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LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection Section 421606, Altoona Pennsylvania

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Notice

LTPP Seasonal Monitoring Program

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15. Supplementary Notes The report is a cooperative effort between Pennsylvania Department of Transportation (PADOT), Long Term Pavement Performance (LTPP) Division Federal Highway Administration (FHWA), and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office (NARCO).		
16. Abstract This report provides a description of the installation of seasonal monitoring instrumentation and initial data collection for the seasonal experimental study conducted as part of the Long Term Pavement Performance (LTPP) program at the General Pavement Study (GPS) section 421606 on SR 220 near Altoona, Pennsylvania. This Jointed Reinforced Concrete Pavement (JRCP) pavement test section was instrumented on August 09, 1995. The instrumentation installed included time domain reflectometry (TDR) probes for moisture content, thermistor probes for temperature, resistivity probe for frost depth, tipping bucket rain gauge, piezometer to monitor the ground water table, snap rings to measure joint opening, and an on-site datalogger. Initial data collection was performed on August 10, 1995 which consisted of deflection measurements with a Falling Weight Deflectometer (FWD), joint opening and faulting, elevation, temperature, frost depth, TDR, and water table measurements. Profile data will be collected during scheduled visits with the LTPP profiler. The report contains a description of the test site and its location, the instruments installed, their locations and characteristics, problems encountered during installation, specific site circumstances and deviations from the standard guidelines, and a summary of the initial data collection.		
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I. Introduction

The installation of the LTPP instrumentation on seasonal site 421606 near Altoona, Pennsylvania was performed on August 09 - August 10, 1995. The test section is a GPS-4 experiment, located on Northbound Route 220, approximately 1.0 kilometer North of S.R.4034 (Figure A-1 in Appendix A). The highway consists of two 3.7 m wide Jointed Reinforced Concrete Pavement (JRCP) lanes in each direction with a 3.0 m wide asphalt concrete paved outside shoulder and a 1.2 m wide asphalt concrete paved inside shoulder. The Portland cement slabs are jointed at 14.02 meters.

The pavement structure consists of 250 mm of reinforced concrete on 210 mm of crushed gravel base. The subgrade consists of gravely lean clay with sand and boulders. Pavement structure information from the GPS material drilling logs is presented in Appendix A, Figure A-2. Properties determined from the laboratory material tests are shown in Table 1.

Table A-1 in Appendix A summarizes the distress, IRI values from the LTPP profiler longitudinal profile measurements, and Falling Weight Deflectometer deflection values as monitored since 1989. The uniformity survey results are summarizes in Table A-2 and the deflection values and analysis results from the FWDCHECK are also presented in Appendix A.

The site is in a wet-freeze zone and resides in cell 28 (Jointed Reinforced Concrete on fine subgrade soil) of the Seasonal Monitoring Program. Salt is frequently used for ice control at this location (20 to 30 times a year). Listed below is a summary from the LTPP climate database, based on eleven years of data:

- Freezing Index (C-Days) 351
- Precipitation (mm) 914
- No. of Freeze/Thaw Cycles 86
- Days Above 32°C 4
- Days Below 0°C 118
- Wet Days 152

The annual average daily traffic (AADT) in 1993 was 6852 for the entire road. 48.6% of the traffic was in the GPS direction and 44.5% in the GPS lane (3049 AADT in GPS lane). 15.3% of the GPS lane volume consisted of trucks. This data was gathered from 319 days of volume and vehicle classification data. The estimate of the annual ESALS in the GPS lane is 196.3 KESALS using vehicle ESALS taken from 5 days of WIM data in 1994.

Installation of the instrumentation was a cooperative effort between Pennsylvania Department of Transportation (PADOT), Federal Highway Administration Long Term Pavement Performance Division, and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office staff. The following personnel participated in the instrumentation installation:

Hesham Ali	FHWA
John Klemunes	FHWA
Debbie Walker	FHWA/TXDOT
Ali Al-Dughaim	M.O.C. Saudi Arabia
Mike Gomolka	L. Robert Kindall Associates
Randy Kirsch	L. Robert Kindall Associates
Sam Onyeaka	PADOT - Central Office
Paul Roberts	PADOT Engineering District 9-0
Pete Simpson	PADOT Engineering District 9-0
Wally Tomassetti	PADOT Engineering District 9-0
J. Brough	PADOT St. Clairsville Maintenance
B. McDonald	PADOT St. Clairsville Maintenance
T. Paul	PADOT St. Clairsville Maintenance
P. Ritchey	PADOT St. Clairsville Maintenance
T. Ritchey	PADOT St. Clairsville Maintenance
H. Shroyer	PADOT St. Clairsville Maintenance
Steve Walter	PADOT St. Clairsville Maintenance
W. Welsh	PADOT St. Clairsville Maintenance
Brandt Henderson	Pavement Management Systems (NARCO)
Alfred Lip	Pavement Management Systems (NARCO)
Douglas Marshall	Pavement Management Systems (NARCO)
Randy Plett	Pavement Management Systems (NARCO)
Dilan Singaraja	Pavement Management Systems (NARCO)

Table 1. Material Properties

Description	Surface	Base	Subgrade
Material (Code)	Portland Cement Concrete JRCP (05)	Crushed Gravel (304)	Gravely lean Clay with Sand and Boulders (117)
Thickness (mm)	254	213	
Lab Max Dry Density (kg/m^3)		2307	1898
Lab Opt Moisture Content (%)		6	12
In-situ Wet Density (kg/m^3) *			
In-situ Dry Density (kg/m^3) *			
In-situ Moisture Content (%) *			
Liquid Limit		20	32
Plastic Limit		15	19
Plasticity Index		5	13
% Passing # 200		7.8	47.3

* Note: Not collected for PCC pavements

II. Instrumentation Installation

Site Inspection and Meeting with Highway Agency

A preliminary planning meeting was held at the District 9-0 engineering office in Hollidaysburg, Pennsylvania on July 21, 1995. The attendees at the meeting were:

• Glen Keipar	PA DOT District 9-0, Geotechnical Engineer
• Mike Long	PA DOT Pavement Design, Pavement Engineer
• Ed Stolte	PA DOT District 9-0, Liaison Engineer
• Wally Tomassetti	PA DOT District 9-0, Pavement Management Engineer
• Brandt Henderson	PMSL, Field Operations Manager
• Bill Phang	PMSL, Program Manager

A presentation on the installation of seasonal monitoring instrumentation and monitoring requirements were provided by Bill Phang and Brandt Henderson of Pavement Management Systems. Plans for the installation on August 09 and August 10, 1995 were discussed. Concerns were raised regarding the equipment availability for coring and augering the instrumentation hole. The district did not have available equipment capable of coring 305 mm or augering 250 mm to a depth of 2 meters. Mr. Wally Tomassetti was to look into contracting the drilling and coring to a local soils firm. There was some concern of encountering boulders during the drilling operations. It was decided that the weather station post hole be drilled first to determine if there were any boulders at the planned location.

Following the meeting the site was visited by Wally Tomassetti (PADOT), Bill Phang, and Brandt Henderson of PMSL. A visual survey of the general location was conducted with potential locations for instrument hole, combination piezometer/bench mark and cabinet/weather pole. The weather pole and cabinet were to be placed at least 9.14 m from the pavement edge on the East side of the embankment. Extensions would be required for the TDR cables to set the cabinet 9.14 m from the pavement edge. Site distances and traffic control requirements were reviewed. The adjacent SPS 3 sections were to have a FWD and Manual Distress Survey (MDS) at the time of installation. This would require extending the traffic control to the limits of the SPS 3 experiment section. Correspondence from the site inspection and planning meeting are in Appendix B.

A pre-installation meeting was held at the District 9-0 office in Hollidaysburg, PA on August 08, 1995. Arrangements were made to meet on site at 0800 hours with traffic control to be in place by 0830 hours.

Equipment Installed

The equipment installed at the test site included instrumentation for measuring air, pavement and subsurface temperature, subsurface moisture content, frost depth, precipitation, and water table. An equipment cabinet was installed to hold the datalogger, battery pack, and all electrical connections from the instrumentation. A list of the equipment installed is shown in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial Number
Instrumentation Hole		
MRC Thermistor Probe	1	42AT
CRREL Resistivity Probe	1	42AR
TDR Probes	10	42A01-42A10
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16573
Campbell Scientific PS12 Power Supply	1	5662
Weather Station		
TE525MM Tipping Bucket Rain Gage	1	12097-693
Campbell Scientific 107-L Air Temperature Probe	1	42AAT
Observation Well/Bench Mark	1	N/A

Equipment Check/Calibration

Prior to installation, each measurement instrument was checked or calibrated. The tipping bucket rain gauge was connected to the CR10 datalogger for calibration. A plastic container with 473 ml of water was placed in the tipping bucket. The container had a small hole in the bottom, which allowed all the water to be drained out in 45 minutes. For the 473 ml of water, the tipping bucket should measure 100 tips $\pm$ 3 tips. The results showed 100 tips, which was within specification.

The air temperature and thermistor probes were connected to the CR10 datalogger simultaneously. They were checked by placing the probes in ice, room temperature, and hot water. In order for the probes to pass this check, the temperatures for each probe should correspond to the water temperature. The check indicated that the air temperature and thermistor probes were working properly. A second check was done where the air temperature and thermistor probes were connected to the datalogger and run, in air, for 24 hours. The minimum, maximum, and mean temperature for each sensor were checked. All 18 thermistors were similar in their minimum, maximum, and mean readings respectively, therefore the probes were considered functioning correctly. The results of the air temperature and thermistor probes along with the spacing between the thermistors are presented in Appendix B.

The wiring of the resistivity probe was checked using continuity measurements between each electrode and the corresponding pins on the connector. The distance between each electrode was measured and recorded as shown in Table B-4 in Appendix B. Contact resistance measurements were performed with the probe immersed in a salt water bath. The results of these measurements are presented in table B-5 and B-6 of Appendix B for two and four-point resistance respectively. The initial data collected indicates that the probe is functioning correctly. Due to defects in the manufacturing, clear silicon sealant was used to cover exposed wires to the electrodes. The checks on the resistivity probe indicated all electrodes were functioning as expected with reasonable resistance values.

The functioning of the TDR probes were checked by performing measurements in air, water, methyl alcohol, and with the prongs shorted at the circuit board and at the end of the probe. The traces were taken and the dielectric constant was calculated for the water, air, and methyl alcohol. These values were checked against expected dielectric constants for each medium. The test indicated that all probes were functioning properly. Results of the TDR measurements are presented in Appendix B.

Equipment Installation

The installation was confirmed for 0830 hours on August 09, 1995. Traffic control for the installation and monitoring was provided by Pennsylvania Department of Transportation, St. Clairsville maintenance yard. The pavement surface drilling and the instrumentation hole augering was conducted by Mike Gomolka and Randy Kirsch of L. Robert Kindall Associates. The augering of the post hole, and combination piezometer/ bench mark was done by PADOT equipment and drillers Paul Roberts and Pete Simpson. H. Shroyer of PADOT sawed the trench for the cabling. The installation of the measurement equipment, the observation piezometer, weather station pole, and cabinet was performed by PMSL staff. Assistance was provided by John Klemunes and loan staff/visiting researchers from the FHWA-LTPP division office, and PADOT personnel.

The instrumentation was installed on the North end of GPS 421606, in the Northbound lane of route 220, 1.0 km North of the junction with route S.R.4034 near Altoona, Pennsylvania. The combination bench mark/piezometer was placed in the shoulder at station 4+00. The in-pavement instrumentation was installed in the outer wheel path at station 5+32. The stainless steel pavement surface temperature probe was installed against the wall of the trench. The cabling from the instrumentation was placed in a 51 mm flexible conduit and buried in a trench running from the instrument hole to an equipment cabinet installed on the slope of the roadway embankment, 10.7 m from the instrumentation hole. The weather pole was installed immediately behind the equipment cabinet. Figure 1 provides the location and distances for the various instrumentation and equipment installed.

The installation generally followed the procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". There was some confusion on the day of the installation because of the presence of the core holes in the slab adjacent to the 5+00 end. Ideally the instrument hole should have been in a slab that did not contain any deformations. The 0+00 end also contained the core holes, therefore the 5+00 end was retained as the location for the instrument hole. The post hole was drilled first to determine if the presence of boulders would dictate the location of the weather station and thus the instrument hole. No boulders were encountered at the post hole location. The combination piezometer/bench mark was installed a few centimeters from the edge of the paved shoulder to a depth of 4.3 m at station 4+00. A 150 mm flight auger was used for drilling the hole. Water was not encountered during the drilling.

The instrument hole was drilled in the pavement surface, in the outside wheel path, 1.04 m from the edge of the travel lane at station 5+35. A 305 mm diamond cutting bit attached to a truck mounted drilling unit was used for this purpose. The driller had a few problems with the bit binding and catching on the reinforcing steel which resulted in a delay in completing the hole. The resulting hole had rough edges for good bonding with the PCC patch. A 127 mm wide by 220 mm deep saw cut was made between the core hole and the edge of the pavement, using a heavy duty pavement sawing machine. The remainder of the material from the trench was removed with picks and shovels.

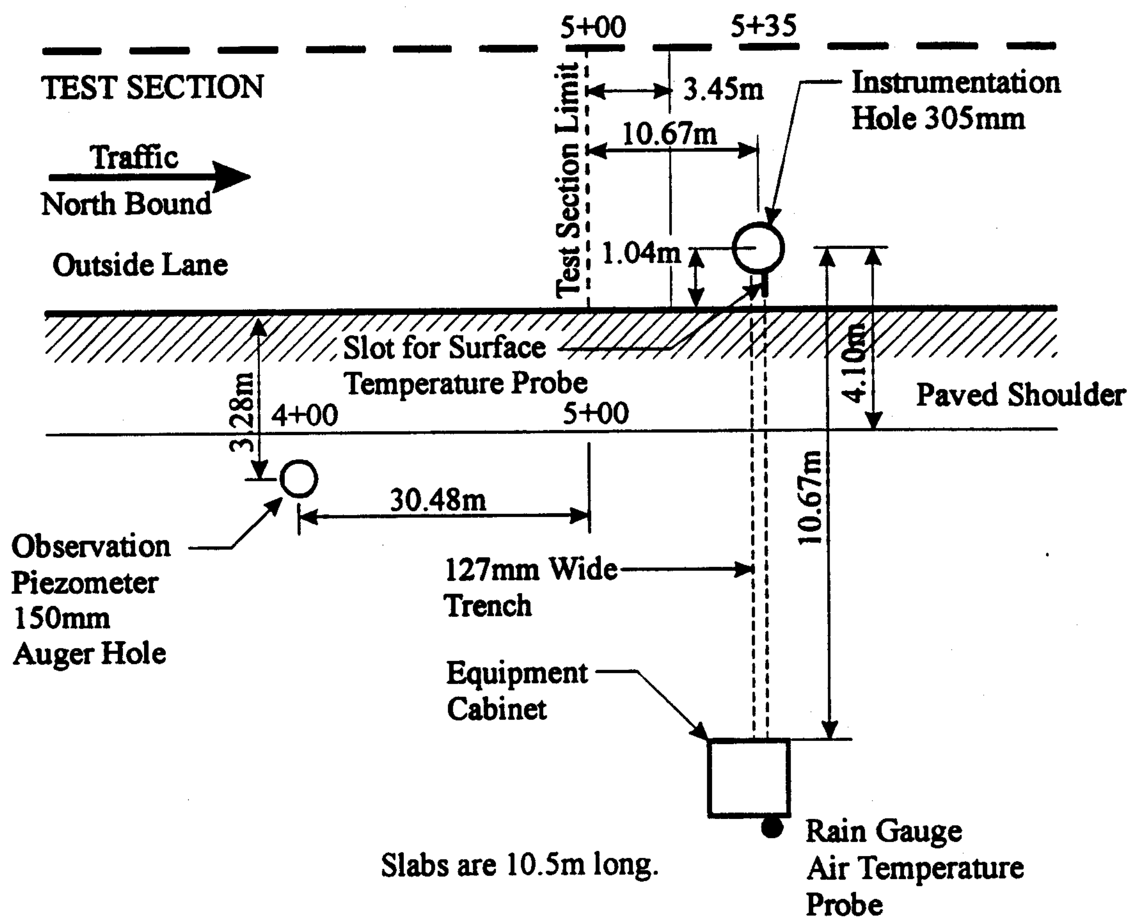
A 305 mm flight solid stem auger was used initially to drill the instrument hole. This was a tight fit through the 305 mm hole drilled in the concrete layer. The road base consisted of crushed stone. The subgrade soil consisted of a mixture of silts and clays. Cobbles were encountered from a depth of 1.27 m to a depth of 1.52 m. At approximately 1.6 m below the surface the stem of the auger broke off. From this depth on PADOT's 250 mm hollow stem auger was used until completion of the hole at a depth of 2.11 m. The hollow end of the auger was blocked off such that less material mixing would occur. Material was removed in 0.3 to 0.4 m lifts. Care was taken to ensure that the material was stored in the order of excavation. The material removed was stored in buckets with distinct layers separated. The findings from the drilling is presented in Figure 2.

The material extracted from the hole was then placed and compacted in order of removal with the instrumentation in place. During the placement of the instrumentation the materials put back in the hole were compacted as firmly as possible, yet excess material remained from each layer. Placement and compaction of the instrumentation and materials was rotated between FHWA, PENDOT, and PMSL personnel to provide everyone with the opportunity to experience the placement of the instrumentation. Rain arrived in the latter part of the afternoon before all instrumentation was installed. A tent was set up over the instrumentation hole such that water could not enter the instrument hole.

Samples of the material placed around each TDR probes were retrieved and a field moisture determination was conducted at the site with sample material retained for laboratory moisture determination by the PADOT Materials and Research Laboratory. A summary of the TDR, field, and laboratory moisture contents can be found in table 6. Two Standard Proctor tests were conducted in the field to determine the density of the soil layers. Mr. John Klemunes demonstrated the procedure to some persons on site. The sample from the crushed gravel base (0.4 m depth) yielded a dry density of 2030 kg/m^3 at

3.9% moisture content. The second test conducted on the clayey silt layer from a depth of 1.2 m yielding a density of 1940 kg/m^3 at 8.5% moisture. The dry density calculation data sheets are presented in Tables C-3 and C-4 of Appendix C. Approximately 0.07 m^3 of material remained after the compaction of the instrument hole. It is possible that the stones and cobbles extracted from the hole did not compact effectively in the lateral direction. At the time of compaction the soils seemed to be compacted to a stable state. The section will be monitored for settlement.

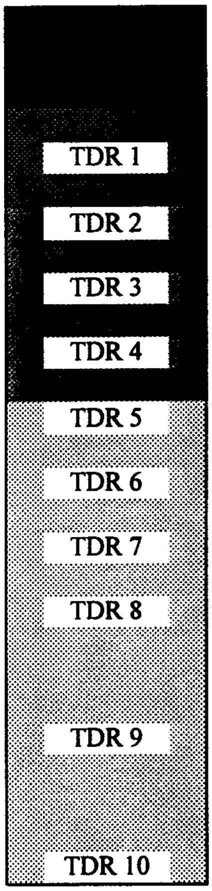
The equipment cabinet and pole for the rain gauge and air temperature probe were installed as per manual guidelines. The excavation of the trench proceeded smoothly. The wiring of the instrumentation to the equipment cabinet was completed on the second day of installations, August 10, 1995.



- Height of Air Temperature Probe: 2.81m
- Height of Tipping Bucket Rain Gauge: 2.85m
- Depth of Piezometer: 4.30m

Figure 1. Location of Seasonal Monitoring Instrumentation Installed at GPS 421606

Material	Depth (mm)
Jointed Reinforced Concrete Pavement (JRCP)	260
Crushed Stone	510
Silty Clay	900
Clayey Silt some Cobbles	2110



TDR depth (mm)	Comments
	Average Core Depth 260 mm
380	Resistivity Probe Depth 286 mm Thermistor Probe Depth 311 mm Dry Density 2030 kg/m^3
550	
690	
850	
1000	Dry Density 1940 kg/m^3
1160	
1300	
1460	
1780	
2030	

Figure 2. Profile of Pavement Structure and Probe Depths from Surface, Station 5+35

To check for breakage of the TDR probes during installation, each probe was connected to the cable tester and it's wave form monitored during compaction of the material around it. The TDR traces are included in Appendix C. The TDR probes were placed such that the cables coming out of them were evenly spaced around the perimeter of the hole to avoid water migrating along a bundle of cables. 1.52 m coaxial cable extensions were added to the 12.19 m TDR cables to extend the cable length to match the offset of the equipment cabinet. The top TDR probe was inverted to prevent damage to the cable and printed circuit board, from the PCC surface. The thermistor and resistivity probes were installed at opposite sides of the instrumentation hole with the thermistor probe 0.311 m and the resistivity probe 0.286 m below the pavement surface. The cables were kept spaced as much as possible until they converged at the opening of the flexible conduit pipe, placed about 50 mm from the edge of the core hole. The cables were then tie wrapped and passed through the conduit to the equipment cabinet. The ends of the conduit were plugged with a mastic pipe sealant.

Tables 3, 4, and 5 present the installed depths of the TDR probes, thermistor sensors, and the resistivity probe respectively. Table 6 gives TDR, field, and laboratory measured moisture content during installation. A comparison of the moisture content from the TDR traces, field, and laboratory determination indicate some discrepancies. The field and laboratory moisture contents generally compare more favourably. Given the method under which the material was sampled and the variability in the material, the results can be considered reasonable. It should be noted that the calculation of moisture is dependent on the calibration inputs to the TDR model. Differences of moisture content in the range of 1 to 2% are not uncommon.

Table 3. Installed Depths of TDR Sensors

Sensor #	Depth from Pavement Surface (m)	Layer
42A01	0.380	Base
42A02	0.550	Subgrade
42A03	0.690	
42A04	0.850	
42A05	1.000	
42A06	1.160	
42A07	1.300	
42A08	1.460	
42A09	1.780	
42A10	2.030	

Table 4. Installed Location of MRC Thermistor Sensors

Unit	Channel Number	Depth from Pavement Surface (m)	Remarks
1	1	0.025	This unit was installed in the PCC layer.
	2	0.127	
	3	0.229	
2	4	0.333	This unit was installed below the PCC layer into the base and subgrade.
	5	0.404	
	6	0.481	
	7	0.557	
	8	0.634	
	9	0.786	
	10	0.940	
	11	1.088	
	12	1.242	
	13	1.394	
	14	1.547	
	15	1.699	
	16	1.854	
	17	2.004	
	18	2.164	

Table 5. Location of Electrodes of the Resistivity Probe

Connector Pin Number	Electrode Number	Depth from Pavement Surface (m)
36	1	0.315
35	2	0.366
34	3	0.417
33	4	0.466
32	5	0.517
31	6	0.569
30	7	0.620
29	8	0.670
28	9	0.721
27	10	0.771
26	11	0.821
25	12	0.872
24	13	0.924
23	14	0.974
22	15	1.027
21	16	1.077
20	17	1.128
19	18	1.177
18	19	1.229
17	20	1.278
16	21	1.330
15	22	1.381
14	23	1.432
13	24	1.483
12	25	1.535
11	26	1.585
10	27	1.635
9	28	1.685
8	29	1.735
7	30	1.787
6	31	1.838
5	32	1.888
4	33	1.939
3	34	1.990
2	35	2.041
1	36	2.093

Table 6. TDR, Field, and Laboratory Moisture Content During Installation

Sensor Number	Sensor Depth (m)	Layer	TDR Moisture Content (by wt)*	Field Moisture Content (by wt)*	Lab Moisture Content (by wt)*
42A01	0.380	Base	6.6	5.0	4.4
42A02	0.550	Subgrade	11.6	13.5	11.9
42A03	0.690		10.0	14.1	11.5
42A04	0.850		8.4	13.2	11.7
42A05	1.000		8.4		
42A06	1.160		6.9	9.8	10.1
42A07	1.300		8.4	11.7	9.4
42A08	1.460		8.4	9.6	10.6
42A09	1.780		8.4	13.1	11.7
42A10	2.030		6.9	12.2	10.7

* Note: Raw data given in Appendix C

Site Repair and Cleanup

The instrumentation hole and trench were repaired by pouring and hand compacting a 'quickcrete' concrete mix. The cut surfaces should have had adequate rough surfaces to bond with the concrete.

The trench for the cabling from the instrumentation hole to the edge of pavement was leveled with the native soils to the existing bottom of the paved layer. The concrete portion of the trench, from the instrument hole to the shoulder, was filled with the 'quickcrete' mix and hand compacted. The asphalt shoulder was filled and compacted with asphalt cold mix to the level of the existing surface. The remainder of the trench was filled with native material and compacted, followed by a cleanup of loose materials from the paved area. Traffic control was removed at approximately 1800 hours and the lane reopened to traffic. Removal of the asphalt trench material and other disposable items were handled by the PADOT St.Clairsville maintenance crew.

Patch/Repair Area Assessment

The site was visited on a regular basis (monthly - weather depending) since the installation date. The concrete surface on the trench needed to be cleaned and fixed. This was done during the October 12, 1995 site visit. The repairs done in October did not bond well to the existing surface. In subsequent visits we have had to patch the trench; the instrument hole itself has held up well. The trench area needs to be removed and replaced with new concrete.

III. Initial Data Collection

The second day activities included connecting the instrumentation to the datalogger, initial data collection, and checks on functioning of installed equipment. This consisted of examination of the data collected over the day from the onsite datalogger, mobile datalogger, deflection testing, joint faulting, water table, manual resistivity, and the elevation survey. A sample days data collected by the onsite datalogger is presented in Appendix D (Table D-1).

Air Temperature, Subsurface Temperature, Rain-fall Data

The air temperature, pavement subsurface temperature profile, and rainfall data, collected on August 10 by the CR10 datalogger, were examined. The equipment and datalogger appeared to be functioning properly. The battery voltages were checked and found to be acceptable. The plots of the temperature profiles from the August 10, 1995 datalogger upload are presented in Appendix D (figures D-1 and D-2).

The tipping bucket rain gauge was checked by determining the number of tips recorded from 473 ml of water discharged into the gauge over a 1 hour time period. The rain gauge was found to be operating properly.

TDR Measurements

TDR data was collected using the mobile system provided by FHWA. The mobile system contains a CR10 datalogger, battery pack, two TDR multiplexers, and a resistance multiplexer circuit board. Version 2.2 of the MOBILE program was used to collect and record the TDR wave form traced for each sensor.

Figure D-3 in Appendix D shows the initial TDR traces collected with the MOBILE data acquisition system for all 10 sensors. Only the second set of TDR traces are shown in the because the first set of traces were used to adjust the starting locations of the traces. The figures indicate that the multiplexers and TDR sensors were working properly.

Resistance Measurement Data

Resistance data was collected in two modes, automated and manual. The MOBILE data acquisition system automatically performs two point contact resistance measurements and stores the values in terms of millivolts between adjacent electrodes. Figure D-4 shows pavement depth versus measured voltage produced by the MOBILE system. Manual contact resistance and resistivity measurements were performed using a Simpson Model 420d function generator, a Fluke Voltmeter, a Fluke Ameter, and a FHWA switching box. The measured contact resistance and four-point resistivity data are plotted in Figure D-5 and Figure D-6 respectively. Table D-2 and D-3 in Appendix D shows the raw data for the 2-point and the 4-point resistance respectively.

The general trend of the automated resistance voltage, manual contact resistance, and the four-point resistivity collected are similar. The results would indicate that there is no problem with the operation of the equipment. The resistance of the soils will change as the soil moisture changes and the soil particles reorient themselves. The change we are trying to capture is the soil moisture changing from liquid to solid state and vise versa.

Deflection Measurement Data

Deflection measurements followed procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". The analysis results from the FWDCHECK program from the installation dates are presented in Appendix D. Since then, six more data sets have been collected on September 28, October 12, December 07, 1995, and April 11, May 02, and June 06, 1996.

Longitudinal Profile Data

According to the guidelines, since this is in a frost area, the survey should be performed on five different occasions; one survey during the middle of each season and one survey during the late winter period (fully frozen condition). There have been three surveys conducted to this date. The first survey was conducted on January 11, 1996 with an IRI value of 93.26 inches/mile, second on March 01, 1996 with an IRI of 94.92 inches/mile, and the third on April 10, 1996 with an IRI of 96.88 inches/mile.

Joint Opening and Faulting

The installation of snap rings to measure the joint opening was completed on October 12, 1995. The Joint opening and the joint faulting measurements are taken in conjunction with the FWD join test during each site visit.

Elevation Surveys

One set of the surface elevation survey was performed following the guidelines. It was assumed that the elevation at the top of the piezometer pipe was 1.000 meters. The survey was conducted on August 10, 1995 and the results are presented in Appendix D. Since then, three sets of the surface elevations were performed on October 12, 1995, on April 11, 1996, and June 06, 1996..

