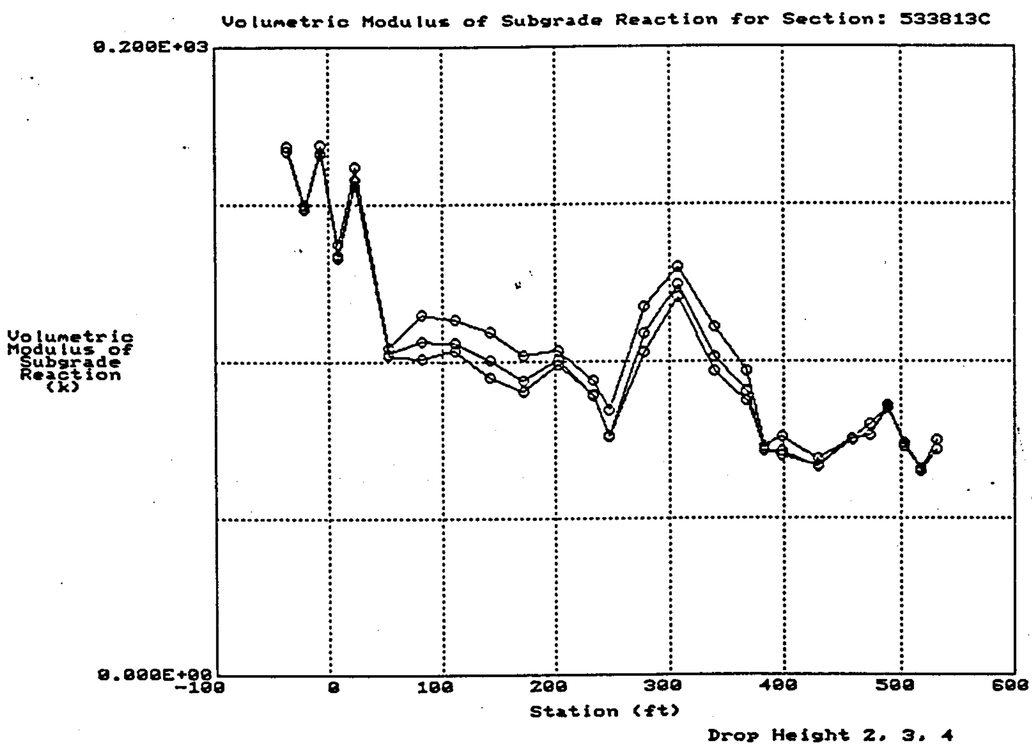


Figure A4. Volumetric modulus of subgrade reaction from FWDCheck.

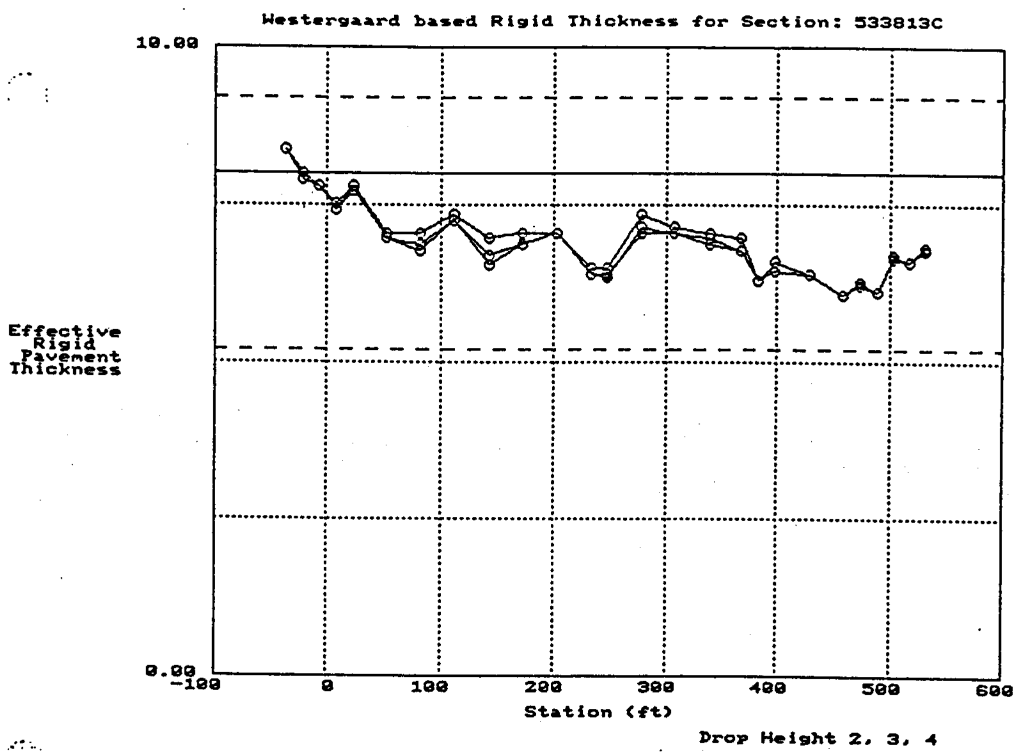


Figure A5. Westergaard based rigid thickness from FWDCheck.

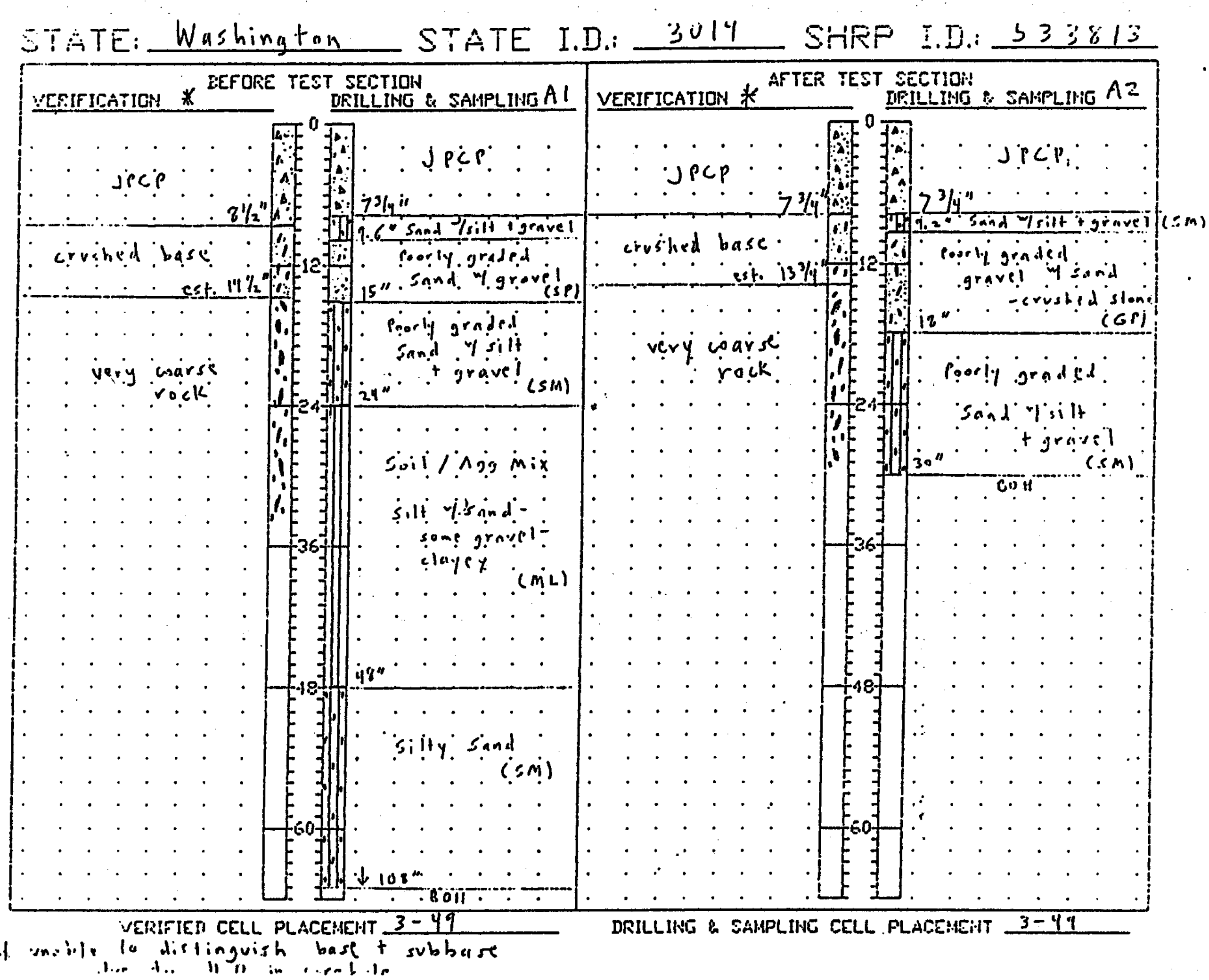


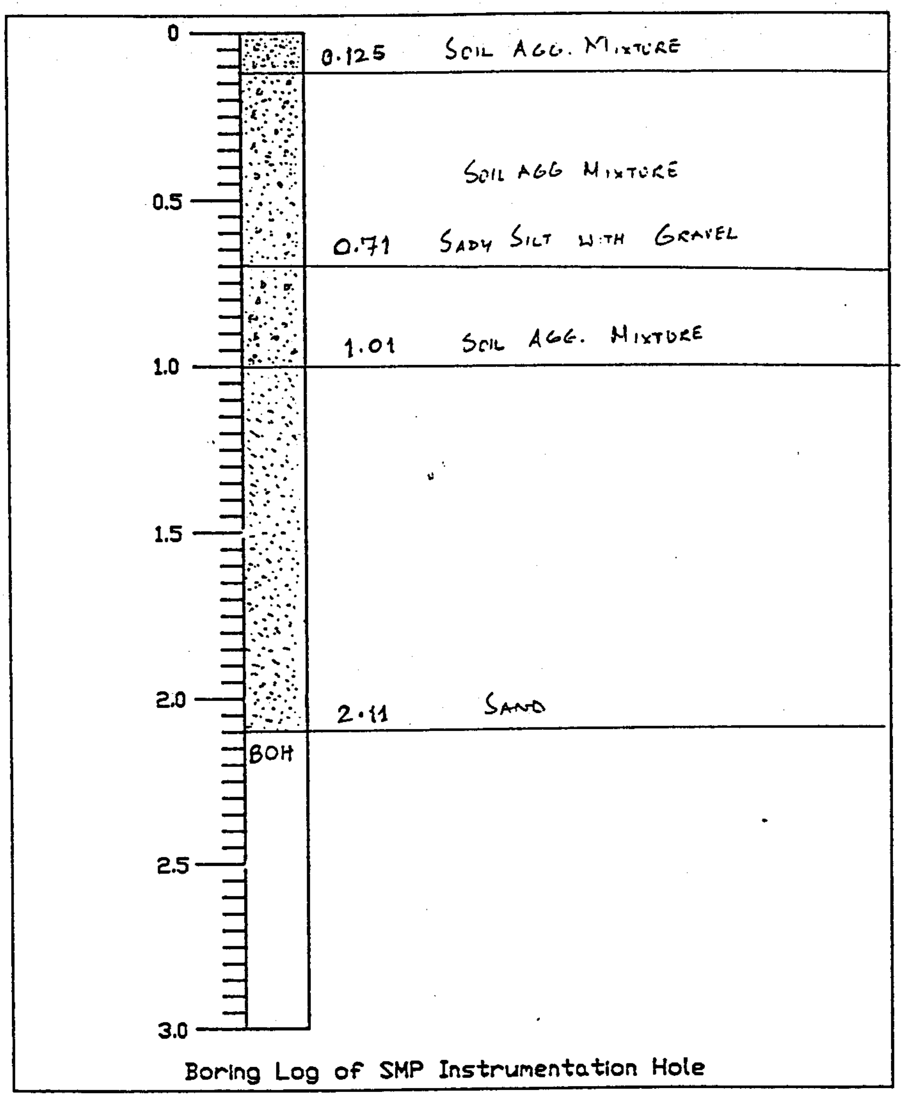
Figure A6. Profile of test section.

