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Federal Highway Administration

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection

Section 320204

Battle Mountain, Nevada

Report No. FHWA-32-0204

June 1997

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LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 320204, Battle Mountain, Nevada

Report No. FHWA-32-0204

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16. Abstract This report contains a description of the instrumentation installation activities and initial data collection for test section 320204 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 the eastbound outside lane of Interstate Route 80, near Battle Mountain, Nevada. This section was instrumented on October 9, 1996. The instruments installed included TDR probes for moisture content, thermistor probes for subsurface temperature, tipping bucket rain gauge for precipitation, resistivity probe for frost depth, piezometer to monitor ground water table, and an on-site datalogger. Initial data was collected on October 11, 1996. This included FWD and precipitation data, elevation, air and subsurface temperature, and TDR moisture measurements. This report also contains a 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 NEVADA SECTION 320204

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 320204 near Battle Mountain, Nevada. The equipment installation activities were completed on October 9, 1996 and initial data was collected on October 11, 1996.

Section Location

Section 320204 is a Specific Pavement Studies (SPS) section selected for SMP. This section is located on the outside lane of eastbound Interstate Route 80, a multi-lane highway facility in the State of Nevada. The closest city to the section is Battle Mountain, Nevada. The beginning of the section is at milepost 225.1, 1.7 miles east of the Mote interchange. This section is a SPS-2, "Strategic Study of Structural Factors for Rigid Pavements" section, meeting the seasonal monitoring program core experimental design cell number 23 requirements. Figure A1 in appendix A contains a map showing the location of the section.

Section Details

The pavement section consists of 279mm of Portland Cement Concrete (PCC) with 152mm aggregate base (AB) over medium sand subgrade. The test section has a 3.70m travel lane with a 3.35m wide portland cement concrete shoulder. Additional details are summarized in table 1.

Table 1. Details of section 320204 in Nevada.

Functional Classification of Roadway	Interstate Highway, Rural, Arterial
Number of Lanes/Direction	Two
Pavement Type	Portland Cement Concrete
Estimated Annual ESAL Applications on the Test Lane	534 KESALs
Climatic Classification	Dry-Freeze, SMP Cell #23

Pre-installation FWD testing was carried out on the test section on March 27, 1996. 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	PCC	AB	Silty Sand
Thickness (mm)	279*	152*	N/A
Proctor Dry Density (kg/m^3)	---	---	1990
Proctor Moisture Content (%)	---	---	11.4
Field Measured Density (kg/m^3)	---	2328@5.8%MC***	1858@17.3%MC***
Laboratory Maximum Dry Density (kg/m^3)	---	2227@6%MC	1970@10.0%MC
Liquid Limit	---	---	---
Plastic Limit	---	---	---
Plastic Index	---	NP	NP
Percent Passing #200	---	8.9%	68.0%

MC Moisture Content
AC Asphalt Concrete
AB Aggregate Base
NP Non-Plastic
* Layer thickness from construction records
** Proctor density test could not be carried out on the day of instrument installation because of rains during installation
*** Density in the field was measured using Nuclear gauge

According to information provided by the Western region climate center at Desert Research Institute in Reno, the following climatic conditions exist in the vicinity of site:

Precipitation	:	209mm	No. of Days Above 32° C	:	62
No. of Wet Days	:	62	No. of Days Below 0° C	:	189

Note: The LTPP weather database does not have information about SPS sites at this point. Hence information from other sources was obtained.

Installation of instrumentation was carried out on October 9, 1996 and initial data collection was performed on October 11, 1996. Instrument installation was a cooperative effort between Nevada Department of Transportation (Nevada DOT) and Nichols Consulting Engineers (NCE) LTPP Western Region Coordination Office staff. The following personnel participated in the installation:

Sirous Alavi	:	NCE	Srikanth Holikatti	:	NCE
Mark Potter	:	NCE	Michael Esposito	:	NCE
Richard Smith	:	NCE	Kevin Kawalkowski	:	NCE
Jerry Etchenverry	:	Nevada DOT	James White	:	Nevada DOT
Lonnie See	:	Nevada DOT	Michael Denson	:	Nevada DOT
Robert Whited	:	Nevada DOT	Walter Shaffer	:	Nevada DOT
Jack Holtz	:	Nevada DOT	Donald Gillespie	:	Nevada DOT

Jeanne Thames	:	Nevada DOT	Renee Duffy	:	Nevada DOT
Mary Rice	:	Nevada DOT			

INSTRUMENT INSTALLATION

Meeting With Highway Agency

A planning meeting between NCE and Nevada DOT was held in Winnemucca, Nevada on September 4, 1996 to discuss the SMP instrumentation, required equipment, the installation schedule, and installation team responsibilities. Nevada DOT 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 Douglas Frith and Mark Potter on September 4, 1996. Distress survey and FWD testing of the section was carried out on March 27, 1996.

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, battery, and the CR10 datalogger. A solar panel was mounted on the backside of the equipment cabinet and connected to the battery. 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.

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 45 minutes and 101 tips to drain 473ml of water. The two screws at the bottom of the rain gauge were not adjusted, as the number of tips were 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. They were found to be in working order.

Table 3. Equipment installed.

Equipment	Quantity	Serial No.
Instrument Hole		
MRC Thermistor Probe	1	32B#1
TDR Sensors	10	32B01-32B10
Resistivity Probe	1	32#BR
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16585
Battery Pack	1	401215
Weather Station		
TE 525 Tipping Bucket Rain Gauge	1	12041
Air Temperature Probe	1	8709
Radiation Shield	1	None
Solar Panel	1	None
Observation Well/Bench Mark	1	None

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	0.018	Unit installed in base & subgrade
	5	0.093	
	6	0.173	
	7	0.247	
	8	0.325	
	9	0.476	
	10	0.628	
	11	0.775	
	12	0.932	
	13	1.084	
	14	1.236	
	15	1.387	
	16	1.538	
	17	1.694	
	18	1.840	

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. The bench mark did not have a serial number.

The resistivity probe was checked for continuity and conductivity using a digital multi meter. The probe was free of any problems. The spacing between each electrode was measured and recorded, these are given in table 5.

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		
37	1	0.029	0.028	0.029	X	0.028
9	2	0.079	0.078	0.079	X	0.050
18	3	0.131	0.130	0.131	X	0.053
27	4	0.183	0.180	0.182	X	0.051
36	5	0.231	0.231	0.231	X	0.052
8	6	0.282	0.282	0.282	X	0.050
4	7	0.333	0.332	0.333	X	0.051
23	8	0.384	0.383	0.383	X	0.051
5	9	0.438	0.435	0.435	X	0.053
24	10	0.486	0.485	0.486	X	0.049
6	11	0.536	0.536	0.536	X	0.052
25	12	0.588	0.588	0.588	X	0.052
7	13	0.640	0.638	0.639	X	0.050
26	14	0.691	0.689	0.690	X	0.054
8	15	0.739	0.738	0.739	X	0.047
27	16	0.789	0.789	0.789	X	0.050
9	17	0.841	0.840	0.841	X	0.053
28	18	0.892	0.891	0.892	X	0.050
10	19	0.943	0.942	0.943	X	0.051
29	20	0.994	0.993	0.994	X	0.052
11	21	1.044	1.043	1.044	X	0.049
30	22	1.097	1.094	1.096	X	0.052
12	23	1.145	1.145	1.145	X	0.052
31	24	1.197	1.196	1.197	X	0.050
13	25	1.246	1.246	1.246	X	0.051
32	26	1.297	1.298	1.298	X	0.051
14	27	1.349	1.349	1.349	X	0.050
33	28	1.400	1.400	1.400	X	0.053

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

Connector Pin Number	Electrode Number	Distance from Top (m)			Continuity	Spacing (m) between Electrodes
		Line 1	Line 2	Average		
15	29	1.452	1.451	1.452	X	0.052
34	30	1.502	1.501	1.502	X	0.050
16	31	1.553	1.551	1.552	X	0.050
35	32	1.606	1.603	1.605	X	0.053
17	33	1.656	1.654	1.655	X	0.051
36	34	1.707	1.705	1.706	X	0.051
18	35	1.754	1.755	1.755	X	0.051
37**	36	1.808	1.807	1.808	X	0.048
Bottom		1.831	1.832	1.832		

**Pin number 37 is used instead of pin 19.

Instrument Installation

Analysis of pre-installation FWD data indicated uniformity of the section. Surface distress (shrinkage cracks) at the leave end and other specific site conditions such as fill thickness warranted that the instrumentation be placed at the approach end of the section. The equipment installation followed the schedule given below;

0745 : Depart from Battle Mountain.
0800 : Arrive at site, start unpacking equipment in preparation for installation.
0815 : Traffic control in place, instrumentation hole and piezometer located and marked, FWD testing of instrumentation hole.
0815-0845 : Drill piezometer, saw cutting of thermistor unit 1 slot, conduit trench, and instrument hole.
0845-0930 : Installation of piezometer, drill weather station pole hole, place pole, and concrete the base.
0930-1000 : Install equipment cabinet.
1000-1030 : Excavation of instrumentation cable trench.
1030-1200 : Layout the cables, run the cables through the conduit, drill instrument hole.
1200-1500 : Installation of thermistor unit #2, resistivity probe, 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 approach end of the section at a distance of 3.18m (station 0-10.5') before 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 concrete layer. The pavement temperature sensors (thermistors, unit #1) were installed in the PCC 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 2.10m deep. Figure C1 in appendix C presents the site layout and instrument location. All the TDR probes were placed with an "S" shaped stress relief loop in their cables. The TDR probes were placed in an offset fan pattern such that the lead wires were on the side closest to the pavement edge. 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 9.75m away, to the right of lane edge on almost level ground. 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.

Table 6. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
32B01	0.350	Base
32B02	0.505	Subgrade
32B03	0.663	
32B04	0.818	
32B05	0.965	
32B06	1.113	
32B07	1.277	
32B08	1.429	
32B09	1.735	
32B10	2.035	

Each TDR probe was connected to the 1502B cable tester, while the soil around it was being compacted. TDR traces were generated during the backfilling of the instrument hole to ensure that they were not damaged during installation. Moisture samples were collected at each TDR probe location. A representative Proctor sample was taken at a depth of 0.60m from the pavement surface and the Proctor density test was performed. Since the large beam balance was damaged, the compacted proctor sample was divided into smaller parts for the purpose of determining the weight of the sample.

The moisture samples were split into two parts. One part was tested in accordance with the SMP installation and initial data collection guidelines, 1994. The other part of the sample was labeled and handed over to Nevada DOT personnel for moisture determination in their central materials laboratory. A comparison of field and laboratory determined moisture contents is presented in table 7.

Table 7. Moisture contents during installation in field and laboratory.

Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by wt)	
			Field Measured *	Laboratory Measured**
32B01	0.350	Base	1.9	6.2
32B02	0.505	Subgrade	2.4	5.1
32B03	0.663		2.8	4.6
32B04	0.818		3.1	6.4
32B05	0.965		15.2	12.6
32B06	1.113		17.6	12.6
32B07	1.277		12.4	14.1
32B08	1.429		13.3	14.3
32B09	1.735		15.6	12.5
32B10	2.035		19.2	15.3

* Moisture contents determined in the field from the material sampled at each TDR probe depth as per FHWA LTPP SMP installation and initial data collection Guidelines, April 1994.

** The moisture contents were determined from split samples in Nevada DOT central materials laboratory.

It is seen from the above data that field measured moisture contents were significantly different from the moisture contents determined in the laboratory. This significant variability observed in moisture contents was due to some extent to 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 number 2 as per the SMP instrument installation guidelines. The resistivity probe lead wires were checked for continuity after backfilling the instrumentation hole. Table 8 and table 9, respectively, present the installed locations of thermistor sensors and the resistivity probe with reference to the pavement surface.

Table 8. Installed locations of MRC thermistor sensors.

Unit No.	Channel No.	Depth from Pavement Surface (m)	Remarks
1	1	0.025	PCC
	2	0.130	
	3	0.236	
2	4	0.345	Base
	5	0.420	
	6	0.500	Subgrade
	7	0.574	
	8	0.652	
	9	0.803	
	10	0.955	
	11	1.102	
	12	1.259	
	13	1.411	
	14	1.563	
	15	1.714	
	16	1.865	
	17	2.021	
	18	2.167	

Table 9. Installed locations of resistivity sensors.

Connector Pin Number	Electrode Number	Depth From Pavement Surface
36	1	0.361
35	2	0.411
34	3	0.463
33	4	0.514
32	5	0.564
31	6	0.615
30	7	0.665
29	8	0.716
28	9	0.768
27	10	0.818
26	11	0.869
25	12	0.921
24	13	0.972
23	14	1.023
22	15	1.071
21	16	1.122
20	17	1.173
19	18	1.224
18	19	1.275
17	20	1.326
16	21	1.376
15	22	1.428
14	23	1.478
13	24	1.529
12	25	1.579
11	26	1.630
10	27	1.682
9	28	1.733
8	29	1.784

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

Connector Pin Number	Electrode Number	Depth From Pavement Surface
7	30	18734
6	31	1.885
5	32	1.937
4	33	1.988
3	34	2.039
2	35	2.087
1	36	2.116
Bottom		2.140

A 152mm diameter flight auger was used to bore the observation piezometer/benchmark at the edge of pavement shoulder at a distance of 15.16m (section station 0+49.75'), and 4.19m 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. A set of 19mm diameter steel snap rings were placed on either side of the pavement joints in accordance with LTPP guidelines.

