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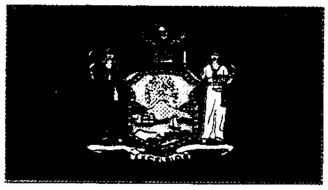

New York

LTPP Seasonal Monitoring Program

Site Installation and Initial
Data Collection
Section 360801, Hamlin
New York

Report No. FHWA-TS-96-36-01 **June 1996**

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LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 360801, Hamlin, New York

Report No. FHWA-TS-96-36-01

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The report is a cooperative effort between New York Department of Transportation (NYSDOT) Transportation Research and Development Bureau, Long Term Pavement Performance (LTPP) Division Federal Highway Administration, and Pavement Management Systems Limited LTPP North Atlantic Region Coordination Office.

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 program at the Specific Pavement Study (SPS-8) section 360801 on Lake Ontario State Parkway in Hamlin, New York. This asphalt concrete surface pavement test section was instrumented on August 22, 1995. The instrumentation installed included time domain reflectometry probes for moisture content, thermistor probes for temperature, resistivity probes for frost-depth, tipping bucket rain gauge, piezometer to monitor the ground water table, and an on-site datalogger. Initial data collection was performed on August 23, 1995 which consisted of deflection measurements with a Falling Weight Deflectometer, elevation, temperature, frost depth, TDR, and water table measurements. Longitudinal profile measurement are collected during scheduled visits with the LTPP profiler. The report contains a description of the test site and its location, the instruments installed at the site and their locations, characteristics of the installed instruments and probes, problems encountered during installation, specific site circumstances and deviations from the standard guidelines, and a summary of the initial data collection.

17. Key Words Instrumentation, Monitoring, Survey, FWD, LTPP profiler, Time Domain Reflectometry, Thermistor, Piezometer, Electrical Resistance, Electrical Resistivity.		18. Distribution Statement	
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NEW YORK SECTION 360801

I. Introduction

The installation of the LTPP instrumentation on seasonal site 360801 near Hamlin, New York was performed on August 22 - August 23, 1995. The test section is a SPS-8 experiment, located on Eastbound Lake Ontario State Parkway (LOSP), approximately 3.2 km West of S.R.19. A map indicating the location detail of the site is presented in Figure A-1 of Appendix A. The highway consists of two 3.6 m wide lanes in each direction, with a 1.7 m wide paved outside shoulder and a concrete curb near the inside lane edge. A 22.6 m wide grass median separates traffic in both directions. The LOSP is primarily used to access recreational facilities located along the shores of Lake Ontario.

The pavement structure, which is close to the lake Ontario shoreline, consists of 125 mm of asphalt concrete on a 225 mm crushed stone base. The subgrade predominantly consists of clayey sand with gravel. The subgrade conditions throughout the site are highly variable. The pavement structural design depths and the materials sampling and testing plan is presented in Figure A-2 of Appendix A. Pavement structure information from the SPS material drilling logs are presented in Figure A-3. 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 November 09, 1994. The uniformity survey results are summarized 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 4 (thin AC on fine subgrade) of the Seasonal Monitoring Program. Below is a summary from the LTPP climate database based on seven years of data:

• Freezing Index (C-Days)	461
• Precipitation (mm)	991
• No. of Freeze/Thaw Cycles	89
• Days Above 32°C	5
• Days Below 0°C	129
• Wet Days	180

The climatic data listed above was taken from site 361011, since there was no climatic data available for site 360801. Site 361011 is approximately 160 kilometers East of 360801, and is the closest LTPP site that could be used for climatic data. An Automated Weather Station (AWS) installed near the junction of the LOSP and S.R. 19 will collect air temperature, relative humidity, solar radiation, wind speed/direction, and rainfall data for the SPS-8 test sections.

This portion of the LOSP was constructed in 1994. The estimated Annual Average Daily Traffic (AADT) in 1994 was 860 (SPS lane). Truck traffic consisted of approximately 0.9% of the traffic in the SPS lane. The estimate of annual KESALS in the SPS lane using vehicle ESALS is 0.9. These figures are based on 43 days of AVC coverage and 42 days of WIM data gathered during October and November, 1994. A WIM installed 1.21 km's East of station 0+00 of SPS 360801 and 2.0 km West of S.R. 19 will provide continuos volume, weight, and vehicle classification for this SPS-8 project.

Installation of the instrumentation was a cooperative effort between State of New York Department of Transportation (NYSDOT), Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Division, and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office (NARCO) staff. Dr. Lynne Irwin, Cornell Local Roads Program, Cornell University, Ithaca, NY visited the installation with two graduate students from Denmark to observe and assist with the installation. The following personnel participated in the instrumentation installation:

Julian Bendana	NYSDOT - TR&DB - MO
Dan McAuliffe	NYSDOT - TR&DB - MO
Rick Morgan	NYSDOT - TR&DB - MO
William Roth	NYSDOT - TR&DB - MO
Wes Yang	NYSDOT - TR&DB - MO
Darryl Byers	NYSDOT - Geotechnical Bur. Region 4
Freddie Galott	NYSDOT - Geotechnical Bur. Region 4
Paul Peffers	NYSDOT - Geotechnical Bur. Region 4
Edd Reedhead	NYSDOT - Geotechnical Bur. Region 4
Duane Wilcox	NYSDOT - Geotechnical Bur. Region 4
Harold Wilcox	NYSDOT - Geotechnical Bur. Region 4
Ron Hoyt	NYSDOT - Geotechnical Bur. - MO
Jeff Dunlap	NYSDOT - Maintenance - Monroe Co. W.
Ralph Harmon	NYSDOT - Maintenance - Monroe Co. W.
Dave Pennella	NYSDOT - Maintenance - Monroe Co. W.
Susanne Baltzes	Cornell University
Gregers Hilderbrand	Cornell University
Lynne Irwin	Cornell University
Gabe Cimini	PMSL NARCO
Scott Comstock	PMSL NARCO
Tim Comstock	PMSL NARCO
Brandt Henderson	PMSL NARCO
Edward Lesswing	PMSL NARCO
Alfred Lip	PMSL NARCO
Randy Plett	PMSL NARCO
Dilan Singaraja	PMSL NARCO

Table 1. Material Properties

Description	Surface	Base	Subgrade *
Material (Code)	Dense Graded HMAC (01)	Dense Graded Aggr. Base (308)	Clayey Sand with Gravel (217)
Thickness (mm)	125	225	
In-Situ Density (kg/m^3)	2266	2197	2099
In-Situ Moisture Content (%)		2.3	5.4
Lab. Dry Density (kg/m^3)			1826
Lab. Moisture Content (%)			12.7
Specific Gravity			2.71
Liquid Limit			23
Plastic Limit			16
Plasticity Index			7
% Passing #200			31.6

* Note: The subgrade soil was highly variable dependent on the location samples were taken. The values presented in this table are form station 2+50.

II. Instrumentation Installation

Site Inspection and Meeting with Highway Agency

A preliminary planning meeting was held at the Monroe County West Residency in Spencerport, New York on July 20, 1995. The attendees at the meeting were:

• Jeff Dunlop	RE - Monroe Co. W.
• Dave Penella	ARE - Monroe Co. W.
• R. Darryl Byers	NYSDOT - Region 4 Soils
• Richard Kiehl	NYSDOT - Region 4 Soils Eng.
• Edd Reedhead	NYSDOT - Region 4 Soils
• Maurice McGrath	NYSDOT - GEB - MO
• Rick Morgan	NYSDOT - TR&DB - MO
• Brandt Henderson	PMSL - NARCO
• Edward Lesswing	PMSL - NARCO
• Bill Phang	PMSL - NARCO

A presentation on the installation of seasonal monitoring instrumentation and monitoring requirements was provided by Bill Phang and Brandt Henderson of Pavement Management Systems. Reasons for picking this site for the seasonal monitoring program were discussed along with the details and the frequency of scheduled testing. Brandt Henderson then gave a more detailed description of roles and responsibilities of the agencies and the personnel involved with the installation. The list of materials required by NYSDOT was presented. Plans to contact the office of Parks, Recreation, and Historical Preservation (NYSOPRHP) were made to inquire about any restrictions that might affect the installation. Correspondence regarding the installation are presented in Appendix B.

A pre-installation meeting was arranged and conducted on August 21, 1995 at the site. Final details of the installation were discussed with NYSDOT members and David Herring of NYSOPRHP. Mr. Herring requested that the weather station pole be painted green to blend in with the foliage. Traffic control would remain in place for the week. FWD testing, to pick the most uniform end for the installation, was conducted during the pre-installation meeting. It was decided in the duration of the meeting that the installation would be at the 0+00 end. Utilities were marked and cleared. Arrangements were made to meet on site at 0800 hours on Tuesday August 22, 1995.

Equipment Installed

The equipment installed at the test site included instrumentation for measuring air, pavement, and subsurface temperatures, precipitation, subsurface moisture content, frost depth, and water table. An equipment cabinet was installed to hold the datalogger, battery pack, and all electrical connections from the instrumentation. The equipment cabinet was not installed till a later date, September 26, 1995, because there was none available at the time of installation. The equipment installed are shown in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial Number
Instrumentation Hole		
MRC Thermistor Probe	1	36BT
CRREL Resistivity Probe	1	36BR
TDR Probes	10	36B01-36B10
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16577
Campbell Scientific PS12 Power Supply	1	5656
Weather Station		
TE525MM Tipping Bucket Rain Gage	1	12085
Campbell Scientific 107-L Air Temperature Probe	1	36BAT
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 were 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 needed to 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 to be functioning correctly. The results from the calibration of the air temperature and the thermistor probes along with the spacing between the thermistors are presented in Appendix B. The calibration sheets for the room temperature and 24 hour test could not be located and are not presented in this report.

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 and four point resistivity measurements were performed with the probe immersed in a salt water bath. The results from these tests are presented in Tables B-4 and B-5, in Appendix B. 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 properly.

The function of the TDR probes were checked by performing measurements in air, water, methyl alcohol, and with the prongs shorted at the circuit board and 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 tests indicated that all probes were functioning properly. The probe connectors were dipped in a rubberized sealing compound for water proofing. A 's-loop' was placed just above the connector and tie rapped to protect the connector during installation. Results of the TDR measurements are presented in Appendix B.