State ID. 53

SHRP ID. 3813

Station -6.80m (0-22'3')

Date(dd/mm/yy) 17/07/96



Start Time —

End Time —

Prepared By HAIPING ZHOU

Employed By NCE

Figure A7. Boring log of instrumentation hole.

Revised May 29, 1992

SHEET 4

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ____

STATE CODE 53

SHRP SECTION ID 3813

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/18/95

SURVEYORS: MAE, ___, ___
PAVEMENT SURFACE TEMP - BEFORE 36.6 °C; AFTER 36.9 °C
PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) __

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	1	0	0
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	0	0	0
AREA AFFECTED (Square Meters)	.0	.0	.0
3. LONGITUDINAL CRACKING (Meters)	4.7	.0	2.3
Length Sealed (Meters)	.0	.0	.0
4. TRANSVERSE CRACKING (Number of Cracks)	1	0	2
(Meters)	.7	.0	6.6
Length Sealed (Meters)	.0	0	.0
JOINT DEFICIENCIES			
5a. TRANSVERSE JOINT SEAL DAMAGE Sealed? (Y, N)			N
If "Y" Number of Joints		0	0
5b. LONGITUDINAL JOINT SEAL DAMAGE Number of Longitudinal Joints that have been sealed (0, 1, or 2)			0
Length of Damaged Sealant (Meters)			___.__
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	.4	.0	.9
7. SPALLING OF TRANSVERSE JOINTS Number of Affected Joints	1	1	2
Length Spalled (Meters)	.1	.1	.2

ENTERED
JAN 30 1996
By RS

Revised May 29, 1992

SHEET 5

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 53

SHRP SECTION ID 3 8 1 3

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/28/13
SURVEYORS: m E _, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
8a. MAP CRACKING (Number)			0
(Square Meters)			0
8b. SCALING (Number)			0
(Square Meters)			0
9. POLISHED AGGREGATE (Square Meters)			54 7.2
10. POPOUTS (Number per Square Meter)			See 17
MISCELLANEOUS DISTRESSES			
11. BLOWUPS (Number)			0
12. FAULTING OF TRANSVERSE JOINTS AND CRACKS - REFER TO SHEET 6			
13. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 7			
14. LANE-TO-SHOULDER SEPARATION - REFER TO SHEET 7			
15. PATCH/PATCH DETERIORATION			
Flexible (Number)	0	0	0
(Square Meters)	0	0	0
Rigid (Number)	0	0	0
(Square Meters)	0	0	0
16. WATER BLEEDING AND PUMPING (Number of Occurrences)			0
Length Affected (Meters)			0

17. OTHER (Describe) 10 popout 10 Total

ENTERED JAN 30 1998 By RS

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ____

STATE CODE 53

SHRP SECTION ID 3813

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/38/13

SURVEYORS: [illegible], ___

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES (CONTINUED)

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Page 1 of 2

Point[1] Distance (Meters)	Joint or Crack (J/C)	Crack Length (Meters)	Well Sealed (Y/N)	Length of Joint Spalling, m L	M	H	Faulting[2], mm 0.3m	0.75m
3	J	3.6	N	0	0	0	2.5	2.8
4.9	J						2.2	4.3
7.6	J						2.0	2.8
14.2	J						4.1	4.5
18.7							1.8	6.7
23.3							1.5	2.5
27.2							2.5	5.8
32.5							2.3	5.3
37.0							2.4	3.8
41.7							-0.2	4.6
46.1							2.9	4.2
50.8							2.9	3.5
55.4							2.2	8.4
60.1							2.4	6.5
64.6							2.7	4.5
69.2							6.4	5.5
73.8							3.2	5.0
78.3							3.1	3.0
82.9							2.3	3.0
87.5	J	3.6				0	6.3	5.5
89.4	C	3.6	N	0	0	.5	1.4	0.2
92.1	J					0	3.6	3.8
96.7	J						2.3	2.2
98.7	C	3.6	N	0	0	0	2.6	-4.0
101.3	J						4.6	4.6
105.9	J						1.2	4.6
110.4	J	3.6	N	0	0	0	3.3	3.5

ENTERED
JAN 30 1995
By RS

Note 1. Point Distance is from the start of the test section to the measurement location.

Note 2. If the "approach" slab is higher than the "departure" slab, faulting is recorded as positive (+ or 0); if the "approach" slab is lower, record faulting as negative (-) and the minus sign must be used.

Revised April 23, 1993

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 53

SHRP SECTION ID 3813

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 07/30/93
SURVEYORS: ME, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED
PORTLAND CEMENT CONCRETE SURFACES
(CONTINUED)

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Page 2 of 2

Point[1] Distance (Meters)	Joint or Crack (J/C)	Crack Length (Meters)	Well Sealed (Y/N)	Length of Joint Spalling, m: L	M	H	Faulting[2], mm: 0.3m	0.75m
115.0	J	3.6	N	.0	.0	.0	3.9	5.8
119.5							4.3	6.5
124.2							4.6	4.8
128.8							6.3	5.6
133.4							5.2	4.7
138.0							3.0	7.5
142.6							3.0	8.3
147.2							6.5	5.9
151.6	J	3.6	N	.0	.0	.0	3.1	4.5

ENTERED
JAN 30 1996
By RS

Note 1. Point Distance is from the start of the test section to the measurement location.

Note 2. If the "approach" slab is higher than the "departure" slab, faulting is recorded as positive (+ or 0); if the "approach" slab is lower, record faulting as negative (-) and the minus sign must be used.

Revised May 29, 1992

SHEET 7

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 5 3

SHRP SECTION ID 3 8 1 3

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 7/ 3 8/ 1 3

SURVEYORS: m E _, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED
PORTLAND CEMENT CONCRETE SURFACES
(CONTINUED)

13. LANE-TO-SHOULDER DROPOFF

14. LANE-TO-SHOULDER SEPARATION

Point No.	Point[1] Distance (meters)	Lane-to-shoulder[2] Dropoff (mm)	Lane-to-shoulder Separation (mm)	Well Sealed (Y/N)
1.	0.	+18.6	_ _ _.	N
2.	15.25	+18.6	_ _ _.	
3.	30.5	+22.0	_ _ _.	
4.	45.75	+29.0	_ _ _.	
5.	61.	+21.2	_ _ _.	
6.	76.25	+27.8	_ _ _.	
7.	91.5	+29.0	_ _ _.	
8.	106.75	+24.2	_ _ _.	
9.	122.	+29.0	_ _ _.	
10.	137.25	+27.0	_ _ _.	
11.	152.5	029.0	_ _ _.	N

not a well paved shoulder
grass growing + fill with dirt

ENTERED
JAN 30 1996
By RS

Note 1. Point Distance is from the start of the test section to the measurement location. The values shown are SI equivalents of the 50 ft spacing used in previous surveys.

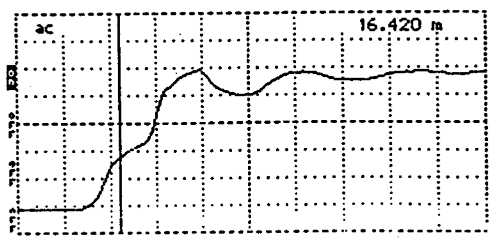
Note 2. If heave of the shoulder occurs (upward movement), record as a negative (-) value. Do not record (+) signs, positive values are assumed.

APPENDIX B

Installed Instrument Information

Appendix B Includes the following supporting information

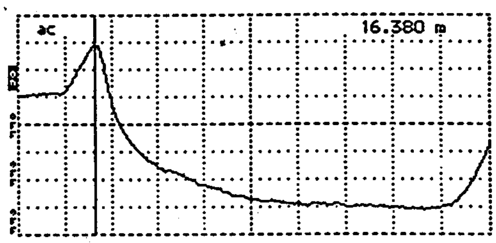
Cursor .... 16.420 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 6-15-95
Cable 53A01
Notes In Air

Input Trace
Stored Trace
Difference Trace

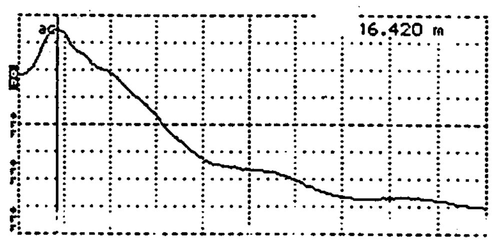
Cursor .... 16.380 m
Distance/Div..... .25 m/div
Vertical Scale.... 74.8 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 7-16-95
Cable 53A01
Notes In water 19°C

Input Trace
Stored Trace
Difference Trace

Cursor .... 16.420 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 6-15-95
Cable 53A01
Notes Shorted at start

Input Trace
Stored Trace
Difference Trace

Figure B1. TDR trace obtained for sensor 53A01 during calibration.

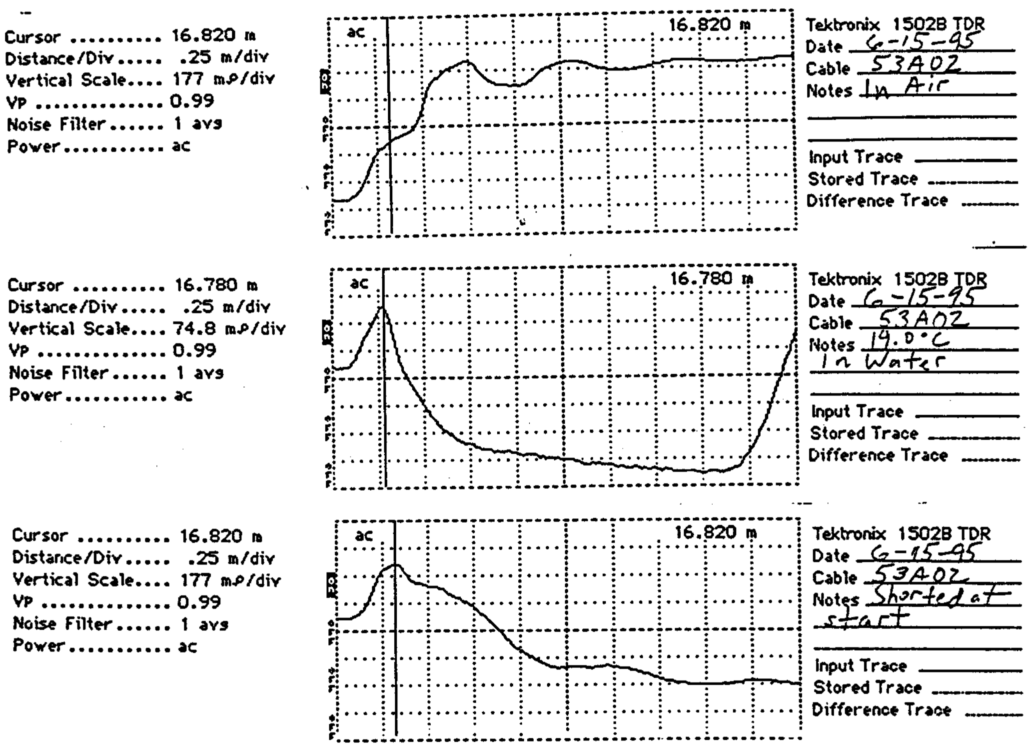


Figure B2. TDR trace obtained for sensor 53A02 during calibration.