Site Repair

The instrumentation hole and the conduit trench were patched by Nevada DOT personnel with ready mix 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 is performing well.

INITIAL DATA COLLECTION

Initial data was collected on October 11, 1997. The functionality of installed equipment was checked and onsite data collected by the Onsite data logger was examined. Examination of onsite data revealed that the time and day for the CR10 module needed to be changed, accordingly the date and time were changed. The equipment and datalogger were functioning correctly. The battery voltage was checked and found acceptable.

Mobile data was not collected using the mobile data acquisition system. The mobile data acquisition box was nonfunctional during the seasonal instrumentation installation. Manual TDR traces were collected as part of the initial data collection. However, mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors.

Post installation FWD testing of the section was completed 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 D1 in appendix D. The joint opening and joint faulting data during initial data collection are given in tables D2 and D3 in appendix D, respectively.

The resistivity probe installed at this site is quite different than the probes installed at other seasonal sites. It was discovered during the in-house review of site installation information that the pin to electrode configuration was completely random. After careful thought and discussion a set of data sheets with proper switch positions corresponding to the electrode locations was developed to facilitate manual two point resistance and four point resistivity data collection in the field without difficulty.

SUMMARY

This report describes the SMP equipment installation activities at section 320204 located in the State of Nevada. The section is located on the eastbound outside lane of Interstate Route 80 near Battle Mountain. The beginning of the section is at milepost 225.1, 2.7 miles east of the Mote interchange. This is a SPS-2 section in the "dry-freeze" climatic zone, meeting the requirements of SMP cell number 23.

The site was inspected on September 4, 1996. A planning meeting with Nevada DOT representatives was held in Winnemucca on September 4, 1996 to discuss SMP equipment installation and work responsibilities. Successful installation of SMP equipment and initial data collection were completed on October 9 and 11, 1996, respectively, in accordance with the LTPP SMP installation 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.
- Frost depth measurements.
- Pavement joint movements.

A resistivity probe was installed at this site as the site is in "dry-freeze" zone. The equipment installation hole is located at the approach end of the section at a distance of 3.18m from the section beginning. The equipment cabinet is located 11.28m to the right of the lane edge on almost level ground. Surface distress (shrinkage cracks) at the leave end and other specific site conditions, such as fill thickness, warranted that the instrumentation be placed at the approach end of the section. Post installation checks indicated proper functioning of all installed equipment. Post installation FWD testing and a distress survey were performed as per LTPP guidelines.

Mobile data was not collected using the mobile data acquisition system. The mobile data acquisition box was nonfunctional during the seasonal instrumentation installation. However, manual TDR traces, two point resistance and four point resistivity data collection were performed as part of the initial data collection. Mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors.

The resistivity probe installed at this site is substantially different from those installed at the other six sites. During the in-house review of the installation information it was discovered that the pin to electrode configuration was completely random. After careful thought and discussion, a set of data sheets with proper switch positions corresponding to the electrode locations were developed to facilitate manual two point resistance and four point resistivity data collection in the field without difficulty. These were the only 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.
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.
Table A1. Distress survey summary sheets

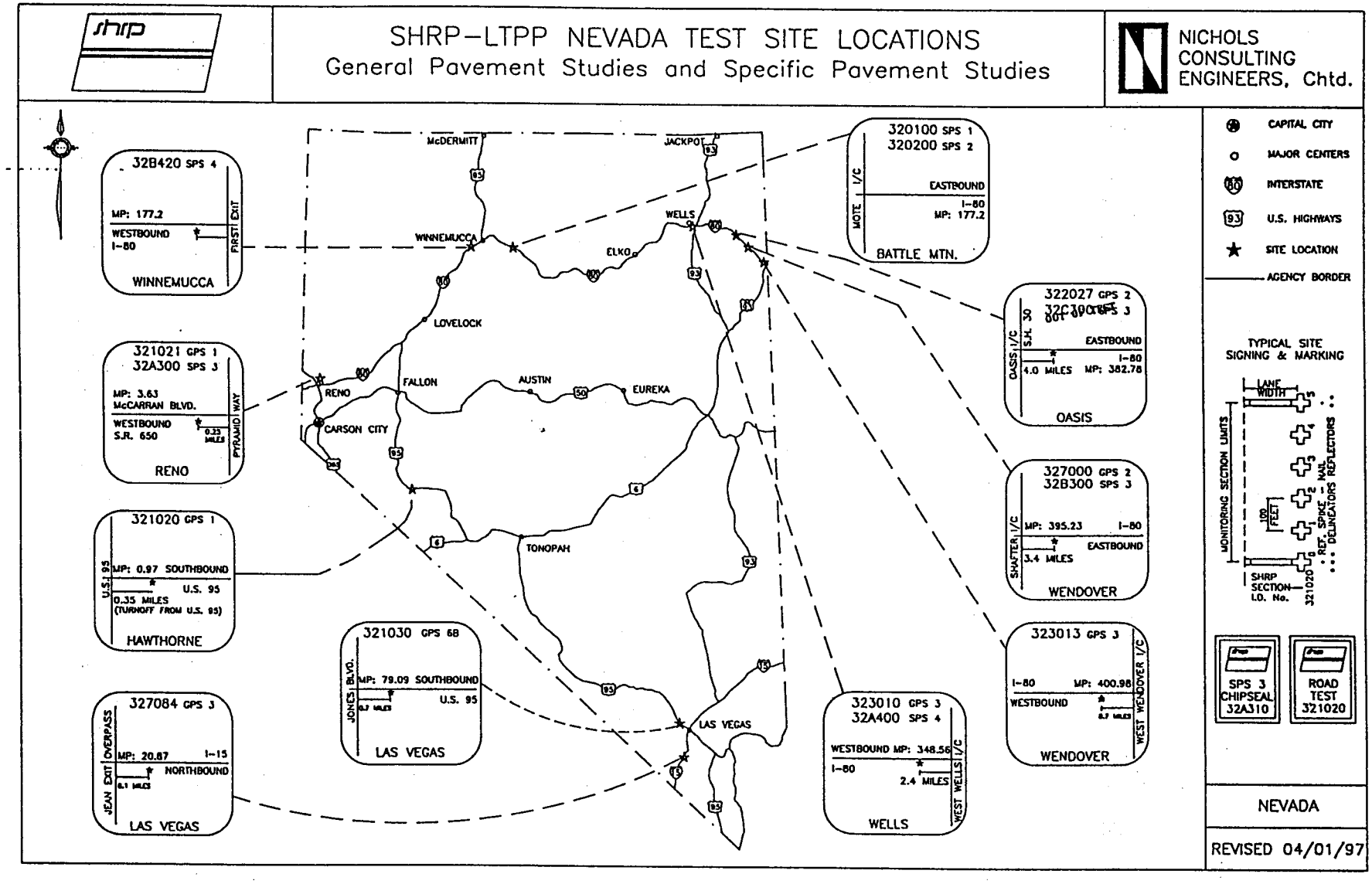


Figure A1. Site location map.

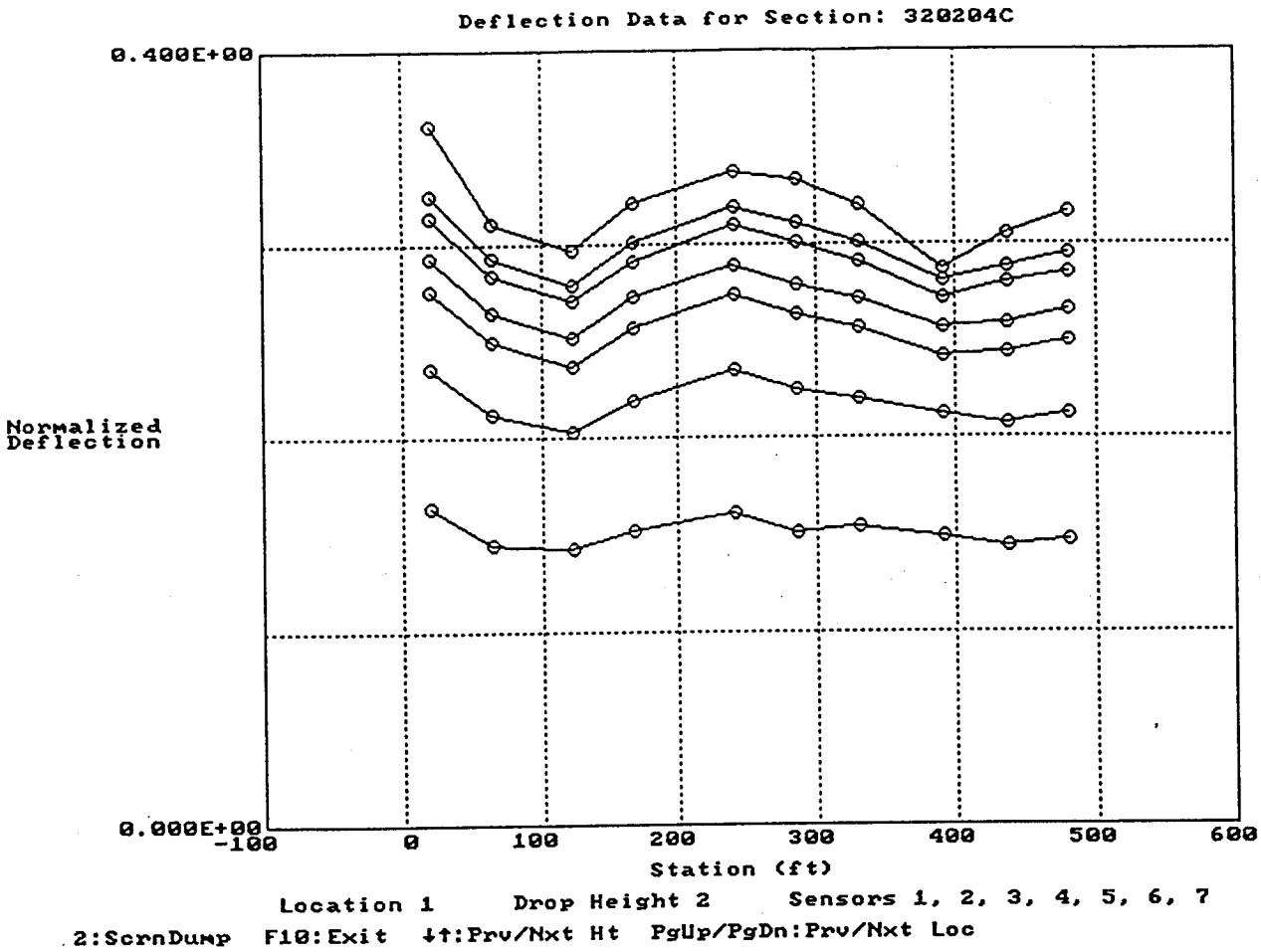


Figure A2. Normalized deflection profile from FWDCheck.