Equipment Installation

Final details for the installation and initial monitoring were discussed during the pre-installation meeting on the afternoon of August 21, 1995. The installation was confirmed for 0800 hours on August 22, 1995. Traffic control for the installation and monitoring was provided by State of New York Department of Transportation, Monroe County West Residency. The pavement surface drilling and augering of the piezometer and instrumentation hole were done by agency equipment and drilling crew under the supervision of Ron Hoyt, NYSDOT Geotechnical branch. The sawing of the trench and cut for the pavement surface temperature probe were done by Brandt Henderson and Wes Yang (NYSDOT-TR & DB) with assistance from NYSDOT region 4 geotechnical and Monroe County West residency personnel. Assistance was provided by the NYSDOT Transportation Research and Development Bureau (TR & DB), Region 4 Geotechnical Bureau, Monroe County West Residency, and Cornell personnel. Coordination of NYSDOT activities and reporting was handled by Rick Morgan, NYSDOT - TR & DB. A video log of the site activities was done by William Roth, NYSDOT - TR & DB. The installation of the measurement equipment, the observation piezometer, weather station pole, and cabinet was performed by PMSL staff.

The instrumentation was installed on the West end of SPS 360801, in the Eastbound lane of LOSP, approximately 3.2 km West of the S.R.19 in Hamlin, New York. The combination piezometer/bench mark was placed in the shoulder at station 1+01. The in-pavement instrumentation was installed in the outer wheel path at station 0-12. The cabling from the instrumentation was placed in a 51 mm flexible conduit and buried in a trench running from the instrument hole to the equipment cabinet location in grassed area adjacent to the shoulder, 8.55 m from the centre of the instrumentation hole. The weather pole was installed 0.3 m 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". The combination piezometer/bench mark was installed 1.9 m from the edge of the paved shoulder to a depth of 4.36 m. Shale was not encountered as expected during the drilling. Water was encountered at approximately 3 m below ground level. The PVC access cover was seated in concrete.

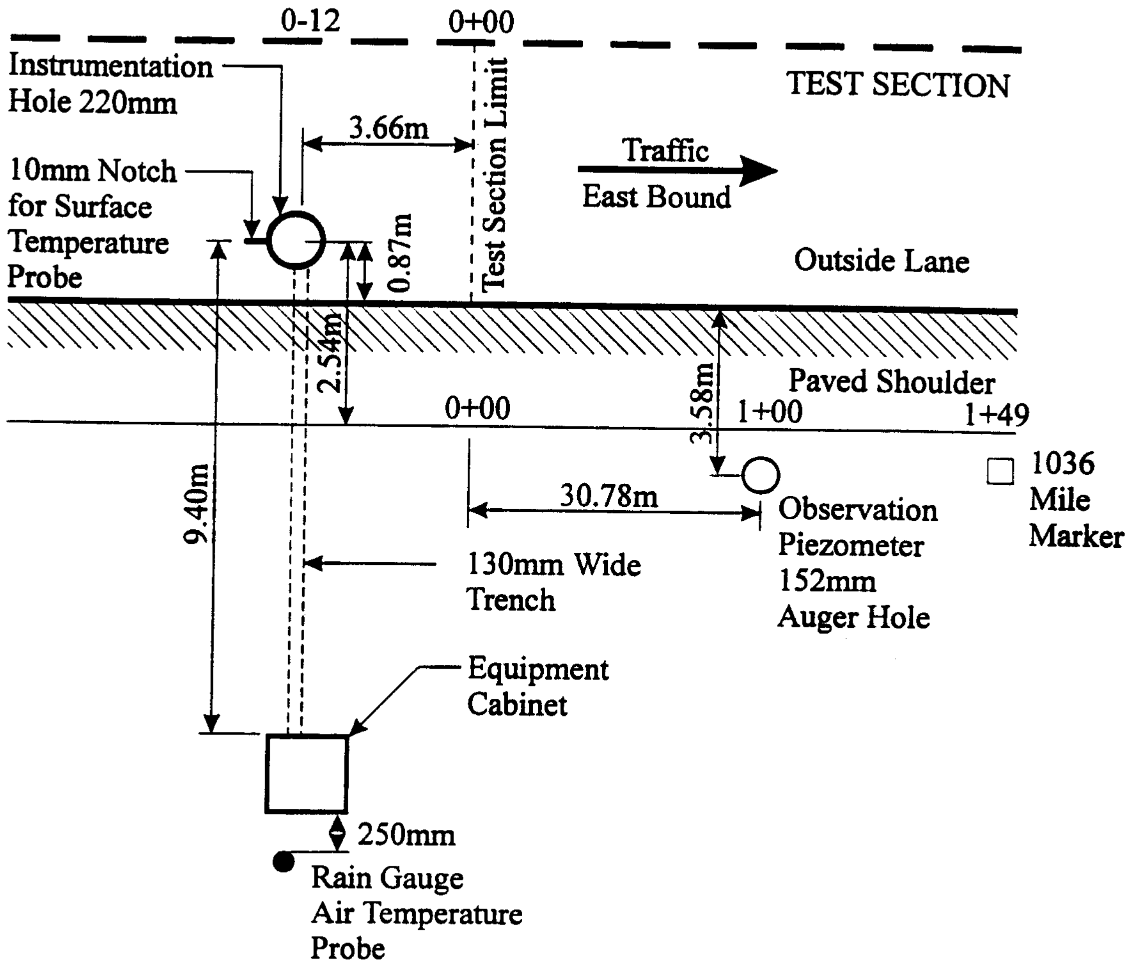
A core hole was drilled in the pavement surface, located in the outside wheel path 0.87 m from the edge of the travel lane at station 0-12, using a 305 mm thin wall diamond core barrel, attached to the truck mounted drilling unit. A 130 mm wide by 250 mm deep trench was saw cut between the core hole and the edge of the pavement using a heavy duty pavement sawing machine. The blade of the pavement saw was used to notch a location for the pavement surface temperature probe at the West edge of the core hole. A number of problems were encountered in sawing the trench for the instrumentation cables. Aside from the saw arriving late, there were problems in getting the unit to start, and supplying water to cool the blade. These problems were resolved by the saw's rental contractor, Admar Supply Co., and NYSDOT Monroe County West residency personnel. Operating the saw became another major obstacle. Although it did not look to be a very complex task, the lack of an experienced operator turned this operation into a trial and error process. A clean cut was finally accomplished by filling the core hole with a cold mix material and setting the blade depth to approximately 150 mm below the surface. In completing the trench an excessive amount of water was used, which resulted in saturation of the aggregate base material. The asphalt concrete portion of the trench was removed in two large chunks. The remainder of the material from the trench was removed with a pick and shovels.

A combination of methods were used to excavate the instrumentation hole. The driller used a 220 mm hollow stem auger with the plug removed to loosen the aggregate material, which was removed by hand. The top 100 - 150 mm's of material was very wet from the trench sawing operation. This saturated material was spread out in a plastic sheet for air drying. The remainder of the instrumentation hole was excavated using a 220 mm hollow stem auger with the hollow end blocked so that material mixing did not occur. Care was taken to ensure that the excavated material was stored in the order that it was removed. Two standard proctor tests of a representative samples from the two main soil layers were conducted in the field. The sandy layer yielded a dry density of 1920 kg/m^3 and the clayey silt layer yielded a dry density of 2045 kg/m^3 (as shown in Table C-3 and C-4 of Appendix C). The drilling was stopped approximately 2.10 m below the surface of the pavement. The findings from the excavation of the instrumentation hole at station 0-12 are presented in Figure 2.

All the material excavated from the instrument hole was placed and hand compacted in the order of removal with the TDR probes, resistivity probes and the thermistor probe placed at the specified locations. The one exception was the coarse surface material that was set out to dry. At the time of installation of the top TDR probes it was not considered suitable. The aggregate material from the trench, which was much drier, was used as a replacement material. During the placement of TDR probe number 1, the larger stones were picked out of the soil, so as to attain maximum soil contact with the probes. Once the probe was surrounded by soil the stones were placed on top of it. The 220 mm borehole was a tight fit for the TDR probes. Material was scraped from the edge of the borehole at the TDR probe locations such that the probes could be set flat on the underlying material. There was some difficulty in inserting the stainless steel component of the thermistor probe into the groove in the pavement. Various hand tools were used to widen the opening such that the probe could be pushed in. The location and elevation information of the instrumentation are presented in figure 2. Samples of the material placed around the TDR probes were retrieved to determine the gravimetric moisture at these locations. A field moisture determination was done at the site with sample material retained for laboratory moisture determination by the NYSDOT regional soils laboratory.

The pole for the rain gauge and air temperature probe were installed as per manual guidelines. The equipment cabinet was not installed until September 26, 1995 because there was not one available at the time of installation. A panel was wired to complete the required testing on the second day of installation. The cables from all instrumentation were placed in a sealed bag and buried to protect them from damage until the equipment cabinet was installed.

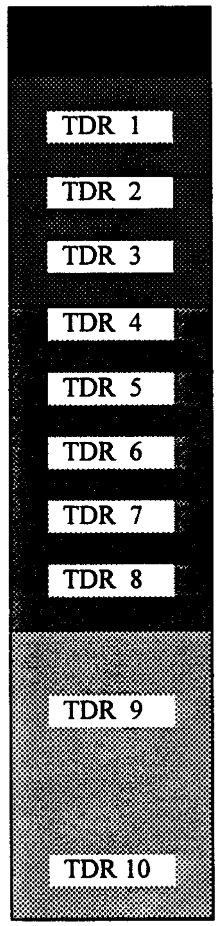
To check for breakage of the TDR probes during installation, each probe was connected to the cable tester and it's wave form monitored during compaction of the material around it. The TDR traces are included in Appendix C. The cables coming from the TDR probes were staggered along the perimeter of the instrument hole to avoid water migrating along a bundle of cables. The top TDR probe was placed with the cabling and the printed circuit board facing downward to avoid contact with the asphalt surface. The top of the thermistor probe and the resistivity probe were 0.165 m and 0.198 m below the pavement surface respectively. The cables from all instrumentation installed converged at the opening of the flexible conduit pipe which was placed about 50 mm from the edge of the core hole. The cables were then tie wrapped and passed through the 51 mm flexible conduit to the equipment cabinet. The ends of the conduit were plugged with a mastic pipe sealant.