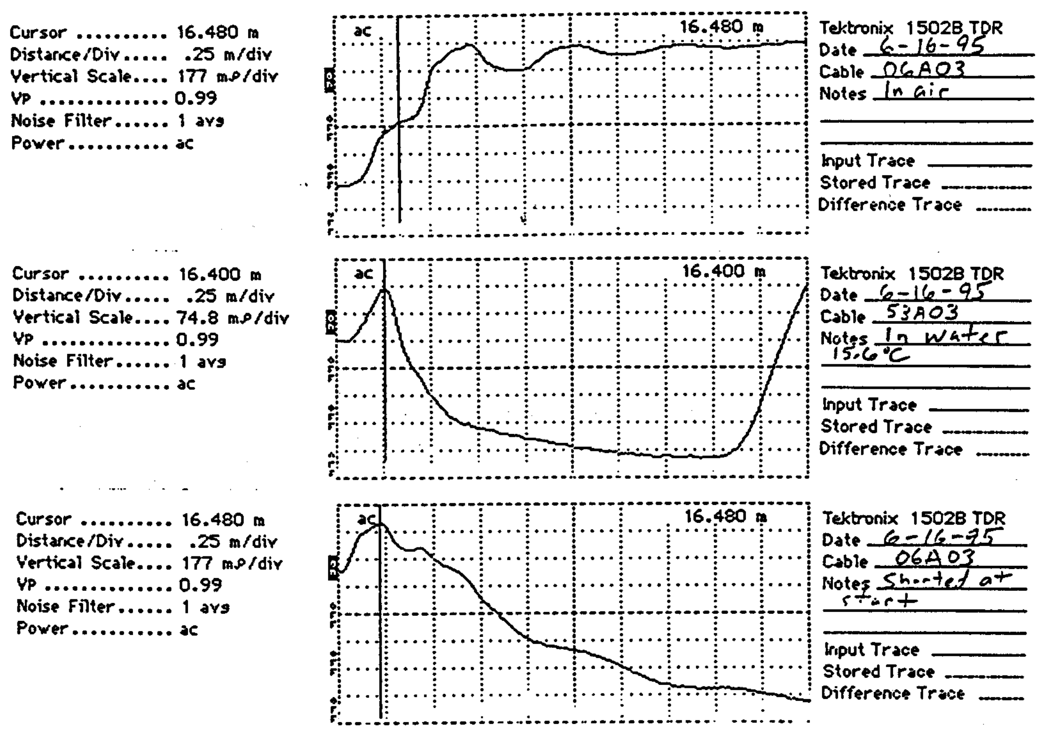


Figure B3. TDR trace obtained for sensor 53A03 during calibration.

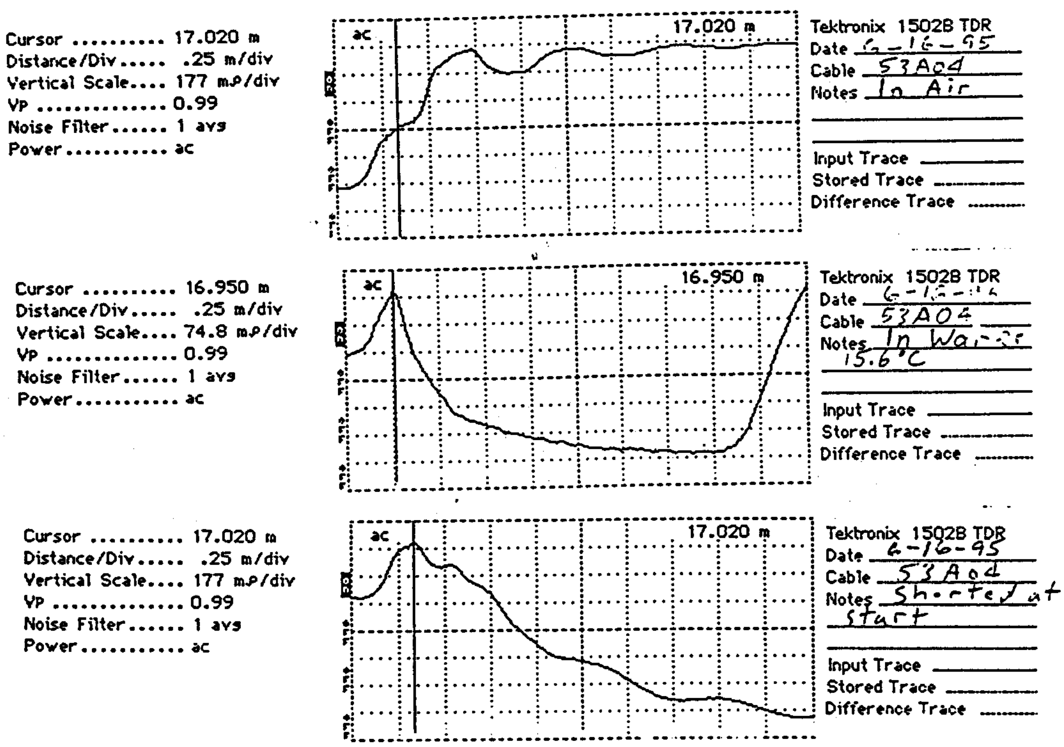


Figure B4. TDR trace obtained for sensor 53A04 during calibration.

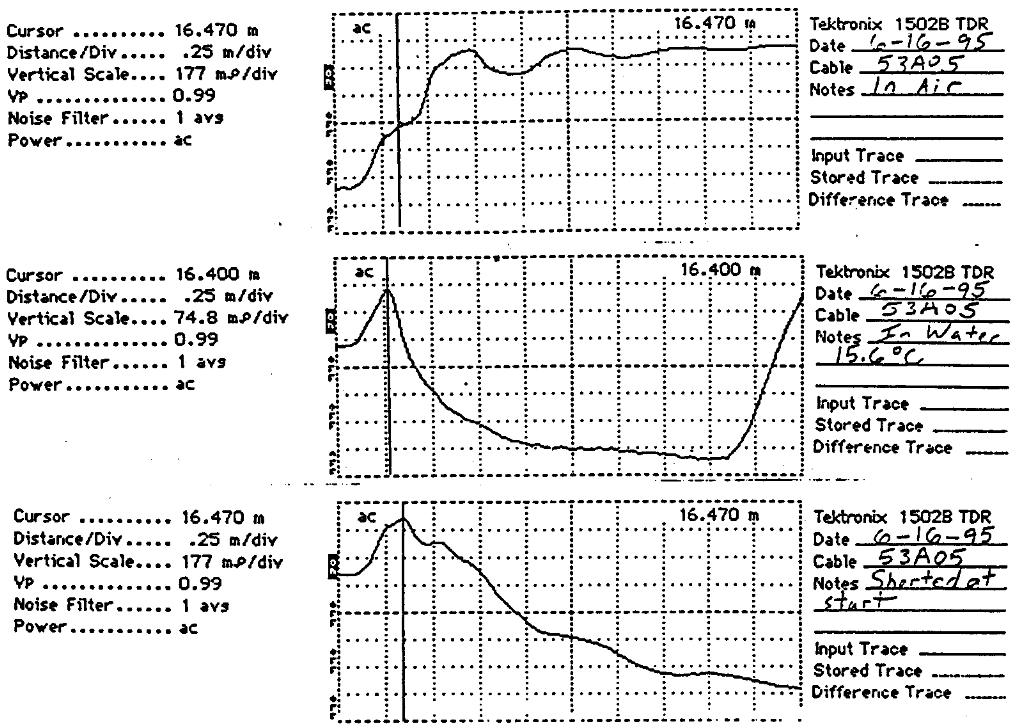


Figure B5. TDR trace obtained for sensor 53A05 during calibration.

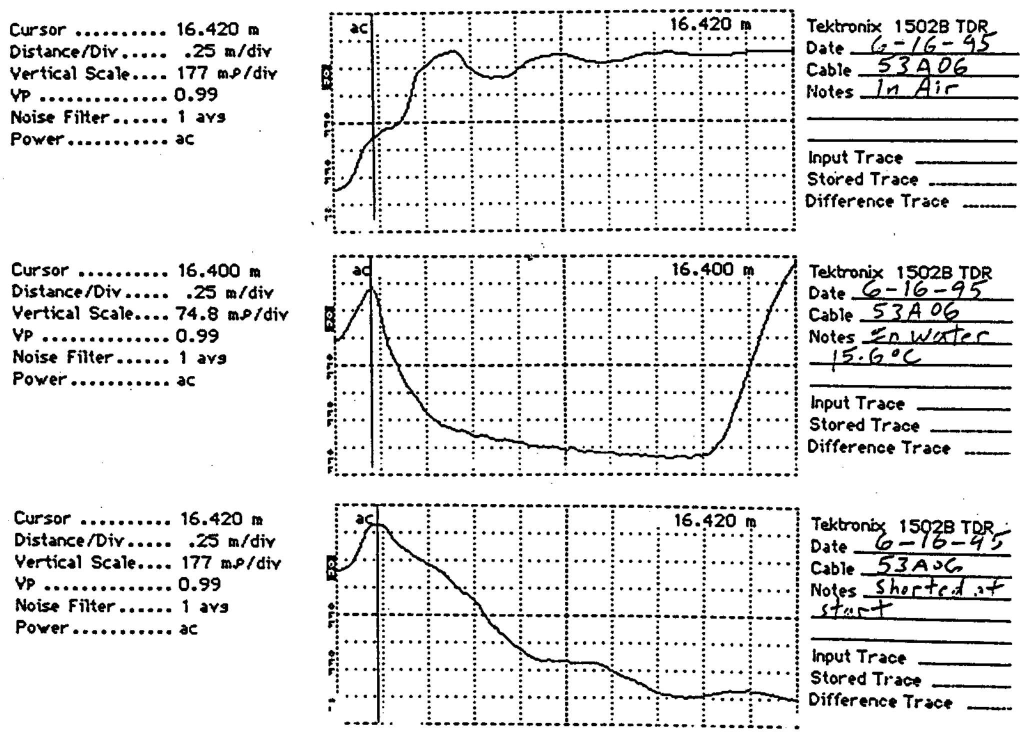


Figure B6. TDR trace obtained for sensor 53A06 during calibration.