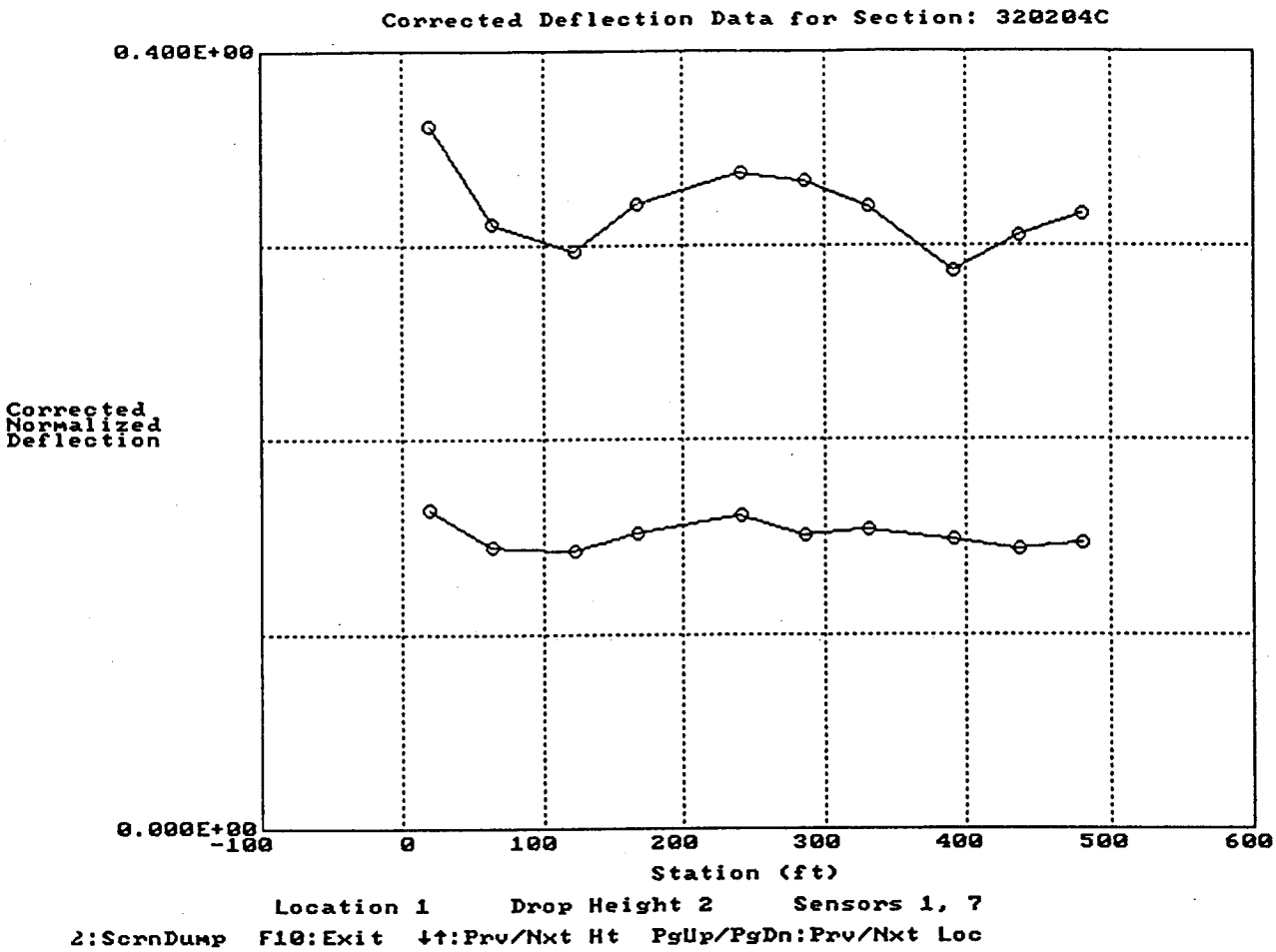


Figure A3. Corrected normalized deflection profile from FWDCheck.

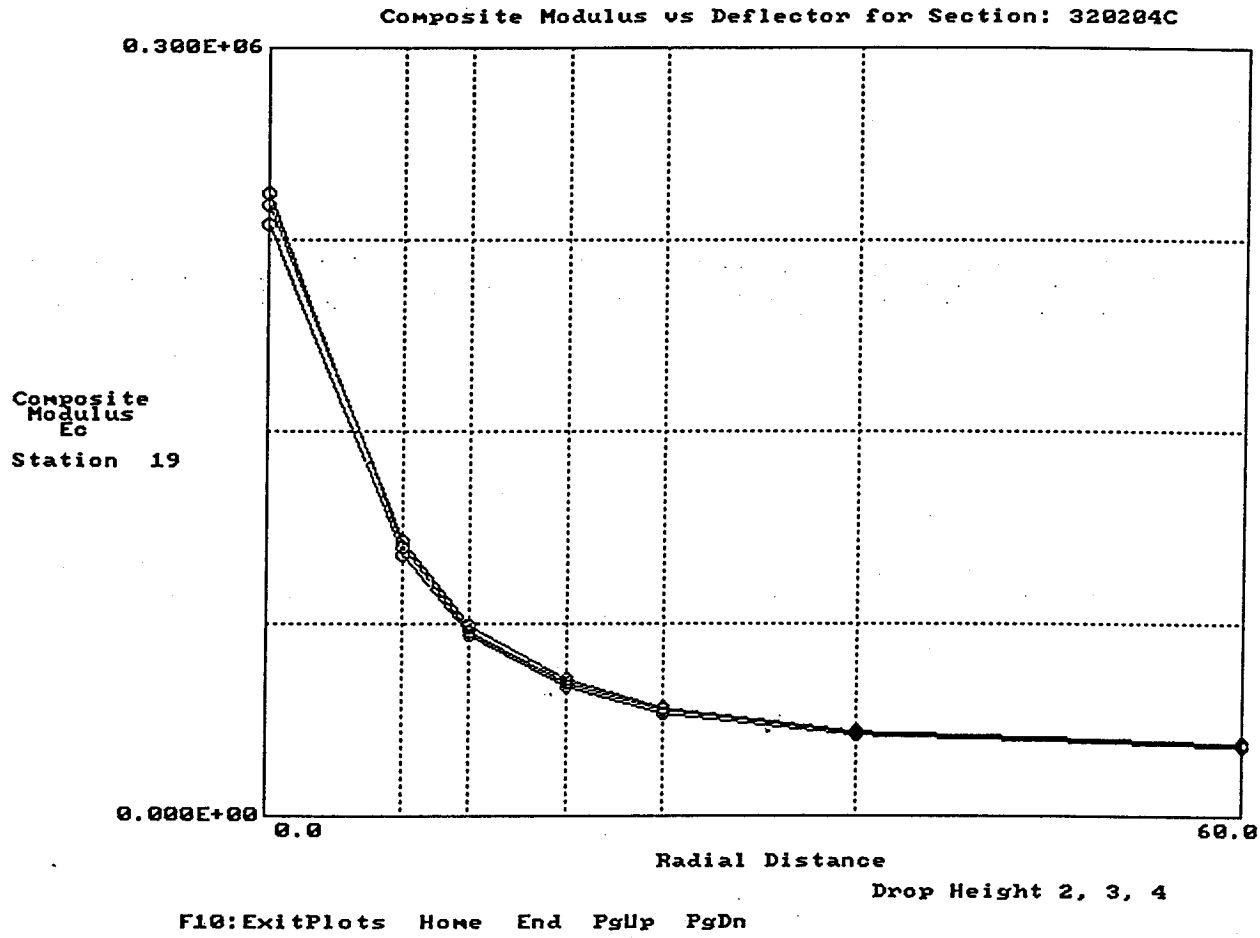


Figure A4. Elastic modulus of subgrade from FWDCheck.

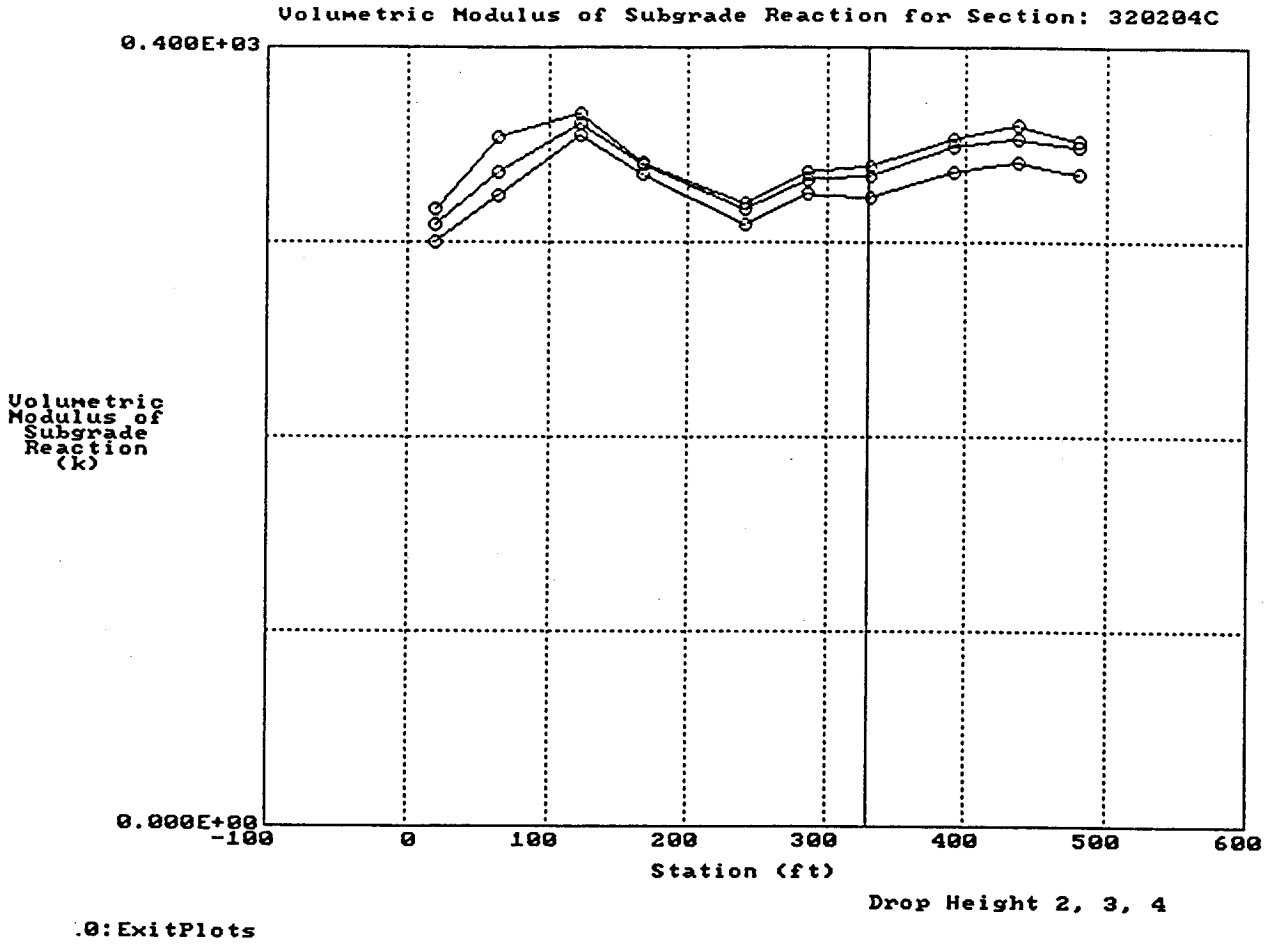


Figure A5. Composite modulus at station 5+00 from FWDCheck.

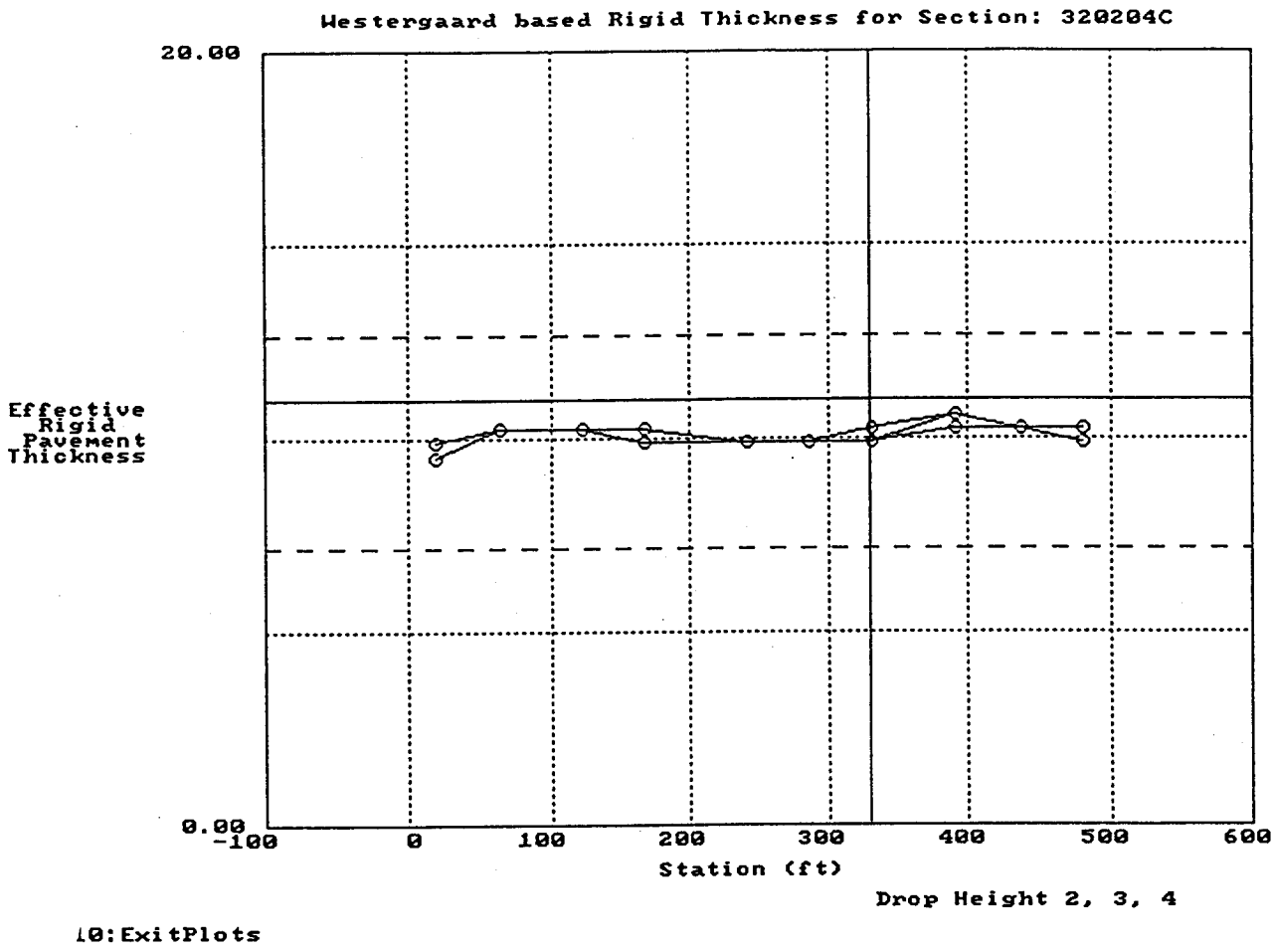


Figure A6. Equivalent structural number from FWDCheck.