Water Depth

The piezometer has been dry since the installation date, as monitored during each site visit. The last visit was on June 06, 1996.

IV. Summary

The installation of the seasonal monitoring instrumentation at the GPS site 421606 near Altoona, PA was completed on August 10, 1995. A check of the equipment and initial data collection was completed on August 10, 1995. The instrumentation, permanently installed at the site, were:

- Time domain reflectometer probes for moisture measurements,
- Thermistor probes for pavement and soil gradient temperature measurements,
- Resistivity probe for frost depth measurements,
- Air temperature, thermistor probe, and tipping bucket rain gauge to record local climatic conditions, and
- Combination piezometer (well) and bench mark to determine changes in water level and pavement elevations.

The pavement gradient temperature and local climatic data are to have continuous data collection stored in an on-site datalogger. The moisture and the frost depth are to be collected during each site visit (14 times per year) using a mobile datalogging system. The water level, electrical resistivity, elevation, joint opening, and joint faulting data are to be collected manually during site visits.

The test section is on Northbound route 220, 1.0 km North of S.R. 4034. The site is located in a hilly area. Fairly steep slopes start at the road right of way on both sides of the road. The pavement resides in a cut area on the slope of a hill and consists of two 3.7 m wide lanes in each direction with a 3.0 m wide asphalt concrete paved outside shoulder and a 1.2 m wide asphalt concrete paved inside shoulder. The pavement structure consists of 250 mm of Jointed Reinforced Concrete Pavement (JRCP) over a 210 mm crushed gravel base. This resides on gravely lean clay with sand and boulders. Bedrock is at a depth of approximately 5.18 m.

All instrumentation was checked prior to installation at the PMSL facility in Amherst, NY. These initial checks indicated that the instrumentation was within specifications, as required for the seasonal monitoring program. Operational checks during installation and the following day indicated that all instrumentation was functioning properly. The air temperature and gradient temperatures measured in the pavement surface compared favourably with the hand held Omega temperature gauge. The temperature profile for the pavement soils appeared reasonable with no outlying sensors. A check of the tipping bucket indicated it was functioning correctly with tips corresponding to amount of water supplied.

Moisture content of the soil was determined by TDR method, field moisture determination, and laboratory results provided by PADOT District 9 Hollidaysburg office. The moisture content determined by the TDR, and from soil samples taken in the field were within the acceptable range.

The installation proceeded as expected with only a few minor problems. The diamond bit auger used to drill through the reinforced concrete pavement took much more time than anticipated. The auger used to drill the soil was the same size as the hole in the PCC pavement. This resulted in the auger getting stuck during the course of the drilling and breaking the stem. The instrument hole drilling was then completed with PADOT's drilling equipment which was at the site for drilling the combination piezometer/bench mark hole.

The installation was completed and the section was opened to traffic by approximately 1800 hours. The PCC patch, although not completely set, was firm enough to hold traffic. A review of the patch on day two of the installation indicated that the patch was secure and sufficiently set. Some material was left over at the end of the compaction of the instrument hole. This was most likely caused by the inability to achieve lateral compaction with some of stones that were extracted from the hole. All instrumentation was installed except for the snap rings to measure joint movement. The installation of the snap ring holes was completed on October 12, 1995.

The ongoing monitoring of this section is progressing fairly well. Problems were encountered in the winter months obtaining traffic control, as the Clairsville maintenance personnel were busy with the flood damage resulting from severe storms and unpredictable weather.

APPENDIX A

Test Section Background Information

Appendix A contains the following supporting information:

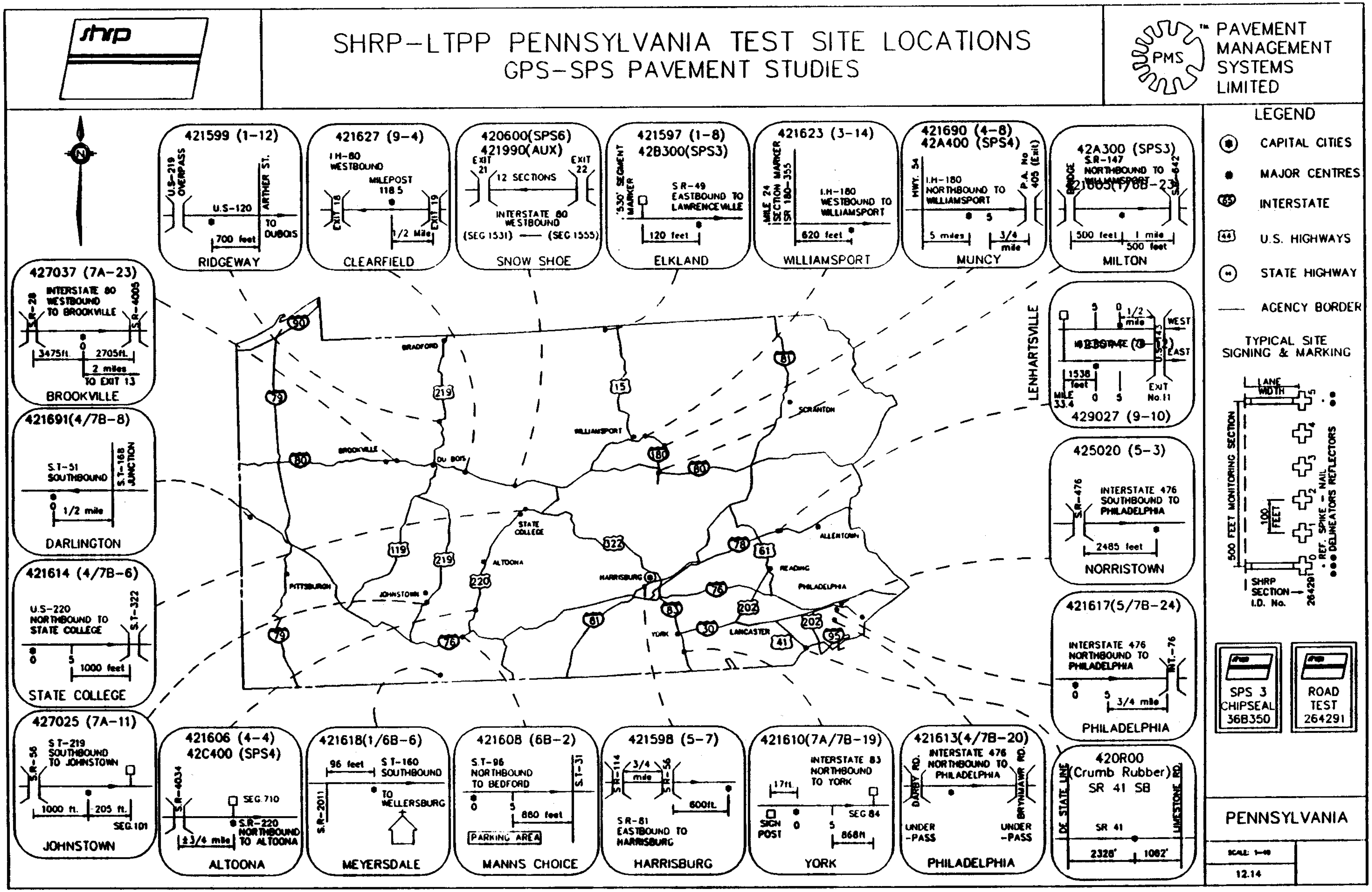


FIGURE A-1 SITE LOCATION MAP - SECTION 421606

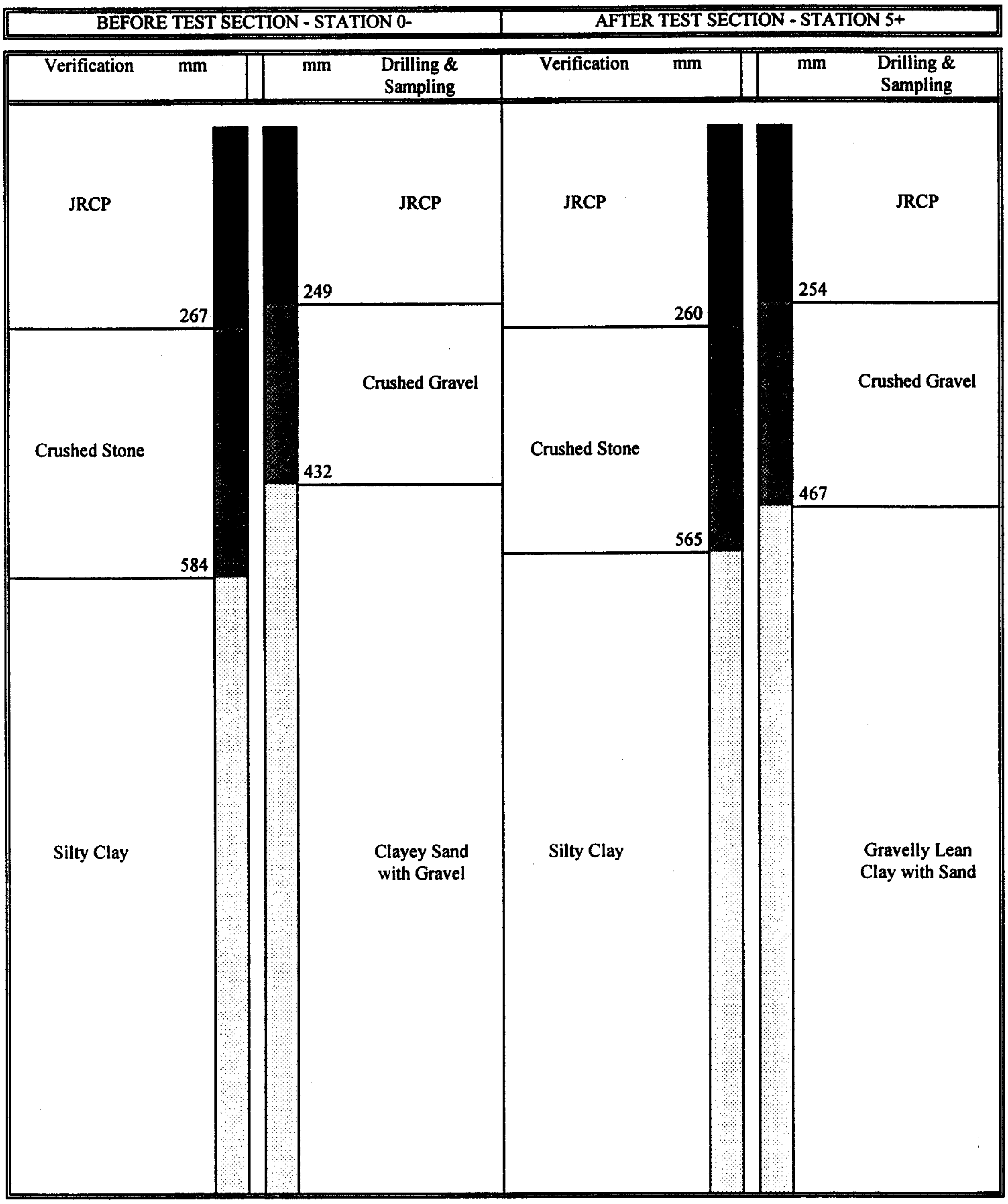


Figure A-2. Profile of Pavement Structure

Table A-1. Site Performance Summary

Distress and Profile Summary		
Distress Summary August 10, 1995	Profile Summary	
	Date (mm-dd-yy)	IRI (in/mi)
Low Sev. Tran. Crack..- 4 Cracks 7.1m	12-11-89	89.81
Number of Low Sev. Joints Sealed - 10	21-05-90	92.59
Number of Joints Sealed - 2	21-09-90	93.14
Long. Joint Seal Damage - 305m	17-10-91	86.95
Low Sev. Long. Joint Spalling - 0.2m	08-10-92	92.60
Map Cracking - 1 area ($549m^2$)	07-10-93	97.03
Low Sev. Rigid Patch - 1 ($0.1m^2$)	27-09-94	93.89
Very fine Map Crack. for Entire Section	30-08-95	96.72

Falling Weight Deflectometer Data Summary

Date	Mean Value for Drop HT 2 (mils)					
	Sensor 1	Sensor 1 std. dev.	Sensor 7	Sensor 7 std. dev.	Mean Temp D1 (F)	Min/Max TempD1(F)
23-08-89	1.65	0.24	0.54	0.12	79	76/83
07-04-93	2.20	0.28	0.87	0.11	65	54/72
09-08-95	1.86	0.27	0.66	0.19	80	77/82

	Effective Thickness	Thickness std dev	Volumetric k	k std dev	Test Pit Vol. k	
					1	2
23-08-89	10.72	0.36	669	144	829	880
	11.43	0.40	830	51		
07-04-93	10.63	0.42	508	64	628	665
09-08-95	10.85	0.47	652	122		

Note: FWD subsection boundary at 200 ft.

Table A-2. Uniformity Survey Results

Seasonal Uniformity Survey	Falling Weight Deflectometer
Site Number: 421606	Data Collection and
Date Surveyed: April 07, 1993	Processing Summary

Section Interval (ft)	Mean Deflection Values for HT 2 (mils) - Corrected							
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Volumetric k	Volumetric k std dev	Effective Thickness	Thickness std dev
-22 - 252	2.20	0.37	0.88	0.15	508	90	10.63	0.47
299 - 532	2.04	0.18	0.77	0.08	565	63	10.77	0.34

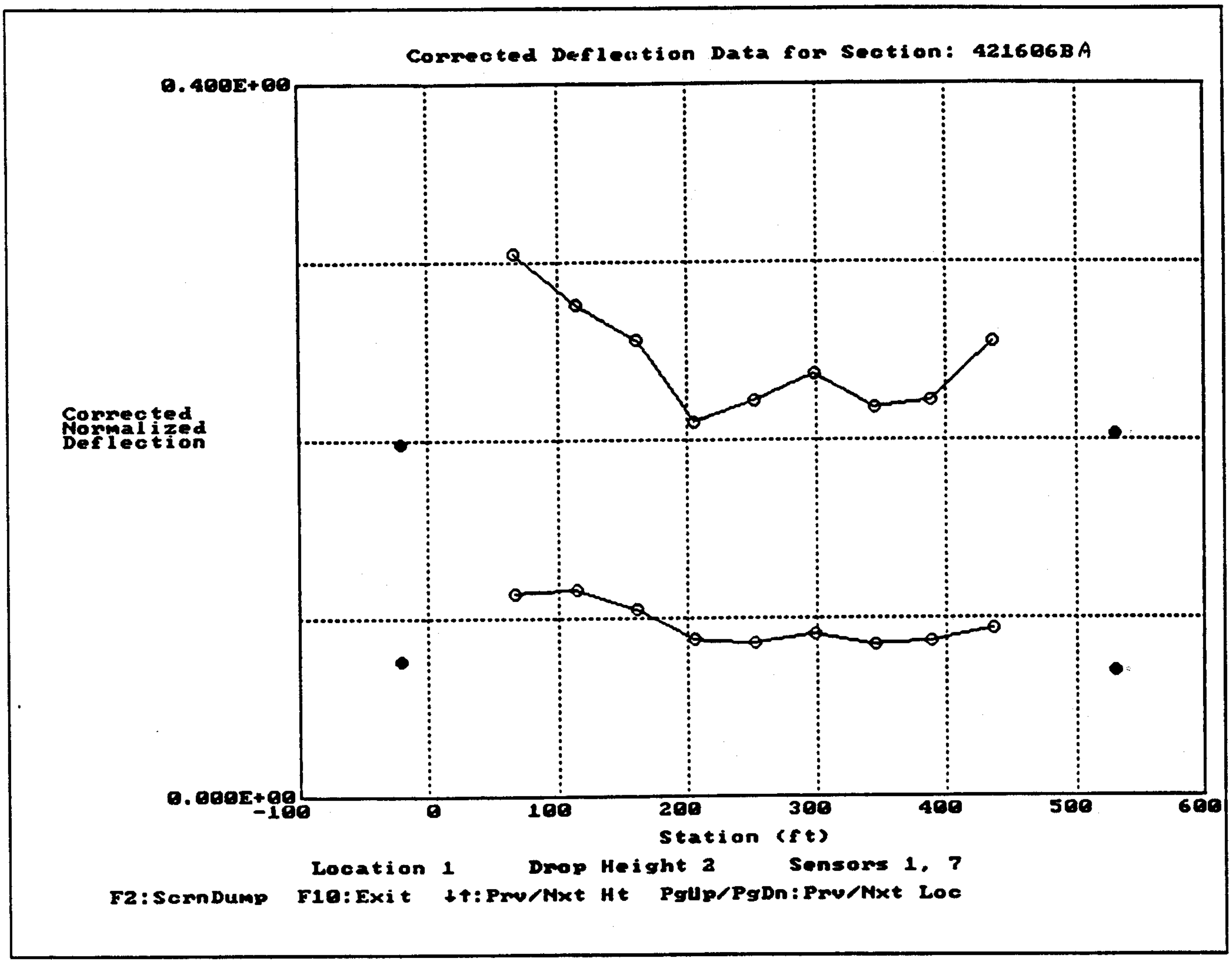


Figure A-3. Deflection Profile from FWDCHECK
(Test Date April 07, 1993)

Table A-3. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date April 07, 1993)

Flexible Pavement Thickness Statistics - 421606BA - Drop Height 2			
Subsection	Station	Volumetric k	Effective Thickness
TP	-22	628	11.00
1	-22	628	11.00
	67	407	9.88
	114	420	10.25
	160	465	10.63
	205	563	11.00
	252	563	11.00
2	299	528	10.63
	345	565	11.00
	389	567	11.00
	436	499	10.25
	532	665	11.00
TP	532	665	11.00
Subsection 1	Overall Mean	508	10.63
	Standard Deviation	90	0.47
	Coeff of Variation	17.70%	4.46%
Subsection 2	Overall Mean	565	10.77
	Standard Deviation	63	0.34
	Coeff of Variation	11.14%	3.11%

APPENDIX B

Supporting Site Visit and Installed Instrument Information

Appendix B contains the following supporting information:

Correspondence from the Site Inspection and the Planning Meeting

PAVEMENT
MANAGEMENT
SYSTEMS

ORIGINAL

MEMORANDUM

TO	Gary Hoffman - LTPP Coordinator Dan Dawood - LTPP Contact	**DATE**	May 4, 1995
FROM	Bill Phang	**PROJECT**	50451025
SUBJECT	Seasonal Monitoring Program - GPS 421606 Instrumentation	**FILE**	12.14

The GPS test section 421606 on SR 220 NB, Altoona, PA was approved as a candidate for the Seasonal Monitoring Program (SMP) core experiment (cell 28) some years ago, although the site was intended for inclusion in the second circuit.

It is now planned to carry out the installation of instrumentation in mid August 1995 and to begin the monitoring of the 8 second circuit sites shortly afterwards.

Please let me know if the PENN DOT will still support the inclusion of GPS 421606 in the Seasonal Monitoring Program. Details of the agency responsibilities during the installation (2 days of traffic control, and men and equipment for drilling and sawing) and during the monitoring (traffic control once monthly and twice per month in the spring) are contained in the FHWA-RD-94-110 Report "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines", copy enclosed for your convenience.

The NA Regional office (Brandt Henderson) will then arrange to test for structural response uniformity and to establish where to install the sensors. A Pre-installation Planning Meeting should be scheduled for later in June, where details of the installation activities involving agency personnel and equipment will be discussed, contacts and schedules established, and responsibilities confirmed. The installation is tentatively planned for mid August 1995, and monitoring for 12 months will begin shortly after. The monitoring will be moved back for one year to sites in the first circuit, but will return to this site afterwards.

The SMP results will provide the means to link pavement response data obtained at random points in time to critical design conditions, and enable evaluation of models relating structural properties of materials and environmental conditions.

415 Lawrence Bell Drive - Suite 3, Amherst, New York; 14221 [716] 632-0804 Fax.[716] 632-4808

Your participation and contributions to the LTPP program are very important and much appreciated.

CC: B. Henderson, NARO
E. Lesswing, NARO
I.J. Pecnik, RE, NARO

PAVEMENT
MANAGEMENT
SYSTEMS

July 28, 1995
50451125-16.01

Mr. W. Tomassetti
Pavement Management Engineer
1620 North Juniata Street
Hollidaysburg, PA 16648

RE: Field Density Test

Dear Mr. W. Tomassetti:

We are forwarding a copy of the FHWA directive regarding the field density tests that will be conducted along with the installation. Please do not hesitate to contact us if you require further information regarding it.

Yours Sincerely,

Brant Henderson
Pavement Management Systems Limited

encl.

415 LAWRENCE BELL DRIVE
UNIT #3
AMHERST. N.Y. 14221
TEL. (716) 632-0804
FAX (716) 632-4808

ORIGINAL

FAX TRANSMITTAL

PMS

To: Wally Tomassetti

Date: July 28, 1995

Fax No.: (814) 696-7103

Sender: Brandt Henderson BH

Project No.: 5-045-11-25

File No.: 12.14

Reference: Seasonal Site Installation

Includes cover sheet plus 4 pages

☑ Original will follow by mail

MESSAGE:

To follow-up the site visit of July 21, 1995, please find enclosed a site plan view and diagram of projected instrument placement for GPS 421606. In preparation for installation we notice we have the wrong deflection profile for GPS 421606. As you will notice from the attached deflection profile the more uniform end of the test section would be between stations 3+00 - 5+00. We would like to relocate the seasonal instrumentation to the middle of first slab outside the 5+00 limit of the test section.

The location of the piezometer, instrumentation, equipment cabinet and instrument weather pole are identified in the planview. Utility clearances will be required at these locations.

If there is any problem with clearances we can review and adjust the location as part of the preinstallation meeting on August 8, 1995.

From our discussion, it sounds like preparation for arranging equipment and supplies for the installation are well underway. I have checked with Texas Transportation Institute (TTI) regarding the 12 inch core barrels. Nobody seems to know what has happened to these barrels. If as you suggested, we expand the 10.25 inch core hole with the 11.0 inch auger we will need to provide a pavement patch with a quick setting concrete mix. The rough edges created by the augering process should provide a good bond for patching.

The following summarizes the supply items requested from the agency.

Asphalt Concrete Cold Mix Material to Patch Shoulder
Filter Sand - 1 bag 80 - 100 lbs.
Bentonite - ½ bag 20 - 40 lbs.
Concrete Mix (Sacrete) 2 bags 160 - 200 lbs.
*Surface Access Cover for Piezometer
Fast Setting Concrete Repair Material (Set 45 or Equivalent)
*We carry a spare access cover with us in the event you have a problem arranging for this item

If you have not received a complete message, please call sender at:

Pavement Management Systems Limited

415 Lawrence Bell Drive, Unit 3, AMHERST, New York 14221 Ph: (716) 632-0804, Fax: (716) 632-4808

FAX TRANSMITTAL

We also require the loan of a standard 4" (102 mm) Procter mold, 5.5 lb. (2.5 kg) hammer and balance with a capacity of 25 lb. (11.5 kg) readable to .01 lbs. (5 gm) for density determination of the subgrade material. I will forward you a copy of the field density test procedures. As verification of field moisture we are also requesting the agency provide laboratory moisture values for soil samples taken at each TDR installation location (10 in total).

The Pavement Management System employees coming for the installation are:

Brandt Henderson	Team Leader
Randy Plett	Project Engineer
Doug Marshall	FWD Operator
James Orzulak	Instrument Technician
Dilan Singaraja	Engineering Assistant
Alfred Lip	Engineering Assistant

Additionally, we are expecting a representative from FHWA-LTPP division along with loan staffer to be onsite for the installation.

Accommodation arrangements have been made at the Days Inn, Altoona.

We would like to arrange to meet on the afternoon of Tuesday, August 8 to review the equipment and supply status along with a discussion on the installation day schedule of activities. If you could let me know a time and place we will arrange to be there.

If you have any questions or need further information do not hesitate to call. I will be out of the office on the week of July 31 - August 4. If you leave a message with the secretary (716-632-0804) I will return your call.

We look forward to seeing you and your co-workers on August 8.

Copies: Aramis Lopez, (w/o attachments)
Dan Dawood, (w/o attachments)

If you have not received a complete message, please call sender at:

Pavement Management Systems Limited

415 Lawrence Bell Drive, Unit 3, AMHERST, New York 14221 Ph: (716) 632-0804, Fax: (716) 632-4808

Table B-1. Air Temperature Thermistor Calibration

LTPP Seasonal Monitoring Study	State Code	[42]
Air Temperature Thermistor Calibration	Test Section Number	[1606]

Before Operation Checks	Calibration Date dd-mm-yy	02-08-95
	Probe S/N	42AAT
	Operator	JO

Mobile Datalogger (24 hour)			Water Room Temperature		Ice Bath 0° C (+/- 1° C)		Hot Water 50° C (+/-)		ok
Mean	Min.	Max.	Reading	Time	Reading	Time	Reading	Time	y/n
22.83	22.59	23.06	23.6	1400	1.18	1600	49.6	1900	y

Probe Accepted	J.O.	(Initials)

Table B-2. MRC Probe Calibration

LTPP Seasonal Monitoring Study	State Code	[42]
MRC Probe Calibration	Test Section Number	[1606]

Before Operation Checks	Calibration Date dd-mm-yy	02-08-95
	Probe S/N	42AT
	Operator	JO

	Mobile Datalogger (24 hour)			Water Room Temp Time 1400	Ice Bath 0 °C (+/- 1 °C) Time 1600	Hot Water 50 °C (+/-) Time 1900	ok
No.	Mean	Min.	Max.	Reading	Reading	Reading	y/n
1	22.8	22.6	23.0	23.4	1.13	48.5	y
2	22.9	22.6	23.1	23.3	1.12	48.4	y
3	22.9	22.8	23.0	23.3	1.09	48.4	y
4	23.0	22.8	23.1	24.1	2.63	51.2	y
5	22.9	22.6	23.1	24.2	2.47	51.3	y
6	22.9	22.8	23.0	24.4	2.84	51.7	y
7	22.5	22.0	22.9	24.3	2.73	51.1	y
8	22.5	21.8	23.2	24.2	2.52	51.4	y
9	22.7	22.0	23.4	23.7	2.52	50.8	y
10	22.6	22.0	23.3	23.5	2.36	51.0	y
11	23.0	22.1	23.8	23.8	2.91	51.8	y
12	22.2	21.6	22.8	23.7	2.90	52.1	y
13	23.0	22.2	23.8	24.0	2.28	52.5	y
14	22.8	21.9	23.8	22.8	2.35	52.3	y
15	22.6	22.0	23.3	23.2	2.28	51.2	y
16	22.6	22.1	23.2	23.4	2.45	53.0	y
17	23.0	22.0	24.0	24.1	2.39	53.1	y
18	23.0	22.0	23.9	23.3	2.49	52.6	y

22.5

Probe Accepted:	J.O.	(Initials)
Probe Length:	1.862	(meters)

Thermistor distance from top of probe in meters									
4	0.022	7	0.246	10	0.629	13	1.083	16	1.543
5	0.093	8	0.323	11	0.777	14	1.236	17	1.693
6	0.170	9	0.475	12	0.931	15	1.388	18	1.853

Table B-3. Description of MRC Thermistor Probe and Sensor Spacing

Unit	Channel No.	Distance from Top of Unit(m)	Remarks
1	1	0.025	0.3302 m long by 6.35 mm stainless steel probe installed in the AC layer.
	2	0.176	
	3	0.326	
2	4	0.022	1.862 m long by 25.4 mm PVC tube installed in the base and subgrade.
	5	0.093	
	6	0.170	
	7	0.246	
	8	0.323	
	9	0.475	
	10	0.629	
	11	0.777	
	12	0.931	
	13	1.083	
	14	1.236	
	15	1.388	
	16	1.543	
	17	1.693	
	18	1.853	