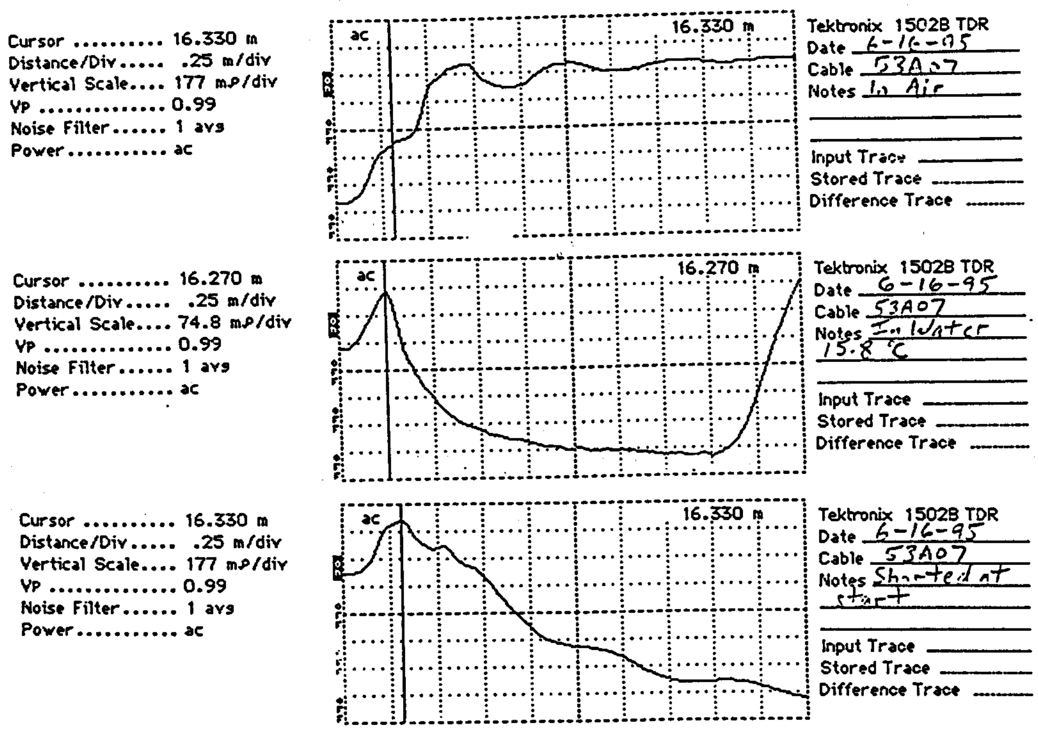


Figure B7. TDR trace obtained for sensor 53A07 during calibration.

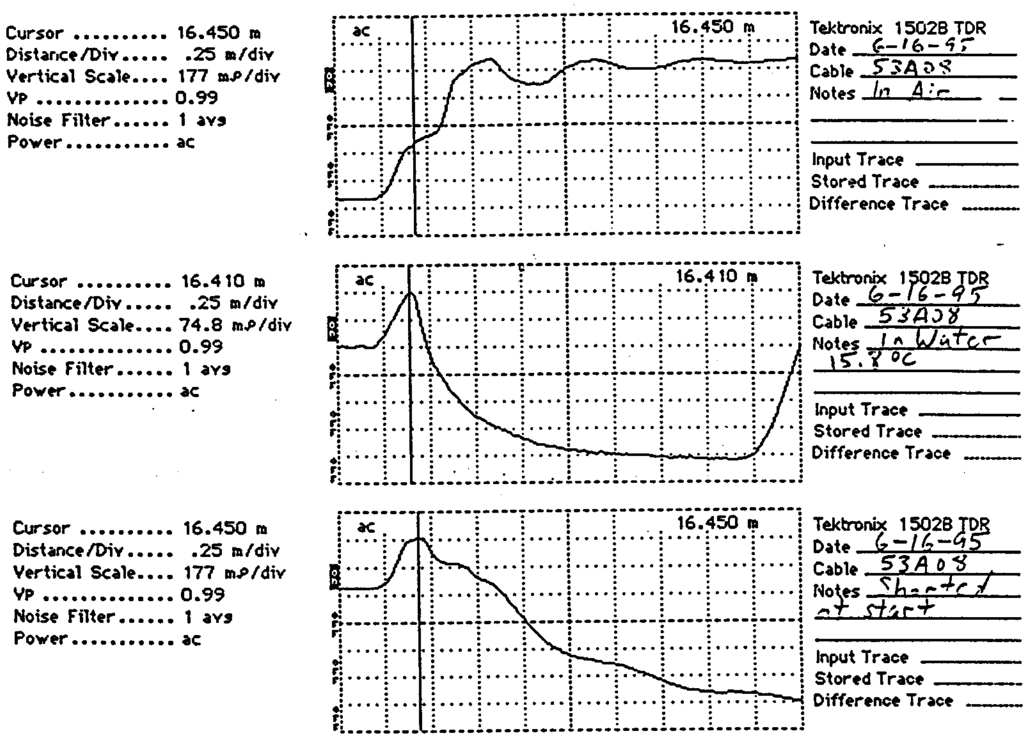


Figure B8. TDR trace obtained for sensor 53A08 during calibration.

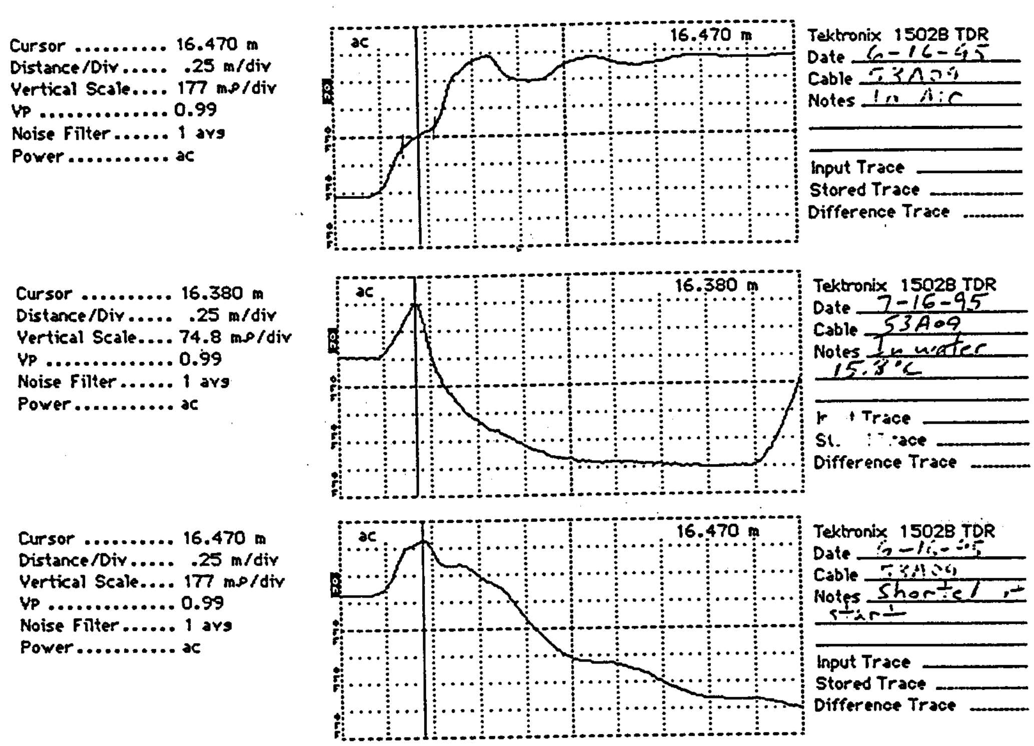


Figure B9. TDR trace obtained for sensor 53A09 during calibration.

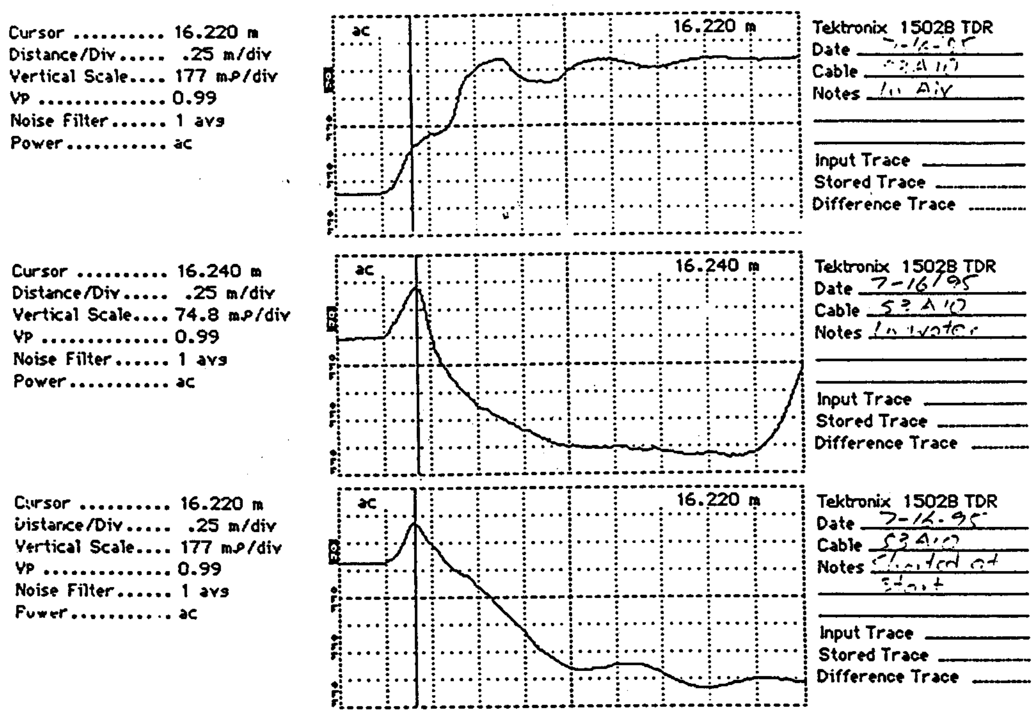


Figure B10. TDR trace obtained for sensor 53A010 during calibration.