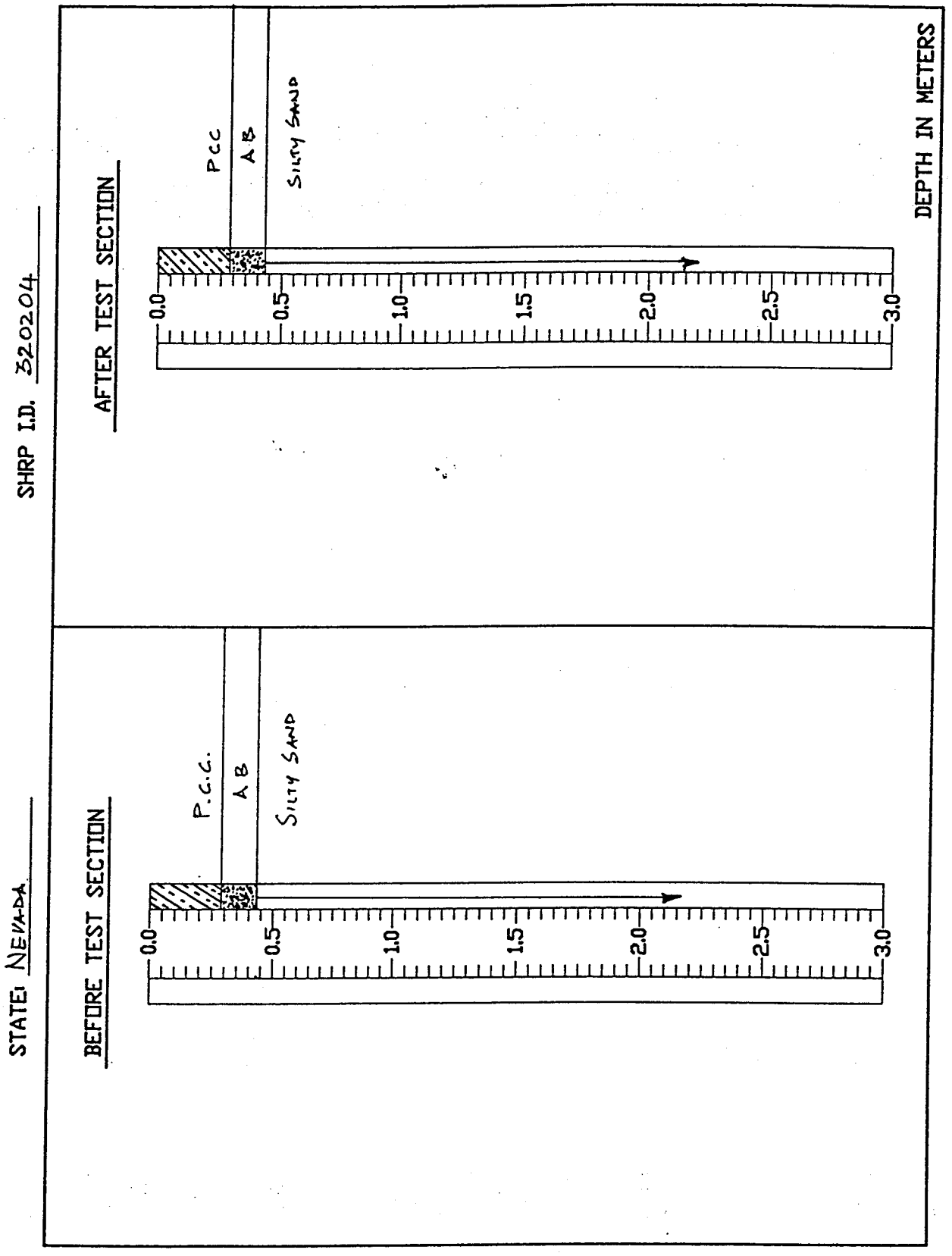
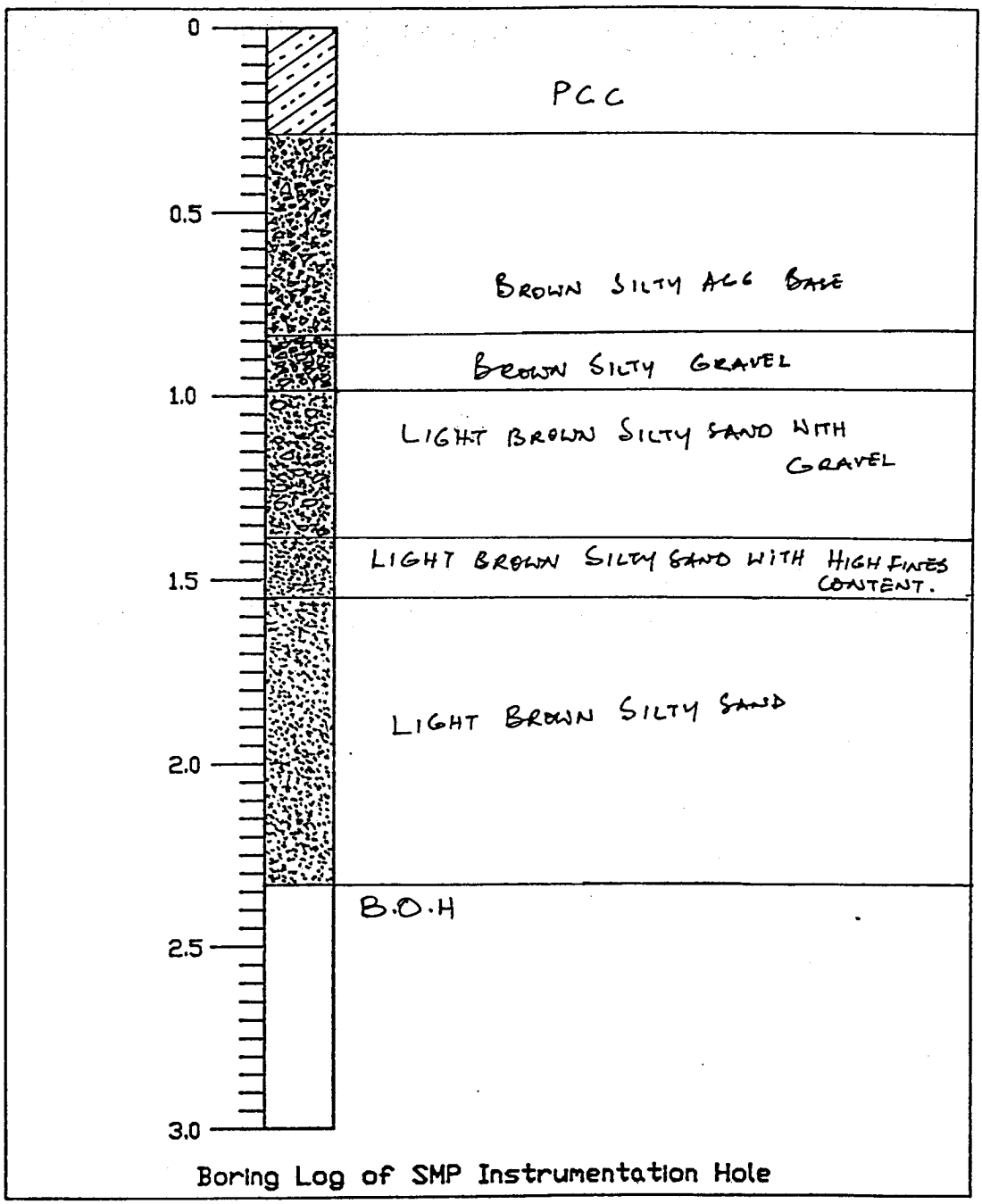


Figure A7. Sampling log of section during construction.

State ID. 32 SHRP ID. 0204

Station 0-10.5' Date(dd/mm/yy) 09/10/96



Boring Log of SMP Instrumentation Hole

Start Time 10.00 AM End Time 11.30 Am.

Prepared By S. HOLIKATTI Employed By NCE

Figure A8. Boring log of instrument hole.

Revised May 29, 1992

SHEET 4 ENTERED STATE ASSIGNED ID _____

DISTRESS SURVEY JAN 06 1997 STATE CODE 32

LTPP PROGRAM By GA SHRP SECTION ID 0204

DISTRESS SURVEY FOR PAVEMENTS WITH JOINTED PORTLAND CEMENT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 03/27/96

SURVEYORS: MJF, EMS, ____
PAVEMENT SURFACE TEMP - BEFORE ____ 8 °C; AFTER ____ 9 °C
PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) N

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. CORNER BREAKS (Number)	0	0	1
2. DURABILITY "D" CRACKING (Number of Affected Slabs)	0	0	0
AREA AFFECTED (Square Meters)	0.0	0.0	0.0
3. LONGITUDINAL CRACKING (Meters)	43.3	0.0	0.0
Length Sealed (Meters)	0.0	.0	.0
4. TRANSVERSE CRACKING (Number of Cracks)	11	0	0
(Meters)	7.0	.0	.0
Length Sealed (Meters)	.0	.0	.0
JOINT DEFICIENCIES			
5a. TRANSVERSE JOINT SEAL DAMAGE Sealed? (Y, N)			Y
If "Y" Number of Joints	33	0	0
5b. LONGITUDINAL JOINT SEAL DAMAGE Number of Longitudinal Joints that have been sealed (0, 1, or 2)			2
Length of Damaged Sealant (Meters)			0.0
6. SPALLING OF LONGITUDINAL JOINTS (Meters)	0.0	0.0	0.0
7. SPALLING OF TRANSVERSE JOINTS Number of Affected Joints	0	0	0
Length Spalled (Meters)	.0	.0	.0

STATE ASSIGNED ID ____

SHEET 5 ENTERED

DISTRESS SURVEY JAN 06 1997

LTPP PROGRAM By CH

STATE CODE 32

SHRP SECTION ID 0204

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 3/27/96

SURVEYORS: MJF, ____

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)			____.
8b. SCALING (Number)			0
(Square Meters)			____.
9. POLISHED AGGREGATE (Square Meters)			____.0
10. POPOUTS (Number)			____0.
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)	____4	____0	____0
(Square Meters)	____1.5	____.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) ____			

Revised April 23, 199

SHEET 6 ENTERED STATE ASSIGNED ID ___

DISTRESS SURVEY JAN 06 1997 STATE CODE 32

LTPP PROGRAM By CH. SHRP SECTION ID 0204

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 3/27/96

SURVEYORS: M I E.

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

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

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
3.7	J		Y	0	0	0	0	1
8.2							0	0
12.9							1	0
17.5							1	2
22.1							0	0
26.6							1	2
31.2							0	0
35.8							1	0
40.3							1	1
44.8							1	1
49.5							1	1
54.0							1	0
58.6							1	0
63.2							1	0
67.7							2	2
72.3							1	1
76.9							1	1
81.5							1	1
86.0							1	1
90.6							0	0
95.2							1	1
99.8							1	0
104.4							0	1
108.9							0	0
113.5							1	1
118.1							0	0
122.7							0	1

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,

SHEET 6

DISTRESS SURVEY

LTPP PROGRAM

ENTERED
JAN 06 1997
By C4H

STATE ASSIGNED ID ______

STATE CODE 3 2

SHRP SECTION ID 0 2 0 4

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 3/27/96

SURVEYORS: M.I.E.

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

12. FAULTING OF TRANSVERSE JOINTS AND CRACKS

Page 2 of

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
127.3	J		Y	0	0	0	3	0
132.0	"		"	"	"	"	0	
136.5	"		"	"	"	"	1	
141.1	"		"	"	"	"	0	
145.7	"		"	"	"	"	1	1
150.3	"		"	"	"	"	1	1

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

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

SHEET 7 ENTERED STATE ASSIGNED ID _____

DISTRESS SURVEY JAN 06 1997 STATE CODE 32

LTPP PROGRAM By CHH SHRP SECTION ID 0204

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 03/27/96

SURVEYORS: MJE, RMS

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.	1.	8.	Y
2.	15.25	1.	10.	
3.	30.5	2.	9.	
4.	45.75	2.	10.	
5.	61.	1.	11.	
6.	76.25	0.	8.	
7.	91.5	2.	10.	
8.	106.75	0.	9.	
9.	122.	1.	9.	
10.	137.25	2.	8.	
11.	152.5	2.	9.	