Table B-4. Resistivity Probe Sensor Spacing

LTPP Seasonal Monitoring Program Data Sheet SMP-C03 Resistivity Probe Check					Agency Code [42] LTPP Section ID [1606]		
Connector Pin No.	Electrode Number	Distance from Top (m)			Continuity	Spacing	Comments
		Line 1	Line 2	Avg.	x	(m)	
36	1	0.029	0.028	0.029	x	0.051	
35	2	0.080	0.079	0.080	x	0.051	
34	3	0.132	0.130	0.131	x	0.049	
33	4	0.181	0.180	0.180	x	0.050	
32	5	0.231	0.230	0.231	x	0.052	
31	6	0.283	0.282	0.283	x	0.051	
30	7	0.334	0.333	0.334	x	0.050	
29	8	0.384	0.383	0.384	x	0.051	
28	9	0.436	0.434	0.435	x	0.049	
27	10	0.485	0.484	0.485	x	0.050	
26	11	0.535	0.534	0.535	x	0.051	
25	12	0.586	0.585	0.586	x	0.052	
24	13	0.638	0.637	0.638	x	0.050	
23	14	0.689	0.687	0.688	x	0.052	
22	15	0.741	0.740	0.741	x	0.054	
21	16	0.791	0.790	0.791	x	0.051	
20	17	0.842	0.841	0.842	x	0.049	
19	18	0.891	0.890	0.891	x	0.052	
18	19	0.943	0.942	0.943	x	0.049	
17	20	0.993	0.991	0.992	x	0.051	
16	21	1.044	1.043	1.044	x	0.051	
15	22	1.095	1.094	1.095	x	0.055	
14	23	1.146	1.144	1.146	x	0.052	
13	24	1.198	1.196	1.197	x	0.051	
12	25	1.249	1.248	1.249	x	0.050	
11	26	1.299	1.298	1.299	x	0.050	
10	27	1.349	1.348	1.349	x	0.050	
9	28	1.395	1.398	1.399	x	0.050	
8	29	1.449	1.448	1.449	x	0.052	
7	30	1.501	1.500	1.501	x	0.052	
6	31	1.552	1.551	1.552	x	0.050	
5	32	1.603	1.601	1.602	x	0.051	
4	33	1.654	1.652	1.653	x	0.051	
3	34	1.705	1.703	1.704	x	0.050	
2	35	1.754	1.753	1.755	x	0.052	
1	36	1.807	1.805	1.807	x	n/a	
	Bottom	1.829	1.829	1.829	n/a	n/a	

Prepared by	JO/DM	Employer	PMSL
Date (dd-mm-yy)	03-08-95		

Table B-4. Resistivity Probe and Sensor Spacing

LTPP Seasonal Monitoring Program Data Sheet SMP-C03 Resistivity Probe Check					Agency Code [42] LTPP Section ID [1606]		
Connector Pin No.	Electrode Number	Distance from Top (m)			Continuity	Spacing	Comments
		Line 1	Line 2	Avg.	x	(m)	
36	1	0.029	0.028	0.029	x	0.051	
35	2	0.080	0.079	0.080	x	0.051	
34	3	0.132	0.130	0.131	x	0.049	
33	4	0.181	0.180	0.180	x	0.050	
32	5	0.231	0.230	0.231	x	0.052	
31	6	0.283	0.282	0.283	x	0.051	
30	7	0.334	0.333	0.334	x	0.050	
29	8	0.384	0.383	0.384	x	0.051	
28	9	0.436	0.434	0.435	x	0.049	
27	10	0.485	0.484	0.485	x	0.050	
26	11	0.535	0.534	0.535	x	0.051	
25	12	0.586	0.585	0.586	x	0.052	
24	13	0.638	0.637	0.638	x	0.050	
23	14	0.689	0.687	0.688	x	0.052	
22	15	0.741	0.740	0.741	x	0.054	
21	16	0.791	0.790	0.791	x	0.051	
20	17	0.842	0.841	0.842	x	0.049	
19	18	0.891	0.890	0.891	x	0.052	
18	19	0.943	0.942	0.943	x	0.049	
17	20	0.993	0.991	0.992	x	0.051	
16	21	1.044	1.043	1.044	x	0.051	
15	22	1.095	1.094	1.095	x	0.055	
14	23	1.146	1.144	1.146	x	0.052	
13	24	1.198	1.196	1.197	x	0.051	
12	25	1.249	1.248	1.249	x	0.050	
11	26	1.299	1.298	1.299	x	0.050	
10	27	1.349	1.348	1.349	x	0.050	
9	28	1.395	1.398	1.399	x	0.050	
8	29	1.449	1.448	1.449	x	0.052	
7	30	1.501	1.500	1.501	x	0.052	
6	31	1.552	1.551	1.552	x	0.050	
5	32	1.603	1.601	1.602	x	0.051	
4	33	1.654	1.652	1.653	x	0.051	
3	34	1.705	1.703	1.704	x	0.050	
2	35	1.754	1.753	1.755	x	0.052	
1	36	1.807	1.805	1.807	x	n/a	
	Bottom	1.829	1.829	1.829	n/a	n/a	

Prepared by	JO/DM	Employer	PMSL
Date (dd-mm-yy)	03-08-95		

Table B-5. Contact Resistance Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-D03 Contact Resistance Measurements	Agency Code [42] LTPP Section ID [1606]

Test Position	Switch Settings		Voltage (ACV)		Current (ACA)		Comments
	I1 V1	I2 V2	Range	Reading	Range	Reading	
1	1	2	mV	58.6	µA	450	
2	2	3		50.2		455	
3	3	4		48.2		455	
4	4	5		48.1		451	
5	5	6		46.6		451	
6	6	7		44.7		452	
7	7	8		45.0		451	
8	8	9		47.6		450	
9	9	10		49.0		448	
10	10	11		41.8		452	
11	11	12		38.6		444	
12	12	13		37.5		444	
13	13	14		34.2		457	
14	14	15		35.5		456	
15	15	16		41.4		453	
16	16	17		44.2		451	
17	17	18		42.0		452	
18	18	19		40.3		453	
19	19	20		39.1		453	
20	20	21		35.7		454	
21	21	22		34.9		455	
22	22	23		36.1		453	
23	23	24		40.2		450	
24	24	25		46.0		446	
25	25	26		48.7		447	
26	26	27		48.5		445	
27	27	28		46.6		447	
28	28	29		58.8		431	
29	29	30		56.5		437	
30	30	31		165.0		229	
31	31	32		75.0		406	
32	32	33		110.0		343	
33	33	34		37.0		443	
34	34	35		109.4		314	
35	35	36		101.5		334	

Prepared by:	JO	Employer:	PMSL
Date (dd/mm/yy):	03/08/95		

Table B-6. Four-Point Resistivity Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-D04 Four-Point Resistivity Measurements	Agency Code [42] LTPP Section ID [1606]

Test Position	Switch Settings				Voltage (ACV)		Current (ACA)		Comments
	I1	V1	V2	I2	Range Setting	Reading	Range Setting	Reading	
1	1	2	3	4	mV	2.0	μA	429	
2	2	3	4	5		2.2		431	
3	3	4	5	6		2.0		435	
4	4	5	6	7		2.5		435	
5	5	6	7	8		2.1		433	
6	6	7	8	9		2.1		434	
7	7	8	9	10		2.2		433	
8	8	9	10	11		2.0		437	
9	9	10	11	12		2.3		424	
10	10	11	12	13		2.1		436	
11	11	12	13	14		2.2		439	
12	12	13	14	15		2.0		433	
13	13	14	15	16		2.3		437	
14	14	15	16	17		2.1		437	
15	15	16	17	18		2.1		438	
16	16	17	18	19		2.0		435	
17	17	18	19	20		2.1		437	
18	18	19	20	21		2.1		437	
19	19	20	21	22		2.4		437	
20	20	21	22	23		2.0		438	
21	21	22	23	24		2.1		435	
22	22	23	24	25		2.0		434	
23	23	24	25	26		2.0		435	
24	24	25	26	27		2.0		429	
25	25	26	27	28		1.9		430	
26	26	27	28	29		2.0		409	
27	27	28	29	30		2.2		430	
28	28	29	30	31		2.0		420	
29	29	30	31	32		2.2		402	
30	30	31	32	33		2.0		422	
31	31	32	33	34		2.2		423	
32	32	33	34	35		2.1		404	
33	33	34	35	36		2.5		414	

Prepared by:	DM	Employer:	PMSL
Date (dd/mm/yy):	04/08/95		

Table B-7. TDR Probes Calibration

LTPP Seasonal Monitoring Study	State Code		[42]
TDR Probes	Test Section Number		[1606]

Before Operation Checks	AL/JO	Initial	Calibration Date (mm-dd-yy)	03-08-95
			Seasonal Site	42SA

No.	Probe (S/N)	Resistance (ohms) Core	Resistance (ohms) Shield	Probe Shorted Begin Length	Probe Shorted End Length *	Air Begin Length	Alcohol Begin Length	Water Begin Length
1	42A01			16.34		16.34	16.36	16.36
2	42A02			15.87		15.87	15.92	15.93
3	42A03			15.92		15.92	15.93	15.93
4	42A04			15.92		15.92	15.94	15.94
5	42A05			15.92		15.92	15.95	15.95
6	42A06			15.90		15.90	15.93	15.93
7	42A07			16.38		16.38	16.41	16.45
8	42A08			16.68		16.68	16.72	16.72
9	42A09			16.45		16.45	16.47	16.47
10	42A10			16.21		16.21	16.24	16.24

NOTE: Record lengths from TDR

Calculation of Dielectric Constant

Probe Length 0.203 m

V_p Setting 0.99 V_p

$$\varepsilon = \left[\frac{\text{TDRL}}{(\text{PL})(V_p)}\right]^2$$

No.	Air TDR Length	Air Dielectric Constant	Air In Spec. (?)	Alcohol TDR Length	Alcohol Dielectric Constant	Alcohol In Spec. (?)	Water TDR Length	Water Dielectric Constant	Water In Spec. (?)
1	0.20	0.99	y	1.01	25.26	y	1.84	83.82	y
2	0.20	0.99	y	1.00	24.76	y	1.85	84.74	y
3	0.20	0.99	y	1.02	25.76	y	1.86	85.66	y
4	0.20	0.99	y	1.02	25.76	y	1.82	82.01	y
5	0.20	0.99	y	1.00	24.76	y	1.82	82.01	y
6	0.20	0.99	y	0.99	24.27	y	1.85	84.74	y
7	0.20	0.99	y	0.84	17.47	y	1.83	82.92	y
8	0.20	0.99	y	1.01	25.26	y	1.85	84.74	y
9	0.20	0.99	y	1.02	25.76	y	1.83	82.92	y
10	0.20	0.99	y	1.02	25.76	y	1.85	84.74	y

* Note: The short at end locations were recorded incorrectly.

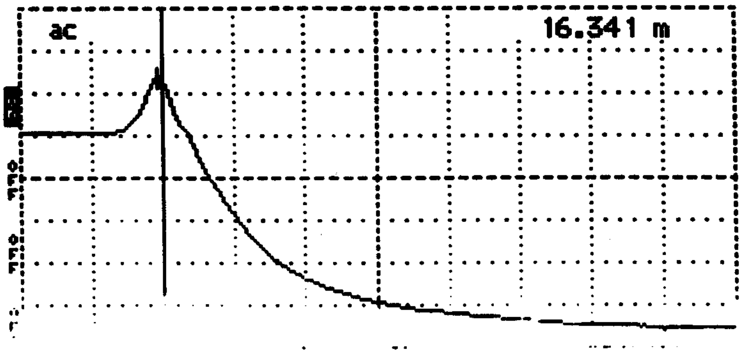
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Serial Number: 42A01 **Date (dd/mm/yy):** 03/08/95

Probe Number 01

Trace 1 - Probe Shorted at Start

sor .... 16.341 m
ance/Div ..... .25 m/div
tical Scale .... 177 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

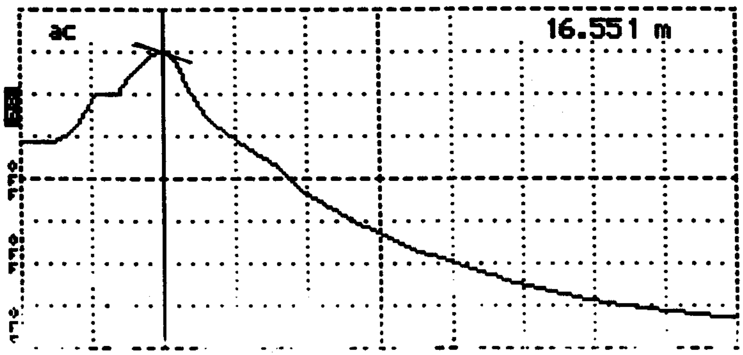


Tektronix 1502B TDR
Date Aug/03/95
Cable 41
Notes Cal. @ office
short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.551 m
ance/Div ..... .25 m/div
ical Scale .... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date Aug 03 /95
Cable #01
Notes short end

Input Trace
Stored Trace
Difference Trace

Figure B-1. TDR Traces Obtained During Calibration

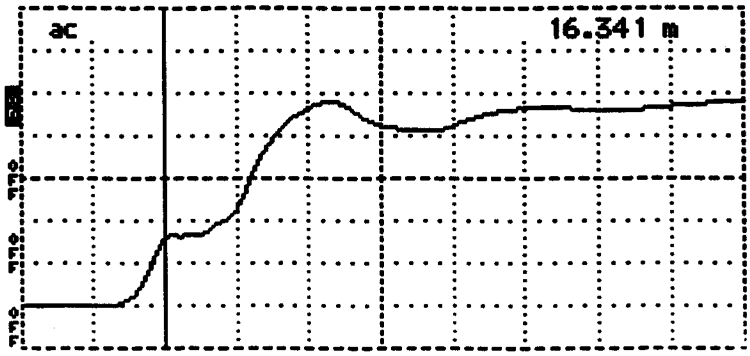
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 01

Trace 3 - Probe in Air

sor .... 16.341 m
ance/Div..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

.20

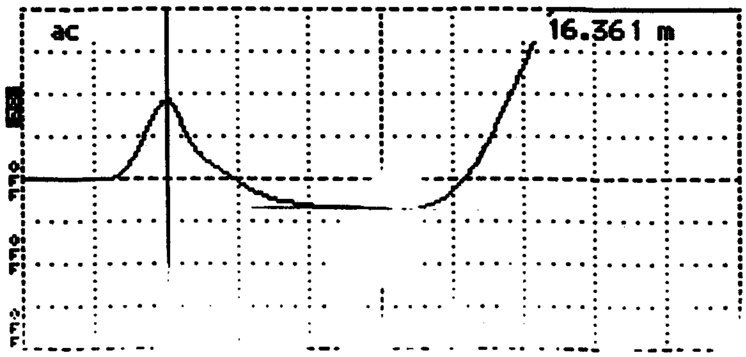


Tektronix 1502B TDR
Date Aug 3/95
Cable #01
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

sor .... 16.361 m
ance/Div..... .25 m/div
tical Scale.... 100 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

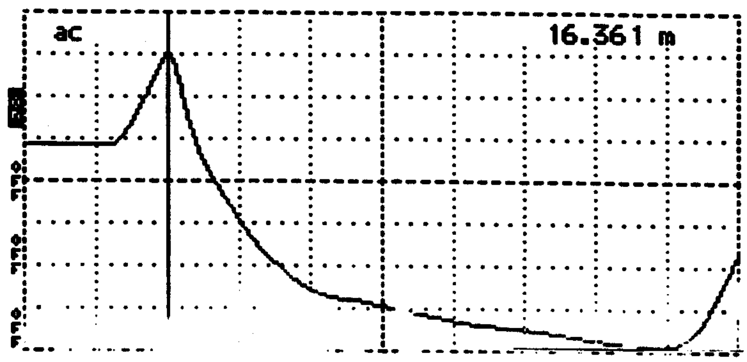


Tektronix 1502B TDR
Date Aug 3/95
Cable #01
Notes Alcohol

Input Trace
Stored Trace
Differen e Trace

Trace 5 - Probe in Water

sor .... 16.361 m
ance/Div..... .25 m/div
tical Scale.... 74.8 mρ/div
.... 0.99
se Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 3/95
Cable #01
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

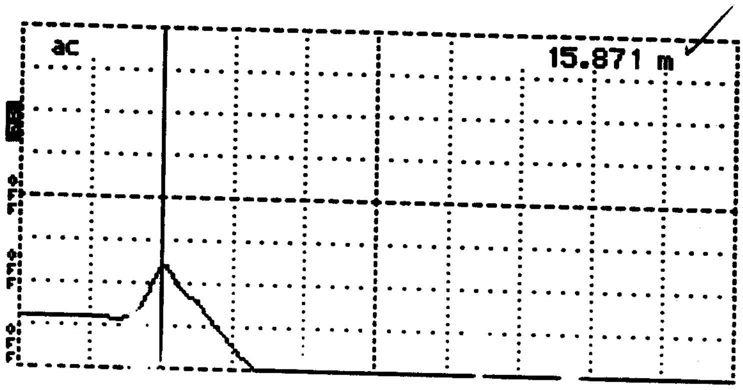
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A02 **Date (dd/mm/yy):** 03/08/95

Probe Number 02

Trace 1 - Probe Shorted at Start

rsor .... 15.871 m
stance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
ise Filter...... 1 avg
wer............ ac

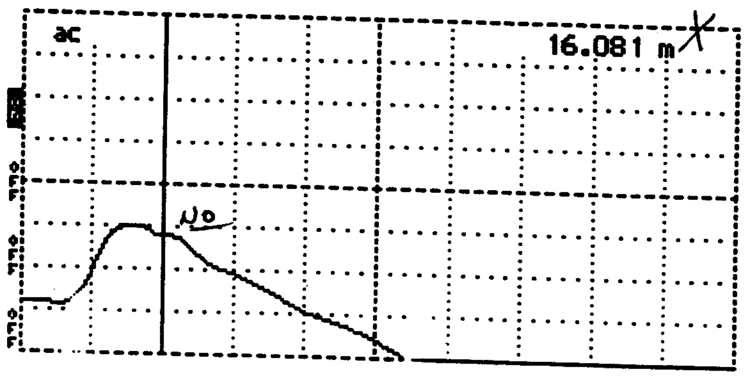


Tektronix 1502B TDR
Date Aug 03/95
Cable #02
Notes Short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 16.081 m
ance/Div..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er............ ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #02
Notes Short end

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

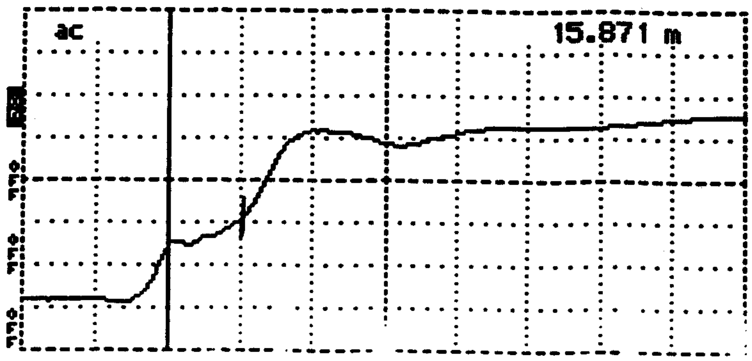
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 02

Trace 3 - Probe in Air

or .... 15.871 m
nce/Div...... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

.20

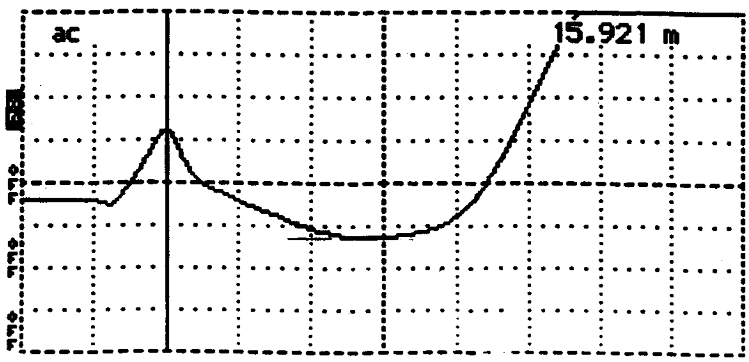


Tektronix 1502B TDR
Date Aug 03/95
Cable #02
Notes Air

Input Trace
Stored Trace
Difference Trac

Trace 4 - Probe in Alcohol

r .... 15.921 m
ce/Div...... .25 m/div
al Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
.... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #02
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 15.931 m
nce/Div...... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

Tektronix 1502B TDR
Date Aug 03/95
Cable #02
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

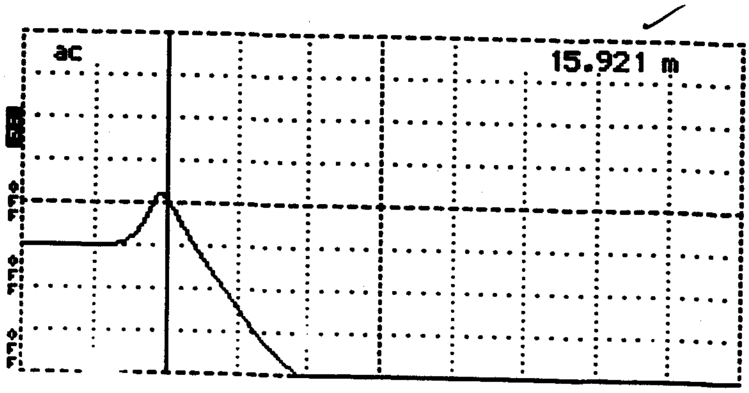
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A03 **Date (dd/mm/yy):** 03/08/95

Probe Number 03

Trace 1 - Probe Shorted at Start

rsor .... 15.921 m
tance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

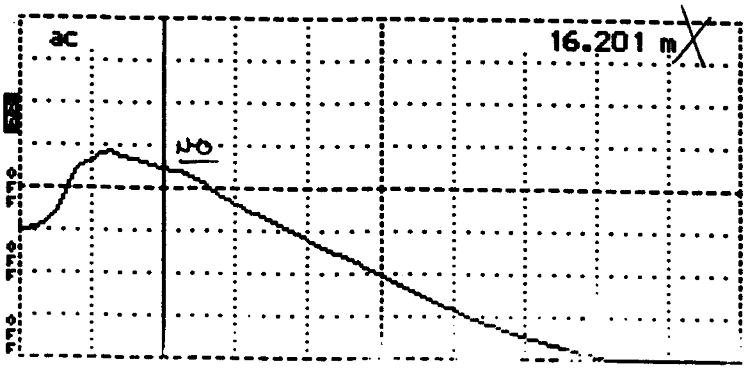


Tektronix 1502B TDR
Date Aug 03/95
Cable #03
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 16.201 m
ance/Div..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #03
Notes short end

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

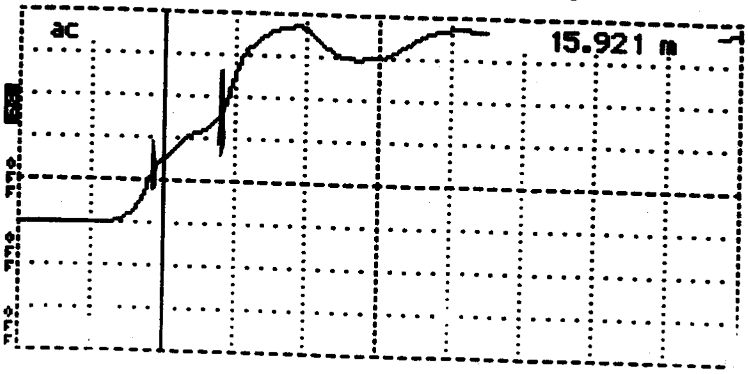
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Number 03

Trace 3 - Probe in Air

Cursor .... 15.921 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power............ ac

.20

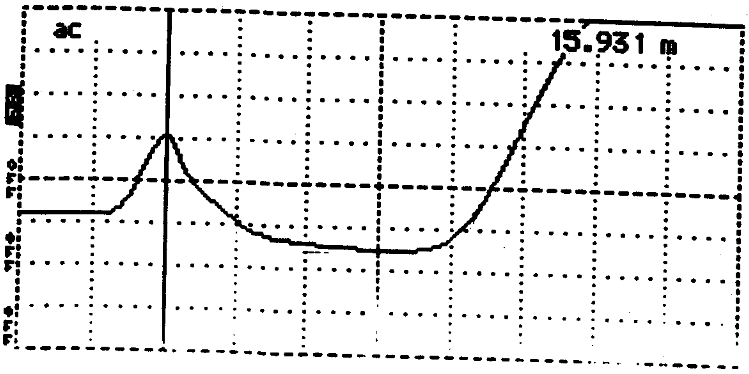


Tektronix 1502B TDR
Date Aug 03/95
Cable #03
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

rsor .... 15.931 m
tance/Div..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
se Filter...... 1 avg
ver............ ac

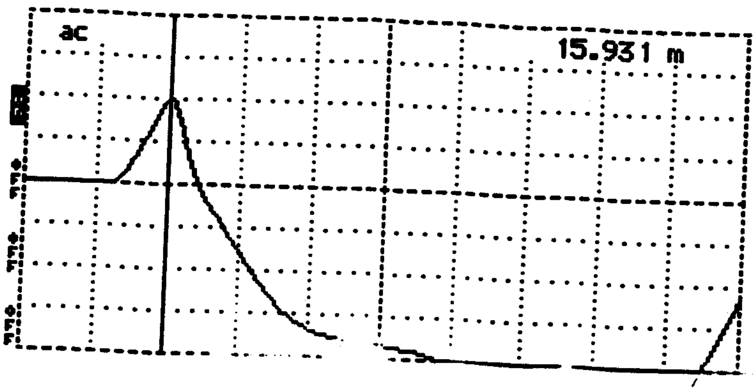


Tektronix 1502B TDR
Date Aug 03/95
Cable #03
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

rsor .... 15.931 m
tance/Div..... .25 m/div
rtical Scale.... 74.8 mρ/div
.... 0.99
se Filter...... 1 avg
ver............ ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #03
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

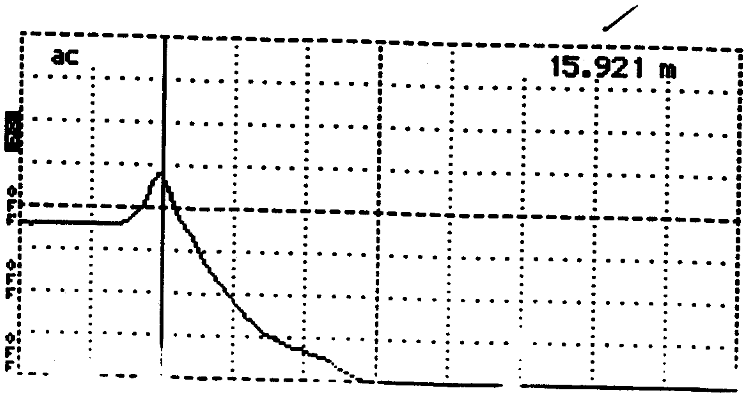
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A04 **Date (dd/mm/yy):** 03/08/95

Probe Number 04

Trace 1 - Probe Shorted at Start

sor .... 15.921 m
tance/Div ..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter ...... 1 avs
ver .... ac

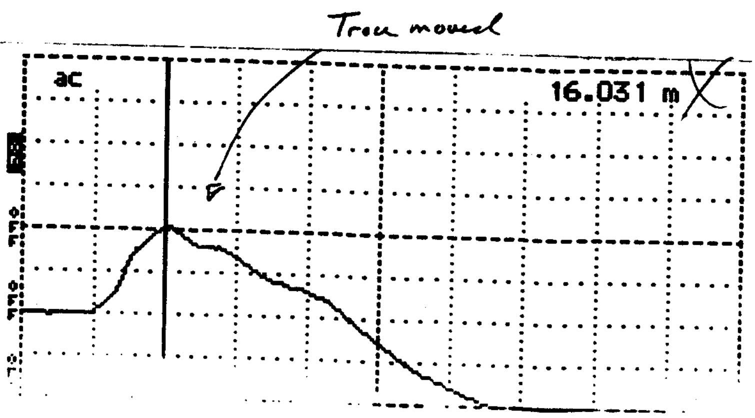


Tektronix 1502B TDR
Date Aug 03/95
Cable #04
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.031 m
ance/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avs
er .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #04
Notes Short end

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

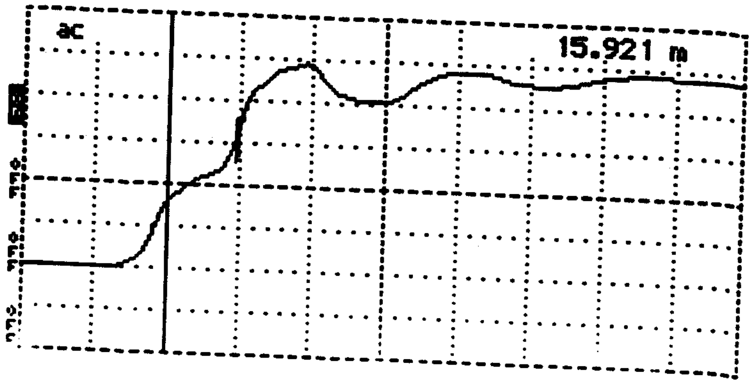
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 04