APPENDIX C

Installed Instrument Information

Appendix C includes the following supporting information:

Table C1. Field measured moisture contents at different depths.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	* State Code [53] * Test Section Number [3813]

Personnel : Michael Esposito
Date : 7/17/95
Start Time : 1.00 PM
Finish Time : 3.45 PM
Surface Type : Portland Cement Concrete
Weather Conditions : Clear.
Unusual Conditions : None

TDR Sensor Number	Field Measured Moisture Content %
10	14.9
9	13.2
8	14.8
7	14.9
6	13.2
5	15.7
4	18.9
3	16.0
2	12.9
1	12.2

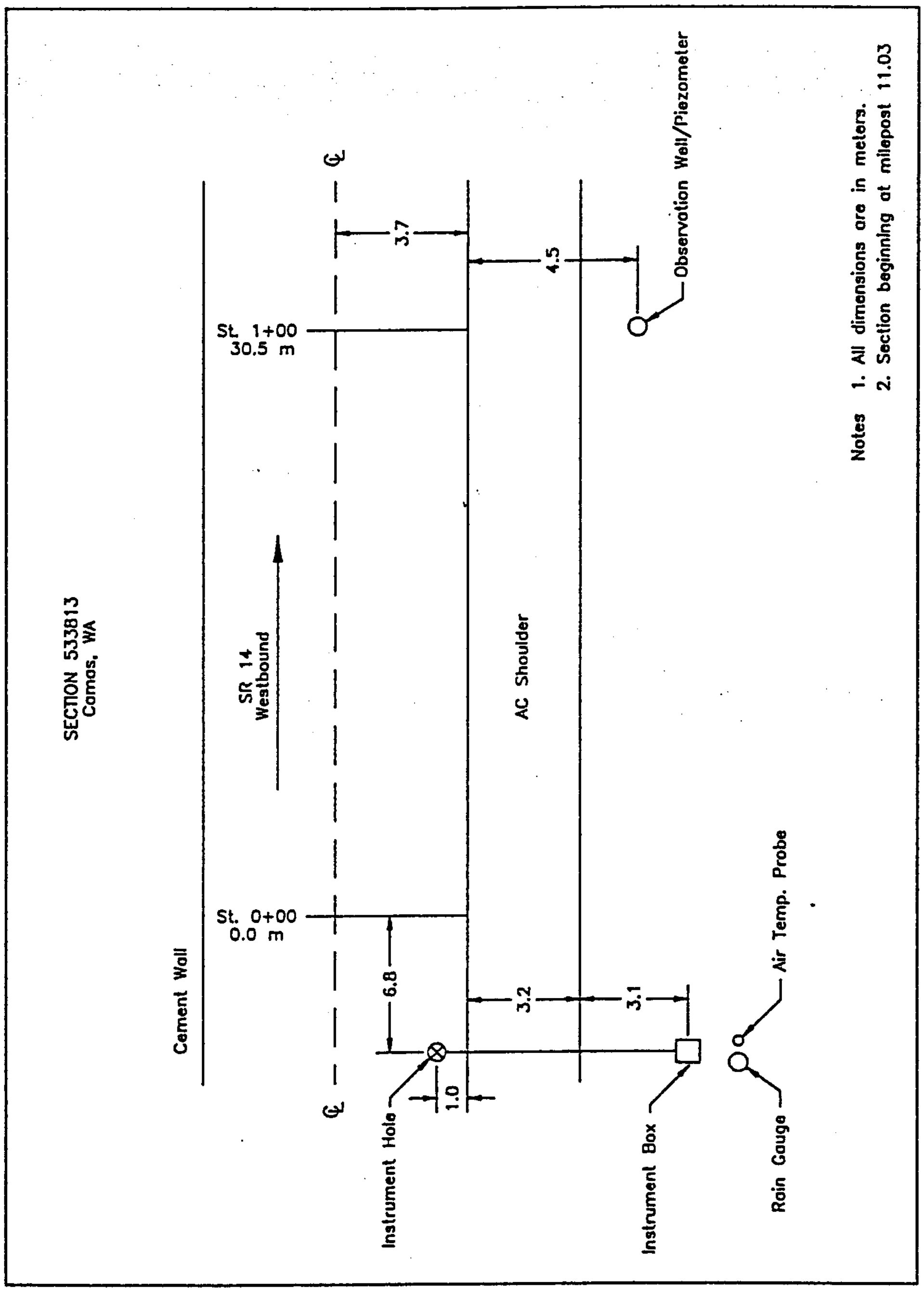


Figure C1. Location of SMP instrumentation on the site.

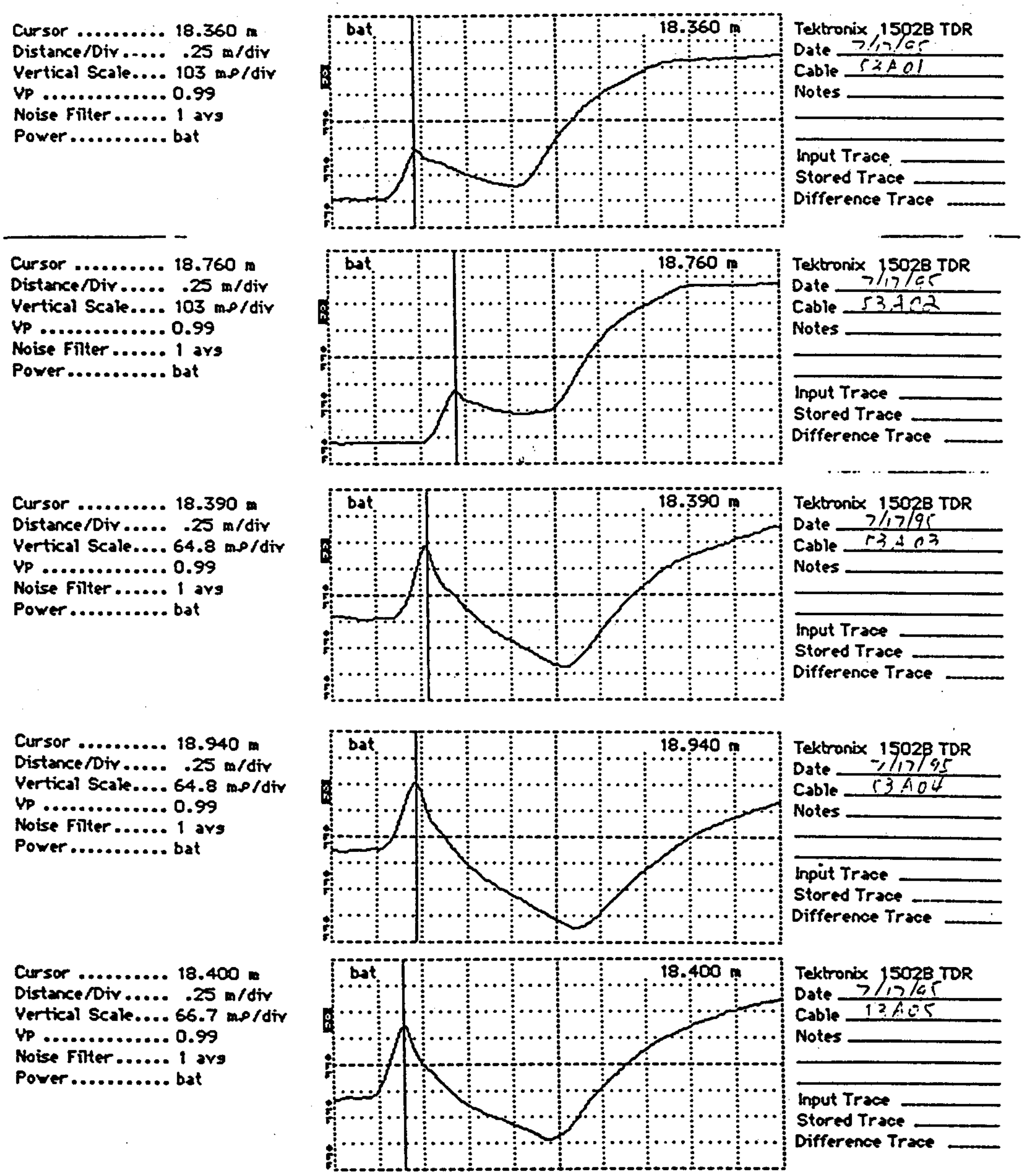


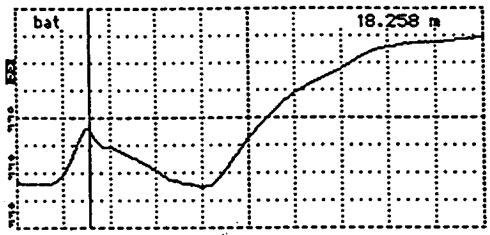
Figure C2. TDR traces obtained for sensors 53A01 through 53A05 during installation.

Cursor .... 18.388 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter...... 1 avs
Power........... bat

Tektronix 1502B TDR
Date 7/17/95
Cable 53A06
Notes

Input Trace
Stored Trace
Difference Trace

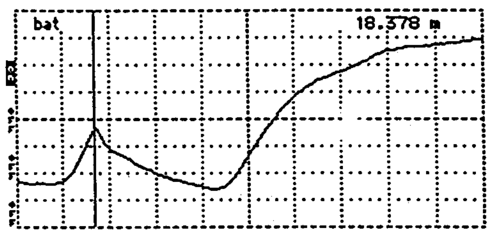
Cursor .... 18.258 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter...... 1 avs
Power........... bat



Tektronix 1502B TDR
Date 7/17/95
Cable 53A07
Notes

Input Trace
Stored Trace
Difference Trace

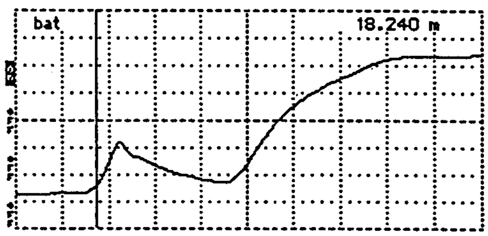
Cursor .... 18.378 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter...... 1 avs
Power........... bat



Tektronix 1502B TDR
Date 7/17/95
Cable 53A08
Notes

Input Trace
Stored Trace
Difference Trace

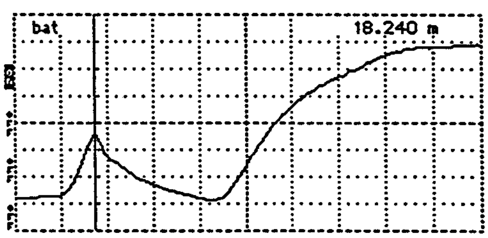
Cursor .... 18.240 m
Distance/Div..... .25 m/div
Vertical Scale.... 109 mρ/div
Vp 0.99
Noise Filter...... 1 avs
Power........... bat



Tektronix 1502B TDR
Date 7/17/95
Cable 53A09
Notes

Input Trace
Stored Trace
Difference Trace

Cursor .... 18.240 m
Distance/Div..... .25 m/div
Vertical Scale.... 83.9 mρ/div
Vp 0.99
Noise Filter...... 1 avs
Power........... bat



Tektronix 1502B TDR
Date 7/17/95
Cable 53A10
Notes

Input Trace
Stored Trace
Difference Trace

Figure C3. TDR traces obtained for sensors 53A06 through 53A10 during installation.