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 feet 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

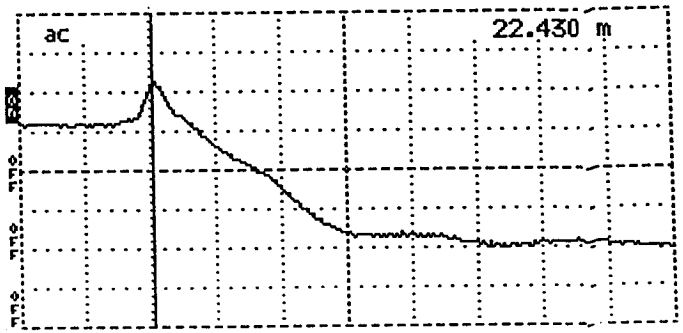
Installed Instrument Information

Appendix B includes the following supporting information:

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [32] LTPP Section ID [0204] SB01

1

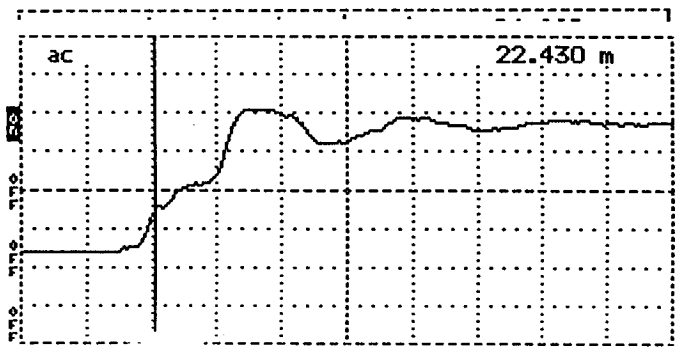
Cursor ..... 22.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB01
Notes SHORT
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



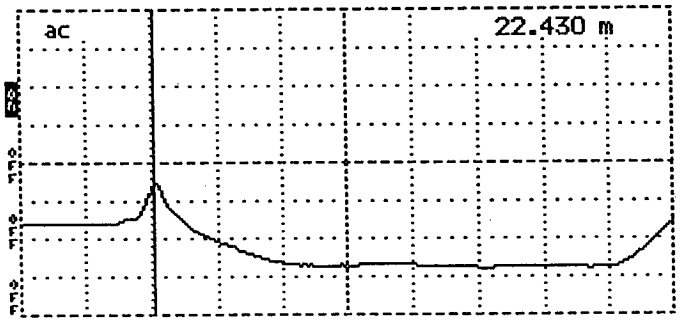
Tektronix 1502B TDR
Date 8-23-96
Cable 32SB01
Notes Air
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.250	1.5

Figure B1. TDR traces obtained during calibration, section 32SB01.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0204] 1 S801

Cursor ..... 22.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB01
Notes water
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.769	77.5

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SA1 Measured Length of Coax Cable: 19.3 m

Comments: _____

Prepared by: ME + KK Employer: NCE

Date (dd/mm/yy): 23/09/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B1. TDR traces obtained during calibration, section 32SB01 (cont'd).

Seasonal Monitoring Program Guidelines: Version 2.1/April 1994

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [32] LTPP Section ID [0204]

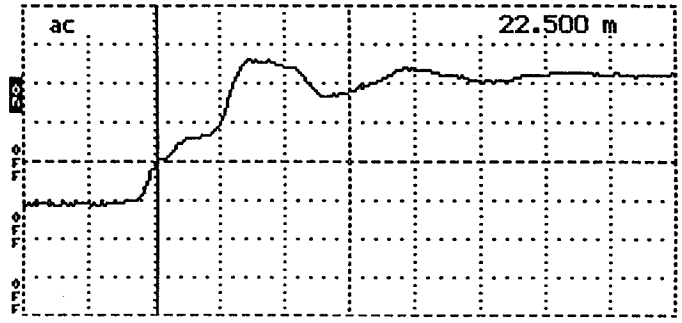
2' 32SB02

Cursor ..... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

Tektronix 1502B TDR
Date 8-23-96
Cable 32SB02
Notes short
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB02
Notes air
Input Trace
Stored Trace
Difference Trace

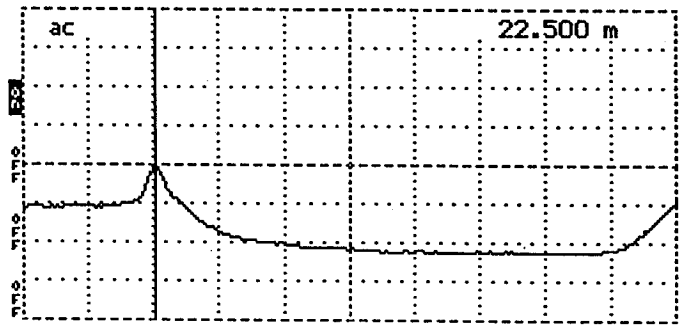
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.225	1.3

Figure B2. TDR traces obtained during calibration, section 32SB02.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0201]

2
32SB02

Cursor ..... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mV/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB02
Notes water

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

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SA02 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mike Pyrah Employer: NCE

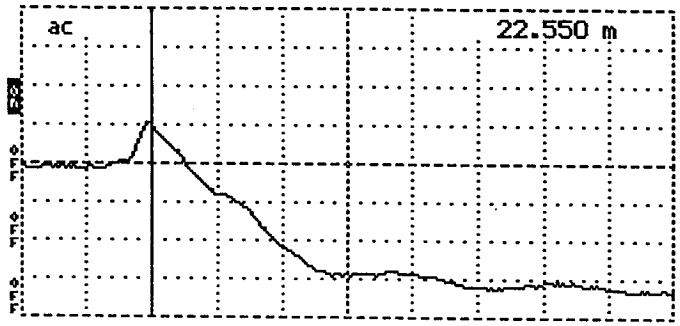
Date (dd/mm/yy): 23/09/96

Figure B2. TDR traces obtained during calibration, section 32SB02 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 2 0 4]

3
32SB03

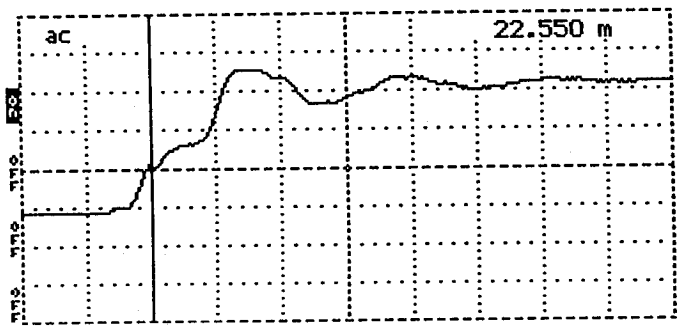
Cursor ..... 22.550 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB03
Notes short
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.550 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 8-23-96
Cable 32SB03
Notes air
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	__.200	__1.0__

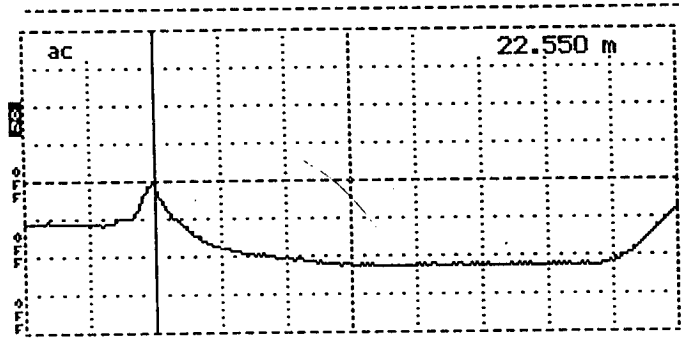
Data Sheet SMP-C01: TDR Probe Check

Figure B3. TDR traces obtained during calibration, section 32SB03.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0204]

3
32SB03

Cursor ..... 22.550 m
Distance/Div..... .25 m/div
Vertical Scale.... 281 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 6-23-96
Cable 32SB03
Notes water
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 3 Measured Length of Coax Cable: 1 8 . 3 m

Comments: _____

Prepared by: Mike Capel Employer: NCE

Date (dd/mm/yy): 2 3 / 0 2 / 9 6

Figure B3. TDR traces obtained during calibration, section 32SB03 (cont'd).

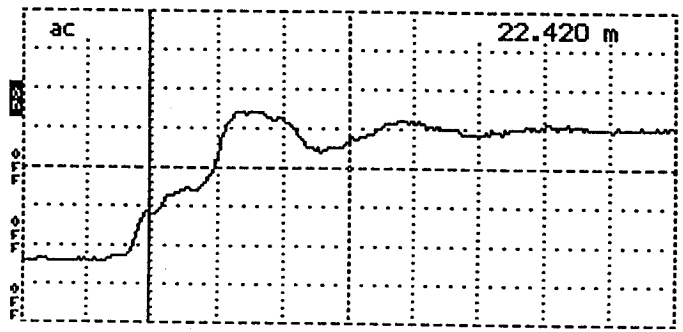
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [32] 4 LTPP Section ID [0204] 32SB04

Cursor ..... 22.420 m
Distance/Div..... .25 m/div
Vertical Scale.... 273 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac

Tektronix 1502B TDR
Date 8-23-96
Cable 32SB04
Notes Short
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.420 m
Distance/Div..... .25 m/div
Vertical Scale.... 273 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



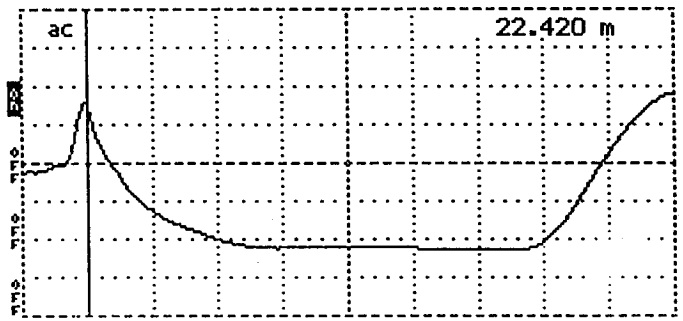
Tektronix 1502B TDR
Date 8-23-96
Cable 32SB04
Notes Air
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.225	1.3

Figure B4. TDR traces obtained during calibration, section 32SB04.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0204] 325B04

Cursor ..... 22.420 m
Distance/Div..... .25 m/div
Vertical Scale.... 163 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 325B04
Notes Water
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 325B04 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mike Cyrul Employer: NCE

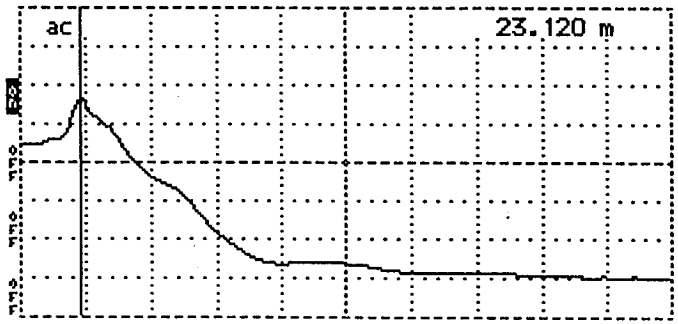
Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B4. TDR traces obtained during calibration, section 32SB04 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [32] LTPP Section ID [0204] 32SB05

Cursor ..... 23.120 m
Distance/Div..... .25 m/div
Vertical Scale.... 258 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac

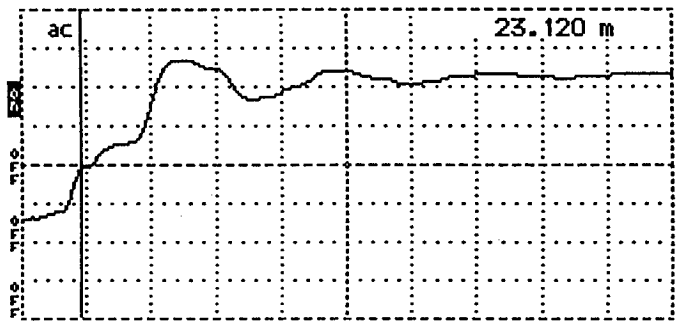


Tektronix 1502B TDR
Date 08/23/96
Cable 32SB05
Notes Short

Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 23.120 m
Distance/Div..... .25 m/div
Vertical Scale.... 258 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB05
Notes Air

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	.225	1.2

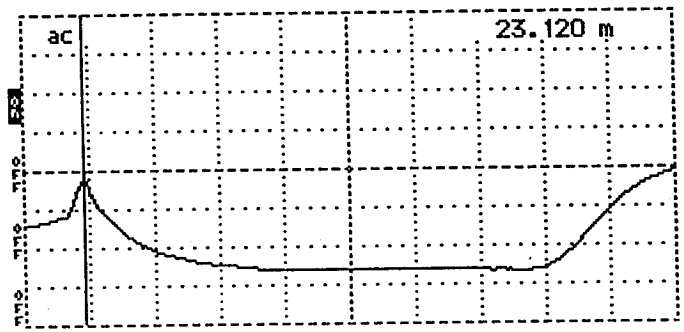
Data Sheet SMP-C01: TDR Probe Check

Figure B5. TDR traces obtained during calibration, section 32SB05.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 2 0 4]