- Height of Air Temperature Probe: 2.82m
- Height of Tipping Bucket Rain Gauge: 2.85m
- Depth of Piezometer: 4.28m

Figure 1. Location of Seasonal Monitoring Instrumentation Installed at SPS 360801

Material	Depth (mm)
HMAC	132
Coarse Aggregate (50 mm+) minimal fines	370
Brown Sand trace Silt	640
Reddish Brown Clayey Silt	1450
Grayish Brown Clayey Silt	2095



TDR depth (mm)	Comments
240	Thermistor Probe Depth 165mm Resistivity Probe Depth 198mm
390 540	Dry Density 1920 kg/m^3
700 840 1000 1130 1300 1610 1920	Dry Density 2045 kg/m^3

Figure 2. Profile of Pavement Structure and Probe Depths, Station 0-12

Tables 3, 4 and 5 present the installed depths of the TDR probes, thermistor sensors, and 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 TDR moisture values were generally higher than the field or laboratory values. This could be attributed to the loss of moisture from material handling and/or material wetting from the coring/sawing activities. The high variability from all the sampling could also be a result of variability in material. In general we have had much better correlation from the other seasonal sites under similar conditions. It should also be noted that the calculation of moisture is dependent on the calibration inputs to the TDR model. The Topp's calibration model, which was developed mainly for sandy soils was used for this correlation. Differences of moisture content in the range of 1 to 2% are not uncommon. Difference as identified for this project, especially between the field and laboratory sampling results are quite unusual.

Table 3. Installed Depths of TDR Sensors

Sensor #	Depth from Pavement Surface (m)	Layer
36B01	0.240	Base
36B02	0.390	Subgrade
36B03	0.540	
36B04	0.700	
36B05	0.840	
36B06	1.000	
36B07	1.130	
36B08	1.300	
36B09	1.610	
36B10	1.920	

Table 4. Installed Location of MRC Thermistor Sensor

Unit	Channel Number	Depth from Pavement Surface (m)	Remarks
1	1	0.025	This unit was installed in the AC layer.
	2	0.068	
	3	0.110	
2	4	0.186	This unit was installed below the AC layer into the subgrade.
	5	0.264	
	6	0.339	
	7	0.413	
	8	0.490	
	9	0.642	
	10	0.793	
	11	0.946	
	12	1.099	
	13	1.251	
	14	1.402	
	15	1.554	
	16	1.708	
	17	1.859	
	18	2.007	

Table 5. Location of Electrodes of the Resistivity Probe

Connector Pin Number	Electrode Number	Depth from Pavement Surface (m)
36	1	0.229
35	2	0.278
34	3	0.329
33	4	0.379
32	5	0.430
31	6	0.481
30	7	0.532
29	8	0.582
28	9	0.633
27	10	0.684
26	11	0.735
25	12	0.785
24	13	0.836
23	14	0.887
22	15	0.937
21	16	0.989
20	17	1.039
19	18	1.089
18	19	1.141
17	20	1.192
16	21	1.242
15	22	1.294
14	23	1.345
13	24	1.395
12	25	1.445
11	26	1.496
10	27	1.545
9	28	1.599
8	29	1.648
7	30	1.697
6	31	1.749
5	32	1.801
4	33	1.852
3	34	1.901
2	35	1.952
1	36	2.002

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)*
36B01	0.240	Base	4.2	-	2.0
36B02	0.390	Subgrade	11.9	5.8	8.0
36B03	0.540		15.1	11.1	10.0
36B04	0.700		19.6	14.7	12.0
36B05	0.850		17.0	11.1	9.0
36B06	1.000		9.7	6.7	9.0
36B07	1.150		15.6	5.5	10.0
36B08	1.310		9.7	7.3	13.0
36B09	1.610		17.0	8.7	15.0
36B10	1.920		19.6	20.0	20.0

* Note: Raw data given in Appendix C

Site Repair and Cleanup

The instrumentation hole was repaired by epoxying the 305 mm core in it's original orientation. The sides of the core and the hole were cleaned with a wire brush to increase the adhesion to the epoxy. The conduit was buried such that there existed at least 50 mm of soil cover to the bottom of the asphalt pavement. The road base material removed from the trench was used to bring it up to grade. The two asphalt pieces removed from the trench were then placed on top of the compacted base. The remainder of the trench was filled with native soil and re-sodded. Traffic control remained in place throughout the night. On the second day of installations the Monroe County crew removed the ACC pieces and patched the trench with hot mix ACC and compacted with a hand maneuvered roller.

On August 29, 1995 the weather station pole was painted green by Rick Morgan and Ed Bikowitz of NYSDOT, as requested by David Herring of OPRHP. On September 26, 1995 the equipment cabinet was installed and the wiring of all instrumentation was completed. A set of data was collected on that day to ensure that the instrumentation was functioning properly.

Patch/Repair Area Assessment

All indications from the site visit on September 26, 1995, were that the instrument hole and trench were in very good condition. Photos of the instrumentation hole area were taken as shown in Appendix E.

III. Initial Data Collection

The second day activities included initial data collection on the site and checks on functioning of installed equipment. This consisted of examination of the data collected over the day by the onsite datalogger, data collection and check of the mobile CR10 datalogger, deflection testing, and elevation survey. A sample of the 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 23 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 equipment cabinet was not installed until September 26, 1995, thus continuous onsite data was not collected till this date. The plots of the temperature profiles from August 23, and September 26, 1995 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 shows the initial TDR traces collected with the MOBILE data acquisition system for all 10 sensors. The figures indicate that the multiplexers of the mobile system 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 is 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 trend of the automated resistance voltage, manual contact resistance, and the four-point resistivity collected are similar. The higher resistance values near the surface can be attributed to the minimal electrode contact area with the soil due to the presence of crushed stone.

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 day of installation and the following day are presented in Appendix D. Since then FWD data has been collected once every month. It should be noted that this site contains highly variable subgrade soil conditions.

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 two surveys conducted at this site, the first on January 12, 1996 with and average IRI of 93.07 inches/mile and the second on March 12, 1996 with an average IRI value of 100.85 inches/mile.

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 23, 1995 and the results are presented in Appendix D. Since then surface elevation surveys have been performed on October 10, 1995, January 09, February 08, and April 09, 1996. NYSDOT Region 4 Survey personnel determined the elevations of the nail on the ash tree at station 0+74, and the top of the piezometer pipe on September 11, 1995. The nail will be used to monitor the stability of the piezometer stand pipe. The first two elevations surveys conducted since the installation indicate that the piezometer stand pipe is stable.

Water Depth

The water level on August 23, 1995 was approximately 1.44 m below the top of the piezometer. The water table at the site is highly variable. Since the installation, the highest level was 0.23 m below the top of the piezometer on March 26, 1996, and the lowest level was 1.61 m on September 26, 1995.

IV. Summary

The installation of the seasonal monitoring instrumentation at the SPS site 360801 near Hamlin, NY was completed on August 23, 1995 except for the equipment cabinet which was installed on September 26, 1995. A check of the equipment and initial data collection was completed on August 23, 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 measurement,
- 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 an automated frost depth measurement is to be collected during each site visit (14 times per year) using a mobile datalogger system. The water level, elevation, and resistivity data are to be collected manually during site visits.

The test section is on Eastbound Lake Ontario State Parkway, 3.2 km West of the S.R. 19. The site is located in a flat area less than a kilometer South of the shores of Lake Ontario. The pavement resides in a slightly elevated platform and consists of four 3.6 m wide lanes with a 22.6 m grass median/ditch separating traffic in either direction. The paved outside shoulder is 1.7 m wide and the inside shoulder consists of a concrete curb. The pavement structure consists of 125 mm of asphalt concrete over a course aggregate base that resides on clayey sand with gravel. The SPS-8 project sampling encountered a rigid shale layer within 2 meters of the surface. There was no rigid layer encountered during the drilling and placement of the instrumentation.

A WIM installed 1.21 km's East of site 360801 will provide continuous traffic data for this section. This WIM was operational at the time of installation.

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. The automated and manual resistivities collected compared favourably. A check of the tipping bucket indicated it was functioning correctly with tips corresponding to the amount of water supplied.

Moisture content of the soil was determined by TDR method, field moisture determination at time of installation by soil drying, and laboratory results provided by NYSDOT Region 4 soils laboratory. There were fairly large differences between the moisture content determined by the TDR method and gravimetric moisture content determined from the samples taken. Some of the differences may be attributed to the loss of moisture during handling of the soil, air drying of the soil, and/or wetting during the coring/sawing operations. The results are more variable than is normal for such comparisons.

The installation generally proceeded as expected with only a few minor problems. The sawing of the trench caused some delay. The operation of the saw was hampered by the lack of experience in operating this unit. This resulted in some excess moisture in the aggregate base material. The installation was completed and the crews left the site by 1800 hours. The removal/replacement of the material from the instrumentation hole was successful, with the material being well consolidated around the instrumentation and the core level with the existing pavement surface at completion. The final connection of the instrumentation was postponed till September 26, 1995 as a cabinet was not available for the instrumentation cabling and the datalogger.

Environmental data will also be monitored by an Automated Weather Station (AWS) located at the junction of the Eastbound Lake Ontario State Parkway and S.R. 19. The ongoing monitoring of this section is progressing fairly well.

APPENDIX A

Test Section Background Information

Appendix A contains the following supporting information:

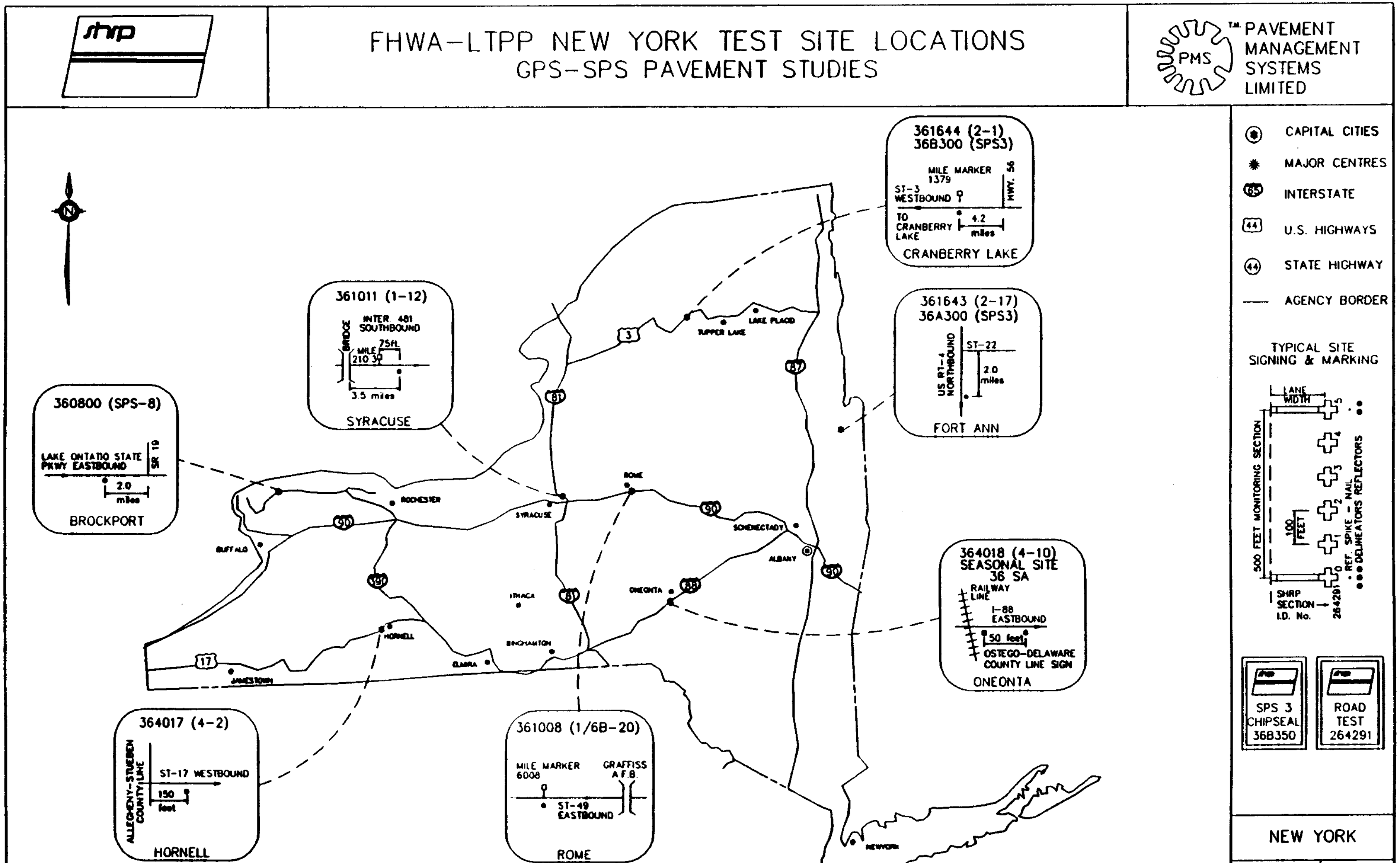


FIGURE A-1 SITE LOCATION MAP - SECTION 360801

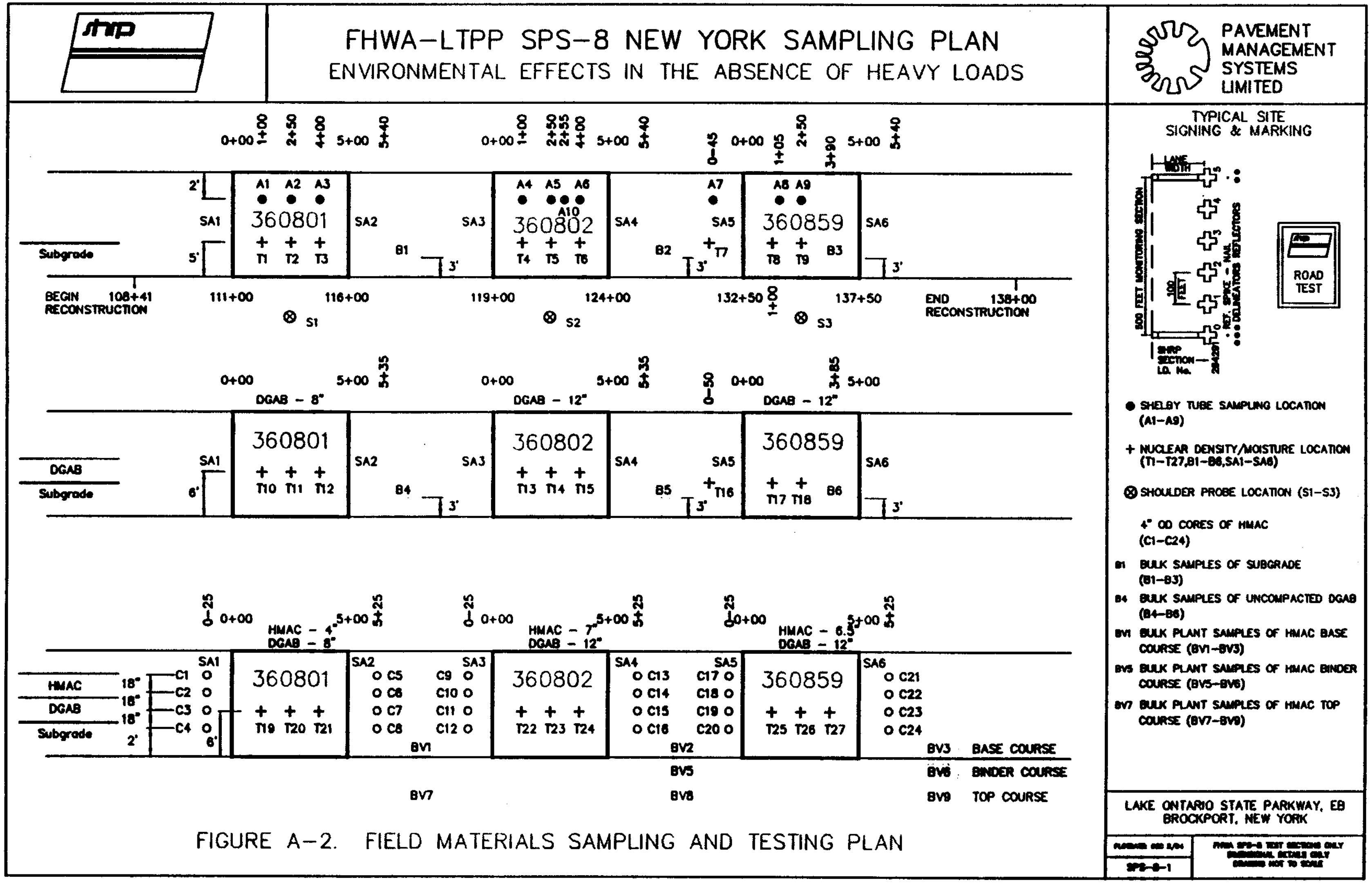
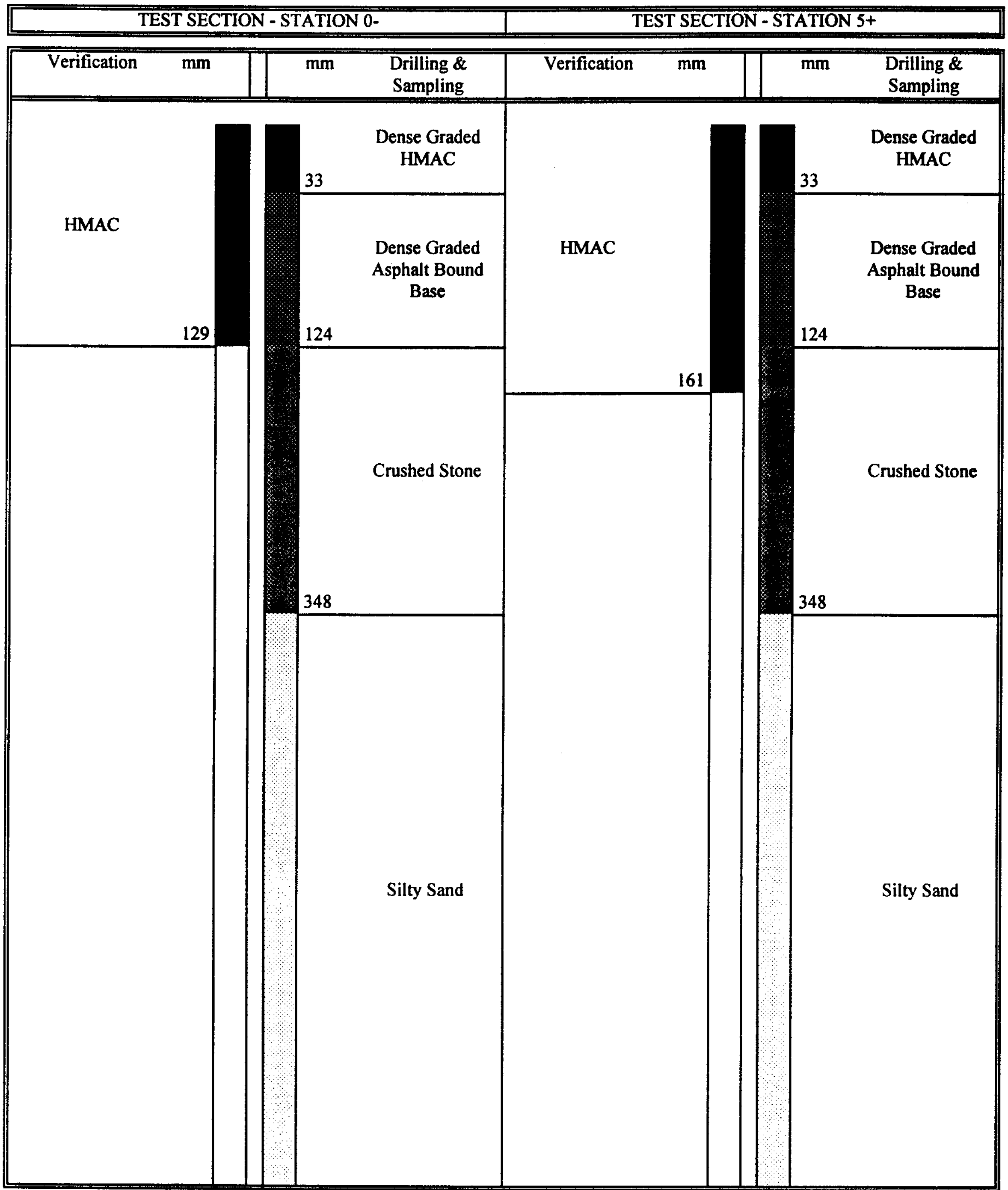


FIGURE A-2. FIELD MATERIALS SAMPLING AND TESTING PLAN



* Verification data was taken from the post construction coring logs. There is no laboratory data available at this time.