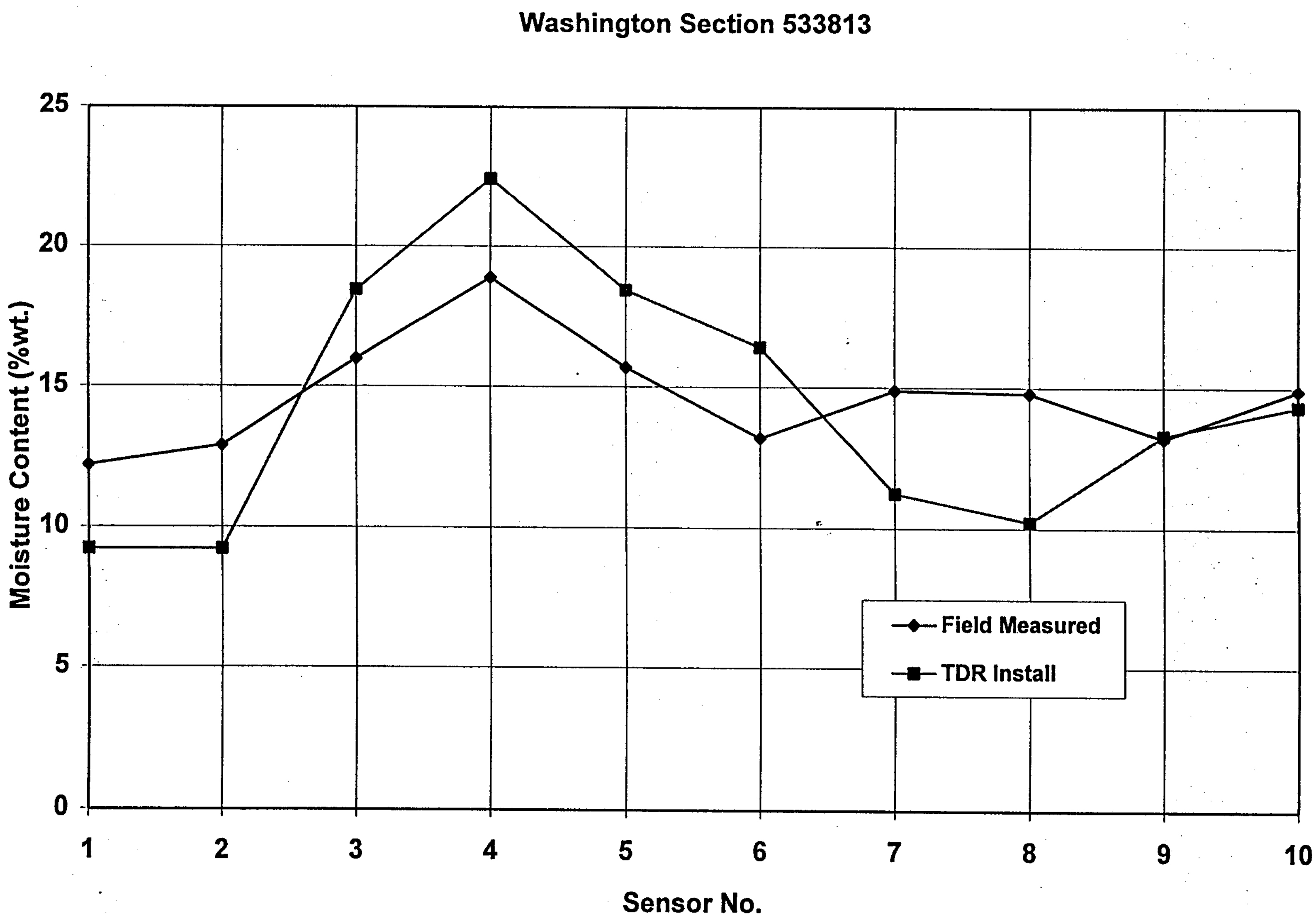


Figure C4. Moisture contents measured during installation.

Figure C5. Instrumentation hole.

Figure C6. Observation well/piezometer.

Figure C7. Initial data collection progress

APPENDIX D

Initial Data Collection

Appendix D includes the following supporting information:

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:35
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 77
Offset: 53537
Sample No: 1

A (m) = 0.99
B (m) = 1.64
Trace Length (m)=0.65
Diele. Const.= 10.4
Volumetr MC (%)= 19.7

Total 1 set(s) data

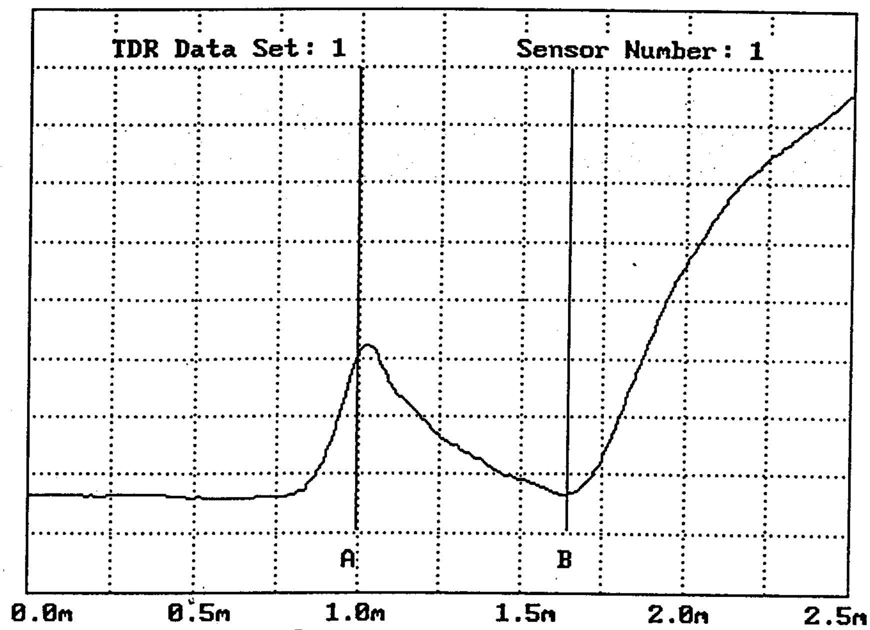


Figure D1. TDR trace of sensor 53A01 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:36
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 78
Offset: 53544
Sample No: 1

A (m) = 0.99
B (m) = 1.63
Trace Length (m)=0.64
Diele. Const.= 10.1
Volumetr MC (%)= 19.1

Total 1 set(s) data

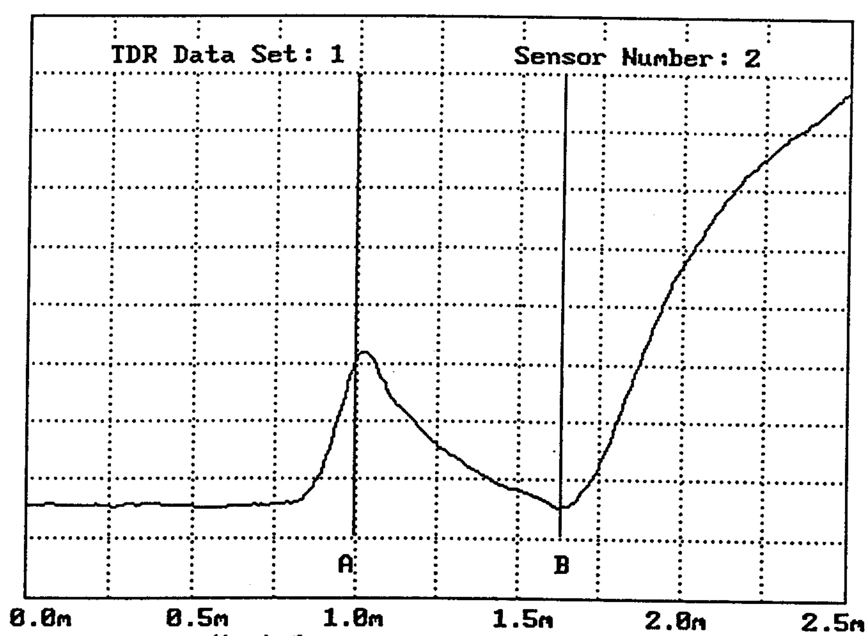


Figure D2. TDR trace of sensor 53A02 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:36
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 77
Offset: 53549
Sample No: 1

A (m) = 0.99
B (m) = 1.64
Trace Length (m)=0.65
Diele. Const.= 10.4
Volumetr MC (%)= 19.7

Total 1 set(s) data

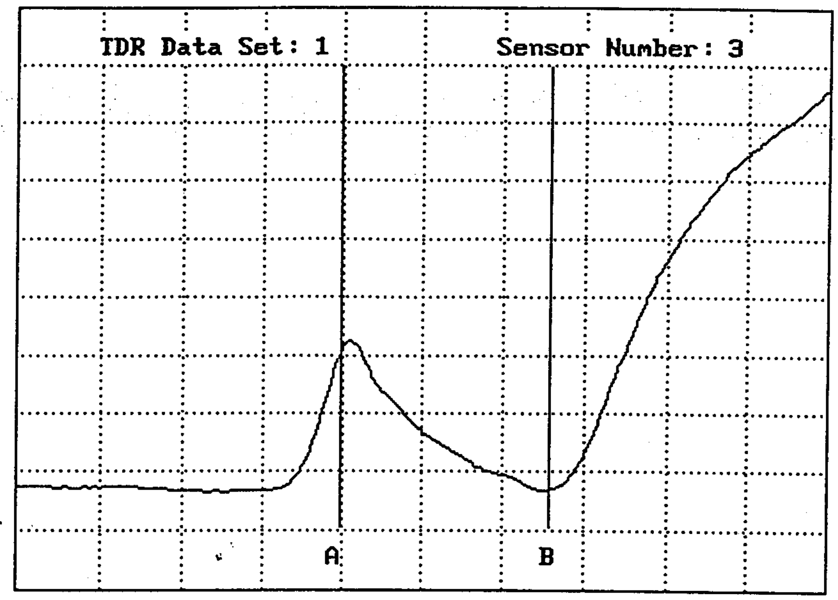


Figure D3. TDR trace of sensor 53A03 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:37
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 77
Offset: 53554
Sample No: 1

A (m) = 0.99
B (m) = 1.64
Trace Length (m)=0.65
Diele. Const.= 10.4
Volumetr MC (%)= 19.7

Total 1 set(s) data

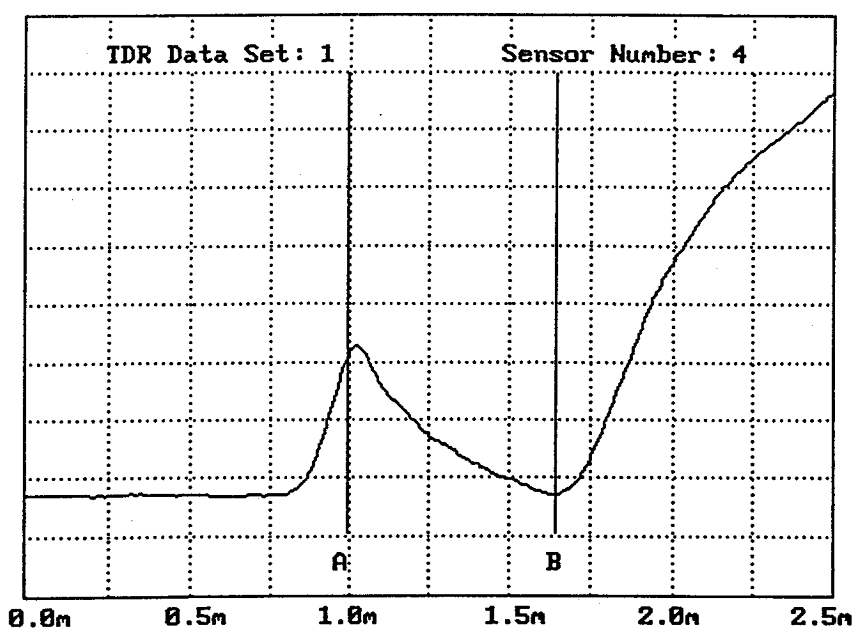


Figure D4. TDR trace of sensor 53A04 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:38
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 78
Offset: 53821
Sample No: 1