Trace 3 - Probe in Air

rsor .... 15.921 m
tance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

.20

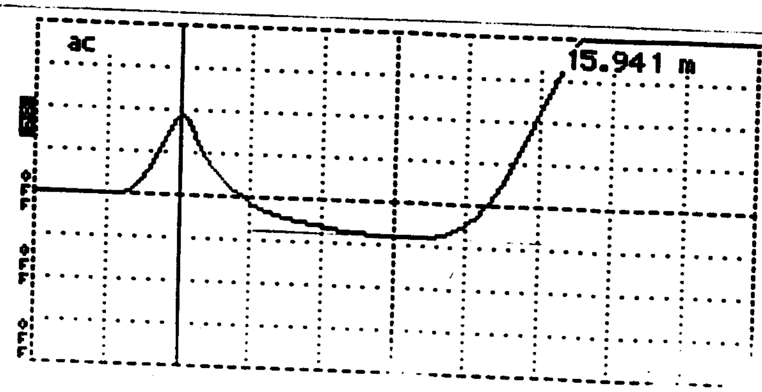


Tektronix 1502B TDR
Date Aug 03/95
Cable #04
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.941 m
ance/Div..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

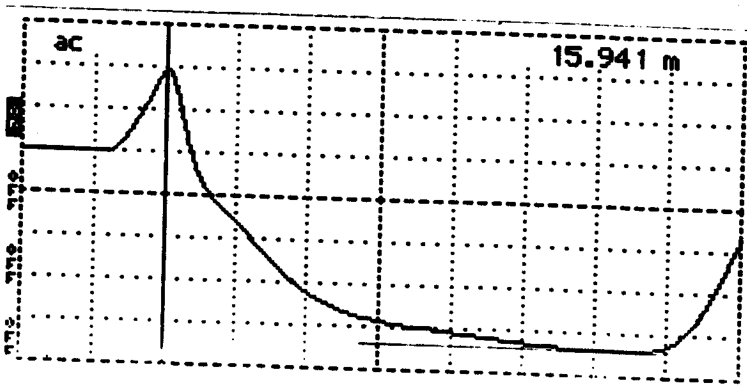


Tektronix 1502B TDR
Date Aug 03/95
Cable #04
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.941 m
ance/Div..... .25 m/div
ical Scale.... 74.8 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #04
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

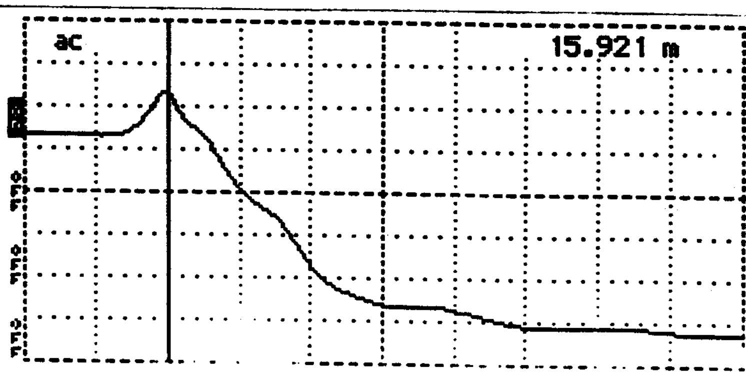
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A05 **Date (dd/mm/yy):** 03/08/95

Probe Number 05

Trace 1 - Probe Shorted at Start

sor .... 15.921 m
ance/Div...... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter....... 1 avg
er............ ac

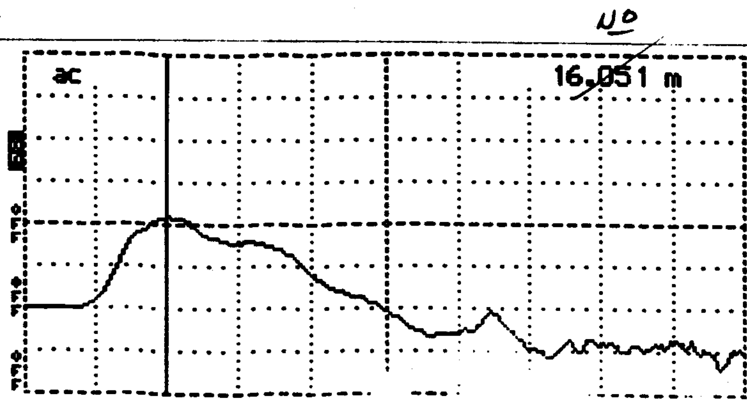


Tektronix 1502B TDR
Date Aug 03/95
Cable #05
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 16.051 m
ance/Div...... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
se Filter....... 1 avg
ver............ ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #05
Notes short end

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

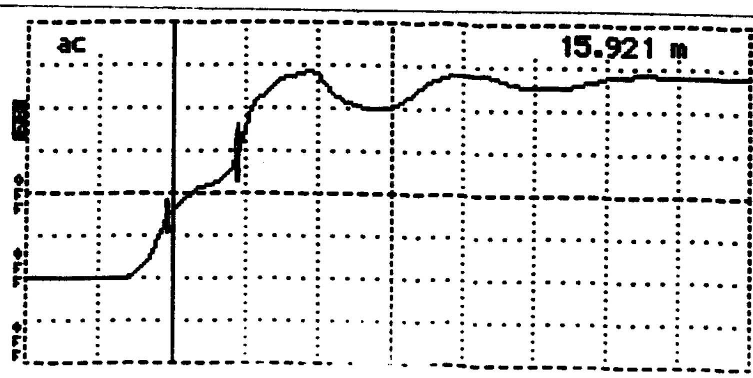
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 05

Trace 3 - Probe in Air

sor .... 15.921 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

.20

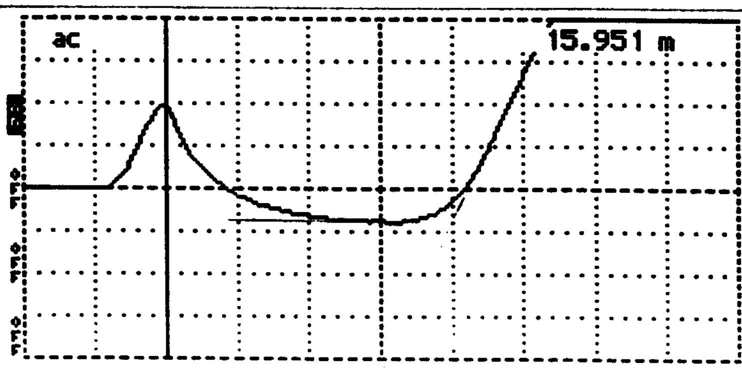


Tektronix 1502B TDR
Date Aug 03/95
Cable #05
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

sor .... 15.951 m
ance/Div ..... .25 m/div
rical Scale.... 100 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #05
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.951 m
nce/Div ..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

Tektronix 1502B TDR
Date Aug 03/95
Cable #05
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A06 **Date (dd/mm/yy):** 03/08/95

Probe Number 06

Trace 1 - Probe Shorted at Start

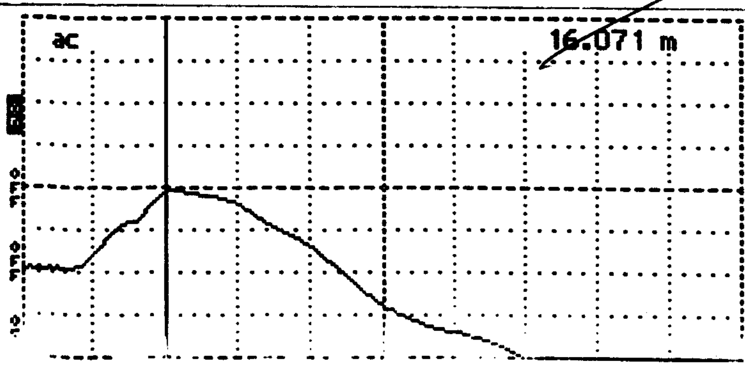
sor .... 15.901 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
se Filter ...... 1 avg
rer .... ac

Tektronix 1502B TDR
Date Aug 03/95
Cable #06
Notes Short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.071 m
ance/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #06
Notes Short End

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

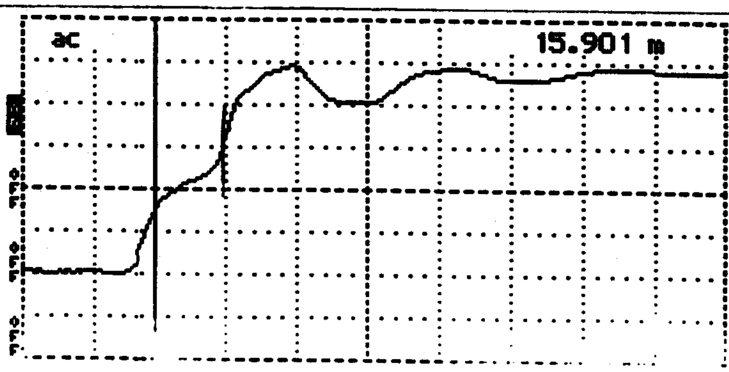
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 06

Trace 3 - Probe in Air

r .... 15.901 m
ce/Div ..... .25 m/div
al Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

.20

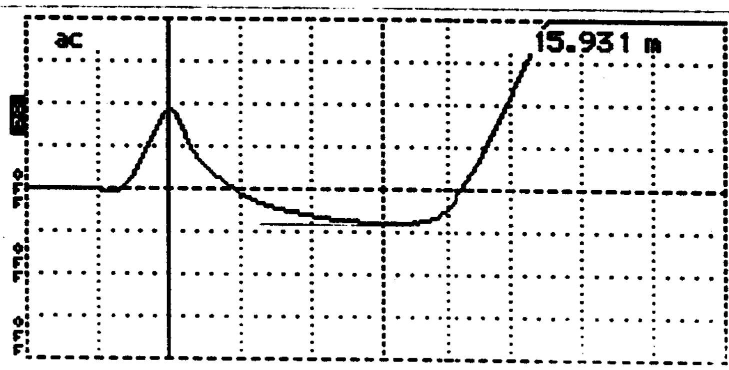


Tektronix 1502B TDR
Date Aug 03/95
Cable #06
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.931 m
ance/Div ..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

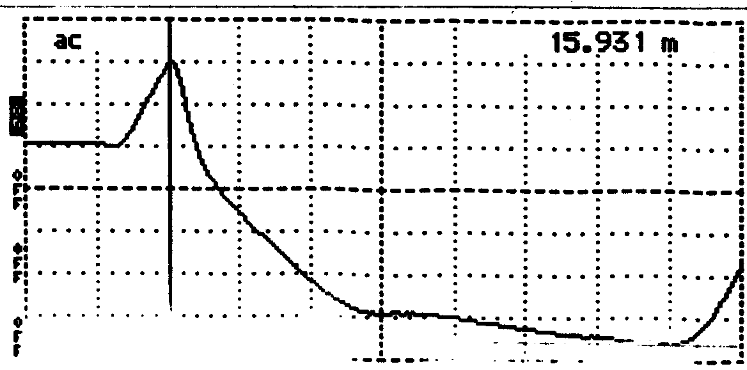


Tektronix 1502B TDR
Date Aug 03/95
Cable #06
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.931 m
ance/Div ..... .25 m/div
ical Scale.... 74.8 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #06
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Serial Number: 42A07 **Date (dd/mm/yy):** 03/08/95

Probe Number 07

Trace 1 - Probe Shorted at Start

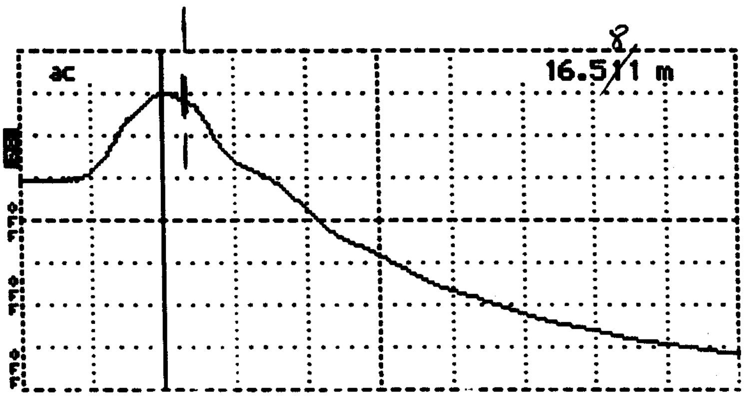
sor .... 16.381 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

Tektronix 1502B TDR
Date Aug 03/95
Cable #07
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.511 m
nce/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #07
Notes Short end

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

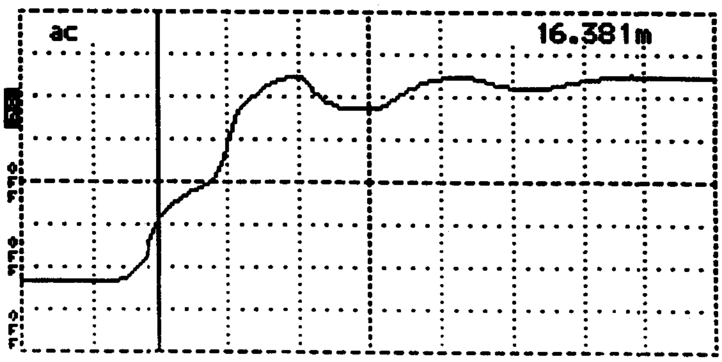
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [16 06]

Probe Number 07

Trace 3 - Probe in Air

or .... 16.381 m
ance/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er .... ac

.20

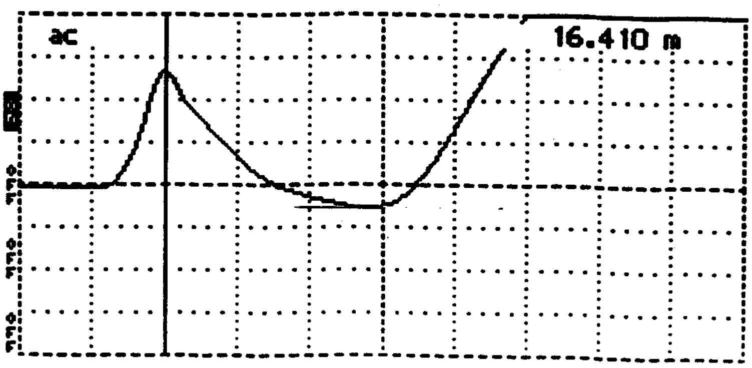


Tektronix 1502B TDR
Date Aug 03/95
Cable #07
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 16.410 m
nce/Div ..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r .... ac

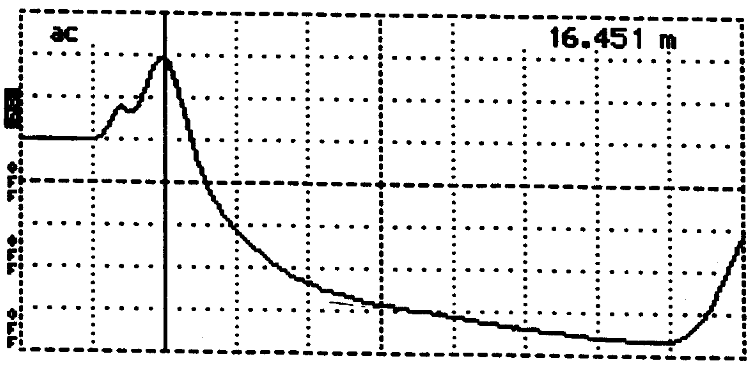


Tektronix 1502B TDR
Date Aug 03/95
Cable #7
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 16.451 m
nce/Div ..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
r .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #07
Notes Water

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

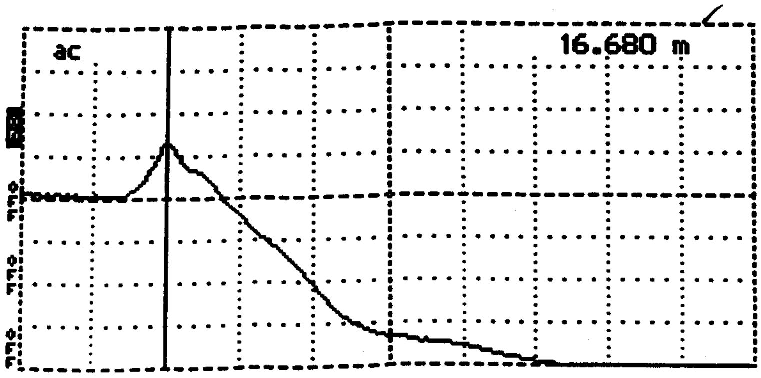
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A08 **Date (dd/mm/yy):** 03/08/95

Probe Number 08

Trace 1 - Probe Shorted at Start

r .... 16.680 m
nce/Div..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

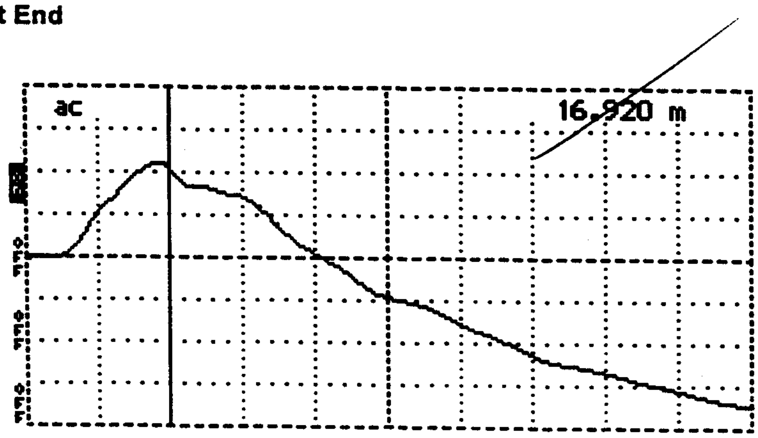


Tektronix 1502B TDR
Date Aug 03/95
Cable #08
Notes Short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

r .... 16.920 m
nce/Div..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #08
Notes Short end

Input Trace
Stored Trace
Difference Trace

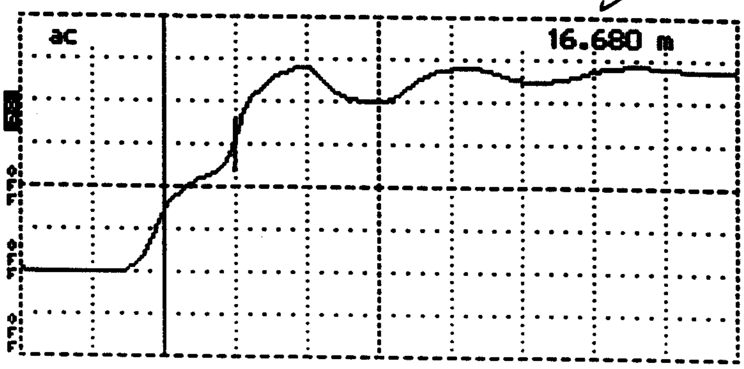
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Number 08

Trace 3 - Probe in Air

sor .... 16.680 m
tance/Div ..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

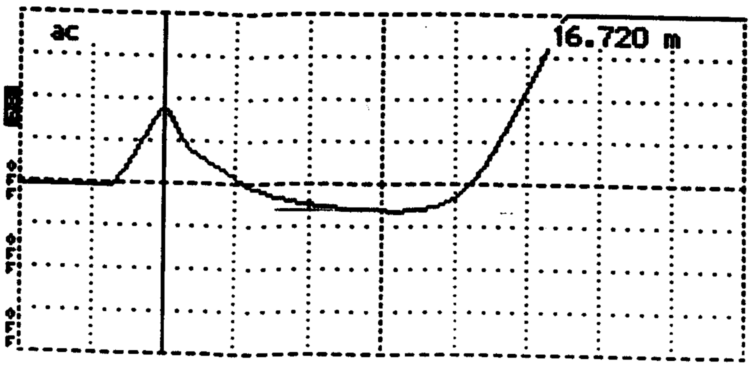


Tektronix 1502B TDR
Date Aug 03/95
Cable #08
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 16.720 m
nce/Div ..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #08
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 16.720 m
ance/Div ..... .25 m/div
ical Scale.... 74.8 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

Tektronix 1502B TDR
Date Aug 03/95
Cable #08
Notes Water

Input Trace
Stored Trace
Difference Trace

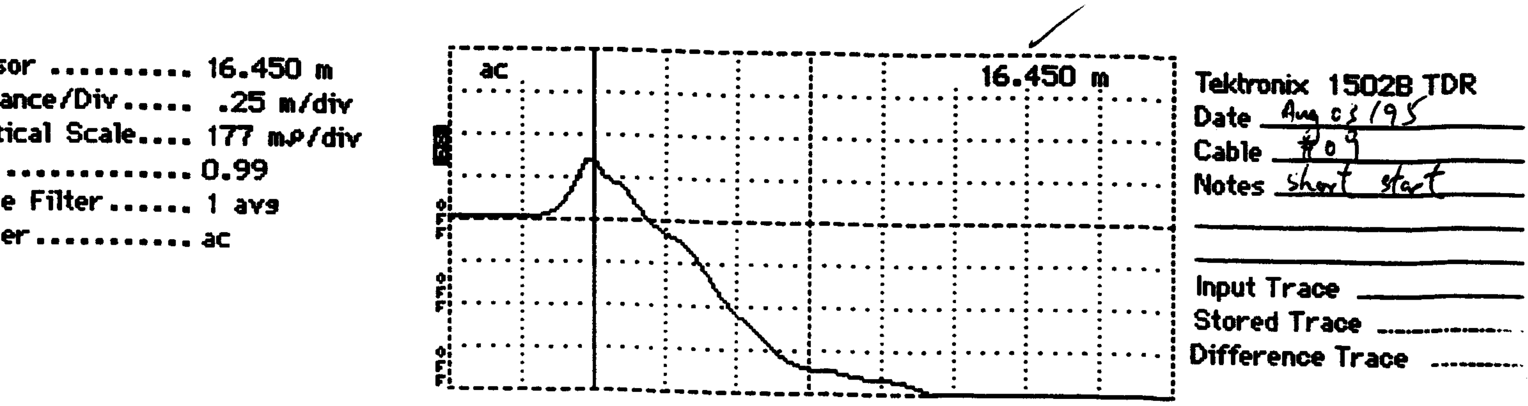
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[42] [1606]

Probe Serial Number: 42A09 **Date (dd/mm/yy):** 03/08/95

Probe Number 09

Trace 1 - Probe Shorted at Start



Trace 2 - Probe Shorted at End

Figure B-1(cont.). TDR Traces Obtained During Calibration

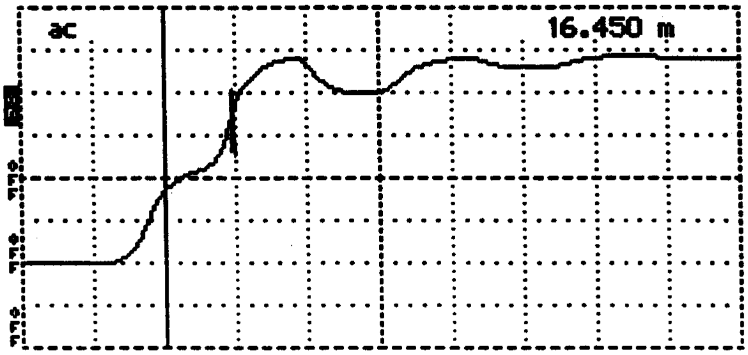
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Number 09

Trace 3 - Probe in Air

r .... 16.450 m
ce/Div ..... .25 m/div
al Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

.20

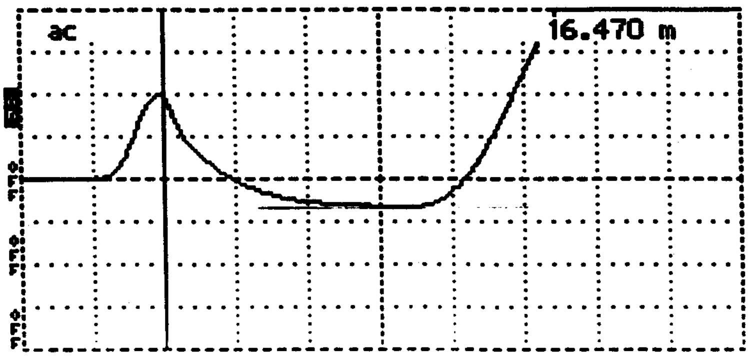


Tektronix 1502B TDR
Date Aug 03/95
Cable #09
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

r .... 16.470 m
ce/Div ..... .25 m/div
al Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

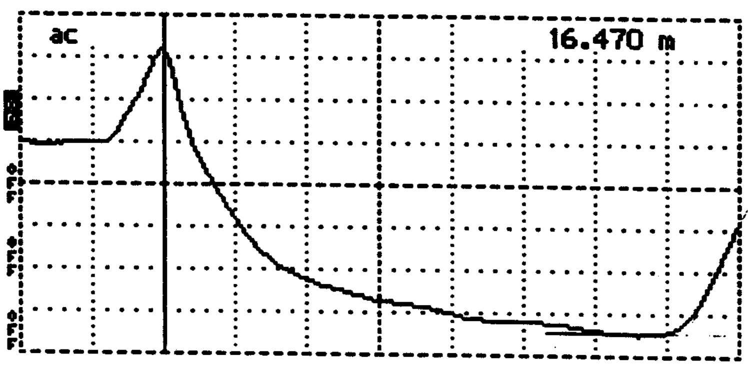


Tektronix 1502B TDR
Date Aug 03/95
Cable #09
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 16.470 m
nce/Div ..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #09
Notes Water

Input Trace
Stored Trace
Difference Trace

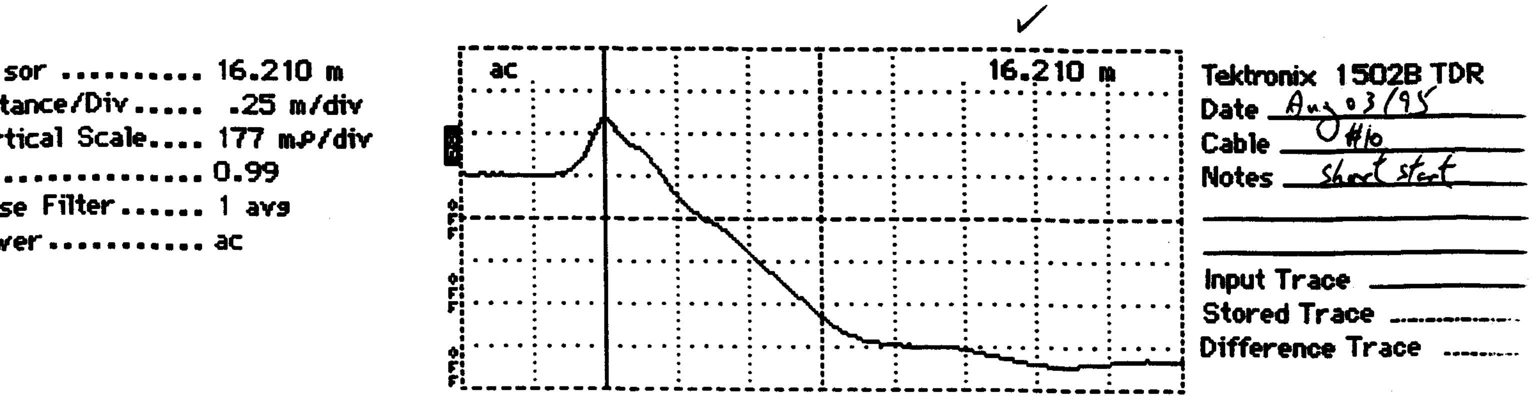
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [1606]

Probe Serial Number: 42A10 **Date (dd/mm/yy):** 03/08/95

Probe Number 10

Trace 1 - Probe Shorted at Start



Trace 2 - Probe Shorted at End

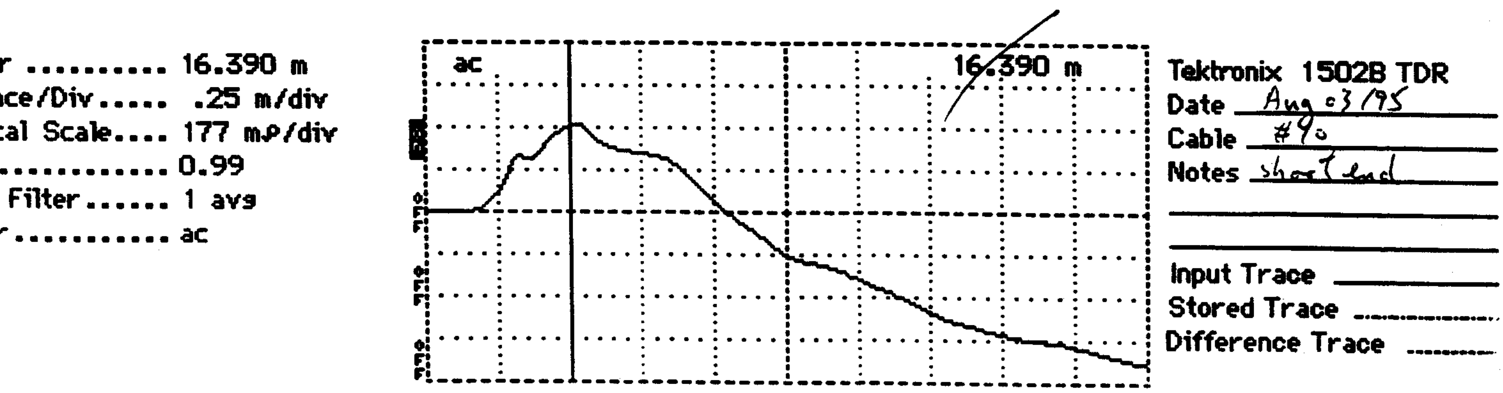


Figure B-1(cont.). TDR Traces Obtained During Calibration

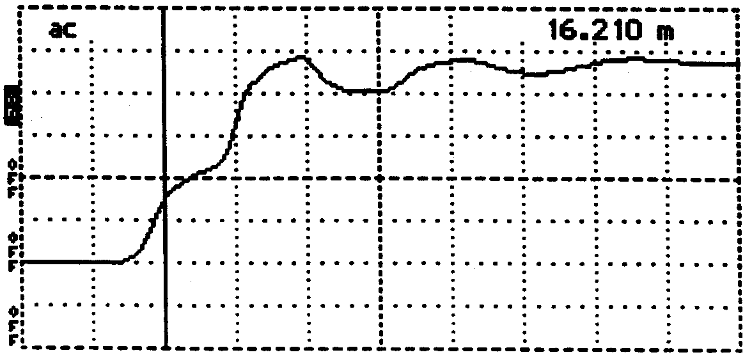
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [42] LTPP Section ID: [16 06]