5
325805

Cursor ..... 23.120 m
Distance/Div..... .25 m/div
Vertical Scale.... 258 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 325805
Notes water

Input Trace _____
Stored Trace _____
Difference Trace _____

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 5 1 0 5 Measured Length of Coax Cable: 1 8 . 3 m

Comments: _____

Prepared by: Mike Eppard Employer: NCE

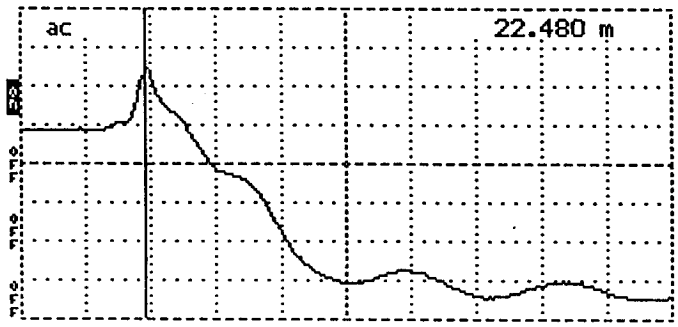
Date (dd/mm/yy): 2 3 / 0 8 / 9 6

Figure B5. TDR traces obtained during calibration, section 32SB05 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [32] LTPP Section ID [0204]

6

Cursor ..... 22.480 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

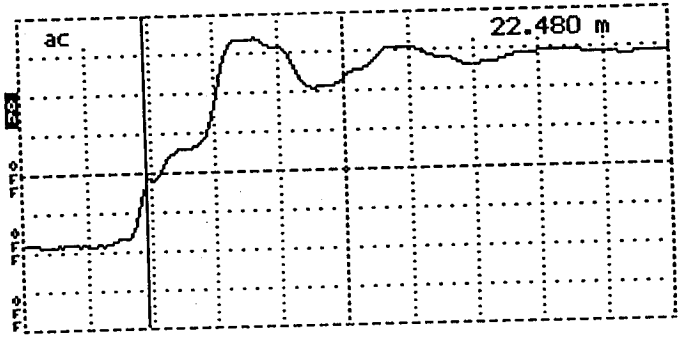


Tektronix 1502B TDR
Date 08/23/96
Cable 32SB06
Notes Short

Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.480 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB06
Notes Air

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	0.225	1.3

Data Sheet SMP-C01: TDR Probe Check

Figure B6. TDR traces obtained during calibration, section 32SB06.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 3] LTPP Section ID [0 2 0 4]

6

Cursor ..... 22.480 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

Tektronix 1502B TDR
Date 08/23/96
Cable 32SB06
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 6 Measured Length of Coax Cable: 1 9 . 3 m

Comments: _____

Prepared by: Mike Epel Employer: NCE

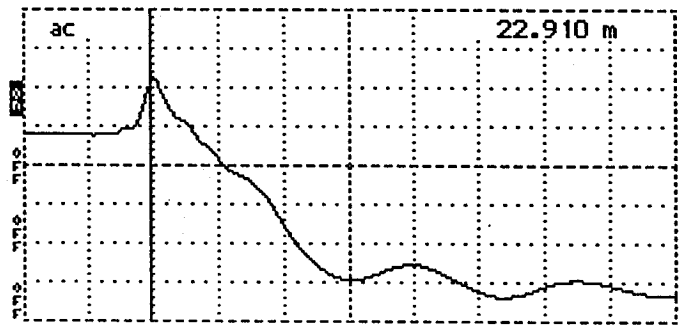
Date (dd/mm/yy): 2 3 / 0 8 / 9 6

Figure B6. TDR traces obtained during calibration, section 32SB06 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 2 0 4]

7
32 SB07

Cursor ..... 22.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

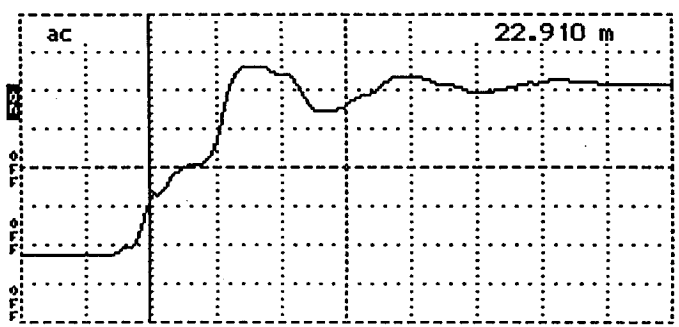


Tektronix 1502B TDR
Date 08/23/96
Cable 32 SB07
Notes Short

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

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

Cursor ..... 22.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32 SB07
Notes Air

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

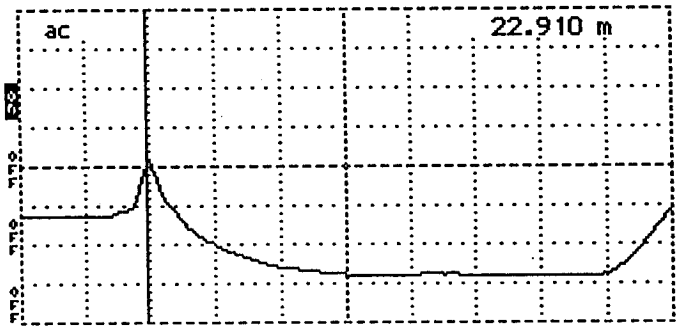
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.250	1.5

Figure B7. TDR traces obtained during calibration, section 32SB07.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0204]

7
32SB07

Cursor ..... 22.910 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB07
Notes Water
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SA07 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mel Cyt Employer: NCE

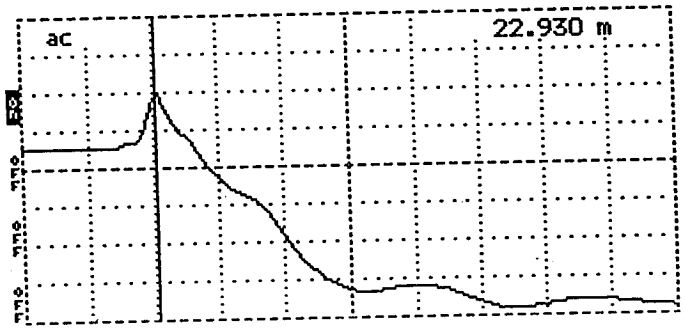
Date (dd/mm/yy): 23/07/96

Figure B7. TDR traces obtained during calibration, section 32SB07 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [6 2 0 4]

32SB08

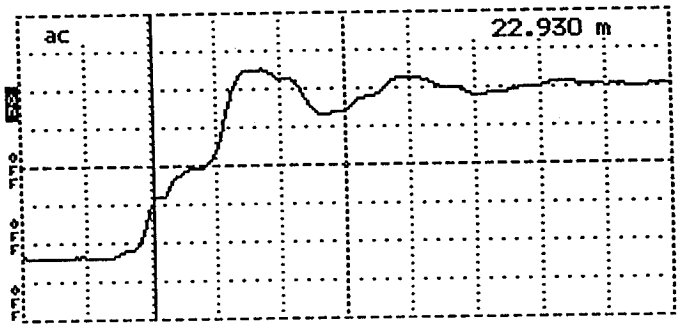
Cursor ..... 22.930 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB08
Notes
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 22.930 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB08
Notes Air
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	0.250	1.5

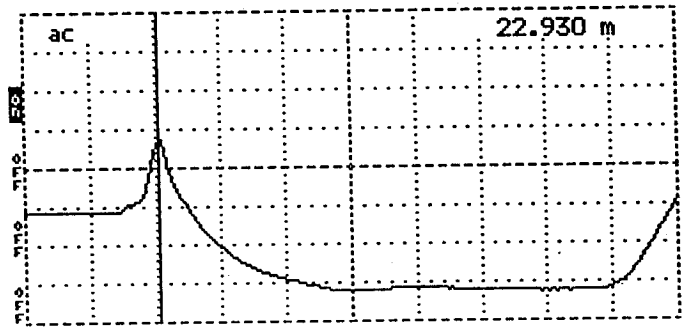
Data Sheet SMP-C01: TDR Probe Check

Figure B8. TDR traces obtained during calibration, section 32SB08.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 2 0 4]

8
325808

Cursor ..... 22.930 m
Distance/Div..... .25 m/div
Vertical Scale.... 154 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB08
Notes water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32S108 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mike Eyrel Employer: NCE

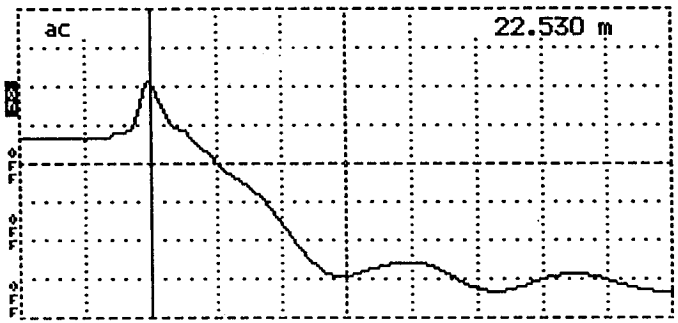
Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B8. TDR traces obtained during calibration, section 32SB08 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 L]	9
	LTPP Section ID [0 2 0 4]	32SB09

Cursor ..... 22.530 m
Distance/Div..... .25 m/div
Vertical Scale.... 211 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

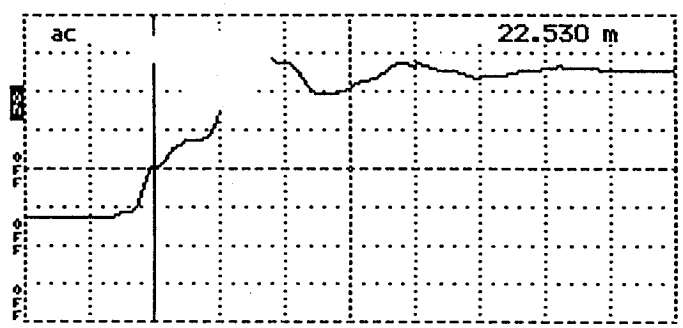


Tektronix 1502B TDR
Date 08/23/96
Cable 32SB09
Notes Short

Input Trace _____
Stored Trace _____
Difference Trace _____

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

Cursor ..... 22.530 m
Distance/Div..... .25 m/div
Vertical Scale.... 243 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB09
Notes Air

Input Trace _____
Stored Trace _____
Difference Trace _____

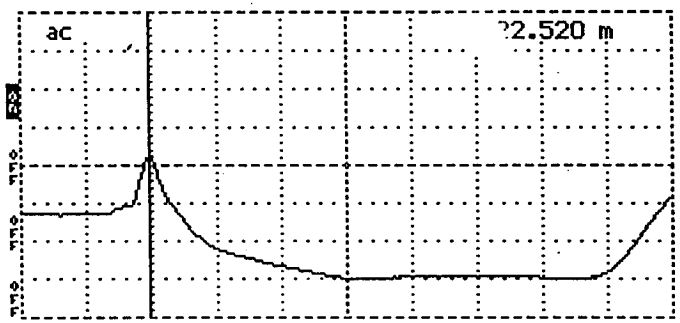
TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	.225	1.3

Data Sheet SMP-C01: TDR Probe Check

Figure B9. TDR traces obtained during calibration, section 32SB09.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] 9 LTPP Section ID [0204] 32SB09

Cursor ..... 22.520 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB09
Notes Water
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SA09 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mike Esperat Employer: NCE

Date (dd/mm/yy): 23/08/96

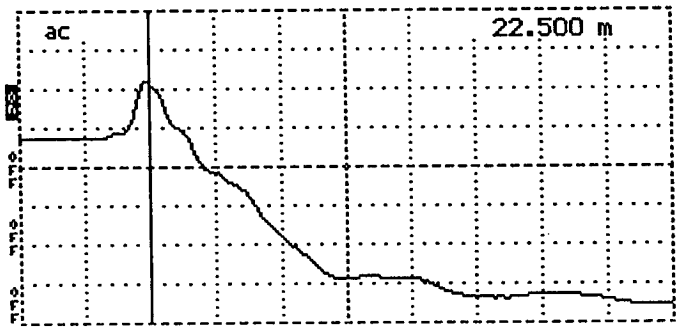
Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B9. TDR traces obtained during calibration, section 32SB09 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 2] LTPP Section ID [0 2 0 4]

10

Cursor ..... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 217 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

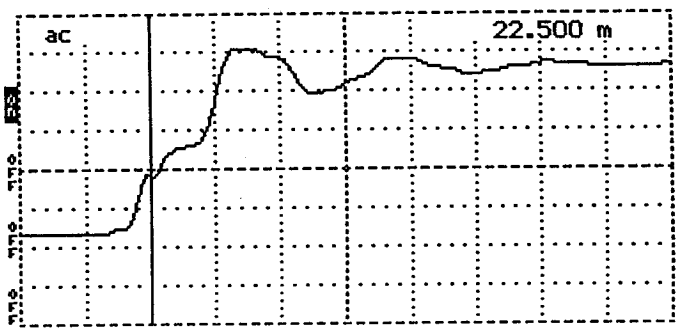


Tektronix 1502B TDR
Date 08/23/96
Cable 32SB10
Notes Short

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

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

Cursor ..... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 217 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB10
Notes Air

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

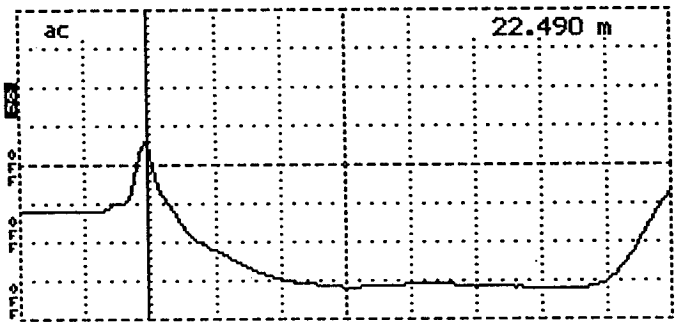
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	.200	1.0

Data Sheet SMP-C01: TDR Probe Check

Figure B10. TDR traces obtained during calibration, section 32SB010.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [ ] [2]	10
	LTPP Section ID [0 2 0 4]	

Cursor ..... 22.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 167 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB10
Notes Water

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

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SB10 Measured Length of Coax Cable: 18.3 m

Comments: _____

Prepared by: Mike Eyad Employer: NCE

Date (dd/mm/yy): 23 / 08 / 96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B10. TDR traces obtained during calibration, section 32SB10 (cont'd).