Figure A-3. Profile of Pavement Structure

Table A-1. Site Performance Summary

Distress and Profile Summary		
Distress Summary August 23, 1995	Profile Summary	
	Date (dd-mm-yy)	IRI (in/mi)
Slight scraping from snowplow @ midlane	06-09-94	63.58
and edge	12-06-95	60.82

Falling Weight Deflectometer Data Summary						
Date	Mean Value for Drop HT 2 (mils)					
(dd-mm-yy)	Sensor 1	Sensor 1 std. dev.	Sensor 7	Sensor 7 std. dev.	Mean Temp D1 (^oF)	Min/Max TempD1 (^oF)
09-11-94	12.64	1.07	1.34	0.36	57	56/59

	Effective SN	SN std dev	Subgrade Modulus (psi)	Modulus std dev (psi)	Test Pit Mod. (psi)	
					1	2
09-11-94	3.64	0.12	17312	2473		

Table A-2. Uniformity Survey Results

Seasonal Uniformity Survey	Falling Weight Deflectometer
Site Number: 360801	Data Collection and
Date Surveyed: August 21, 1995	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	Subg modulus (psi)	Subg modulus std dev	Effective SN	SN std dev
-100 - 250	17.34	1.50	1.07	0.11	20916	2407	2.85	0.12
250 - 600	16.34	1.36	1.04	0.14	23363	3320	2.88	0.14

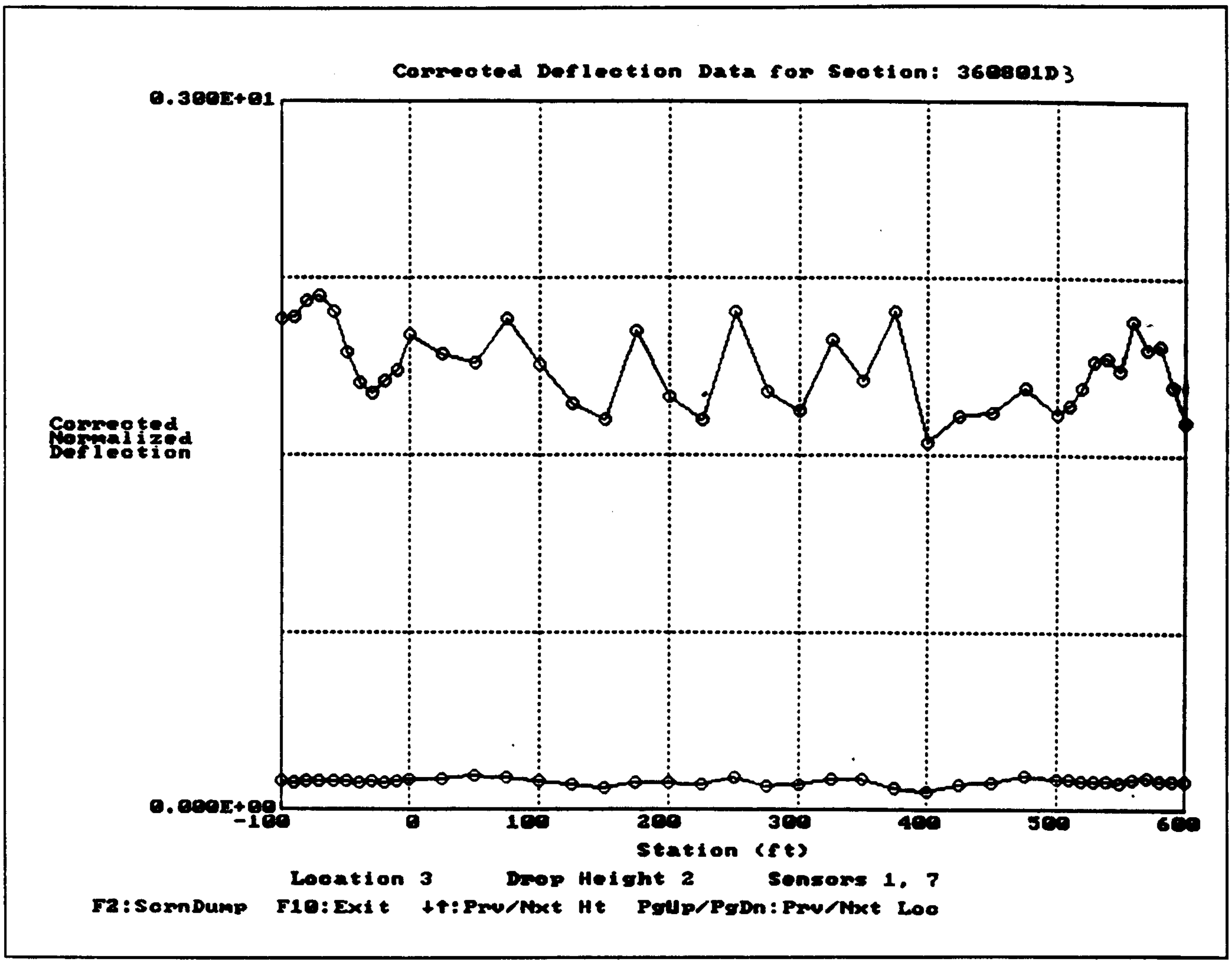


Figure A-3. Deflection Profile from FWDCHECK
(Test Date August 21, 1995)

Table A-3. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date August 21, 1995)

Flexible Pavement Thickness Statistics - 360801DA - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-100	19404	2.75
	-90	19374	2.75
	-80	19029	2.75
	-70	20921	2.65
	-60	20748	2.70
	-50	21772	2.80
	-40	21366	2.95
	-30	20839	3.00
	-20	18538	3.05
	-10	19661	2.95
	0	19942	2.80
	25	21411	2.80
	50	20956	2.85
	75	22189	2.65
	100	21930	2.85
	125	23097	2.95
	150	26372	2.95
	175	16236	2.95
	200	21986	2.95
	225	26021	2.95
	250	17448	2.85
2	275	26333	2.80
	300	25645	2.90
	325	25583	2.65
	350	29354	2.70
	375	17953	2.80
	400	30164	2.95
	425	25452	2.95
	450	25390	2.95
	475	26491	2.80
	500	23509	3.00
	510	22309	3.00
	520	21405	2.95
	530	20821	2.85
	540	20898	2.85
	550	21382	2.90
	560	21106	2.70
	570	23210	2.75
	580	20378	2.85
	590	20932	2.95
	600	18950	3.25
Subsection 1	Overall Mean	20916	2.85
	Standard Deviation	2407	0.12
	Coeff of Variation	11.51%	4.09%
Subsection 2	Overall Mean	23363	2.88
	Standard Deviation	3320	0.14
	Coeff of Variation	14.21%	4.70%

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

Table B-1. Air Temperature Thermistor Calibration

Table B-2. MRC Probe Calibration

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

Table B-4. Resistivity Probe and Sensor Spacing

Table B-5. Contact Resistance Calibration

Table B-6. Four-Point Resistivity Calibration

Table B-7. TDR Probes Calibration

Figure B-1. TDR Traces Obtained During Calibration

LONG TERM PAVEMENT PERFORMANCE
North Atlantic Region
415 Lawrence Bell Drive, Unit 3, Amherst, New York 14221
Tel. (716) 631-5205 Fax (716) 632-4808

IVAN J. PECNIK, P.E.
LTPP Regional Engineer

Mr. L.M. Gurley P.E.
Regional Director
New York State Department of Transportation
Region 4
1530 Jefferson Road
Rochester, NY

January 22, 1996

RE: NYS DOT SPS-8 Project, Lake Ontario State Parkway

Dear Mr. Gurley:

The FHWA-LTPP North Atlantic Regional Office in cooperation with the New York State Department of Transportation has completed the installation of an Automated Weather Station and a Seasonal Monitoring Site at the above noted location in conjunction with your contract D254995. That contract also provided for the construction of the SPS-8 project which is a study of the environmental effects on a pavement in the absence of heavy loads.

During the construction of the project, the installation of the weather station and the seasonal site we have had the opportunity of working with your staff. In particular we would like to take this opportunity to thank Tim Davison and his staff of the Construction Division and the personnel from the Monroe County-West Residency for their assistance in this effort. Their interest and attention to detail made the completion of our experimental project most efficient and satisfactory.

Sincerely,

I.J. Pecnik P.E.
LTPP Regional Engineer, NA

C.C. P. Mack, NYS DOT
W.A. Phang D.Eng., NARO
E. Lesswing, NARO

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
ALBANY, N.Y. 12232

JOHN B. DALY
COMMISSIONER

GEORGE E. PATAKI
GOVERNOR

October 24, 1995

Mr. Brandt Henderson
PMSL - NARO
415 Lawrence Bell Drive
Suite 3
Amherst, NY 14221

Dear Mr. Henderson:

Enclosed are the following concerning the LOSP installation of SMP instruments:

1. Elevations of the permanent benchmark and ground water observation well established by Region 4.
2. Copies of the photos taken during installation.
3. Copy of the video taken during installation.
4. Copy of Rick Morgan's trip report for the installation.

If you have any question concerning these, please contact Rick Morgan of this office (518) 457-4662.

Sincerely,

Dr. Robert J. Perry
Director
Transportation Research and
Development Bureau

RJP:RLM:mmc
enclosures

PAVEMENT
MANAGEMENT
SYSTEMS

ORIGINAL

August 28, 1995
50451125-~~16.06~~ 13.12.8

Mr. Rick Morgan
Materials and Pavement Research
New York State Department of Transportation
1220 Washington Avenue, State Campus
Building 7A, Room 600
Albany, NY 12232

RE: As-constructed Drawing of 360801 Seasonal Instrumentation

Dear Mr. Morgan,

As per our telephone conversation of August 28, 1995, I am sending you the as-constructed drawing for the installation of the seasonal monitoring instrumentation at the SPS-8 site 360801.

Yours Sincerely,

D.A. Singaraja

Dilan A. Singaraja
Junior Engineer
Pavement Management Systems Limited

Encl.

Copies: B.Phang, I.J.Pecnik

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

ORIGINAL

JUL 31 1995

FILE # 13-12-8

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
ALBANY, N.Y. 12232

JOHN B. DALY
COMMISSIONER

GEORGE E. PATAKI
GOVERNOR

July 25, 1995

Mr. William Phang
Pavement Management System-
North Atlantic Regional Office
Suite 3
415 Lawrence Bell Drive
Amherst, NY 14421

Dear Mr. Phang:

Attached for your information are minutes of the meeting held on July 20, 1995, at the Monroe County West Residency in Spencerport, Region 4. The subject of this meeting was the proposed inclusion of the FHWA-LTPP SPS-8 site located on Lake Ontario State Parkway (Monroe County) in the Seasonal Monitoring Program. The scope of this program and the responsibilities of all concerned parties were discussed.

If you have any questions concerning this matter please contact Rick Morgan or Wes Yang of this office (518)-457-5826.