Probe Number 10

Trace 3 - Probe in Air

r .... 16.210 m
nce/Div..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

.20

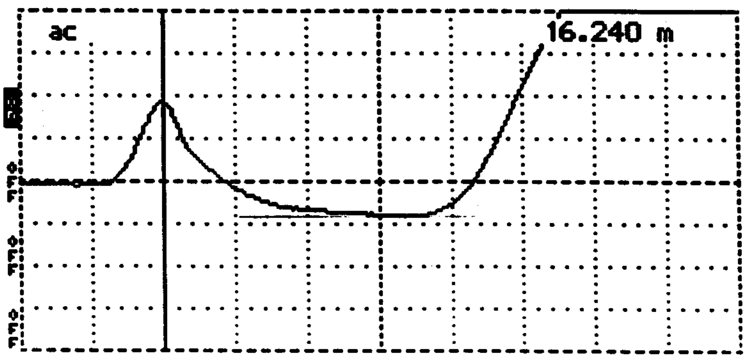


Tektronix 1502B TDR
Date Aug 03/95
Cable #10
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

.... 16.240 m
ce/Div..... .25 m/div
al Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

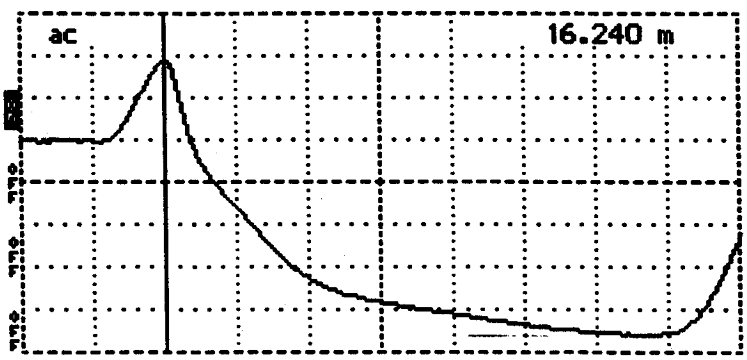


Tektronix 1502B TDR
Date Aug 03/95
Cable #10
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 16.240 m
nce/Div..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 03/95
Cable #10
Notes Water

Input Trace
Stored Trace
Difference Trace

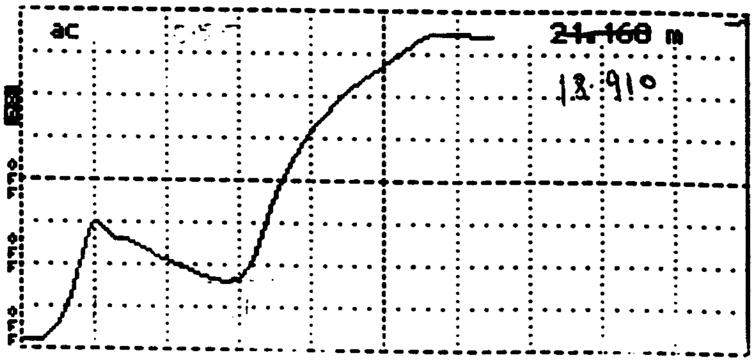
Figure B-1(cont.). TDR Traces Obtained During Calibration

APPENDIX C

Supporting Instrumentation Installation Information

Appendix C contains the following supporting information:

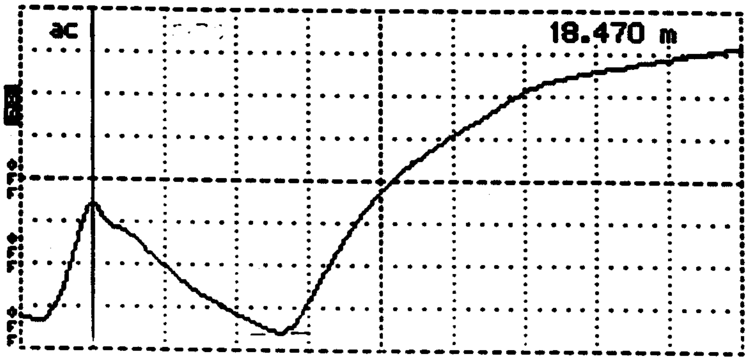
or .... 21.160 m
ance/Div..... .25 m/div
ical Scale.... 70.6 mρ/div
.... 0.99
e Filter...... 128 avg
er............ ac



Tektronix 1502B TDR
Date Aug 9/95
Cable 0 #01
Notes 421606 (Inst (w/ext.)

Input Trace
Stored Trace
Difference Trace

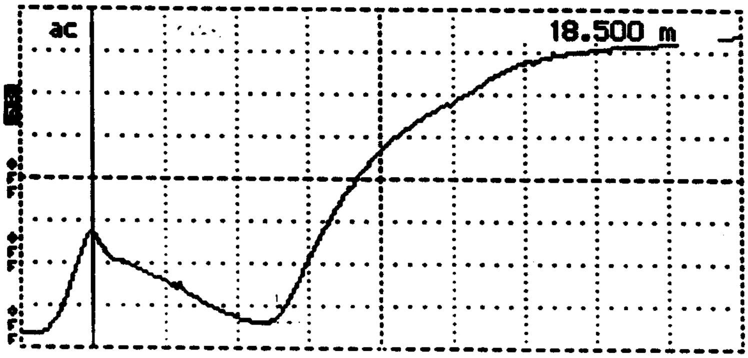
or .... 18.470 m
ance/Div..... .25 m/div
ical Scale.... 70.6 mρ/div
.... 0.99
e Filter...... 128 avg
er............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable 0 #2
Notes 421606 (Ins w/Ext

Input Trace
Stored Trace
Difference Trace

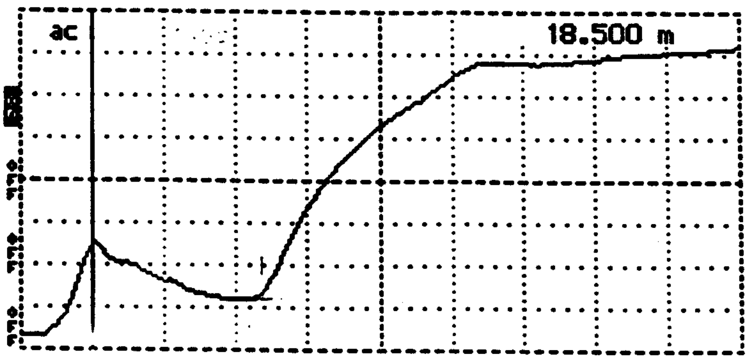
or .... 18.500 m
ance/Div..... .25 m/div
ical Scale.... 74.8 mρ/div
.... 0.99
e Filter...... 128 avg
er............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable 0 #3
Notes 421606 (Insi w/EXT

Input Trace
Stored Trace
Difference Trace

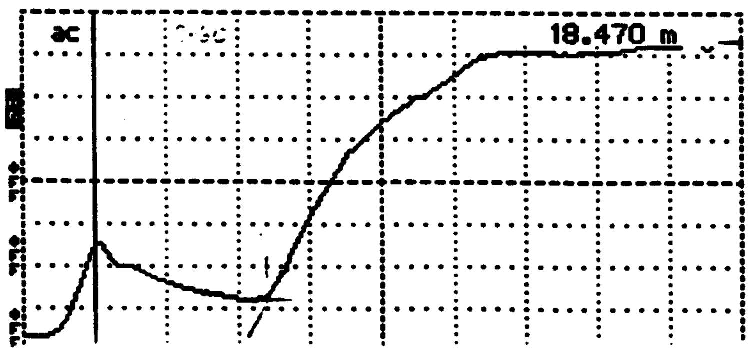
or .... 18.500 m
ance/Div..... .25 m/div
ical Scale.... 88.9 mρ/div
.... 0.99
e Filter...... 128 avg
er............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable 0 #04
Notes 421606 (Inside) w/ EXT

Input Trace
Stored Trace
Difference Trace

sor .... 18.470 m
ance/Div..... .25 m/div
ical Scale.... 88.9 mρ/div
.... 0.99
e Filter...... 128 avg
er............ ac

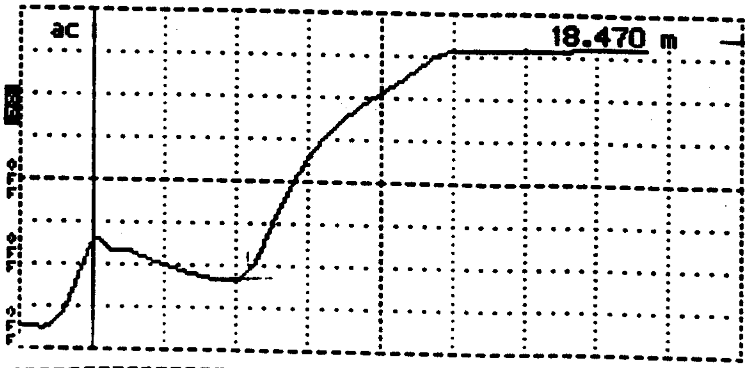


Tektronix 1502B TDR
Date Aug 9 1995
Cable 0 #05
Notes 421606 (Insi w/ EXT

Input Trace
Stored Trace
Difference Trace

Figure C-1. TDR Traces Measured Manually During Installation

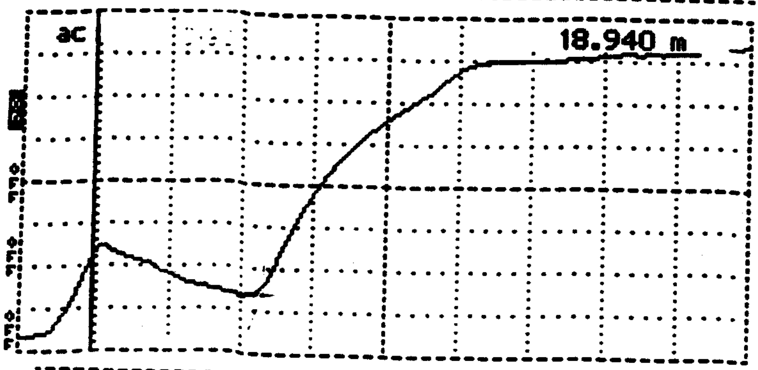
ursor .... 18.470 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mρ/div
VP 0.99
Noise Filter...... 128 avg
Power............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable #06
Notes 421606 (Ins.
w/EXT

Input Trace
Stored Trace
Difference Trace

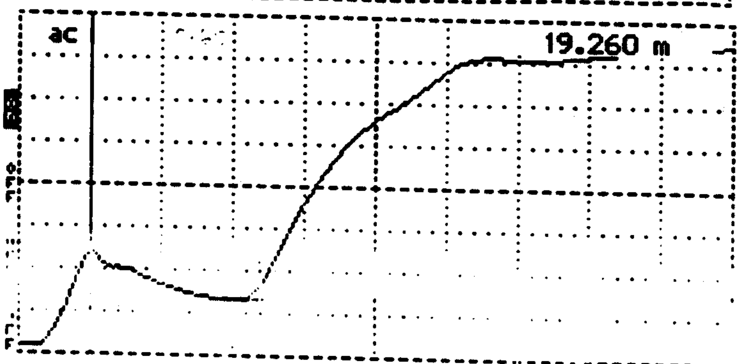
ursor .... 18.940 m
istance/Div..... .25 m/div
ertical Scale.... 91.5 mρ/div
P 0.99
oise Filter...... 128 avg
ower............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable #07
Notes 421606 (Ins.
w/EXT

Input Trace
Stored Trace
Difference Trace

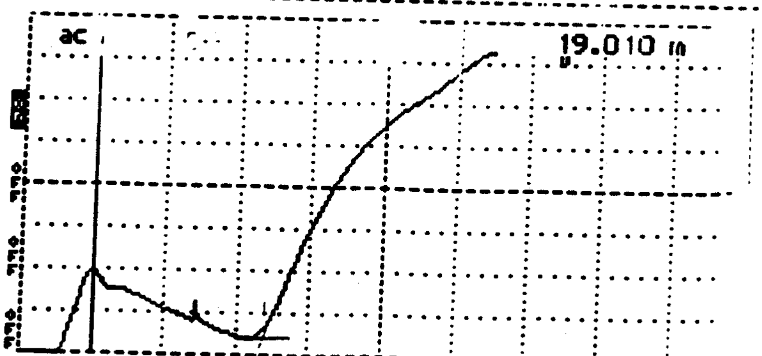
Cursor .... 19.260 m
Distance/Div..... .25 m/div
Vertical Scale.... 88.9 mρ/div
VP 0.99
Noise Filter...... 128 avg
Power............ ac



Tektronix 1502B TDR
Date Aug 9 1995
Cable #08
Notes 421606 (In.
w/ext

Input Trace
Stored Trace
Difference Trace

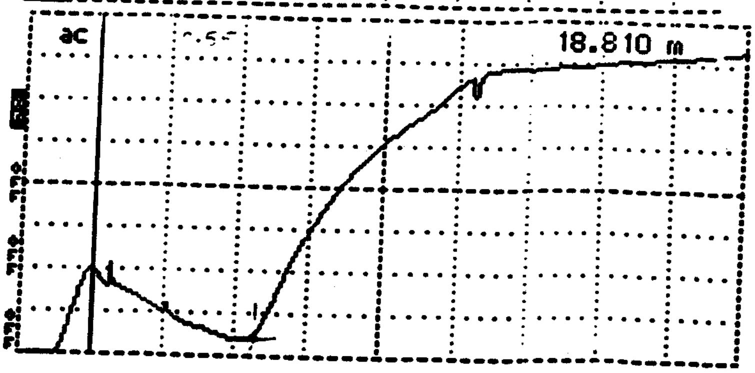
ursor .... 19.010 m
istance/Div..... .25 m/div
ertical Scale.... 74.8 mρ/div
P 0.99
oise Filter...... 1 avg
ower............ ac



Tektronix 1502B TDR
Date Aug 9/95
Cab #09
Not 421606 (Inst.
w/ext.

ace

rsor .... 18.810 m
stance/Div..... .25 m/div
rtical Scale.... 74.8 mρ/div
.... 0.99
ise Filter...... 1 avg
wer............ ac



Tektronix 1502B TDR
Date Aug 9/95
Cable #10
Notes 421606 (Inst.
w/ext.

Input Trace
Stored Trace
Difference Trace

Figure C-1(cont.). TDR Traces Measured Manually During Installation

Table C-1. TDR Moisture Content

TDR No.	Depth (m)	TDR Length (m)	Dielectric Constant (ε)	Volumetric Moisture Content (%)	In-Situ Dry Density (kg/m³)	Gravimetric Moisture Content (%)
42A01	0.38	0.55	7.34	13.41	2030	6.6
42A02	0.55	0.70	11.89	22.49	1940	11.6
42A03	0.69	0.65	10.25	19.42	1940	10.0
42A04	0.85	0.60	8.74	16.39	1940	8.4
42A05	1.00	0.60	8.74	16.39	1940	8.4
42A06	1.16	0.55	7.34	13.41	1940	6.9
42A07	1.30	0.60	8.74	16.39	1940	8.4
42A08	1.46	0.60	8.74	16.39	1940	8.4
42A09	1.78	0.60	8.74	16.39	1940	8.4
42A10	2.03	0.55	7.34	13.41	1940	6.9

Table C-2. Field Measured Moisture Content

LTPP Seasonal Monitoring Study	State Code	[42]
In-Situ Moisture Tests	Test Section Number	[1606]

Weight (gm)	Probe 1	Probe 2	Probe 3	Probe 4	Probe 5
Weight of Pan + Wet Soil	291.2	235.0	198.0	216.7	
Weight of Pan + Dry Soil	283.1	221.3	188.5	205.4	
Weight of Pan	121.0	120.0	121.0	120.0	
Weight of Dry Soil	162.1	101.3	67.5	85.4	
Weight of Wet Soil	170.2	115.0	77.0	96.7	
Weight of Moisture	8.1	13.7	9.5	11.3	
Wt of Moisture/Dry Wt x 100	5.0	13.5	14.1	13.2	

Weight (gm)	Probe 6	Probe 7	Probe 8	Probe 9	Probe 10
Weight of Pan + Wet Soil	181.6	193.7	200.0	201.5	182.5
Weight of Pan + Dry Soil	176.1	186.1	193.0	192.2	175.7
Weight of Pan	120.0	121.0	120.0	121.0	120.0
Weight of Dry Soil	56.1	65.1	73.0	71.2	55.7
Weight of Wet Soil	61.6	72.7	80.0	80.5	62.5
Weight of Moisture	5.5	7.6	7.0	9.3	6.8
Wt of Moisture/Dry Wt x 100	9.8	11.7	9.6	13.1	12.2

Prepared by:	DS	Employer:	PMSL
Date (dd/mm/yy):	09/08/95		

Table C-3. Field Measured Dry Density

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [42] LTPP Section ID [1606]

Depth of Representative Sample (from pavement surface): 0.4 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	2028g	(4.47 lb)
b.	Weight of Mold and Compacted Soil:	4020 g	(8.86 lb)
c.	Weight of Compacted Soil (b-a):	1992 g	(4.39 lb)
d.	Unit Weight of Compacted Soil = (c/943.0) =		2.11 g/cm^3
	= [c/(1/30)] =		(63.3 lb/ft^3)
e.	Dry Density of Compacted Soil = [d/(1+r/100)] =		2.03 g/cm^3
			(126.7 lb/ft^3)

Moisture Content Determination:

m	Tare Weight of Pan:	120.4 g
n.	Weight of Pan and Moisture Sample:	224.2 g
o.	Weight of Pan and Dry Sample:	220.3 g
p.	Weight of Moisture (n -o):	3.9 g
q.	Weight of Dry Sample (o - m):	99.9 g
r.	Moisture Content by Weight = [(p/q)*100] =	3.9 %

Prepared By:	JK	Employer:	FHWA
Date (dd/mm/yy):	09/08/95		

Table C-4. Field Measured Dry Density

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [42] LTPP Section ID [1606]

Depth of Representative Sample (from pavement surface): 1.2 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	2028g	(4.47 lb)
b.	Weight of Mold and Compacted Soil:	4013g	(8.85 lb)
c.	Weight of Compacted Soil (b-a):	1985g	(4.38 lb)
d.	Unit Weight of Compacted Soil = (c/943.0) =		2.10 g/cm^3
	= [c/(1/30)] =		(63.1 lb/ft^3)
e.	Dry Density of Compacted Soil = [d/(1+r/100)] =		1.94 g/cm^3
			(121.1 lb/ft^3)

Moisture Content Determination:

m.	Tare Weight of Pan:	120.0 g
n.	Weight of Pan and Moisture Sample:	218.1 g
o.	Weight of Pan and Dry Sample:	210.4 g
p.	Weight of Moisture (n -o):	7.7 g
q.	Weight of Dry Sample (o - m):	90.4 g
r.	Moisture Content by Weight = [(p/q)*100] =	8.5 %

Prepared By:	JK	Employer:	FHWA
Date (dd/mm/yy):	09/08/95		

REPORT Ref#: A024993 Lab#: 95050562 Pass/Fail: P CAMSPROD

#:		QA Rtng:		Cntrctr:	
N:	A8050019000 4650 213 9998	Smp Cls:	IF	Suplier:	ERTHMT15
#:		Orgnztn:	4650	Lctn Cd:	
Cd:	302 SLSRVY	State R:	0220	JMF #/Y:	/
Ds:	SOIL - DISTURBED	Section:	0710	L/C XRf:	
/S:		Station:		Prt Tkt:	
#:		Colcted:	08/09/1995	Lot Nbr:	4 JARS
Cl:	SUBGRADE	Receivd:	09/05/1995	# Incrm:	4
By:	HENDERSON	Releasd:	09/07/1995	447 XRf:	

47 Remarks: SOIL SAMPLES FROM SMRK SITE 421606. INCREMENT 1 THRU 4 ARE
SAMPLES #1 THRU #4 NEED NATURAL MOISTURE FOR EACH OF 4 INCR.

est Description	Inc Ver	Result Description	Result	P/F
PREPARING SMALL SAMPLE	1	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	1	NATURAL MOISTURE %	4.4	
PREPARING SMALL SAMPLE	2	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	2	NATURAL MOISTURE %	11.9	
PREPARING SMALL SAMPLE	3	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	3	NATURAL MOISTURE %	11.5	
PREPARING SMALL SAMPLE	4	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	4	NATURAL MOISTURE %	11.7	

SAMPLES 1 THRU 4
(NO SAMPLE 5 MATERIAL)

REPORT · Ref#: A024994 Lab#: 95050505

#:	QA Rtng:	Cntrctr:
N: A8050019000 4650 213 9998	Smp Cls: IF	Suplier: ERTHMT15
#:	Orgnztn: 4650	Lctn Cd:
d: 302 SLSRVY	State R: 0220	JMF #/Y: /
s: SOIL - DISTURBED	Section: 0710	L/C XRf:
):	Station:	Prt Tkt:
#:	Colcted: 08/09/1995	Lot Nbr: 5 JARS
l: SUBGRADE	Receivd: 09/05/1995	# Incrm: 5
y: HENDERSON	Releasd: 09/07/1995	447 XRf:

7 Remarks: SOIL SAMPLES FROM SHRP SITE 421606 INC 1 THRU 5 ARE SAMPLES #6 THRU #10 NEED NATURAL MOISTURE FOR EACH OF 5 SAMPLES

est Description	Inc Ver	Result Description	Result	P/F
PREPARING SMALL SAMPLE	~~1~~ 6	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	~~1~~ 6	NATURAL MOISTURE %	10.1	
PREPARING SMALL SAMPLE	~~2~~ 7	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	~~2~~ 7	NATURAL MOISTURE %	9.4	
PREPARING SMALL SAMPLE	~~3~~ 8	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	~~3~~ 8	NATURAL MOISTURE %	10.6	
PREPARING SMALL SAMPLE	~~4~~ 9	PREPARING SMALL SAMPLE		
ATURAL WATER CONTENT	~~4~~ 9	NATURAL MOISTURE %	11.7	
PREPARING SMALL SAMPLE	~~5~~ 10	PREPARING SMALL SAMPLE		
NATURAL WATER CONTENT	~~5~~ 10	NATURAL MOISTURE %	10.7	

SAMPLES 6 THRU 10

APPENDIX D

Initial Data Collection

Appendix D contains the following supporting information:

Table D-1. Sample Data from the Onsite Datalogger During Initial Data Collection, August 11, 1995

```
5,1995,223,100,12.69,19.54,0
6,1995,223,100,25.4,27.95,28.89,28.12,27.13
5,1995,223,200,12.69,18.67,0
6,1995,223,200,24.81,27.32,28.3,27.89,27.06
5,1995,223,300,12.69,18.32,0
6,1995,223,300,24.25,26.73,27.75,27.64,26.96
5,1995,223,400,12.69,17.78,0
6,1995,223,400,23.75,26.19,27.23,27.37,26.82
5,1995,223,500,12.68,17.41,0
6,1995,223,500,23.28,25.69,26.74,27.1,26.67
5,1995,223,600,12.68,17.82,0
6,1995,223,600,23.1,25.25,26.28,26.82,26.51
5,1995,223,700,12.67,18.12,0
6,1995,223,700,22.96,24.9,25.87,26.55,26.34
5,1995,223,800,12.67,18.75,0
6,1995,223,800,23.15,24.62,25.51,26.28,26.16
5,1995,223,900,12.67,19.28,0
6,1995,223,900,23.76,24.53,25.24,26.03,25.99
5,1995,223,1000,12.67,20.7,0
6,1995,223,1000,25.73,24.75,25.09,25.8,25.83
5,1995,223,1100,12.68,22.77,0
6,1995,223,1100,28.49,25.52,25.22,25.61,25.67
5,1995,223,1200,12.69,25.18,0
6,1995,223,1200,31.51,26.74,25.66,25.49,25.53
5,1995,223,1300,12.7,26.29,0
6,1995,223,1300,33.42,28.1,26.38,25.47,25.44
5,1995,223,1400,12.7,24.68,1.5
6,1995,223,1400,33.86,29.3,27.23,25.58,25.4
5,1995,223,1500,12.7,18.58,2.2
6,1995,223,1500,29.02,29.41,27.93,25.81,25.45
5,1995,223,1600,12.69,19.58,0
6,1995,223,1600,27.81,28.48,28.01,26.1,25.56
5,1995,223,1700,12.68,21.61,0
6,1995,223,1700,29.17,28.07,27.82,26.33,25.71
5,1995,223,1800,12.69,23.02,0
6,1995,223,1800,30.7,28.47,27.79,26.45,25.82
5,1995,223,1900,12.69,23.36,0
6,1995,223,1900,30.04,28.8,27.98,26.54,25.91
5,1995,223,2000,12.69,22.13,0
6,1995,223,2000,28.27,28.61,28.09,26.61,25.97
5,1995,223,2100,12.69,19.43,0
6,1995,223,2100,26.62,28.03,27.97,26.7,26.04
5,1995,223,2200,12.68,18.81,0
6,1995,223,2200,25.39,27.32,27.67,26.76,26.1
5,1995,223,2300,12.68,18.68,0
6,1995,223,2300,24.52,26.63,27.25,26.74,26.14
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2,1995,223,2400,26.79,26.98,27.03,26.52,26.1,25.62,25.22,24.96,24.47,24.13,23.78,23.54,23.18,22.79,22.31,21.85,21.35,20.83
3,1995,223,2400,34.41,1329,29.75,1402,29.19,1,28.22,1,27.15,1,26.16,106,25.5,315,25.12,413,24.55,730,24.21,1,23.9,14,23.69,8,23
.32,159,22.92,1,22.46,31,21.98,1,21.46,1,20.91,1
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67,2352,23.41,2254,23.05,2241,22.66,2243,22.19,2230,21.75,2152,21.25,2247,20.78,1840
5,1995,223,2400,12.68,18.89,0
6,1995,223,2400,23.98,26.03,26.8,26.66,26.14
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Section 421606

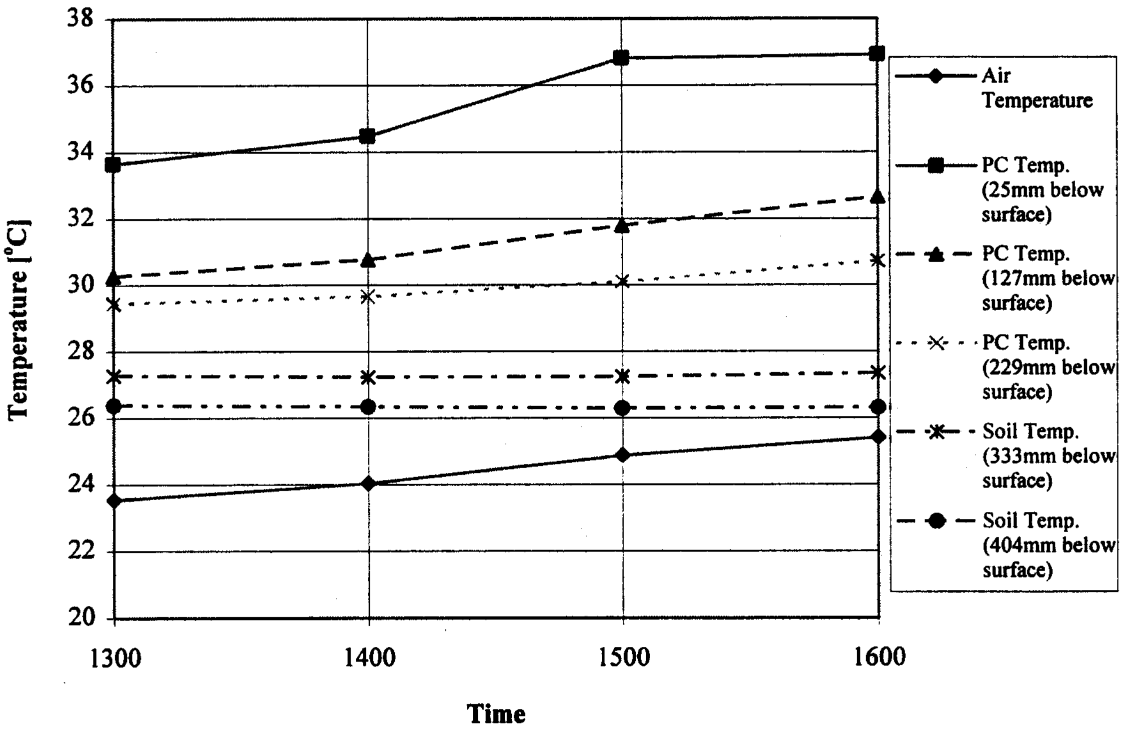


Figure D-1. Air Temperature and First Five Sub-Surface Temperatures From Initial Data Collection, August 10, 1995

Section 421606

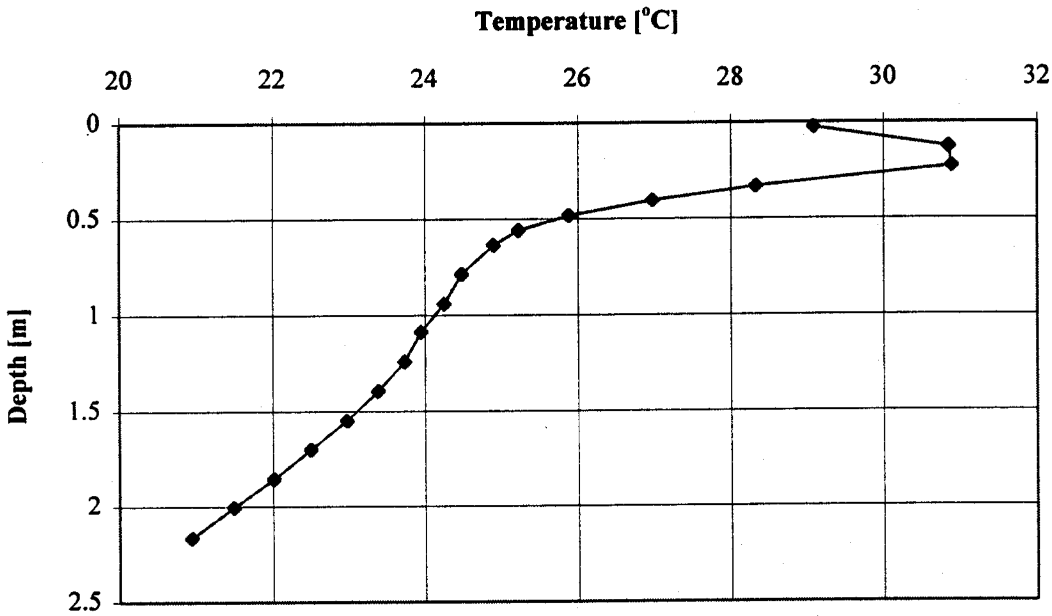


Figure D-2. Average Subsurface Temperature for all 18 Sensors From Initial Data Collection, August 11, 1995

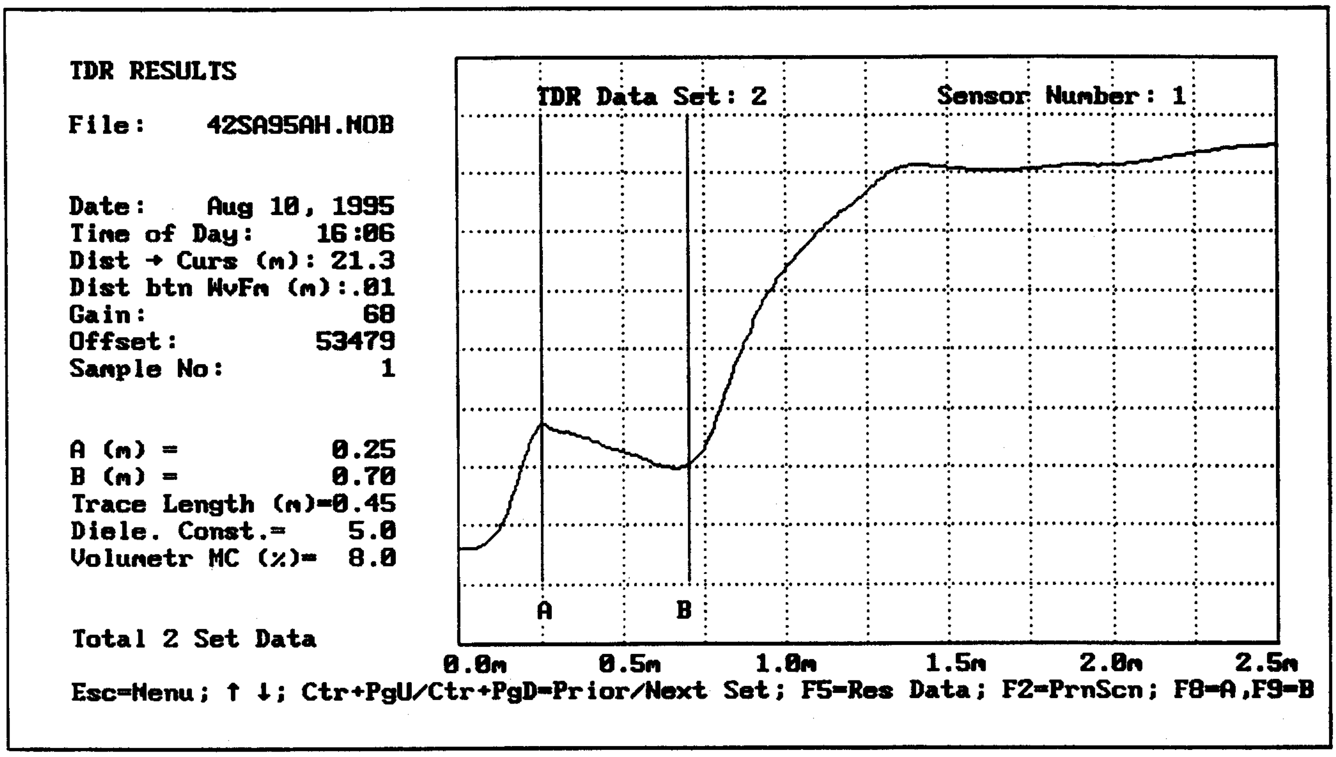


Figure D-3. Initial Second Set of TDR Traces Measured with the Mobile Unit

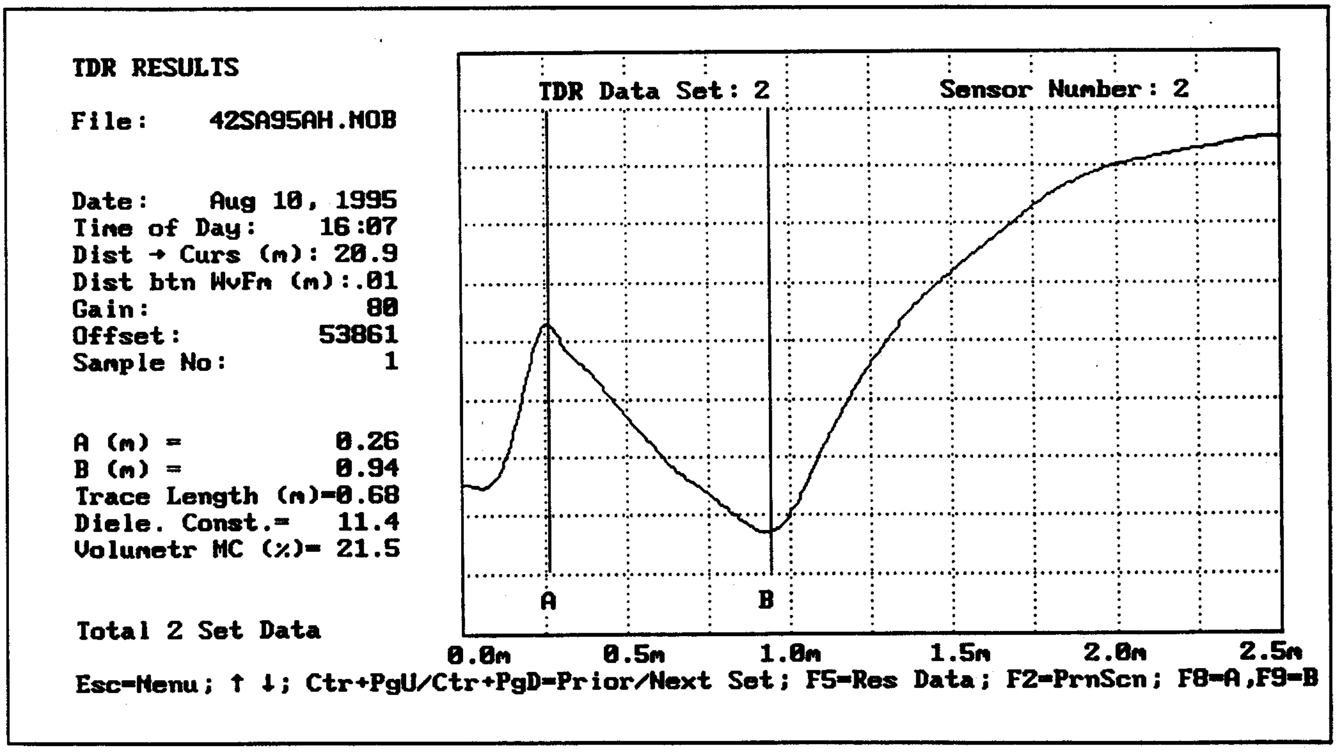


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

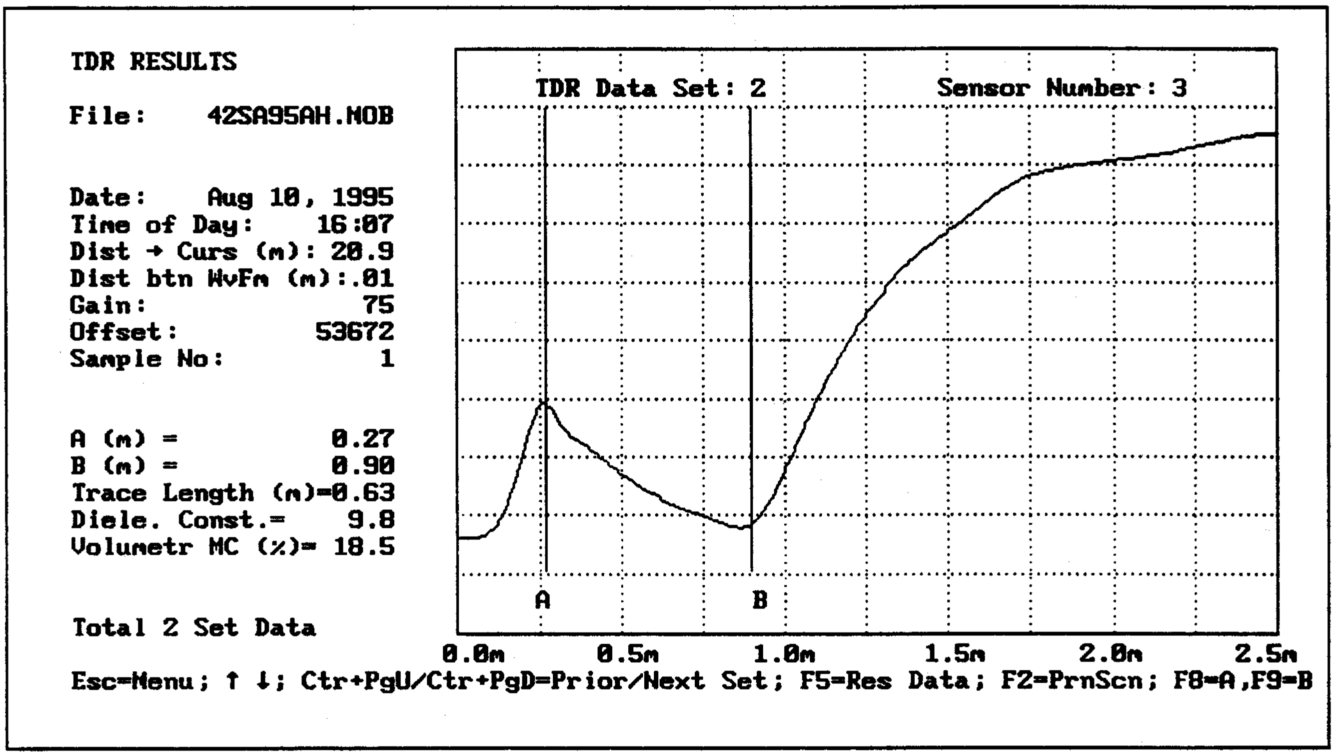


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

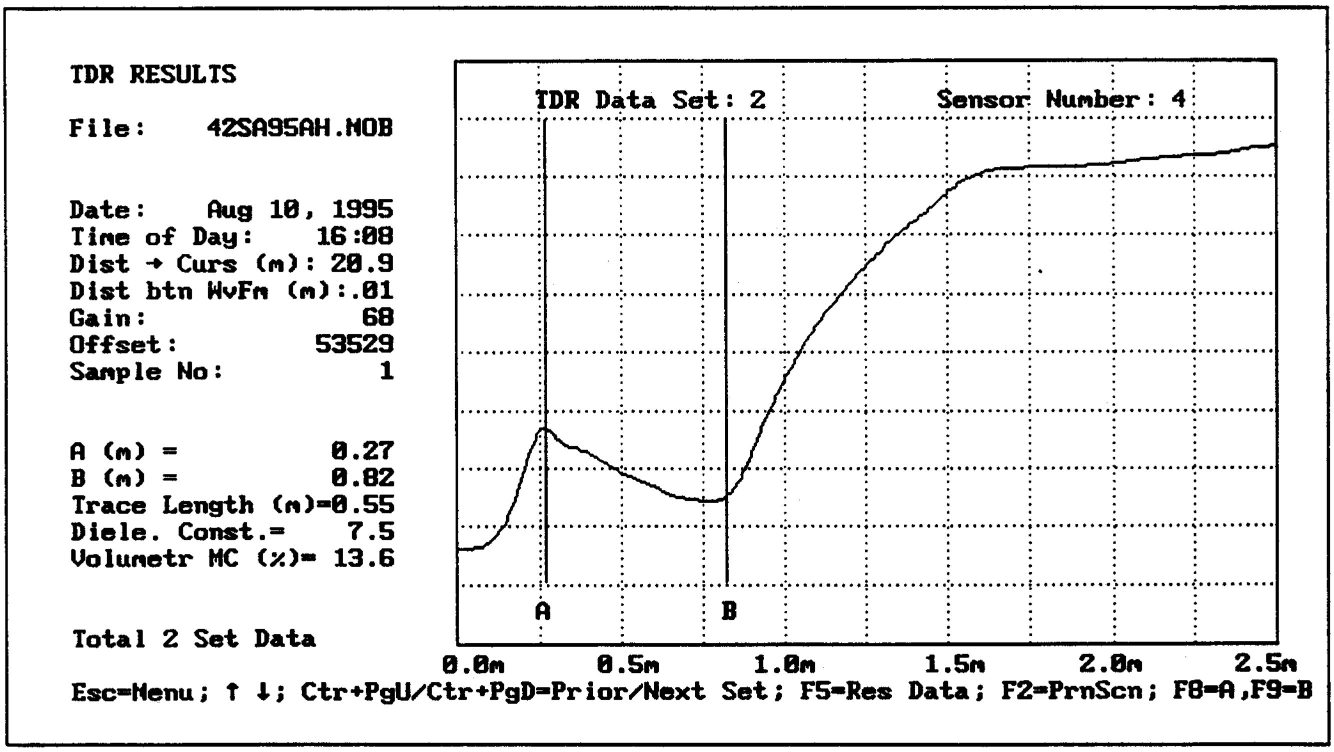


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

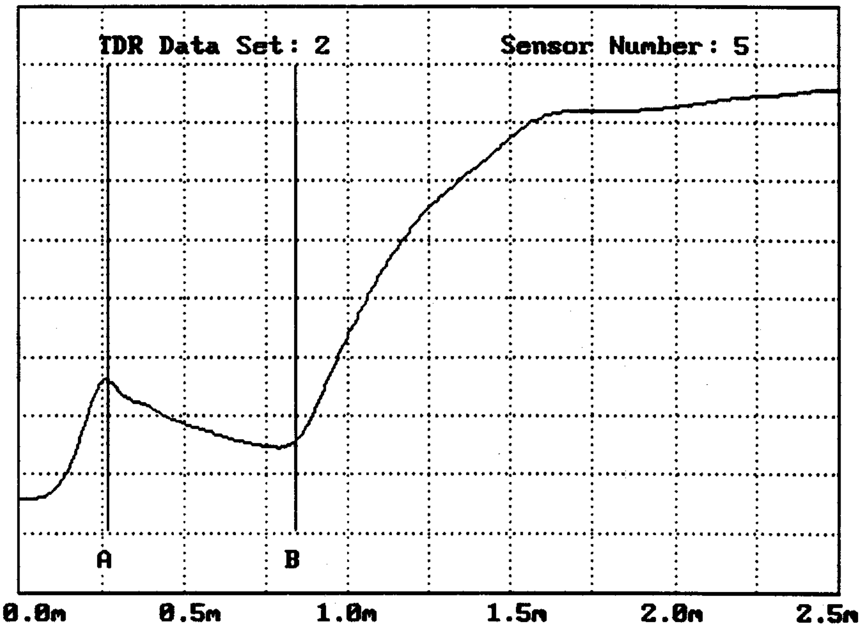
TDR RESULTS

File: 42SA95AH.MOB

Date: Aug 10, 1995
Time of Day: 16:09
Dist → Curs (m): 20.9
Dist btn WvFm (m):.01
Gain: 67
Offset: 53515
Sample No: 1

A (m) = 0.27
B (m) = 0.84
Trace Length (m)=0.57
Diele. Const.= 8.0
Volumetr MC (%)= 14.8

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

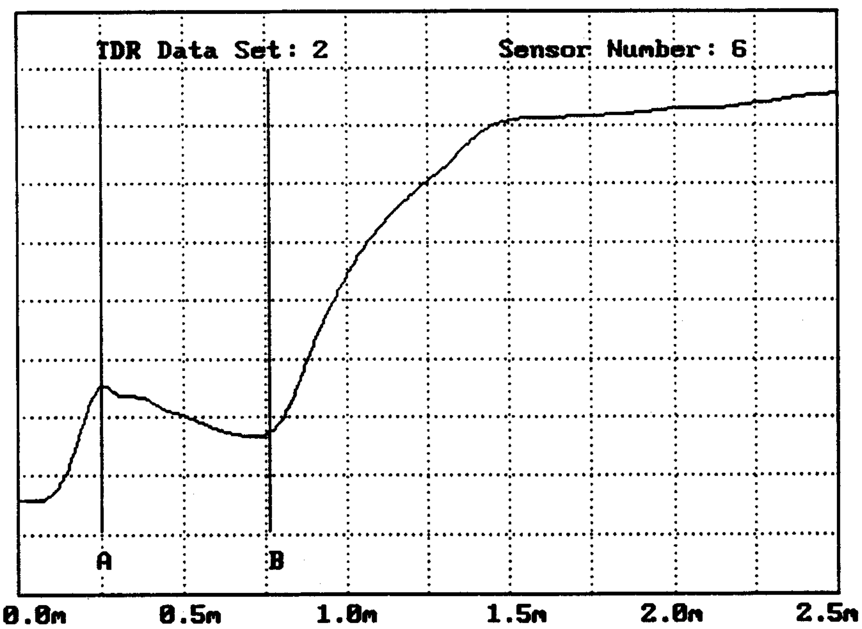
TDR RESULTS

File: 42SA95AH.MOB

Date: Aug 10, 1995
Time of Day: 16:09
Dist → Curs (m): 20.9
Dist btn WvFm (m):.01
Gain: 65
Offset: 53452
Sample No: 1

A (m) = 0.25