Table B1. Dielectric constants in various media during calibration.

State ID: **32**	Date: **26/08/96**	Eployed by: **NCE**
SHRP ID: **0204**	Calibrated by: **Mike Esposito**	

TDR Sensor Number	Calibration in air		Calibration in water	
	App. Length of Trace	Dielectric constant	App. Length of Trace	Dielectric constant
32SB01	0.250	1.5	1.769	77.5
32SB02	0.225	1.3	1.763	76.9
32SB03	0.200	1.0	1.763	76.9
32SB04	0.225	1.3	1.763	76.9
32SB05	0.225	1.3	1.763	76.9
32SB06	0.225	1.3	1.763	76.9
32SB07	0.250	1.5	1.763	76.9
32SB08	0.250	1.5	1.763	76.9
32SB09	0.225	1.3	1.763	76.9
32SB10	0.200	1.0	1.763	76.9

Appendix C

Installation Information

Appendix C has the following supporting information:

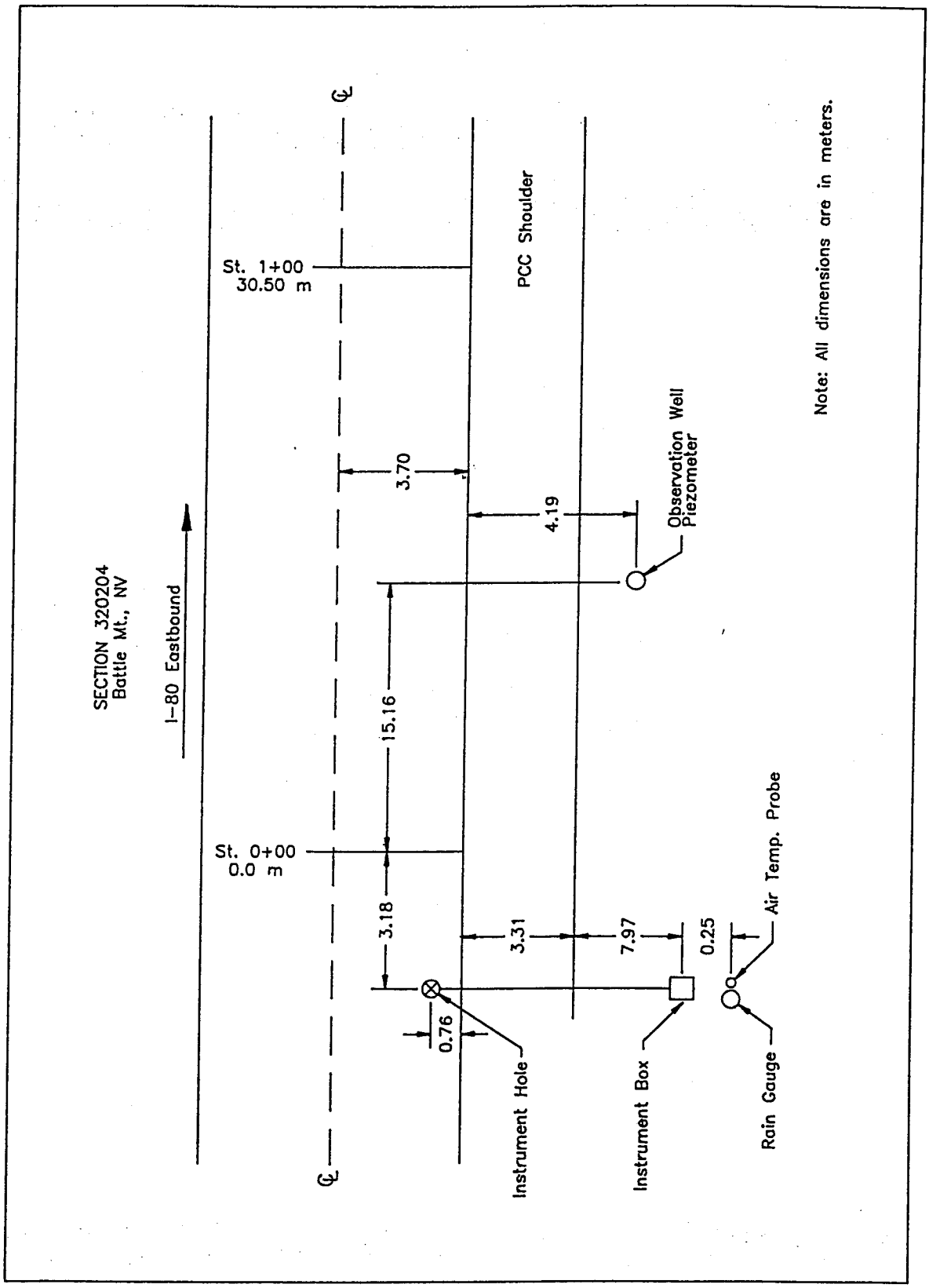
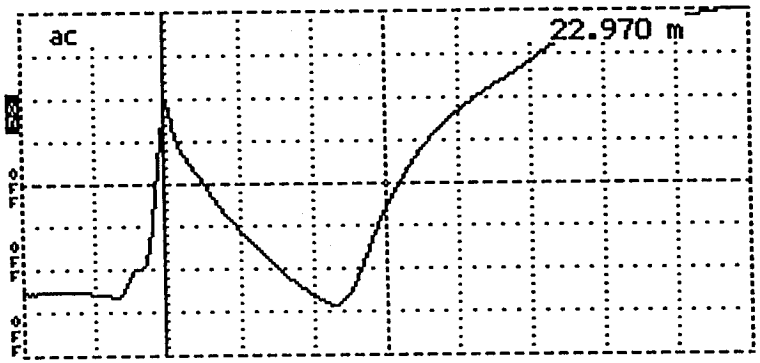


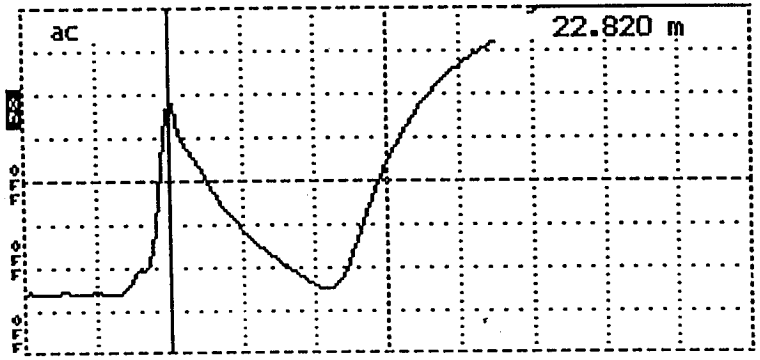
Figure C1. Instrumentation location within the section.

Cursor ..... 22.970 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



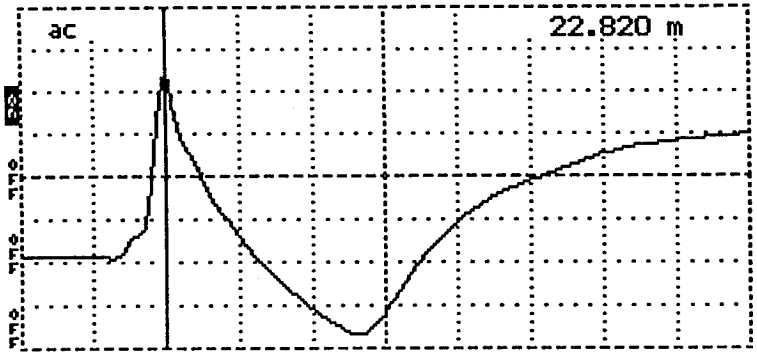
Tektronix 1502B TDR
Date OCT 9- 1996
Cable 325B96,05
Notes Good Trace
Input Trace
Stored Trace
Difference Trace

Cursor ..... 22.820 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



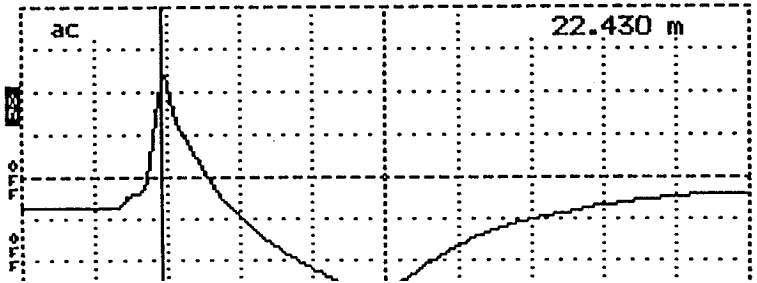
Tektronix 1502B TDR
Date OCT 9 1996
Cable 325B96- 06
Notes Good trace
Input Trace
Stored Trace
Difference Trace

Cursor ..... 22.820 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date OCT 9 - 1996
Cable 325B96,07
Notes Good trace
Input Trace
Stored Trace
Difference Trace

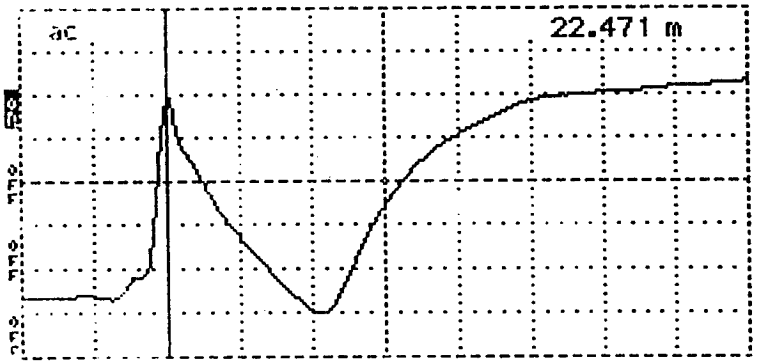
Cursor ..... 22.430 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date OCT 9, 1996
Cable 325B96,08
Notes Good trace
Input Trace
Stored Trace

Figure C2. TDR traces obtained during installation.

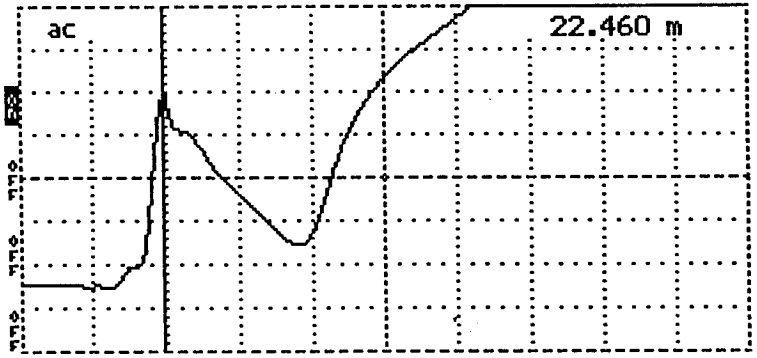
Cursor ..... 22.471 m
Distance/Div..... .25 m/div
Vertical Scale.... 66.7 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10-9-96 (October)
Cable 32SB96, 01
Notes Good trace

Input Trace
Stored Trace
Difference Trace

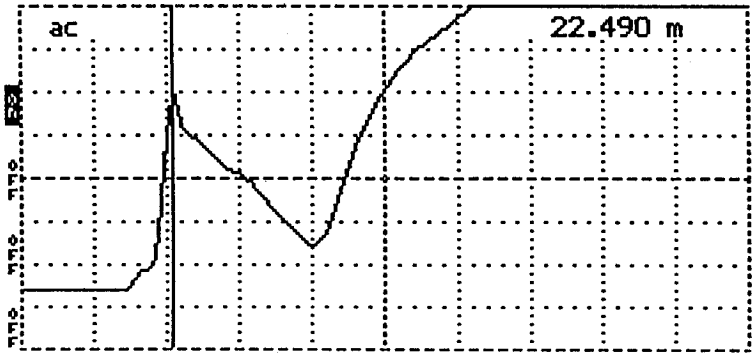
Cursor ..... 22.460 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date OCT 9 - 1996
Cable 32SB96, 02
Notes Good Trace

Input Trace
Stored Trace
Difference Trace

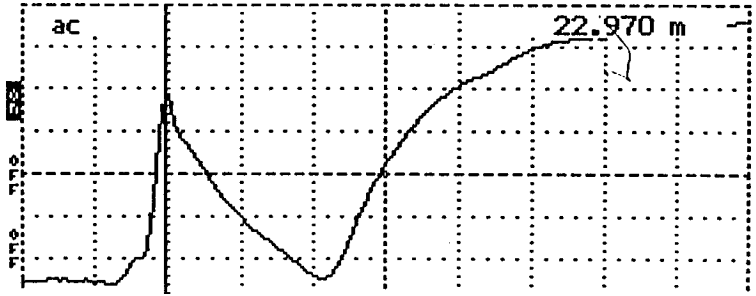
Cursor ..... 22.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date OCTOBER 9 - 1996
Cable 32SB96, 03
Notes Good trace

Input Trace
Stored Trace
Difference Trace

Cursor ..... 22.970 m
Distance/Div..... .25 m/div
Vertical Scale.... 68.6 mΩ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date OCT 9 - 1996
Cable 32SB96 - 04
Notes Good trace

Input Trace
Stored Trace

Figure C2. TDR traces obtained during installation (cont'd).