A (m) = 0.32
B (m) = 1.09
Trace Length (m)=0.77
Diele. Const.= 14.7
Volumetr MC (%)= 27.0

Total 1 set(s) data

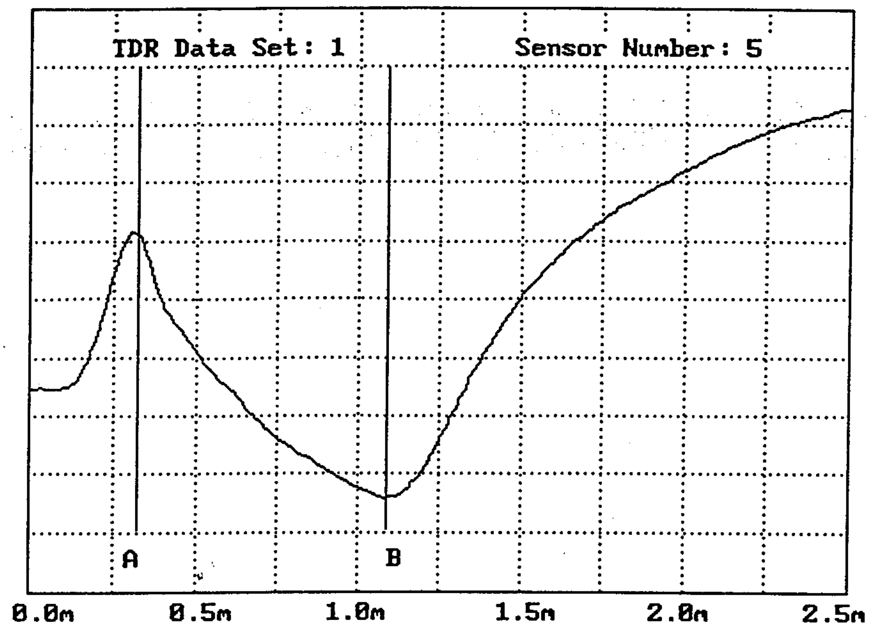


Figure D5. TDR trace of sensor 53A05 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:38
Dist → Curs (m): 18.8
Dist btn WvFm (m):.01
Gain: 76
Offset: 53633
Sample No: 1

A (m) = 0.32
B (m) = 1.05
Trace Length (m)=0.73
Diele. Const.= 13.2
Volumetr MC (%)= 24.6

Total 1 set(s) data

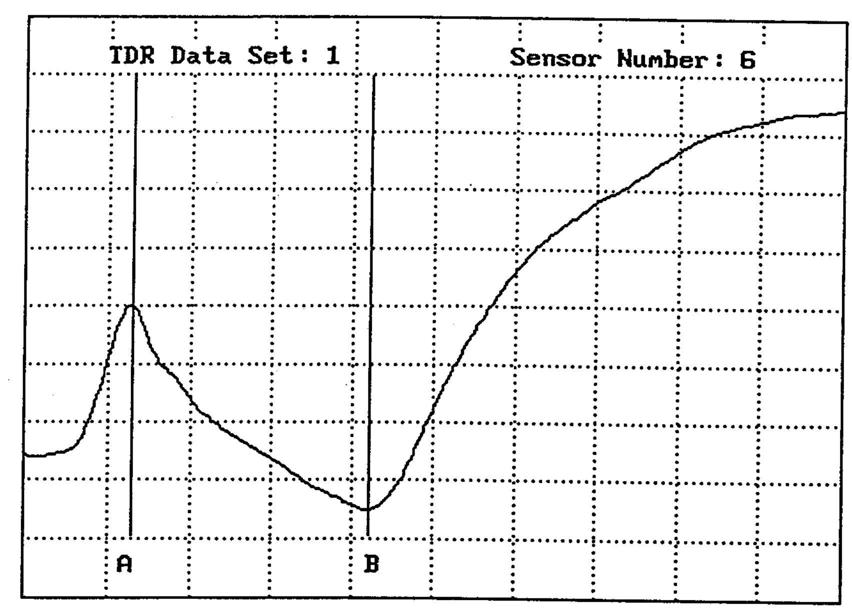


Figure D6. TDR trace of sensor 53A06 obtained by the mobile data acquisition box during initial data collection.

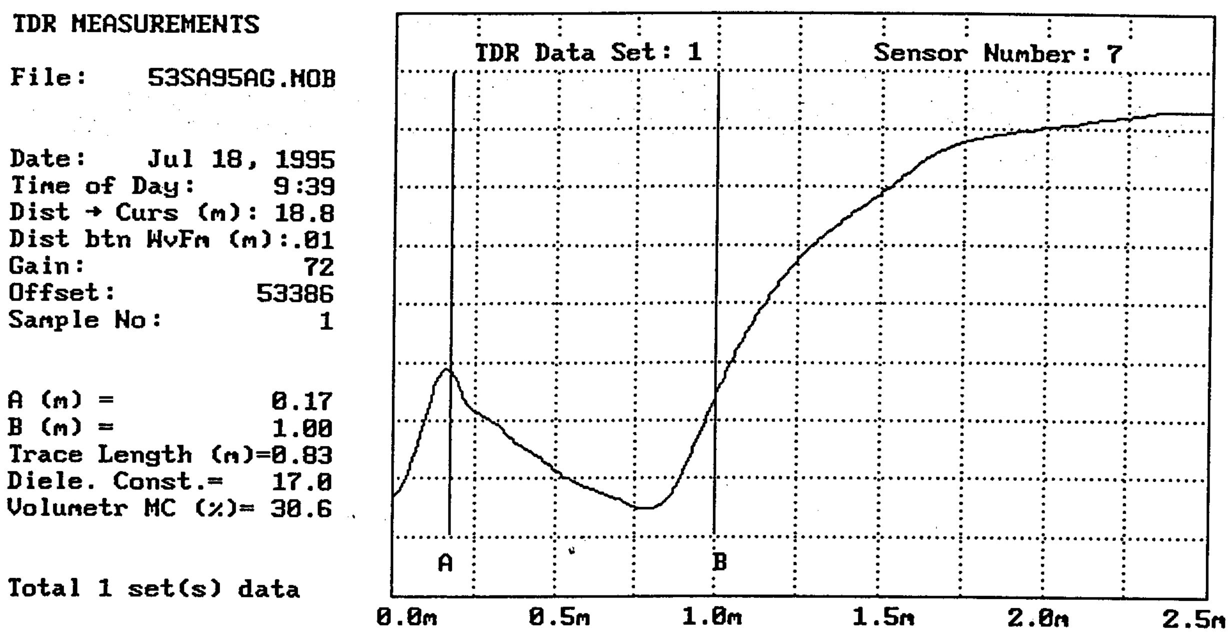


Figure D7. TDR trace of sensor 53A07 obtained by the mobile data acquisition box during initial data collection.

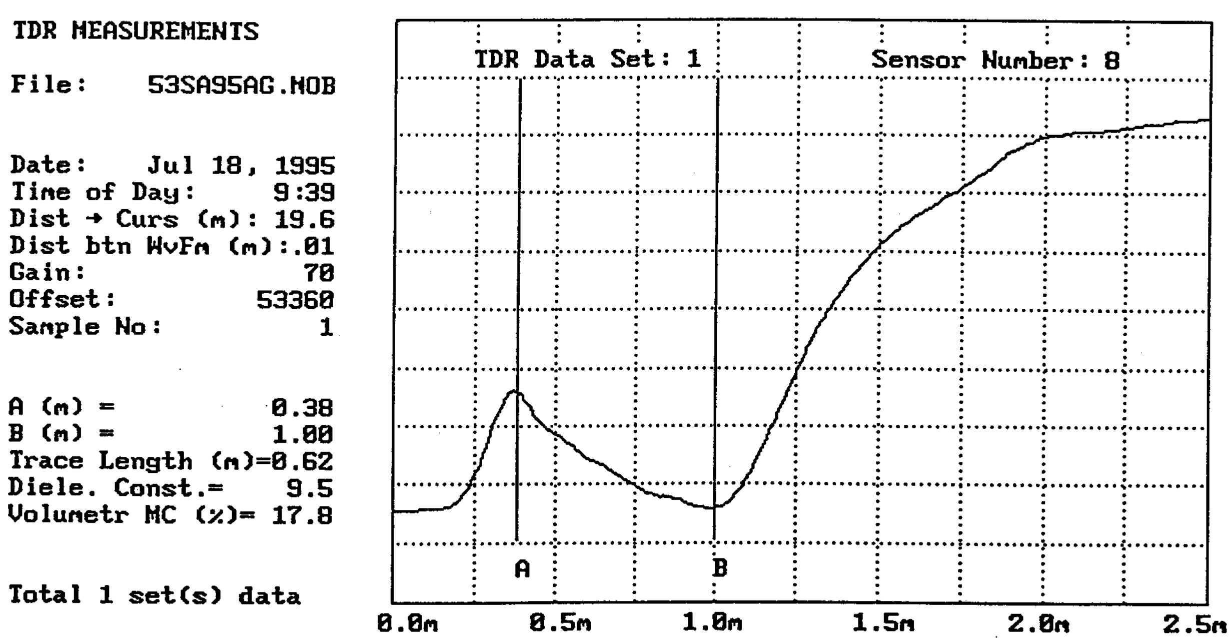


Figure D8. TDR trace of sensor 53A08 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:40
Dist → Curs (m): 19.6
Dist btn WvFm (m):.01
Gain: 67
Offset: 53307
Sample No: 1

A (m) = 0.36
B (m) = 1.00
Trace Length (m)=0.64
Diele. Const.= 10.1
Volumetr MC (%)= 19.1

Total 1 set(s) data

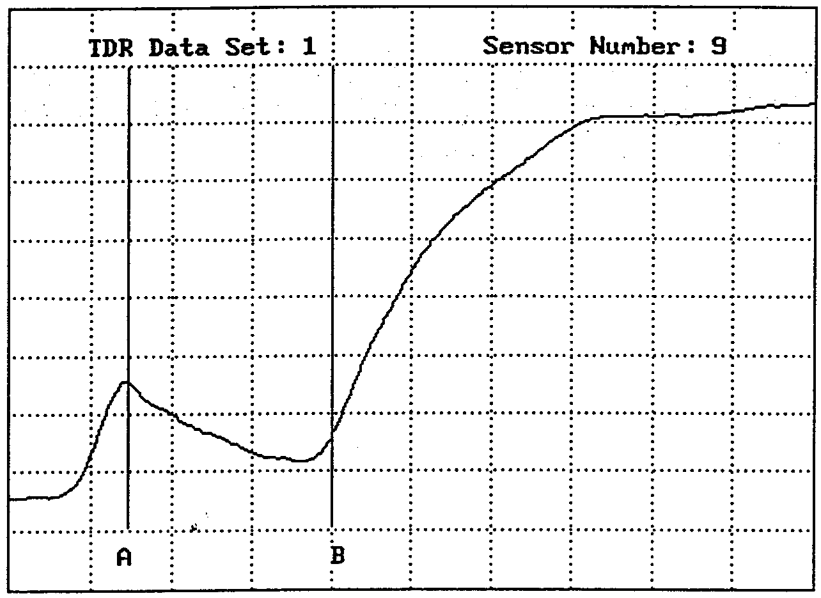


Figure D9. TDR trace of sensor 53A09 obtained by the mobile data acquisition box during initial data collection.