B (m) = 0.76
Trace Length (m)=0.51
Diele. Const.= 6.4
Volumetr MC (%)= 11.3

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

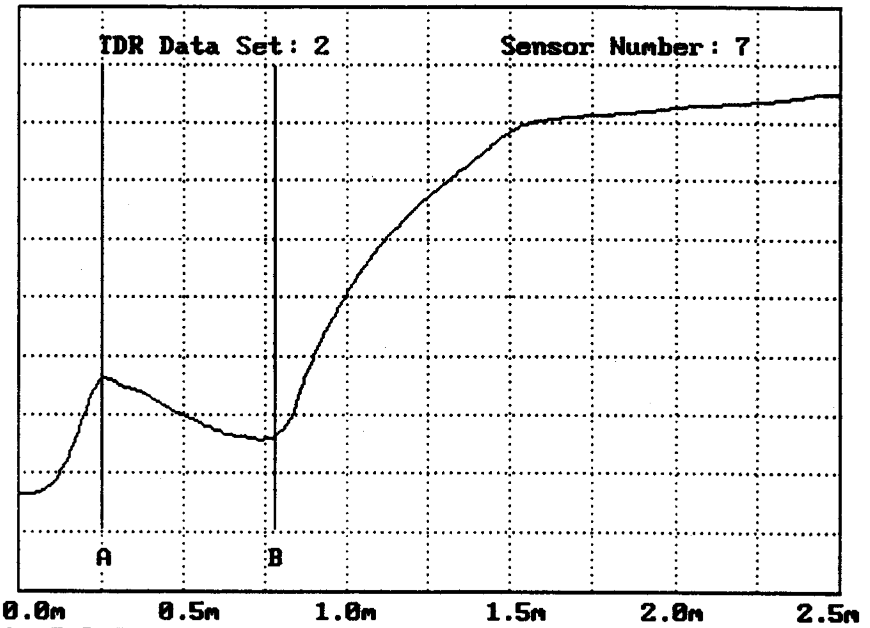
TDR RESULTS

File: 42SA95AH.MOB

Date: Aug 10, 1995
Time of Day: 16:10
Dist → Curs (m): 21.4
Dist btn WvFm (m): .01
Gain: 66
Offset: 53494
Sample No: 1

A (m) = 0.25
B (m) = 0.78
Trace Length (m)=0.53
Diele. Const.= 6.9
Volumetr MC (%)= 12.5

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

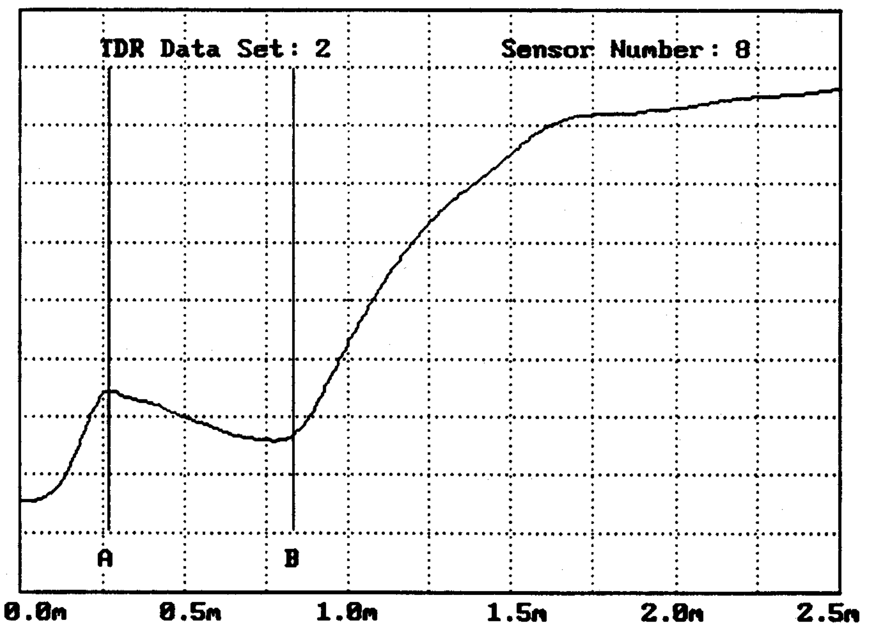
TDR RESULTS

File: 42SA95AH.MOB

Date: Aug 10, 1995
Time of Day: 16:10
Dist → Curs (m): 23.3
Dist btn WvFm (m): .01
Gain: 68
Offset: 53597
Sample No: 1

A (m) = 0.27
B (m) = 0.83
Trace Length (m)=0.56
Diele. Const.= 7.7
Volumetr MC (%)= 14.2

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

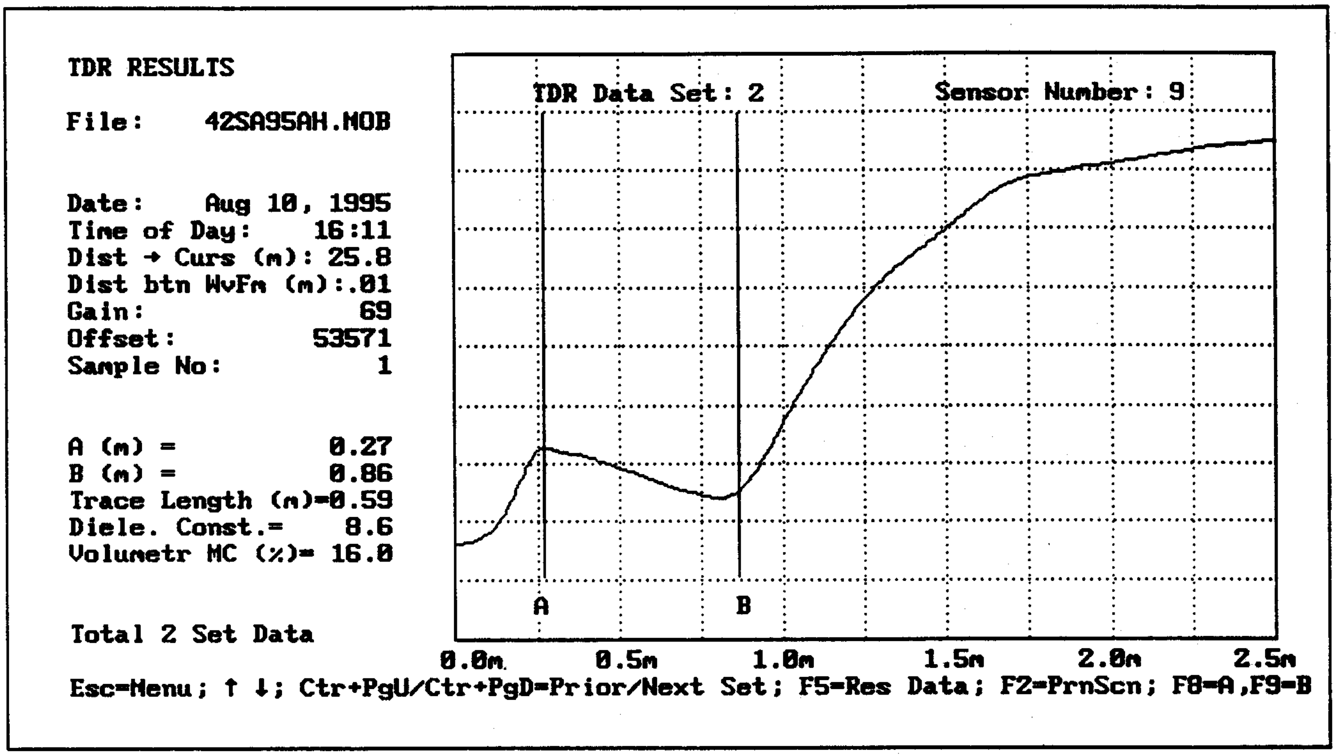


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

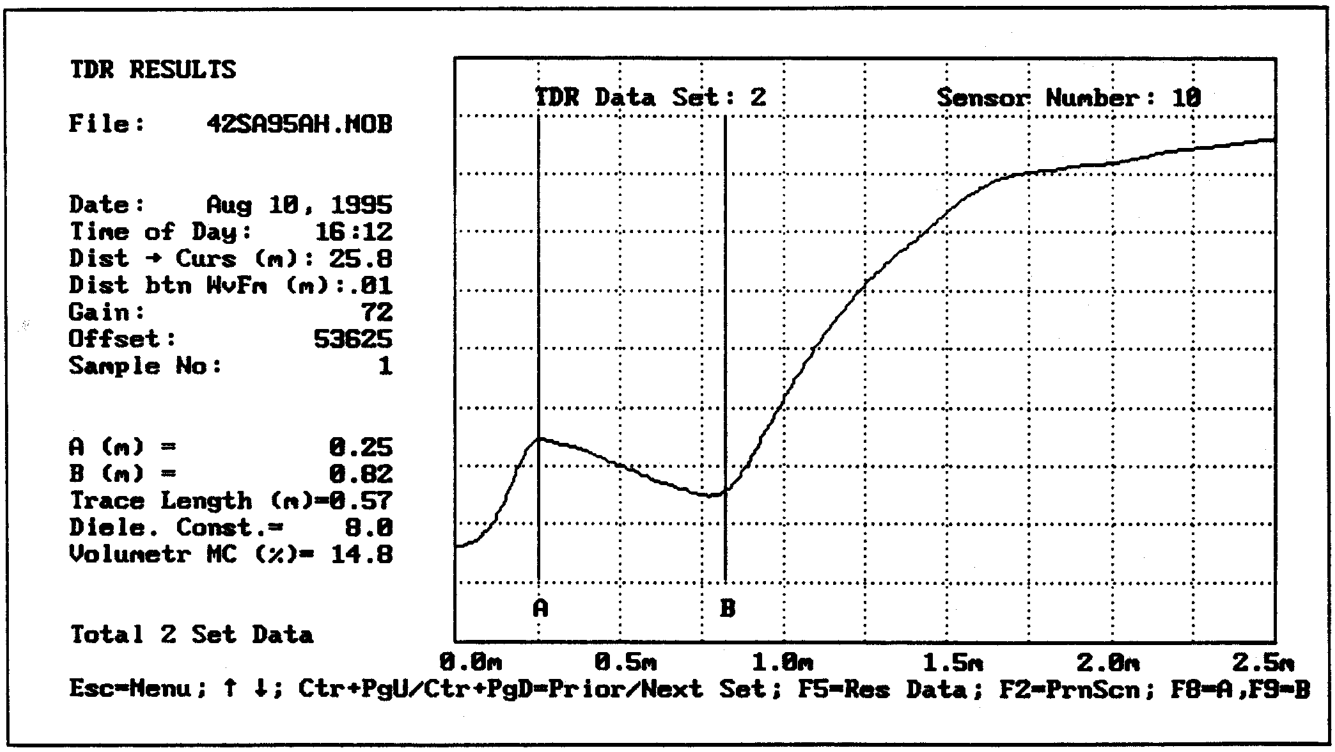


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

Section 421606

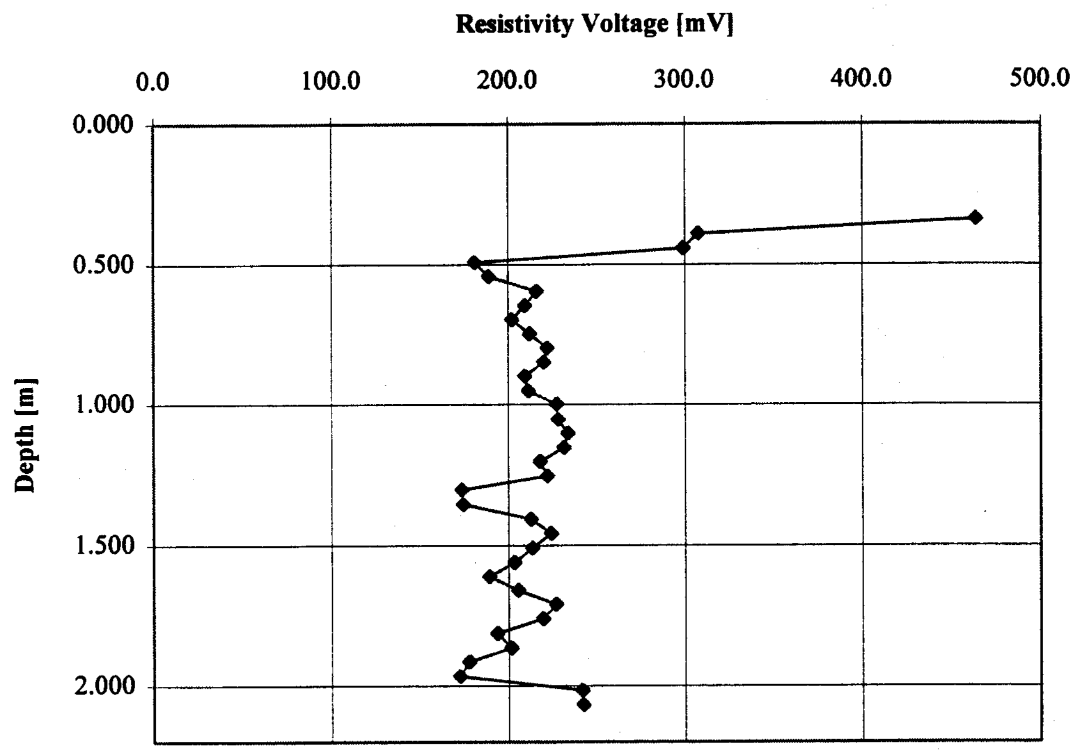


Figure D-4. Voltages Measured Using the Mobile Data System During Initial Data Collection, August 10, 1995

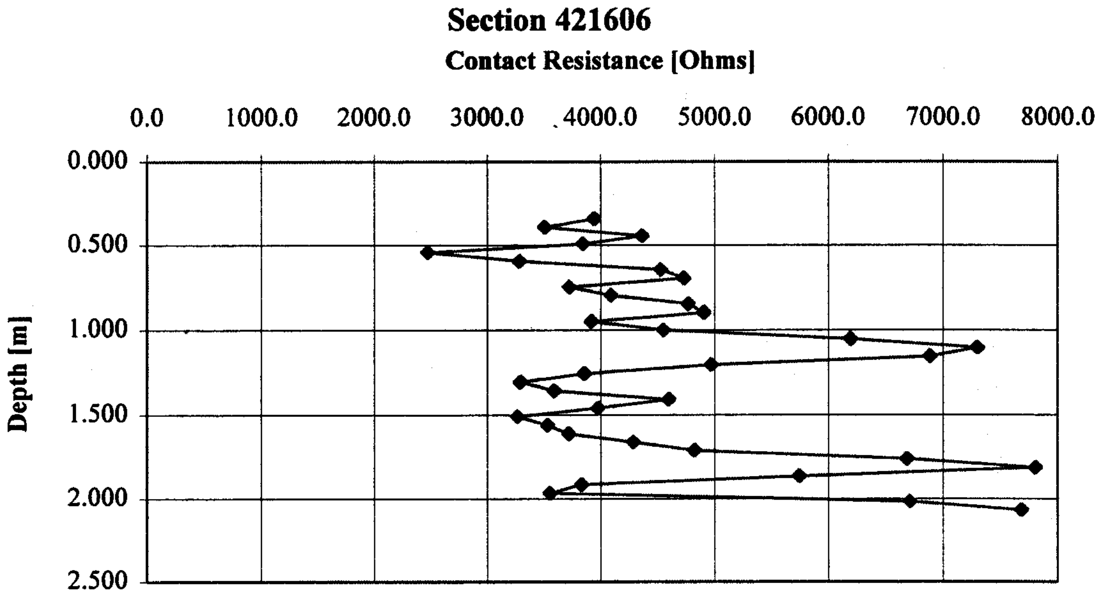


Figure D-5. Manually Collected Contact Resistance
During Initial Data Collection, August 10, 1995

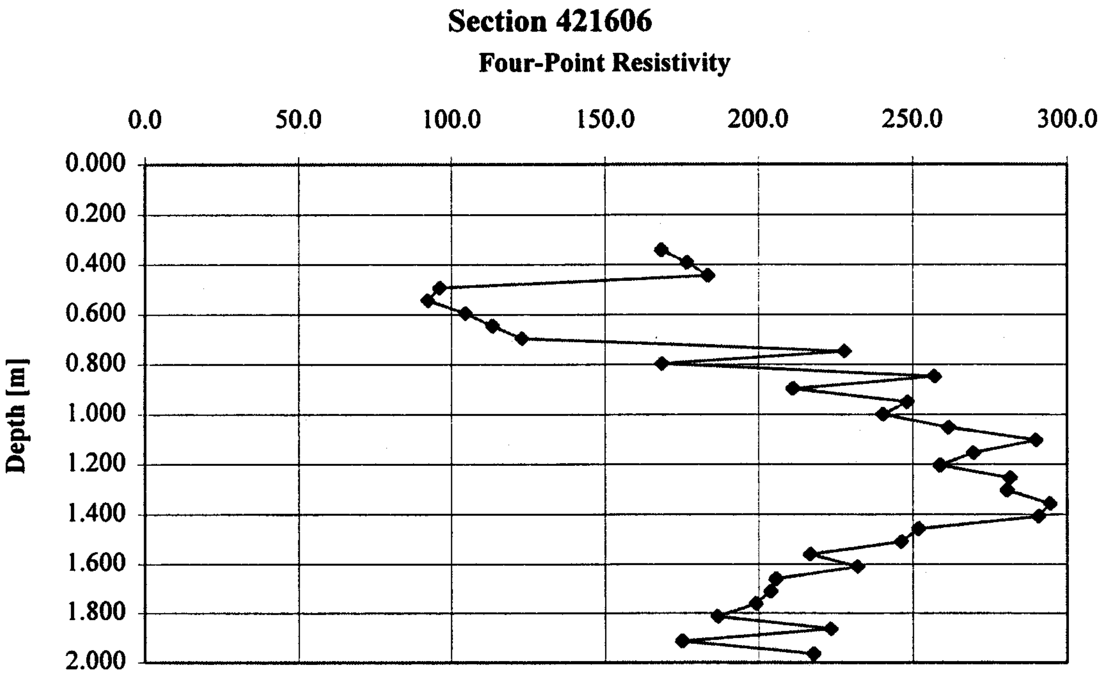


Figure D-6. Manually Collected Four-Point Resistivity
During Initial Data Collection, August 10, 1995

Table D-2. Contact Resistance After Installation

LTPP Seasonal Monitoring Program Data Sheet SMP-D03 Contact Resistance Measurements	Agency Code [42] LTPP Section ID [1606]

Test Position	Switch Settings		Voltage (ACV)		Current (ACA)		Comments
	I1 V1	I2 V2	Range	Reading	Range	Reading	
1	1	2	mV	232.2	μA	58.9	
2	2	3		225.7		64.3	
3	3	4		237.5		54.4	
4	4	5		231.1		60.1	
5	5	6		205.8		83.1	
6	6	7		222.9		67.8	
7	7	8		239.5		52.9	
8	8	9		241.2		51.0	
9	9	10		228.5		61.4	
10	10	11		233.3		57.0	
11	11	12		240.8		50.5	
12	12	13		242.4		49.4	
13	13	14		231.2		59.0	
14	14	15		238.3		52.4	
15	15	16		252.2		40.7	
16	16	17		258.5		35.4	
17	17	18		256.2		37.2	
18	18	19		243.0		48.9	
19	19	20		230.2		59.7	
20	20	21		221.2		67.1	
21	21	22		226.2		63.0	
22	22	23		239.1		52.0	
23	23	24		231.8		58.3	
24	24	25		221.3		67.7	
25	25	26		226.2		64.0	
26	26	27		229.2		61.6	
27	27	28		235.8		55.0	
28	28	29		241.6		50.1	
29	29	30		254.7		38.1	
30	30	31		259.8		33.3	
31	31	32		248.8		43.3	
32	32	33		230.2		60.1	
33	33	34		225.5		63.4	
34	34	35		255.0		38.0	
35	35	36		259.6		33.8	
Prepared by:		AL/DS		Employer:		PMSL	
Date (dd/mm/yy):		10/08/95					

Table D-3. Four-Point Resistivity After Installation

LTPP Seasonal Monitoring Program Data Sheet SMP-D04 Four-Point Resistivity Measurements	Agency Code [42] LTPP Section ID [1606]

Test Position	Switch Settings				Voltage (ACV)		Current (ACA)		Comments
	I1	V1	V2	I2	Range Setting	Reading	Range Setting	Reading	
1	1	2	3	4	mV	8.2	μA	48.7	
2	2	3	4	5		12.1		68.5	
3	3	4	5	6		12.3		67.0	
4	4	5	6	7		4.8		49.9	
5	5	6	7	8		5.5		59.6	
6	6	7	8	9		6.5		62.1	
7	7	8	9	10		7.0		61.7	
8	8	9	10	11		5.7		46.3	
9	9	10	11	12		11.4		50.0	
10	10	11	12	13		9.1		54.0	
11	11	12	13	14		14.4		56.0	
12	12	13	14	15		9.0		42.6	
13	13	14	15	16		10.4		41.9	
14	14	15	16	17		10.0		41.6	
15	15	16	17	18		10.7		40.9	
16	16	17	18	19		12.4		42.8	
17	17	18	19	20		11.0		40.8	
18	18	19	20	21		13.0		50.2	
19	19	20	21	22		14.6		51.9	
20	20	21	22	23		14.3		51.0	
21	21	22	23	24		19.4		65.9	
22	22	23	24	25		15.9		54.7	
23	23	24	25	26		13.0		51.6	
24	24	25	26	27		14.7		59.7	
25	25	26	27	28		11.6		53.5	
26	26	27	28	29		12.1		52.1	
27	27	28	29	30		8.0		38.9	
28	28	29	30	31		8.2		40.2	
29	29	30	31	32		9.7		48.7	
30	30	31	32	33		7.6		40.7	
31	31	32	33	34		9.5		42.5	