Sincerely,

Dr. Robert J. Perry
Director
Transportation Research and
Development Bureau

RJP:RLM:mmc
attachments

c: B. Henderson, Pavement Management System-North Atlantic Regional Office
(w/ attachments)

12.128

ORIGINAL

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

TO: M. E. McGrath, Geotechnical Engineering Bureau, 7-102, MC 0863
J. J. Dunlap, Resident Engineer, Monroe County West, Region 4
R. H. Kiehl, Soils Engineer, Region 4
C. R. DiCenzo, Materials Engineer, Region 4
D. Johnson, Design, Region 4

FROM: R. J. Perry, Transportation R&D Bureau, 7A-600, MC 0869 RJP

SUBJECT: FHWA-LTPP-SEASONAL MONITORING PROGRAM

DATE: July 10, 1995

As part of the FHWA-Long Term Pavement Performance Program (FHWA-LTPP, formerly SHRP), certain sites across the nation have been chosen for inclusion in the Seasonal Monitoring Program. The purpose of this program is to obtain an understanding of the impact on pavement performance of the combined effects of temperature, frost penetration, and moisture. Pavement Management Systems Limited (PMSL-NARO), the Federal contractor for the LTPP program in NYS, has selected the Special Pavement Studies - 8 (SPS-8) site on the Lake Ontario State Parkway (LOSP) in Monroe County for inclusion in this program. Attached for your information are the preliminary guidelines for the selection, instrumentation, and testing of this site.

This is also a reminder of the meeting to discuss the Department's responsibilities toward this program as per your telephone conversation with Rick Morgan of this office. The meeting is to be held Thursday, July 20, 1995 at the Monroe County West Residency, 2441 South Union Street (Rt. 259), Spencerport, NY 14459 at 8:30 a.m.

If you have any questions concerning this matter, please contact Rick Morgan or Wes Yang of this office (518) 457-5826. In case of last minute changes or need of directions, the telephone number of the residency is (716) 352-3471, ask for Dave Pennella, ARE.

RJM:RLM:mmc
Attachment

c: P. Mack, Technical Services Division, 7A-210, MC 0862
I. Pecnik, PMSL, 415 Lawrence Bell Drive, Suite 3, Amherst, NY 14221

[illegible] Contact

ORIGINAL

PAVEMENT
MANAGEMENT
SYSTEMS

MEMORANDUM

TO	Paul Mack - LTPP Coordinator Wes Yang - LTPP Contact	**DATE**	May 5, 1995
FROM	Bill Phang *Bill Phang*	**PROJECT**	50451025
SUBJECT	Seasonal Monitoring Program - SPS 360801 Instrumentation	**FILE**	12.12

Candidate sites for the second circuit (8 sites) of the Seasonal Monitoring Program are being confirmed at this time for purpose of scheduling Pre-installation Planning Meetings and dates for installation. An SMP site in the SPS-8 project on the Lake Ontario State Parkway at Brockport, NY, section 360801, would be a valuable addition to the SMP, filling cell 4 of the core experiment, and this was the subject of earlier discussion by Brandt Henderson and Wes Yang.

NYS DOT hosted the first pilot SMP site at Syracuse GPS 361011, where the performance of different moisture sensors and temperature sensors were evaluated. Details of the adopted hardware and software for subsequent SMP sites are described in the FHWA-RD-94-110 Report "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines", a copy of which is enclosed for your convenience.

After confirmation of support for this candidate site is received, Brandt Henderson will arrange testing of the section for uniformity of load reaction, which assists in deciding where the sensors are to be located. A Pre-installation Meeting with agency participants will then be held so that appropriate DOT staff can gain a detailed understanding of their roles and responsibilities, during installation and in subsequent monitoring. At this meeting, contacts and schedules are established and as well the on-site meeting places are determined.

The installation can be scheduled to take place in August, 1995.

Your participation in the SMP and LTPP has been extensive, very important, and very much appreciated.

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

Table B-1. Air Temperature Thermistor Calibration

LTPP Seasonal Monitoring Study	State Code	[36]
Air Temperature Thermistor Calibration	Test Section Number	[0801]

Before Operation Checks	Calibration Date (dd-mm-yy)	21-08-95
	Probe S/N	36BAT
	Operator	BH/DS

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
					0.0	1705	48.4	1900	y

Probe Accepted	B.H.	(Initials)

* Note: This probe was calibrated and it passed all the tests. Some calibration sheets cannot be located.

Table B-2. MRC Probe Calibration

LTPP Seasonal Monitoring Study	State Code		[36]
MRC Probe Calibration	Test Section Number		[0801]

Before Operation Checks	Calibration Date (dd-mm-yy)	21-08-95
	Probe S/N	37BT
	Operator	BH/DS

	Mobile Datalogger (24 hour)*			Water Room Temp* Time 1400	Ice Bath 0 °C (+/- 1 °C) Time 1300	Hot Water 50 °C (+/-) Time 1900	ok
No.	Mean	Min.	Max.	Reading	Reading	Reading	y/n
1					-0.073	46.6	y
2					-0.073	46.5	y
3					-0.073	46.5	y
4					1.410	46.4	y
5					0.000	48.7	y
6					-0.036	48.6	y
7					-0.073	48.6	y
8					-0.036	48.7	y
9					-0.036	48.6	y
10					-0.110	48.9	y
11					-0.036	48.9	y
12					-0.110	48.6	y
13					-0.036	49.1	y
14					-0.110	49.4	y
15					-0.110	49.1	y
16					-0.110	49.0	y
17					-0.147	48.9	y
18					0.442	47.7	y

Probe Accepted:	BH/DS	(Initials)
Probe Length:	1.854	(meters)

Thermistor distance from top of probe: (meters)									
4	0.021	7	0.249	10	0.628	13	1.086	16	1.543
5	0.099	8	0.325	11	0.781	14	1.237	17	1.694
6	0.174	9	0.477	12	0.934	15	1.389	18	1.842

* Note: This probe was calibrated and it passed all the tests. Some calibration sheets cannot be located.

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	0.177	
	3	0.327	
2	4	0.021	1.854 m long by 25.4 mm PVC tube installed in the base and subgrade.
	5	0.099	
	6	0.174	
	7	0.249	
	8	0.325	
	9	0.477	
	10	0.628	
	11	0.781	
	12	0.934	
	13	1.086	
	14	1.237	
	15	1.389	
	16	1.543	
	17	1.694	
	18	1.842	

Table B-4. Resistivity Probe and Sensor Spacing

LTPP Seasonal Monitoring Program Data Sheet SMP-C03 Resistivity Probe Check	Agency Code [36] LTPP Section ID [0801]

Connector Pin No.	Electrode Number	Distance from Top (m)			Continuity x	Spacing (m)	Comments
		Line 1	Line 2	Avg.			
36	1	0.031	0.030	0.031	x	0.049	
35	2	0.080	0.079	0.080	x	0.051	
34	3	0.131	0.130	0.131	x	0.051	
33	4	0.182	0.180	0.181	x	0.051	
32	5	0.232	0.231	0.232	x	0.052	
31	6	0.284	0.282	0.283	x	0.051	
30	7	0.335	0.333	0.334	x	0.050	
29	8	0.384	0.383	0.384	x	0.051	
28	9	0.435	0.434	0.435	x	0.051	
27	10	0.486	0.485	0.486	x	0.051	
26	11	0.537	0.536	0.537	x	0.051	
25	12	0.588	0.586	0.587	x	0.051	
24	13	0.639	0.637	0.638	x	0.051	
23	14	0.689	0.688	0.689	x	0.050	
22	15	0.739	0.738	0.739	x	0.052	
21	16	0.791	0.790	0.791	x	0.050	
20	17	0.841	0.840	0.841	x	0.051	
19	18	0.892	0.890	0.891	x	0.052	
18	19	0.944	0.942	0.943	x	0.051	
17	20	0.995	0.993	0.994	x	0.050	
16	21	1.044	1.043	1.044	x	0.053	
15	22	1.097	1.095	1.096	x	0.051	
14	23	1.147	1.146	1.147	x	0.051	
13	24	1.198	1.196	1.197	x	0.050	
12	25	1.248	1.246	1.247	x	0.051	
11	26	1.299	1.297	1.298	x	0.049	
10	27	1.348	1.346	1.347	x	0.054	
9	28	1.401	1.400	1.401	x	0.049	
8	29	1.450	1.449	1.450	x	0.049	
7	30	1.499	1498	1.499	x	0.053	
6	31	1.552	1.550	1.551	x	0.051	
5	32	1.603	1.601	1.603	x	0.052	
4	33	1.655	1.653	1.654	x	0.052	
3	34	1.703	1.701	1.703	x	0.052	
2	35	1.756	1.753	1.754	x	0.050	
1	36	1.805	1.803	1.804	x	n/a	
	Bottom			1.829	n/a	n/a	

Prepared by	JO	Employer	PMSL
Date (dd-mm-yy)	01-08-95		

Table B-5. Contact Resistance Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-D03 Contact Resistance Measurements	Agency Code [36] LTPP Section ID [0801]

Test Position	Switch Settings		Voltage (ACV)		Current (ACA)		Comments
	I1 V1	I2 V2	Range	Reading	Range	Reading	
1	1	2	mV	62.6	μA	418.0	
2	2	3		51.3		427.0	
3	3	4		43.7		434.0	
4	4	5		47.1		433.0	
5	5	6		61.0		425.0	
6	6	7		87.1		403.9	
7	7	8		97.1		393.4	
8	8	9		89.3		398.0	
9	9	10		68.0		421.0	
10	10	11		67.8		422.0	
11	11	12		77.2		408.1	
12	12	13		58.2		422.0	
13	13	14		68.2		418.0	
14	14	15		84.7		404.2	
15	15	16		64.0		422.0	
16	16	17		58.4		424.0	
17	17	18		72.4		416.0	
18	18	19		84.7		397.9	
19	19	20		85.7		391.5	
20	20	21		68.0		405.2	
21	21	22		72.8		409.1	
22	22	23		70.8		408.6	
23	23	24		71.3		413.0	
24	24	25		81.8		402.8	
25	25	26		99.6		389.8	
26	26	27		111.6		379.3	
27	27	28		100.8		391.1	
28	28	29		83.5		370.1	
29	29	30		93.5		343.2	
30	30	31		84.8		401.2	
31	31	32		81.4		366.0	
32	32	33		99.4		379.4	
33	33	34		88.3		377.5	
34	34	35		65.0		417.0	
35	35	36		65.2		414.0	
Prepared by:		DM		Employer:		PMSL	
Date (dd/mm/yy):		04/08/95					

Table B-6. Four-Point Resistivity Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-D04 Four-Point Resistivity Measurements	Agency Code [36] LTPP Section ID [0801]