Figure C2. TDR traces obtained during installation (cont'd).

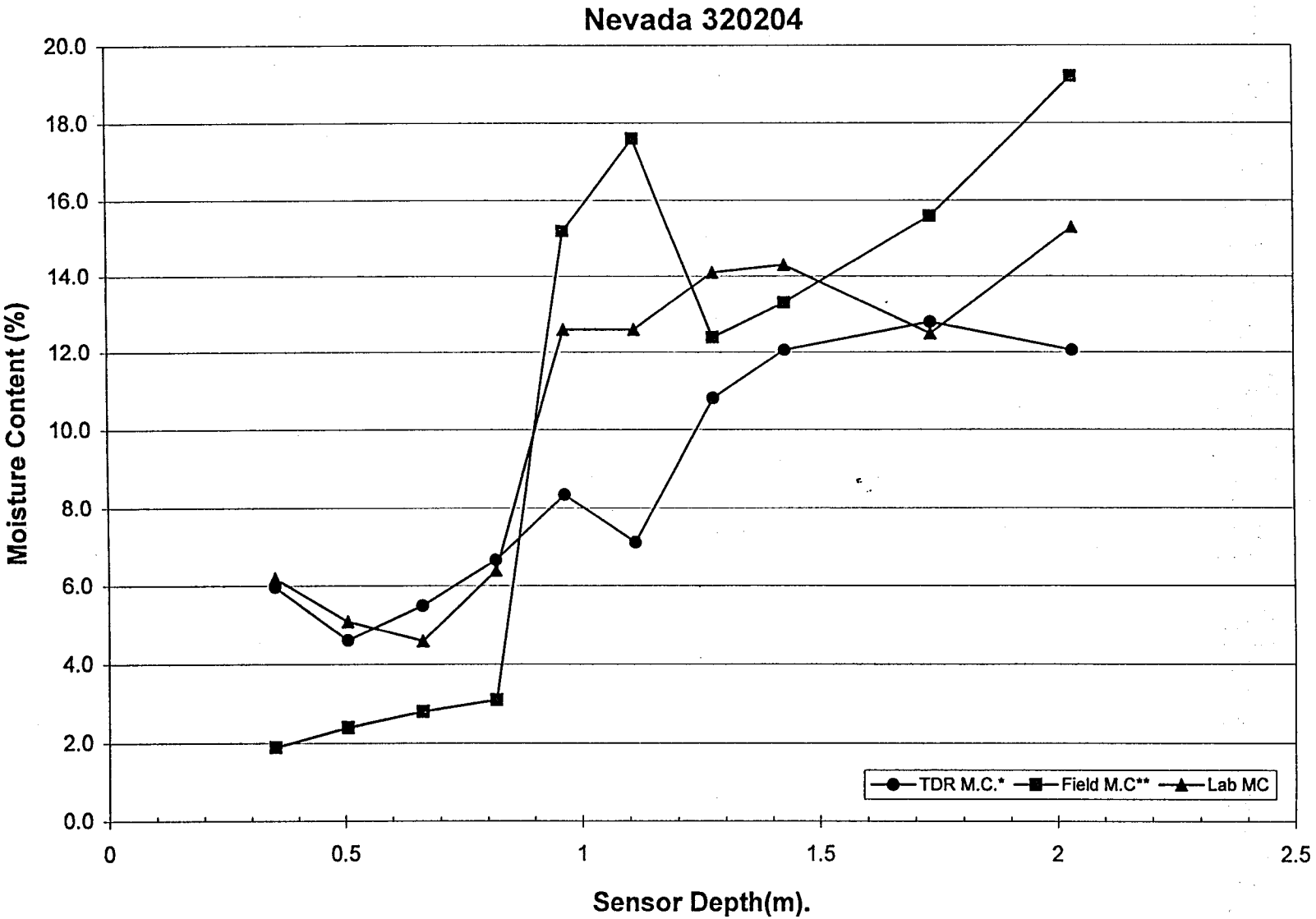


Figure C3. Moisture contents at TDR sensor depths during installation.

Figure C4. Installation of thermistor unit #1.

Figure C5. Instrumentation hole after repair.

Table C1. Measured field moisture contents during installation.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	* State Code [32] * Test Section Number [0204]

Personnel : Phil Friedman
Date : 8/15/95
Start Time : NA
Finish Time : NA
Surface Type : Portland Cement Concrete
Weather Conditions : Clear, Sunny
Unusual Conditions : None

TDR Sensor Number	Field Measured Moisture Content %
10	19.2
9	15.6
8	13.3
7	12.4
6	17.6
5	15.2
4	3.1
3	2.8
2	2.4
1	1.9

Appendix D

Initial Data Collection

Appendix D includes the following supporting information:

Figure D1. Hourly average air and top five sensor temperature during initial data collection.
Table D1. Pavement surface elevations during initial data collection.
Table D2. Joint opening measurements during installation.
Table D3. Joint faulting measurements during installation.

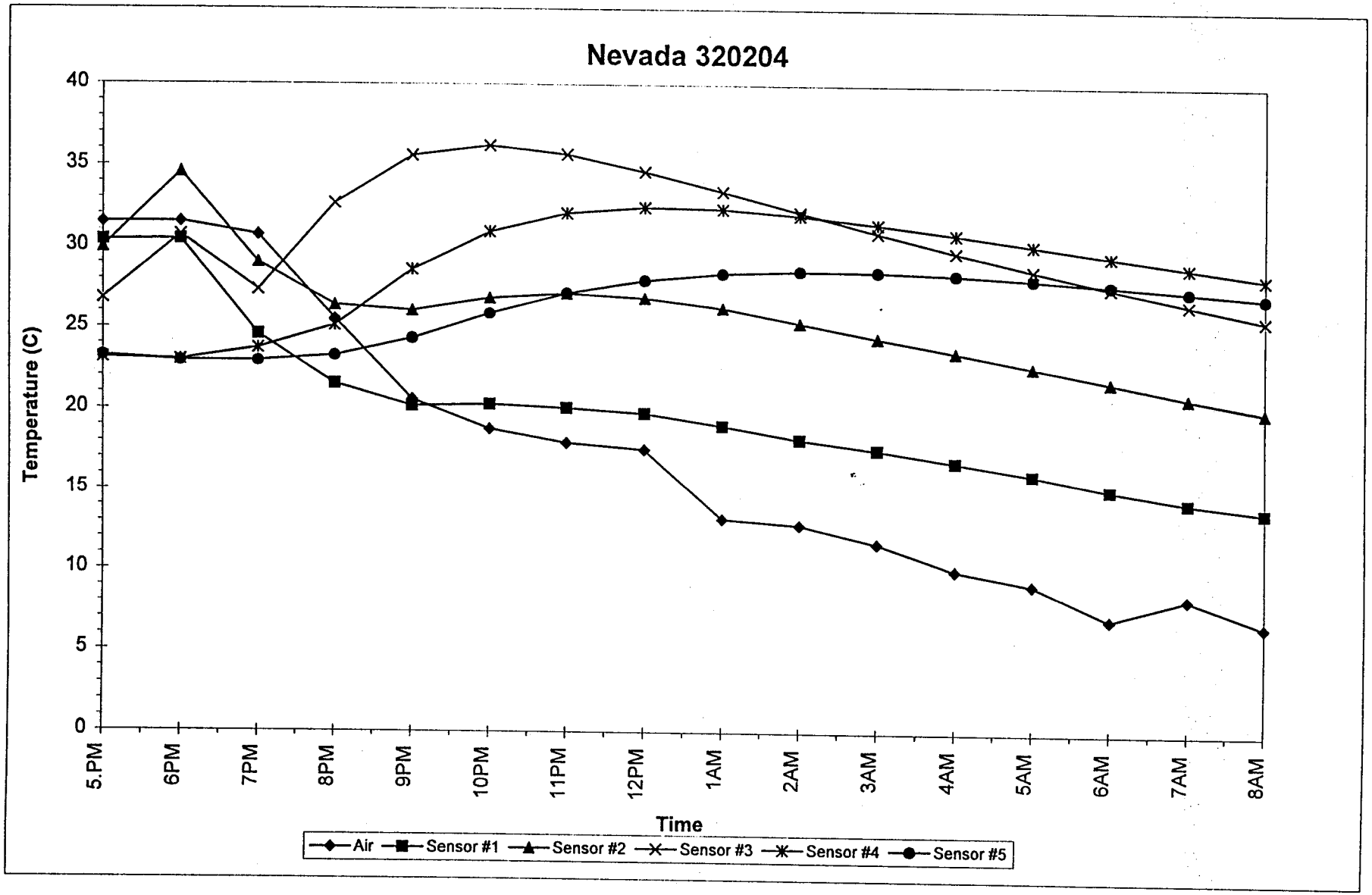


Figure D1. Hourly average air and top five sensor temperature during initial data collection.

Table D1. Pavement elevations at the time of installation.

Station	Offsets in m.			Comments
	PE[1] (0.30)	ML[2] (1.80)	ILE[3] (3.40)	
5.183	1.371	1.397	1.428	Elevation Measurements at Same Locations as FWD Tests
3.048	1.365	1.397	1.429	
0.915	1.367	1.394	1.427	
3.963	1.363	1.390	1.419	
6.098	1.361	1.387	1.420	
8.232	1.363	1.390	1.419	
8.537	1.363	1.391	1.421	
10.671	1.359	1.388	1.417	
12.805	1.358	1.387	1.419	
13.109	1.359	1.387	1.417	
15.244	1.356	1.383	1.418	
17.378	1.358	1.385	1.417	
17.683	1.357	1.385	1.419	
19.817	1.354	1.380	1.414	
21.951	1.358	1.387	1.417	

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

Table D2. Joint opening measurements during installation.

LTPP Seasonal Monitoring Program Data Sheet SMP-D06 Joint Opening Measurements	Agency Code [32] LTPP Section ID [0204]

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	
0-18	11.07 14.00	112.93 112.75	113.41 113.13	119.02 118.75	14.22 14.33
0+12	11.08 14.01	120.04 119.51	117.93 117.45	116.56 116.05	14.48 14.48
0+27	11.09 14.02	114.37 113.92	113.82 113.41	118.08 117.65	14.48 14.63
0+42	11.10 14.03	112.14 111.65	108.89 108.54	116.08 115.72	15.24 15.24
0+57	11.11 14.04	113.79 113.31	107.95 107.57	110.72 110.31	14.48 14.48
0+72	11.12 14.05	113.67 112.90	113.31 112.73	121.36 120.80	14.99 14.99

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

Prepared By: Richard Smith Employer: NCE

Date (dd/mm/yy): 11/10/96

Data Sheet SMP-D06: Joint Opening Measurements

Table D3. Joint faulting measurements during installation.

LTPP Seasonal Monitoring Program Data Sheet SMP-D07 Joint Faulting Measurements	Agency Code [32] LTPP Section ID [0204]

Station (ft.)	Time (Military)	Joint Faulting (mm)		
		Offset (OWP)[1] 0.30m	Offset (ML)[2] 1.80m	Offset (IWP)[3] 3.40m
0-18	1124	0.1	0.0	0.2
0+12	1125	0.1	0.1	0.0
0+27	1126	0.0	0.2	0.1
0+42	1127	0.2	0.2	0.1
0+57	1128	0.1	0.0	0.2
0+72	1129	0.1	0.1	0.2

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

Prepared By: Richard Smith Employer: NCE

Date (dd/mm/yy): 11/10/96

Data Sheet SMP-D07: Joint Faulting Measurements.