32	32	33	34	35		6.2		35.4	
33	33	34	35	36		10.7		49.1	

Prepared by:	AL/DS	Employer:	PMSL
Date (dd/mm/yy):	10/08/95		

Table D-4. Uniformity Survey Results Before and After Installation

Seasonal Uniformity Survey Site Number: 421606 Date Surveyed: August 9 - August 10, 1995	Falling Weight Deflectometer Data Collection and Processing Summary

Section Interval (ft)	Mean Deflection Values for HT 2 (mils) Corrected								Mean Temp D1(F)
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Volumetric k	k std dev	Effective Thickness	Thickness std dev	
346 to 535 **August 09** @1016	1.89	0.15	0.62	0.10	643	67	10.70	0.41	73.0
346 to 533 **August 10** @1454	1.93	0.18	0.65	0.11	623	83	10.77	0.34	91.0

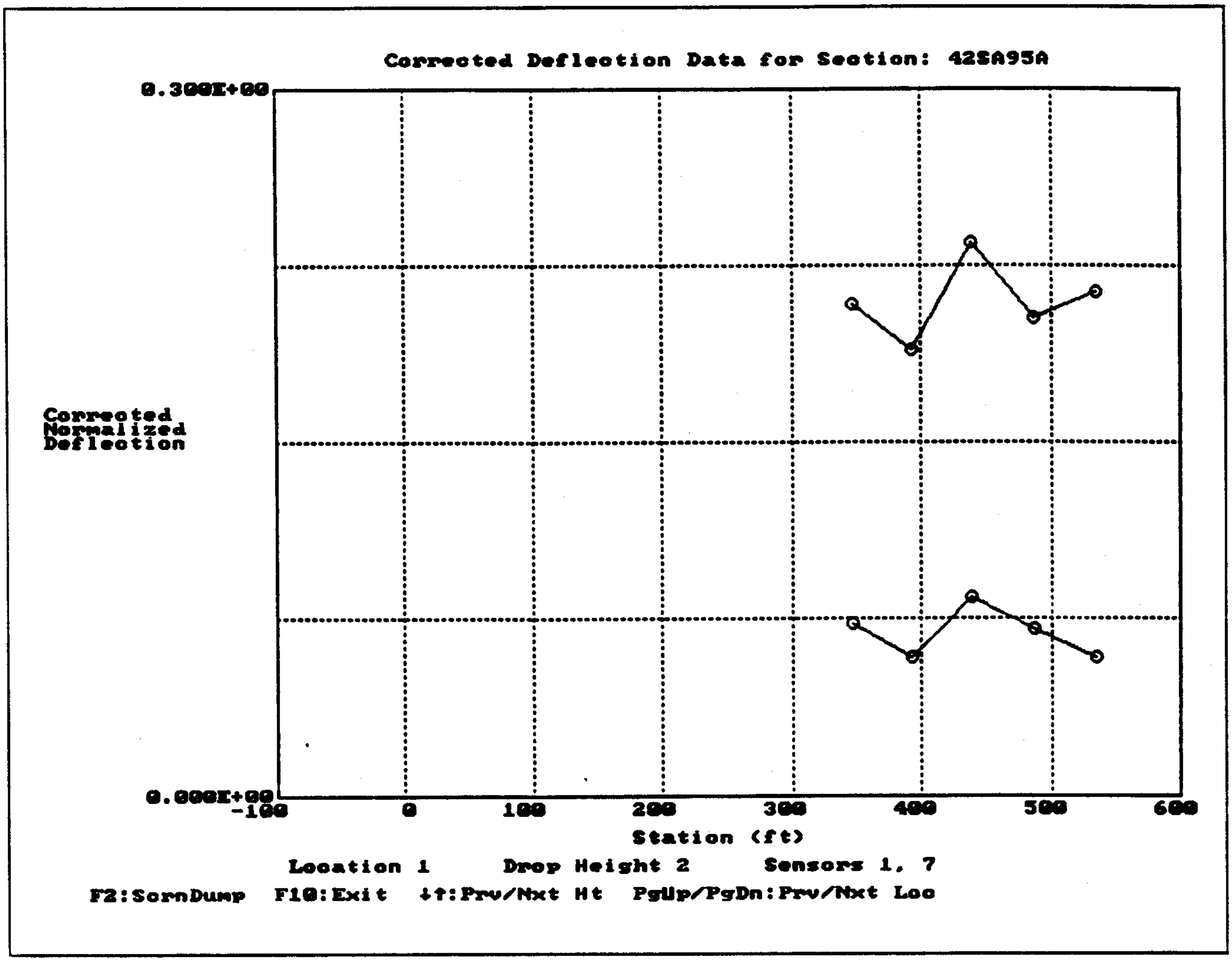


Figure D-7. Deflection Profiles from FWDCHECK
(Test Date and Time August 09, 1995 @ 1016)

Table D-5. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 09, 1995 @ 1016)

Flexible Pavement Thickness Statistics - 42SA95AA - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	346	627	11.00
	393	734	11.00
	439	549	10.25
	486	632	11.00
	535	670	10.25
Subsection 1	Overall Mean	643	10.70
	Standard Deviation	67	0.41
	Coeff of Variation	10.50%	3.84%

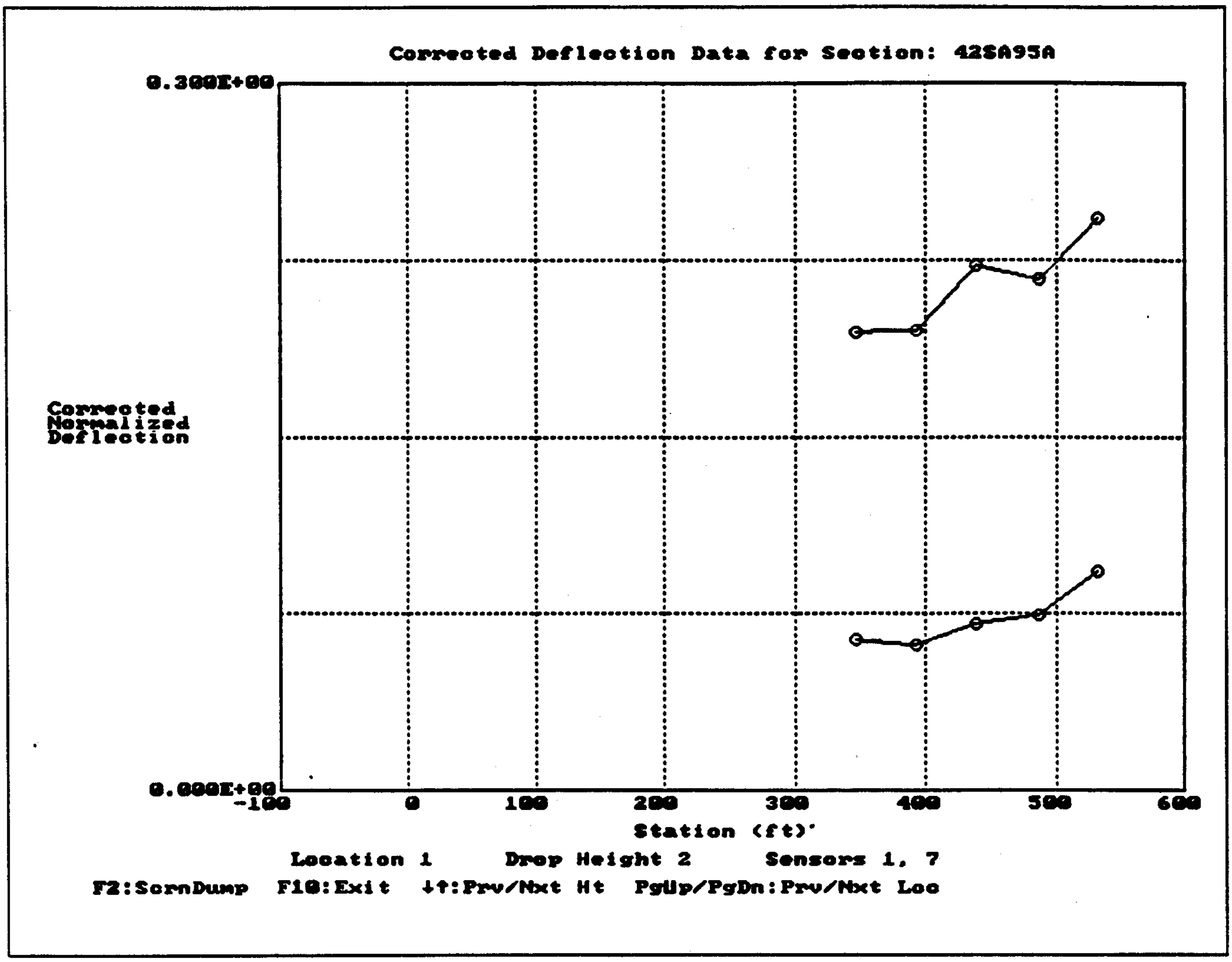


Figure D-8. Deflection Profiles from FWDCHECK
(Test Date and Time August 10, 1995 @ 1454)

Table D-6. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 10, 1995 @ 1454)

Flexible Pavement Thickness Statistics - 42SA95AB - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	346	694	11.00
	393	701	11.00
	439	621	10.25
	487	603	11.00
	533	497	10.63
Subsection 1	Overall Mean	623	10.77
	Standard Deviation	83	0.34
	Coeff of Variation	13.30%	3.11%

Table D-7. Surface Elevation Measurements

LTPP Seasonal Monitoring Study	State Code	[42]
Surface Elevation Measurements	Test Section Number	[1606]

Survey Date	August 10, 1995
Surveyed By	DS/AL
Surface Type	PCC
Benchmark	Observation Piezometer - 1.000 meters - assumed

STATION	PE m offset 0.30m	ML m offset 1.84m	ILE m offset 3.44m
3+26	1.0850	1.1100	1.1425
3+49	1.1275	1.1525	1.1825
3+72	1.1550	1.1800	1.2150
3+72	1.1550	1.1850	1.2175
3+95	1.1900	1.2225	1.2525
4+19	1.2175	1.2475	1.2800
4+19	1.2200	1.2475	1.2775
4+42	1.2575	1.2850	1.3175
4+65	1.2900	1.3175	1.3525
4+65	1.2900	1.3150	1.3500
4+88	1.3325	1.3575	1.3925
5+12	1.3625	1.3900	1.4250
5+12	1.3625	1.3900	1.4250
5+35	1.4500	1.4275	1.4625
5+58	1.4325	1.4550	1.4900

PE	Outer Slab Edge
ML	Mid Slab
ILE	Inner Slab Edge

APPENDIX E

Photographs

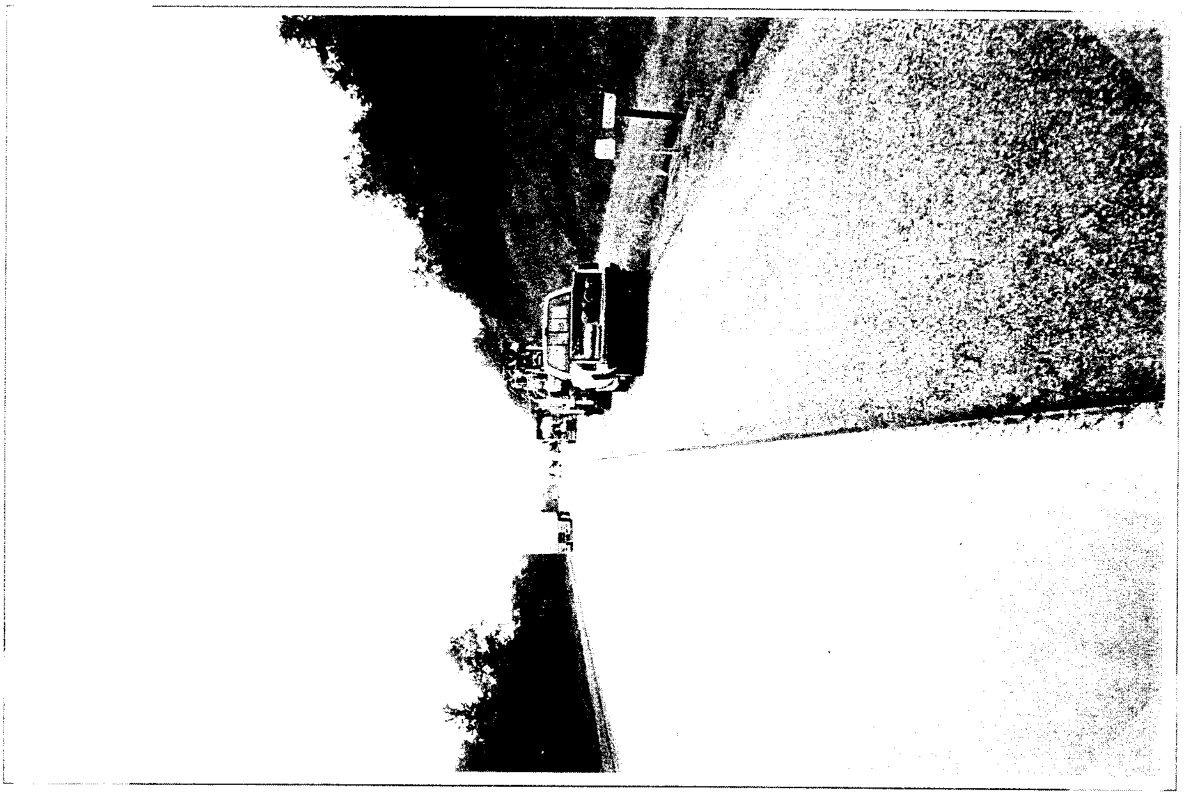


Figure E-1. Site Prior to Installation

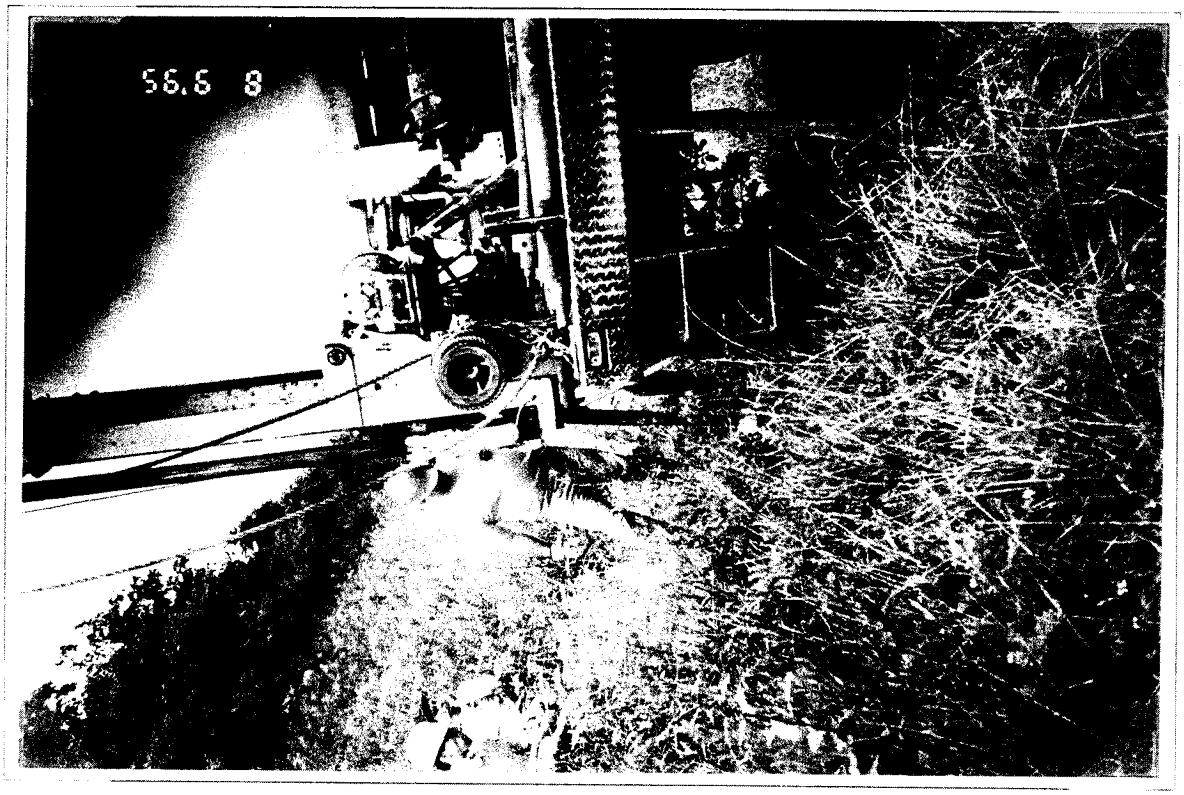


Figure E-2. Drilling Weather Station Post Hole

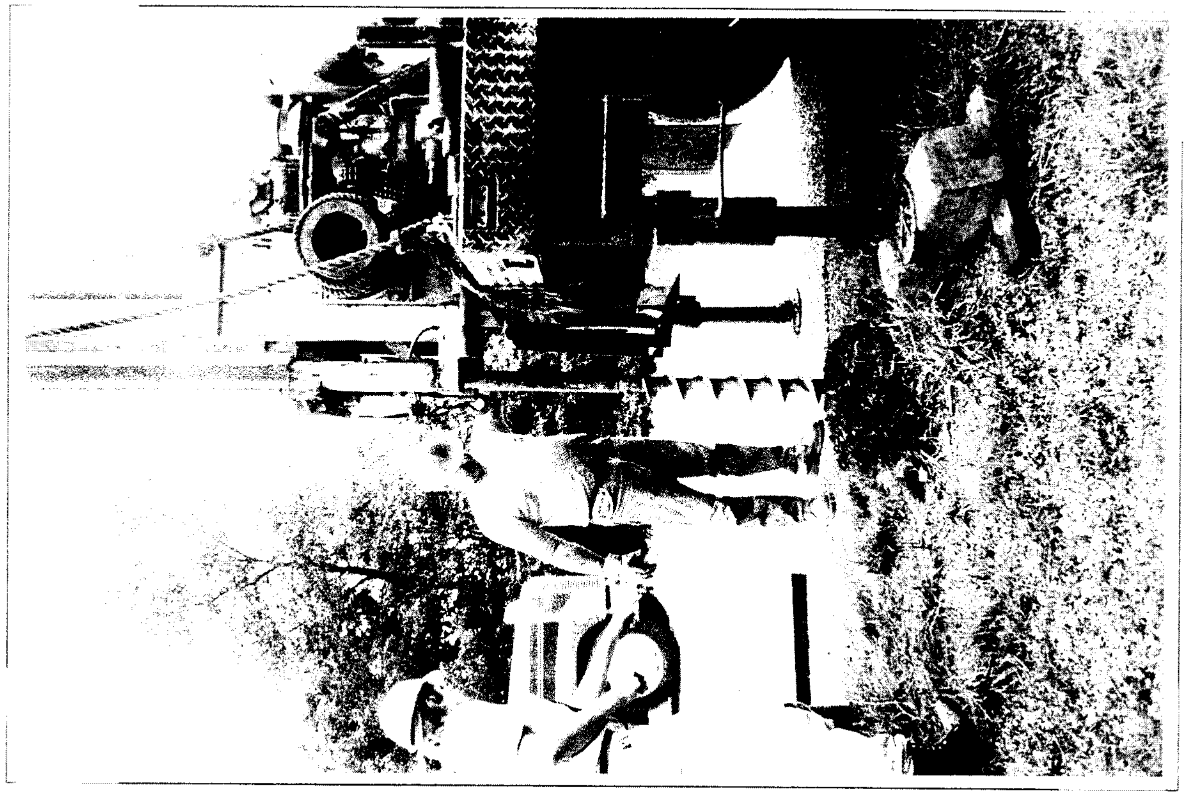


Figure E-3. Drilling Piezometer Hole

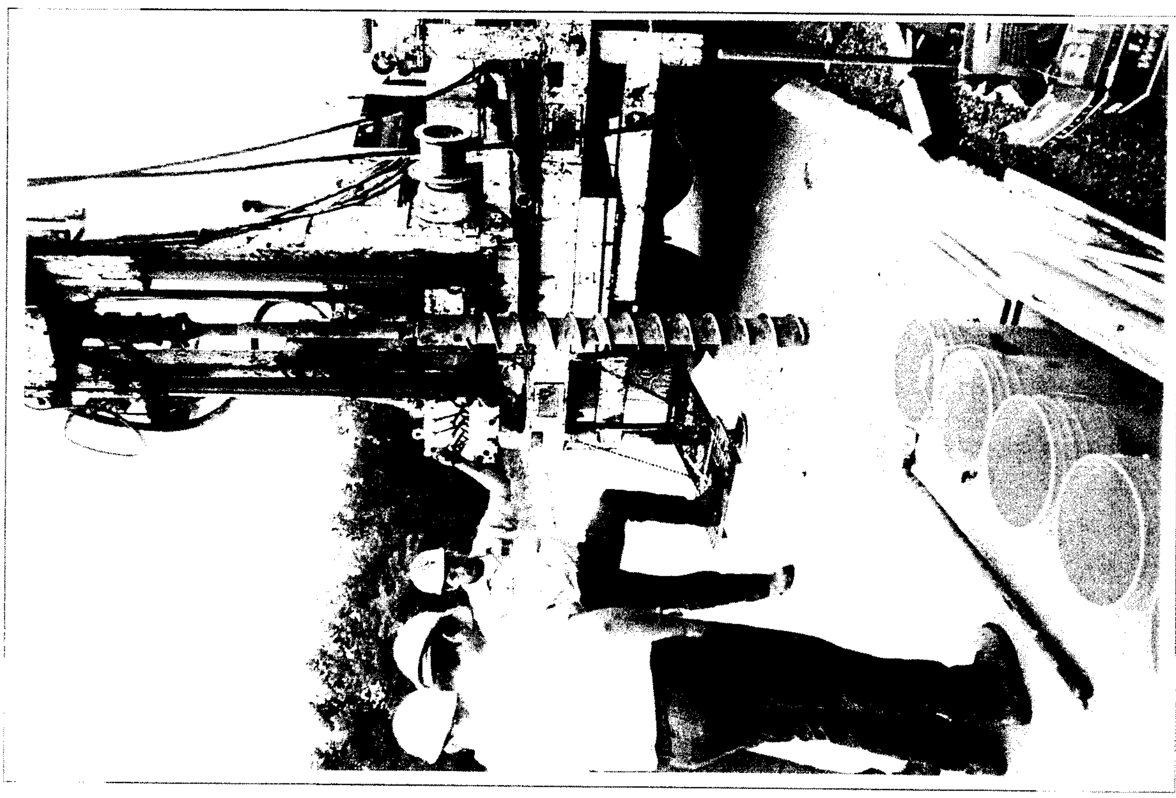


Figure E-4. Drilling Instrument Hole

Figure E-5. Instrument Hole Before Augering with PCC Removed

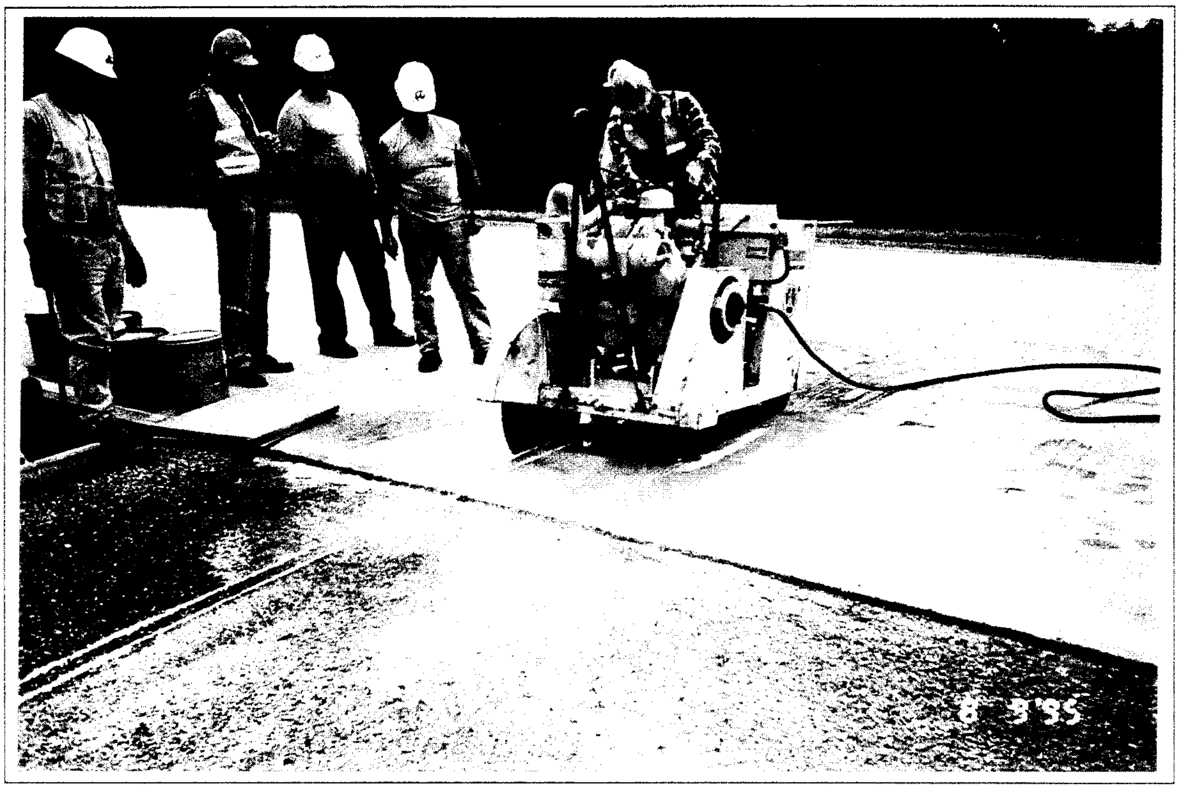


Figure E-6. Sawcutting Trench

Figure E-7. Completed Piezometer

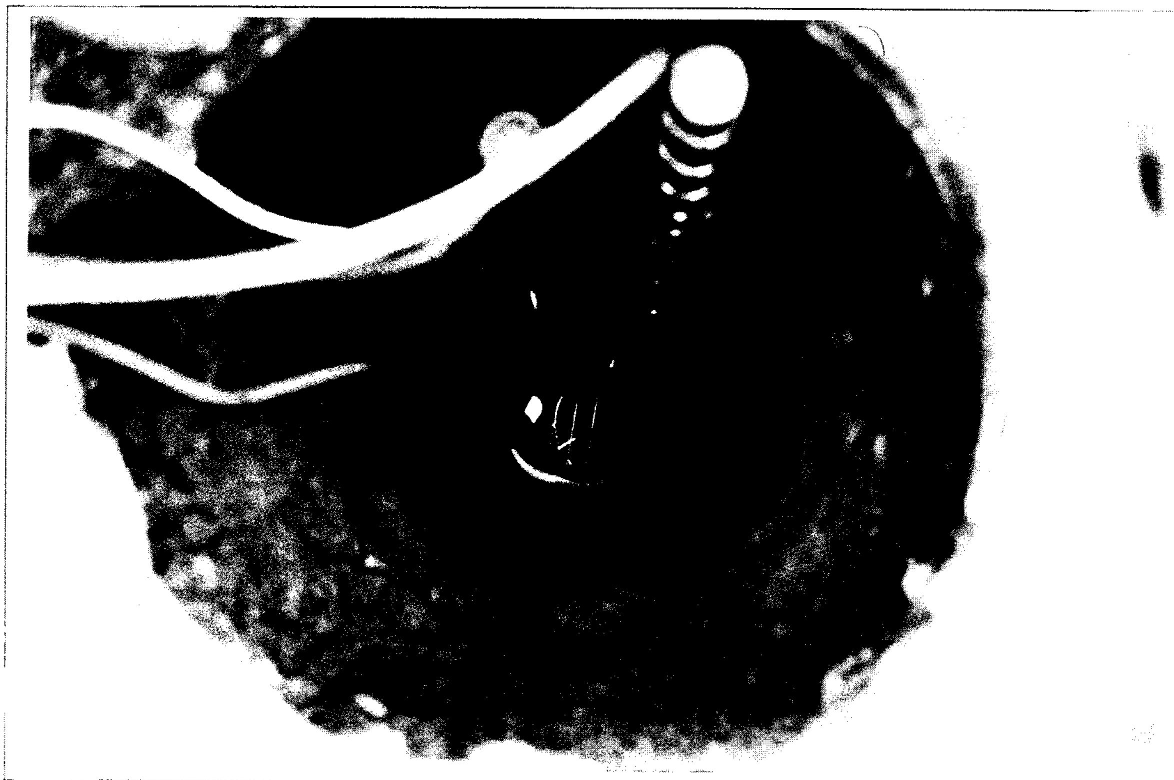


Figure E-8. Instrument Hole During Placement of Probes

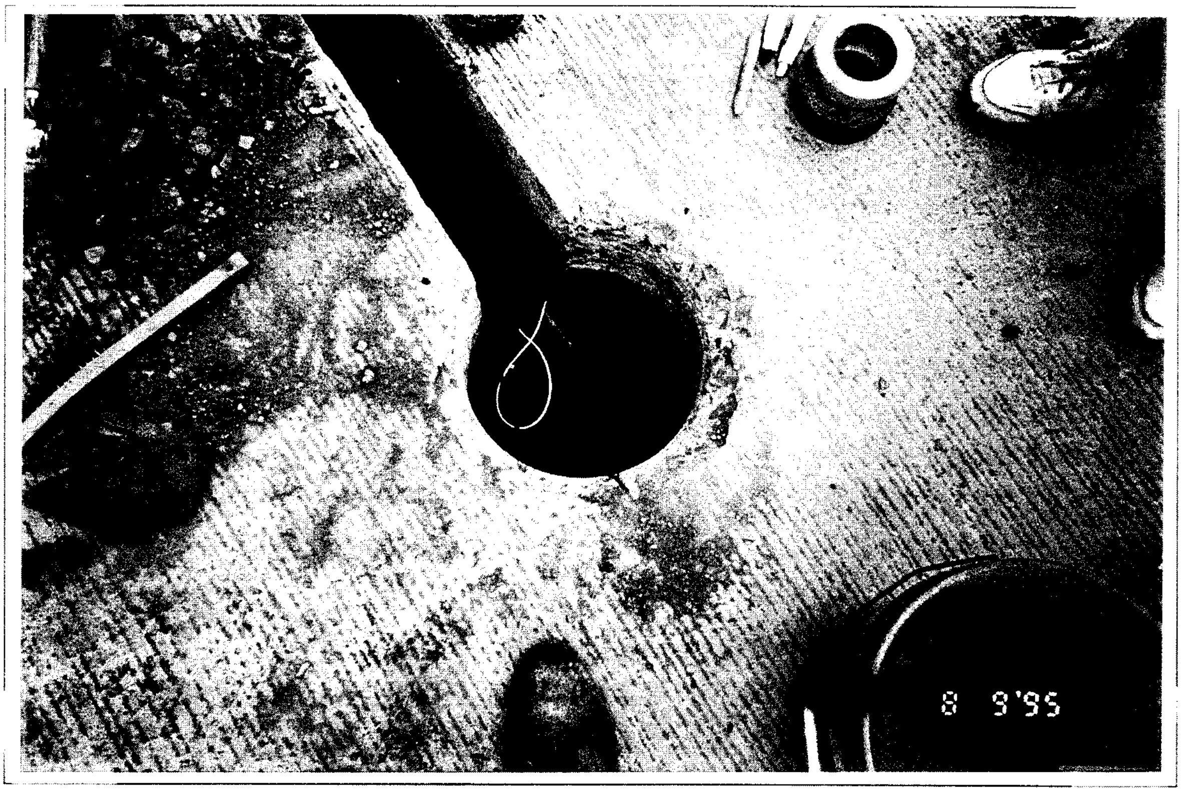


Figure E-9. Instrument Hole with All Instrumentation In It

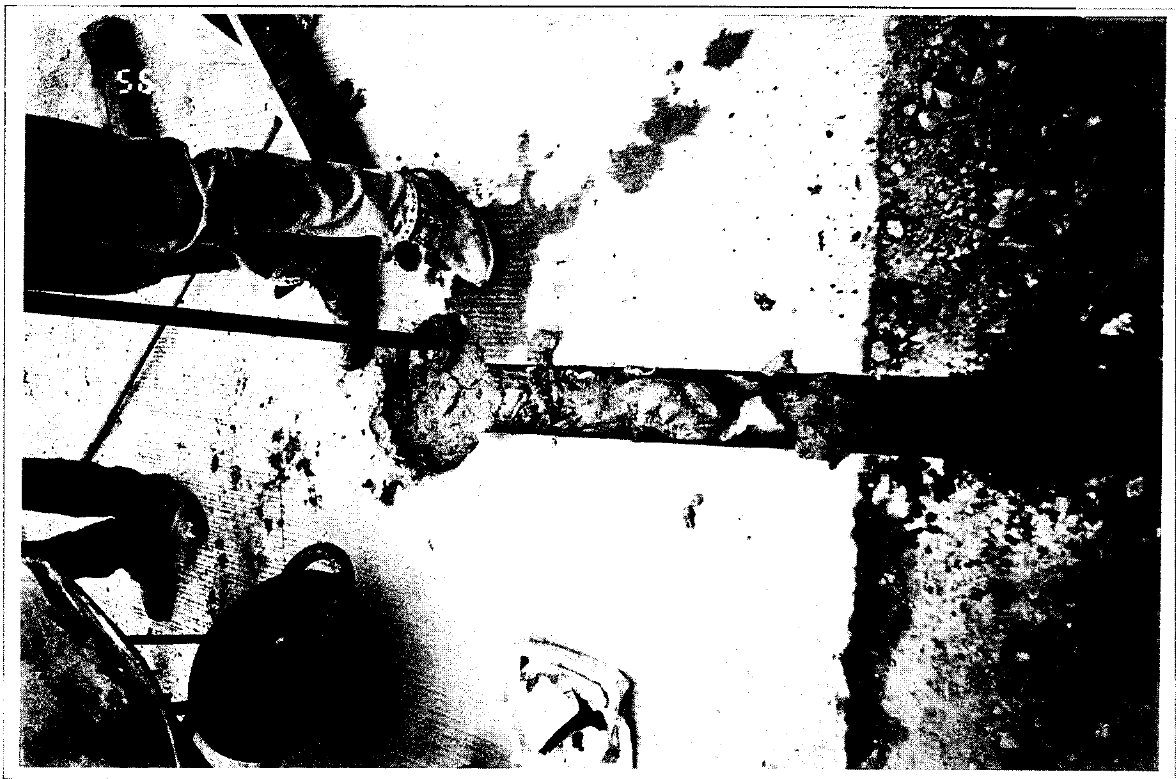


Figure E-10. Compacting PCC in Hole and Trench

Figure E-11. Completed Instrument Hole and Trench - Facing West

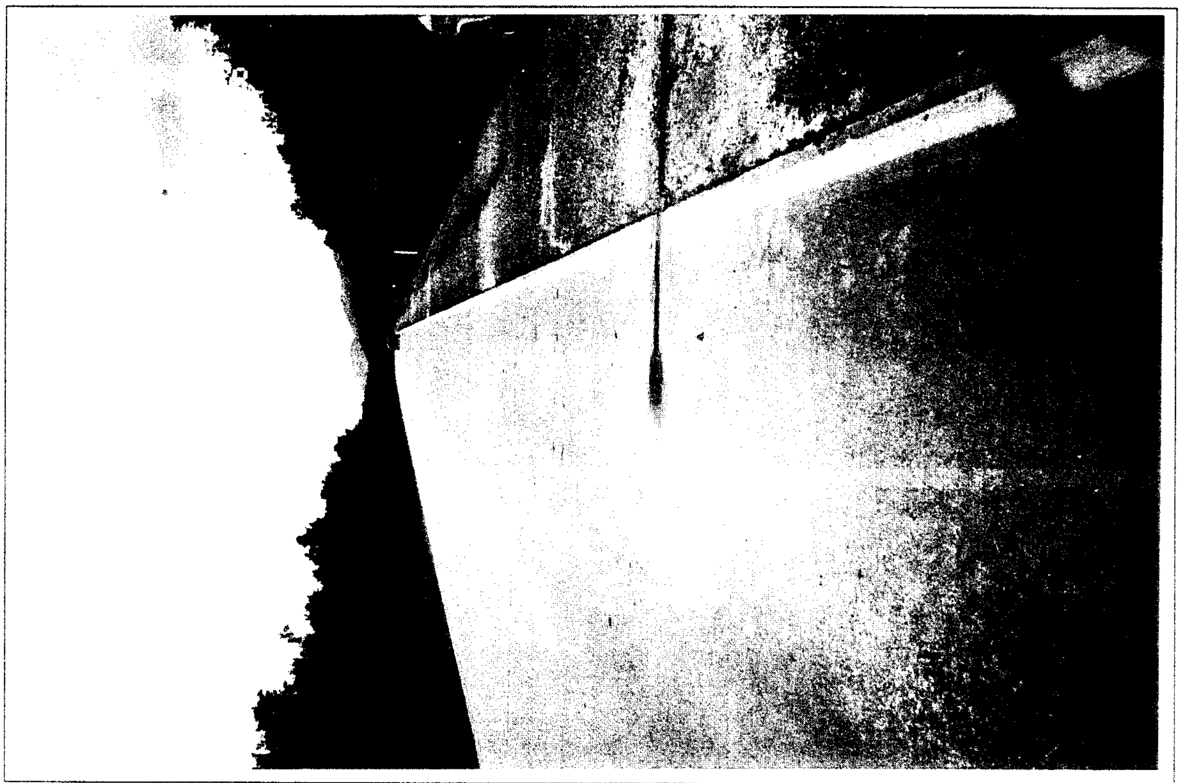


Figure E-12. Completed Instrument Hole and Trench - Facing North

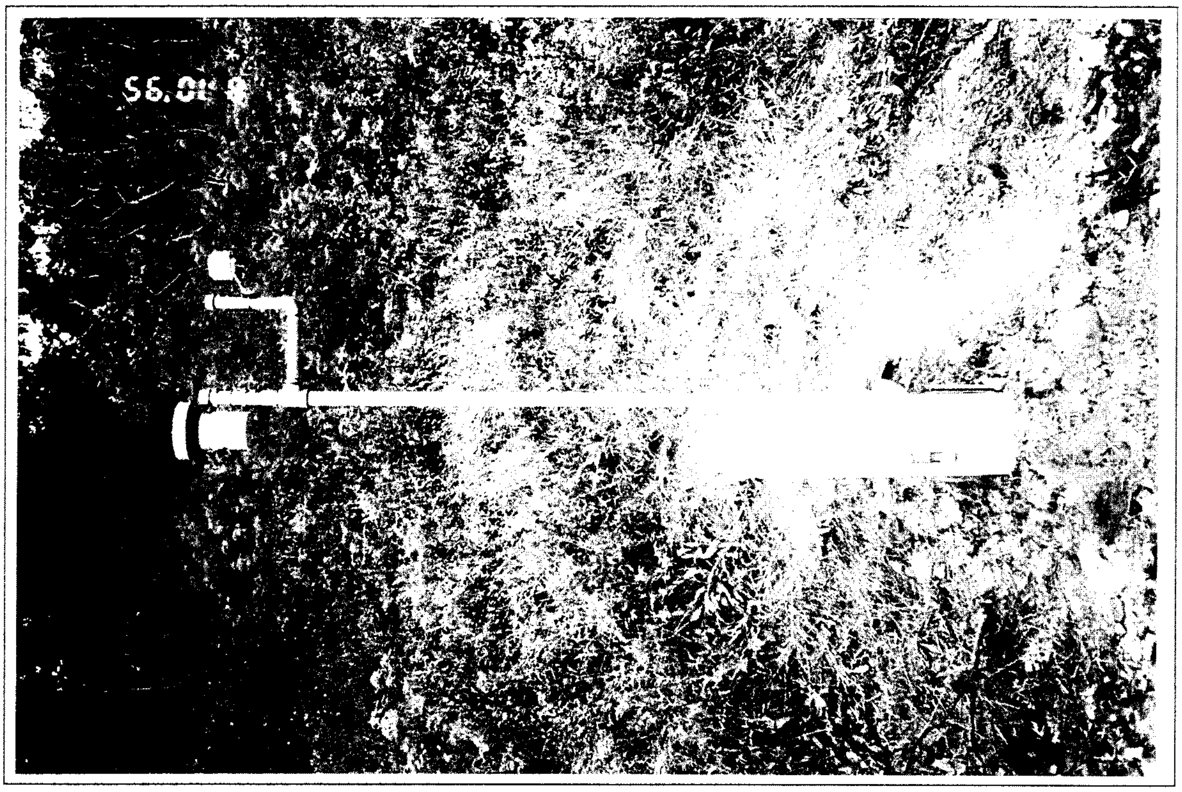


Figure E-13. Weather Station and Equipment Cabinet - Facing East

Figure E-14. Weather Station and Equipment Cabinet - Facing South

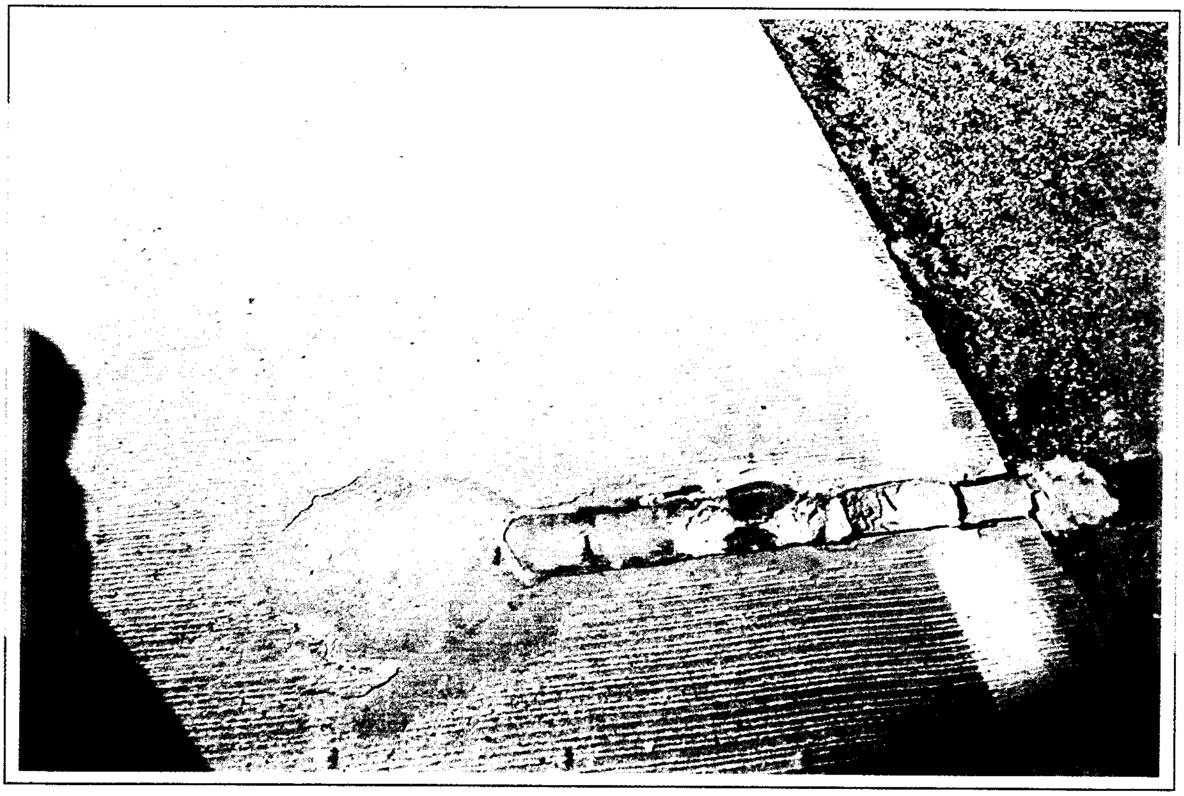


Figure E-15. Instrument Hole and Trench - December 07, 1995