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	2.9	μA	421.0	
2	2	3	4	5		2.9		423.0	
3	3	4	5	6		3.1		421.0	
4	4	5	6	7		2.8		408.1	
5	5	6	7	8		3.1		406.2	
6	6	7	8	9		2.9		404.9	
7	7	8	9	10		2.9		408.2	
8	8	9	10	11		3.0		394.9	
9	9	10	11	12		3.1		403.9	
10	10	11	12	13		2.8		425.0	
11	11	12	13	14		3.1		398.9	
12	12	13	14	15		3.0		398.2	
13	13	14	15	16		2.8		426.0	
14	14	15	16	17		3.3		400.8	
15	15	16	17	18		2.9		405.3	
16	16	17	18	19		2.8		403.3	
17	17	18	19	20		2.9		398.6	
18	18	19	20	21		2.8		407.9	
19	19	20	21	22		2.9		390.8	
20	20	21	22	23		2.8		399.7	
21	21	22	23	24		3.0		404.1	
22	22	23	24	25		2.9		396.8	
23	23	24	25	26		3.1		392.1	
24	24	25	26	27		3.1		387.4	
25	25	26	27	28		3.0		396.8	
26	26	27	28	29		3.1		384.4	
27	27	28	29	30		3.1		387.5	
28	28	29	30	31		2.9		391.2	
29	29	30	31	32		3.0		392.8	
30	30	31	32	33		2.9		376.5	
31	31	32	33	34		2.7		400.6	
32	32	33	34	35		2.9		394.0	
33	33	34	35	36		2.8		387.6	

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

Table B-7. TDR Probes Calibration

LTPP Seasonal Monitoring Study	State Code	[36]
TDR Probes	Test Section Number	[0801]

Before Operation Checks	AL	Initial	Calibration Date (mm-dd-yy)	21-08-95
			Seasonal Site	36SB

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	36B01	1.1	0.6	16.700	16.900	16.900	16.750	16.750
2	36B02	0.6	0.5	16.710	16.910	16.710	16.740	16.740
3	36B03	0.6	0.5	15.940	16.120	15.940	15.960	15.980
4	36B04	0.7	0.5	16.710	16.910	16.710	16.730	16.740
5	36B05	0.7	0.4	16.400	16.590	16.400	16.410	16.430
6	36B06	0.6	0.5	16.350	16.560	16.560	16.680	16.640
7	36B07	0.7	0.4	15.900		15.900	15.940	15.940
8	36B08	0.6	0.5	16.700	16.910	16.700	16.730	16.740
9	36B09	0.6	0.4	16.620	16.800	16.790	16.380	16.400
10	36B10	1.1	0.4	16.380	16.570	16.380	16.400	16.420

NOTE: Record lengths from TDR

Calculation of Dielectric Constant

Probe Length 0.203 m

V_p Setting 0.99 V_p

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

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	1.02	25.76	y	1.83	82.92	y
2	0.20	0.99	y	1.04	26.78	y	1.85	84.74	y
3	0.18	0.80	y	1.02	25.76	y	1.84	83.82	y
4	0.20	0.99	y	1.02	25.76	y	1.84	83.82	y
5	0.19	0.89	y	1.04	26.78	y	1.81	81.11	y
6	0.21	1.09	y	1.01	25.26	y	1.88	87.51	y
7	0.20	0.99	y	1.00	24.76	y	1.83	82.92	y
8	0.21	1.09	y	1.01	25.26	y	1.85	84.74	y
9	0.18	0.80	y	0.97	23.30	y	1.84	83.82	y
10	0.19	0.89	y	1.04	26.78	y	1.88	89.51	y

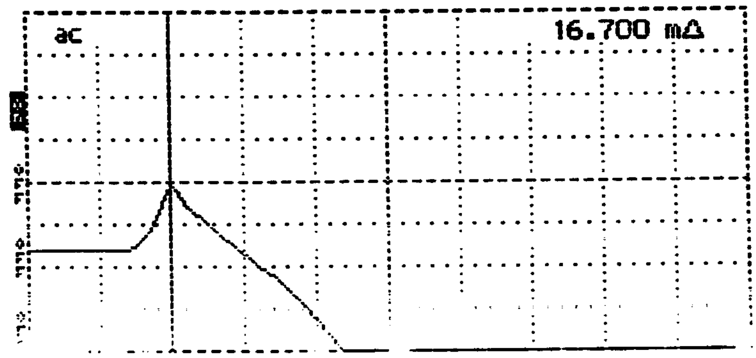
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [0801]

Probe Serial Number: 3680 01 **Date (dd/mm/yy):** 21/08/95

Probe Number 01

Trace 1 - Probe Shorted at Start

rsor .... 16.700 mΔ
tance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac

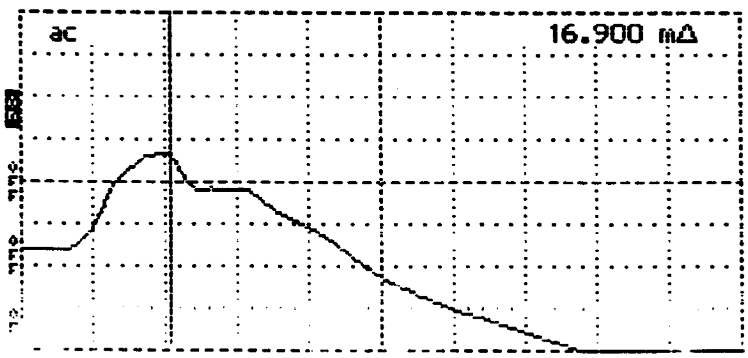


Tektronix 1502B TDR
Date Aug 21/95
Cable 0 #cl
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

rsor .... 16.900 mΔ
tance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date Aug 21/95
Cable 0 #cl
Notes short end

Input Trace
Stored Trace
Difference Trac

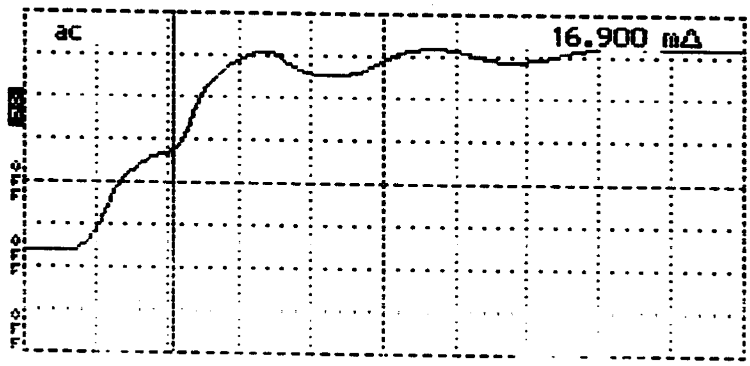
Figure B-1. TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Number 01

Trace 3 - Probe in Air

rsor .... 16.900 mΔ
tance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

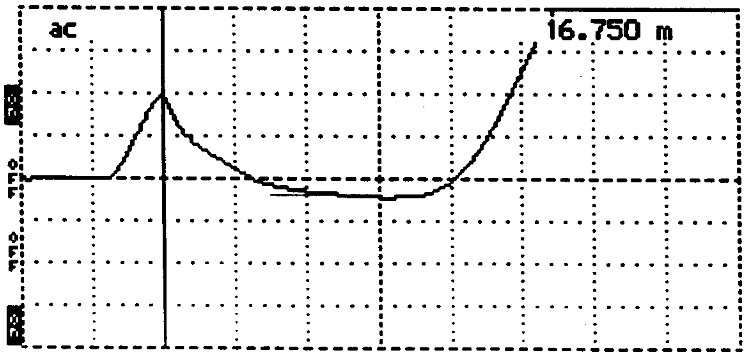


Tektronix 1502B TDR
Date Aug 21/95
Cable #01
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

sor .... 16.750 m
tance/Div..... .25 m/div
tical Scale.... 100 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

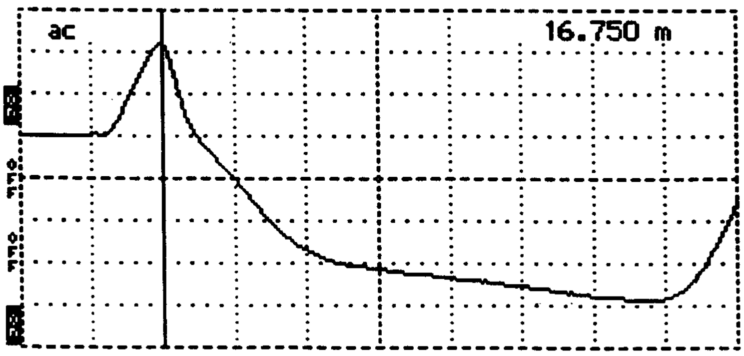


Tektronix 1502B TDR
Date Aug 04/95
Cable #01
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 16.750 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 04/95
Cable #01
Notes Water

Input Trace
Stored Trace
Difference Trace

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

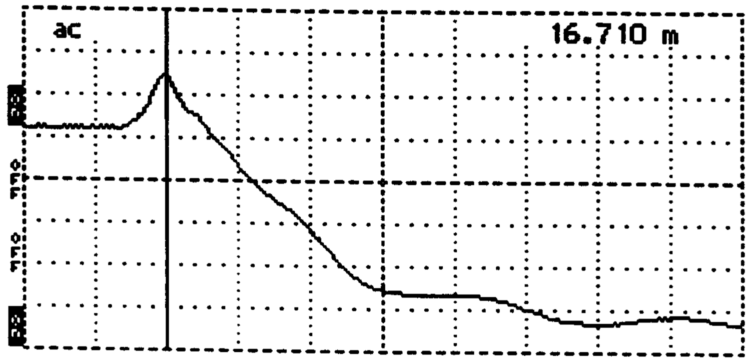
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [08-01]

Probe Serial Number: 36B02 **Date (dd/mm/yy):** 21/08/95

Probe Number 02

Trace 1 - Probe Shorted at Start

sor .... 16.710 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

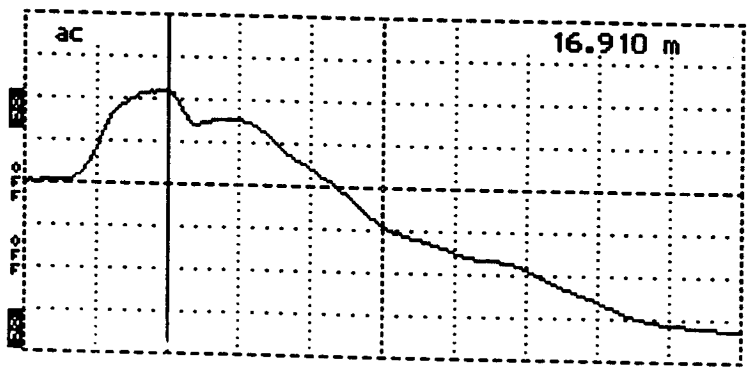


Tektronix 1502B TDR
Date Aug.4/95
Cable #02
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.910 m
nce/Div ..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #02
Notes short end