TDR MEASUREMENTS

File: 53SA95AG.MOB

Date: Jul 18, 1995
Time of Day: 9:40
Dist → Curs (m): 19.6
Dist btn WvFm (m):.01
Gain: 72
Offset: 53411
Sample No: 1

A (m) = 0.23
B (m) = 1.00
Trace Length (m)=0.77
Diele. Const.= 14.7
Volumetr MC (%)= 27.0

Total 1 set(s) data

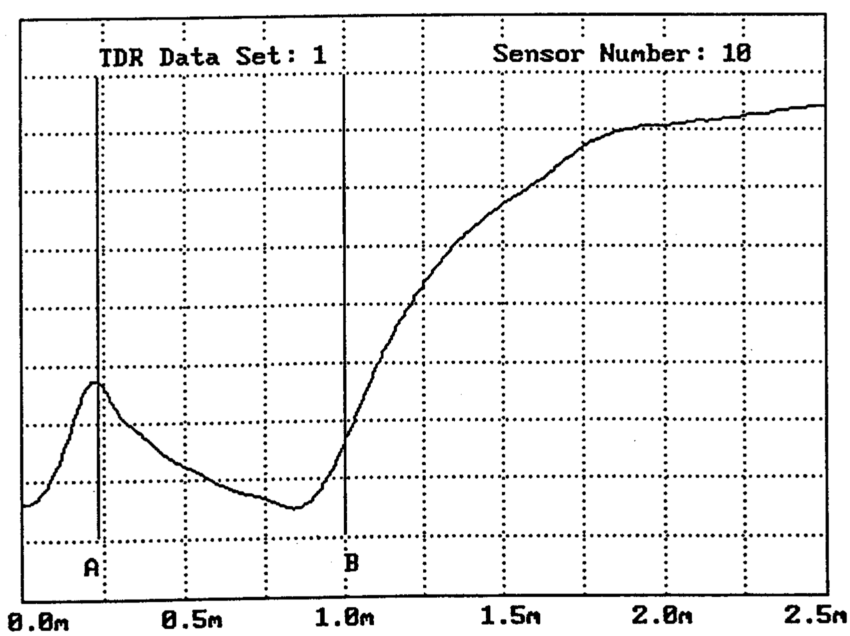


Figure D10. TDR trace of sensor 53A010 obtained by the mobile data acquisition box during initial data collection.

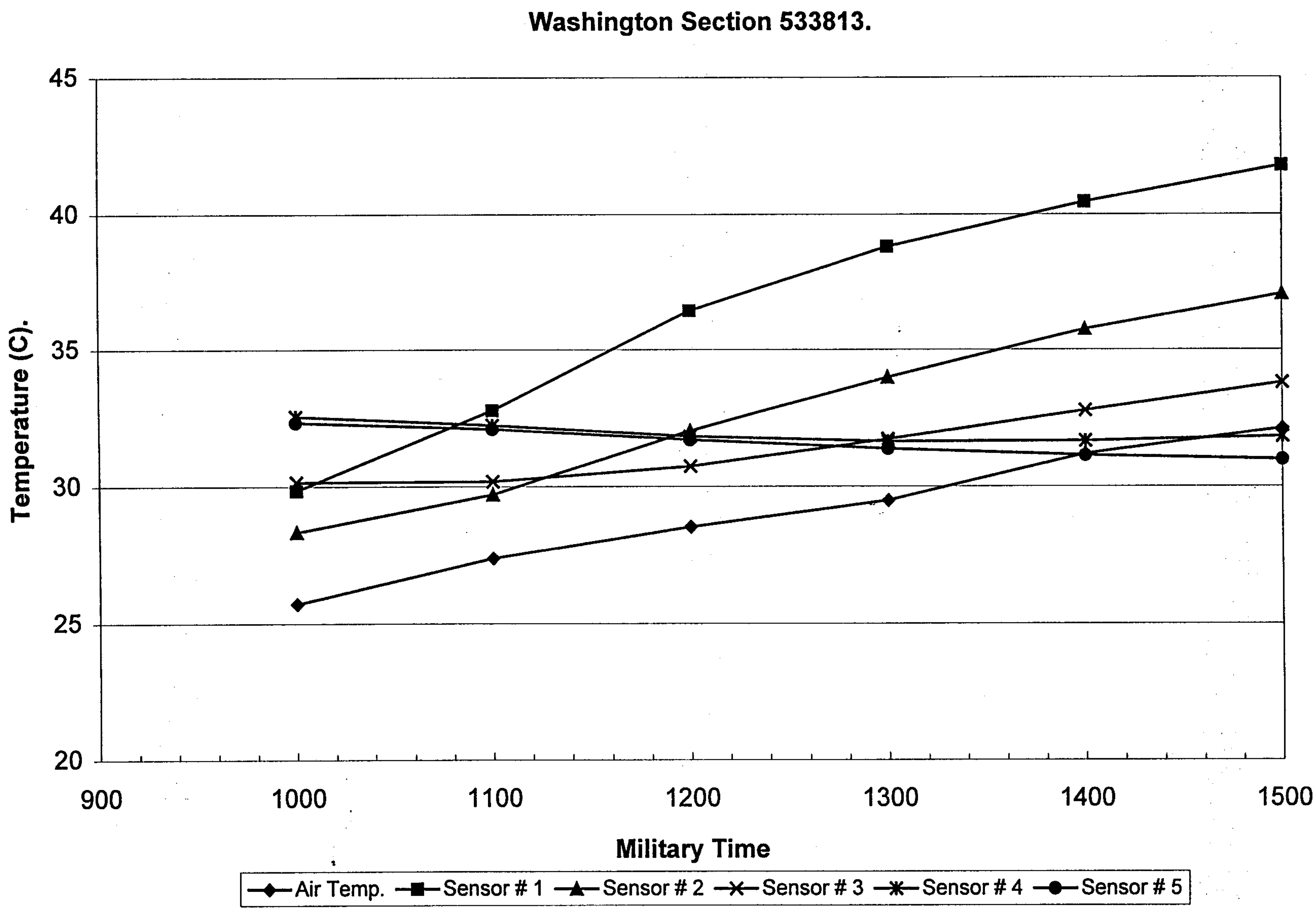


Figure D11. Hourly average air and top 5 sensor temperature.

Table D1. Pavement elevations at the time of installation.

Station	Offsets in m.			Comments
	PE[1] (0.30)	ML[2] (1.83)	ILE[3] (3.35)	
0-45.2	1.125	1.149	1.168	Elevation Measurements at Same Locations as FWD Tests
	1.125	1.147	1.162	
0-29.9	1.120	1.148	1.160	
0.29.4	1.119	1.142	1.162	
	1.120	1.141	1.160	
0-15.6	1.120	1.145	1.160	
0-15.1	1.190	1.145	1.163	
	1.121	1.141	1.165	
0-0.7	1.121	1.151	1.173	
0-0.2	1.123	1.151	1.173	
	1.121	1.146	1.160	
0+14.5	1.120	1.150	1.171	
0+14.9	1.122	1.142	1.170	
	1.125	1.145	1.166	
0+29.7	1.114	1.145	1.167	
0+30.0	1.116	1.146	1.165	
	1.115	1.135	1.161	
0+44.9	1.114	1.142	1.161	

Note: The observation well top cover was assumed as 1.000m for the purpose of elevation measurements.
[1]Outside Pavement Edge
[2]Middle of Lane
[3]Inner Left Edge

Table D2. Joint faulting measurements during installation.

LTPP Seasonal Monitoring Program Data Sheet SMP-D07 Joint Faulting Measurements	Agency Code [53] LTPP Section ID [3813]

Station (ft.)	Time (Military)	Joint Faulting (mm)		
		Offset (OWP)[1] 0.76m	Offset (ML)[2] 1.85m	Offset (IWP)[3] 2.74m
0-45	1245	2.3	3.0	5.6
0-29	1246	4.5	3.2	3.6
0-15	1247	3.9	2.9	6.9
0+00	1248	2.8	2.1	2.3
0+14	1249	7.1	2.2	8.4
0+30	1250	3.0	1.7	5.3

OWP : Outer Wheel Path
ML : Middle of Lane
IWP : Inner Wheel Path

Prepared By: Michael Esposito Employer: NCE

Date (dd/mm/yy): 18/07/95

Data Sheet SMP-D07: Joint Faulting Measurements.

Table D3. Joint opening measurements during installation.

LTPP Seasonal Monitoring Program Data Sheet SMP-D06 Joint Opening Measurements	Agency Code LTPP Section ID	[53] [3813]

Station (ft.)	Time (Military)	Joint Opening (mm)			Joint Width (mm)
		Offset (PE)[1] 0.35m	Offset (ML)[2] 1.90m	Offset (ILE)[3] 3.50m	
0-45	1457	4.926	4.715	4.658	17.3
0-29		4.599	4.498	4.384	14.0
0-15		4.971	4.938	4.447	23.1
0+00		4.386	4.801	4.834	23.1
0+14		4.636	4.751	4.508	16.8
0+30		4.531	4.445	4.579	17.3

PE : Pavement Edge (Outer Lane Edge)
ML : Middle of Lane
ILE : Inner Edge of Lane

Prepared By: Michael Esposito Employer: NCE

Date (dd/mm/yy): 18/07/95

Data Sheet SMP-D06: Joint Opening Measurements

Table D4. Raw data from onsite datalogger during initial data collection.

5	1995	199	1000	12.49	25.72	0		
6	1995	199	1000	29.85	28.35	30.15	32.54	32.33
5	1995	199	1100	12.5	27.39	0		
6	1995	199	1100	32.76	29.71	30.18	32.23	32.09
5	1995	199	1200	12.52	28.54	0		
6	1995	199	1200	36.44	32.02	30.74	31.82	31.7
5	1995	199	1300	12.53	29.49	0		
6	1995	199	1300	38.81	33.98	31.72	31.63	31.37
5	1995	199	1400	12.53	31.19	0		
6	1995	199	1400	40.45	35.75	32.76	31.65	31.13
5	1995	199	1500	12.54	32.12	0		
6	1995	199	1500	41.79	37.06	33.79	31.82	30.99