Input Trace
Stored Trace
Difference Trace

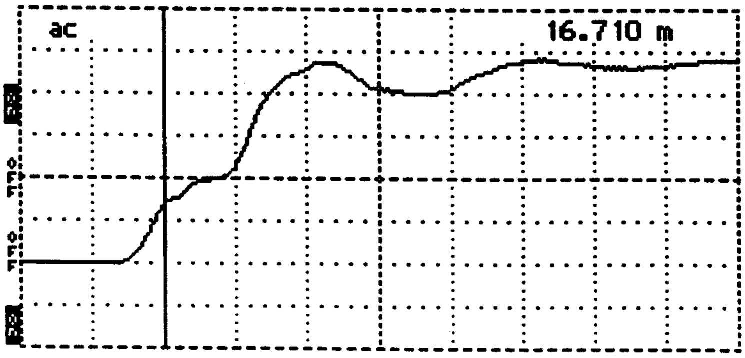
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [08-1]

Probe Number 02

Trace 3 - Probe in Air

or .... 16.710 m
ance/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

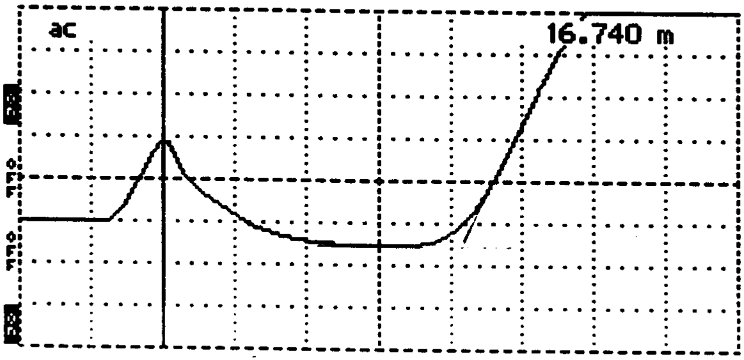


Tektronix 1502B TDR
Date Aug 04/95
Cable #02
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 16.740 m
ance/Div ..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

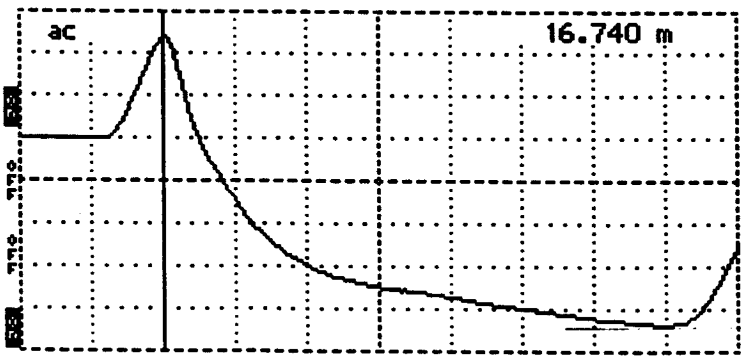


Tektronix 1502B TDR
Date Aug 04/95
Cable #02
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

sor .... 16.740 m
ance/Div ..... .25 m/div
tical Scale.... 74.8 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac



Tektronix 1502B TDR
Date Aug 04/95
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: [36] LTPP Section ID: [0801]

Probe Serial Number: 36B03 **Date (dd/mm/yy):** 21/08/95

Probe Number: 03

Trace 1 - Probe Shorted at Start

Trace 2 - Probe Shorted at End

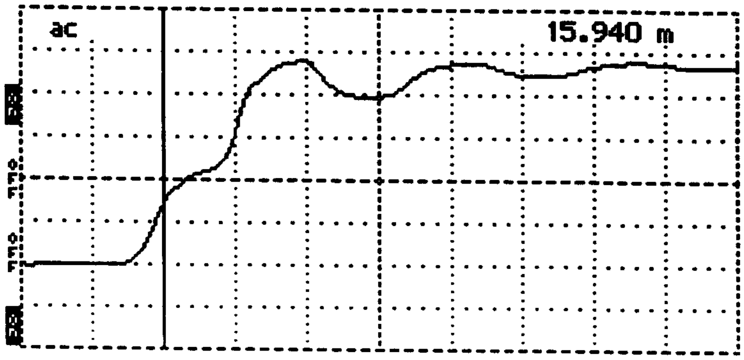
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [0801]

Probe Number 03

Trace 3 - Probe in Air

sor .... 15.940 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

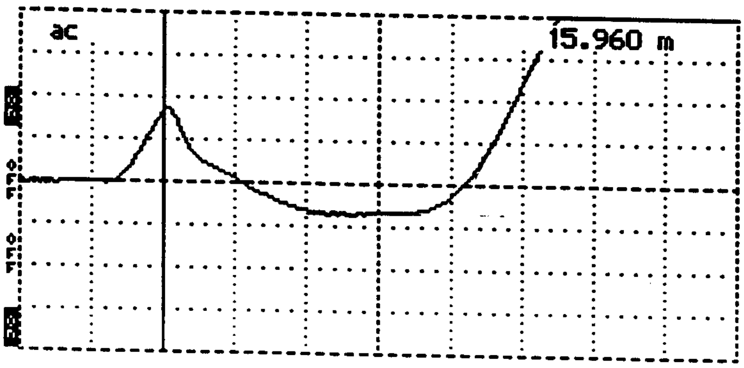


Tektronix 1502B TDR
Date Aug 04/95
Cable #03
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.960 m
nce/Div ..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

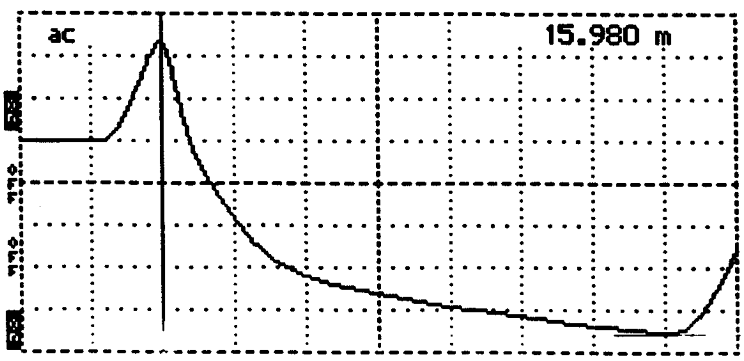


Tektronix 1502B TDR
Date Aug 04/95
Cable #03
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

sor .... 15.980 m
ance/Div ..... .25 m/div
tical Scale.... 74.8 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac



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

Input Trace
Stored Trace
Difference Trace

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

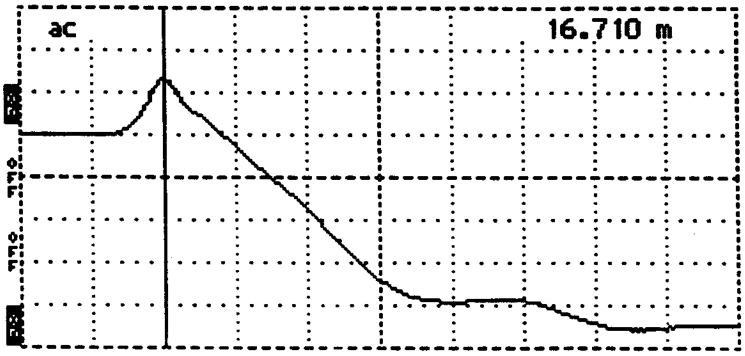
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Serial Number: 36804 **Date (dd/mm/yy):** 21/08/95

Probe Number 04

Trace 1 - Probe Shorted at Start

or .... 16.710 m
ance/Div ..... .25 m/div
ical Scale .... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

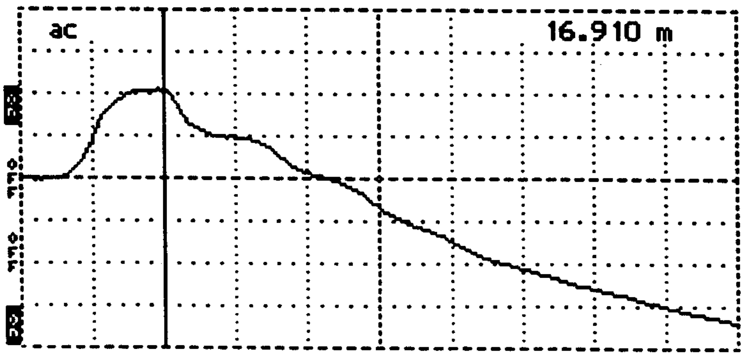


Tektronix 1502B TDR
Date Aug 04/95
Cable #04
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 16.910 m
ance/Div ..... .25 m/div
tical Scale .... 177 mρ/div
.... 0.99
se Filter ...... 1 avg
rer .... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #84
Notes short end

Input Trace
Stored Trace
Difference Trace

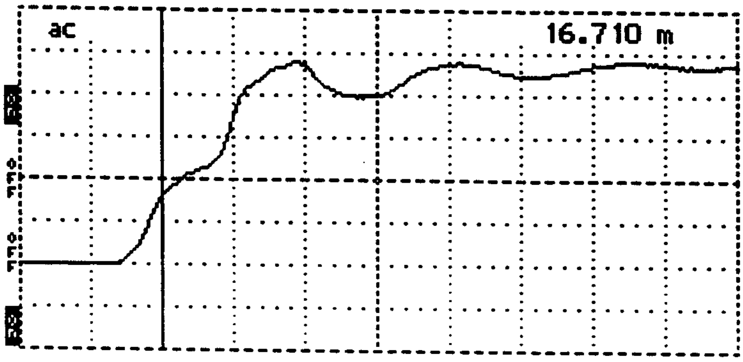
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [illegible]

Probe Number 04

Trace 3 - Probe in Air

or .... 16.710 m
ance/Div..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

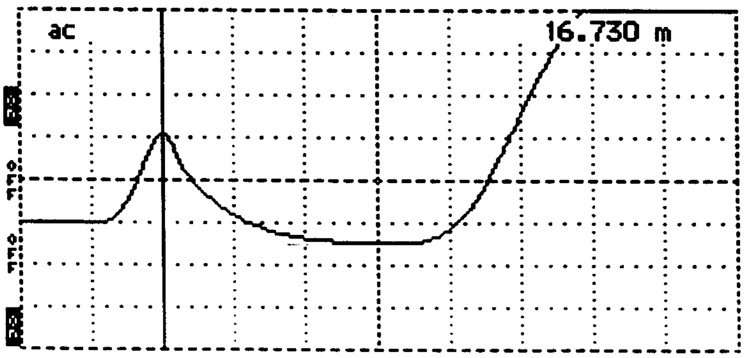


Tektronix 1502B TDR
Date Aug 04/95
Cable #04
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

r .... 16.730 m
nce/Div..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

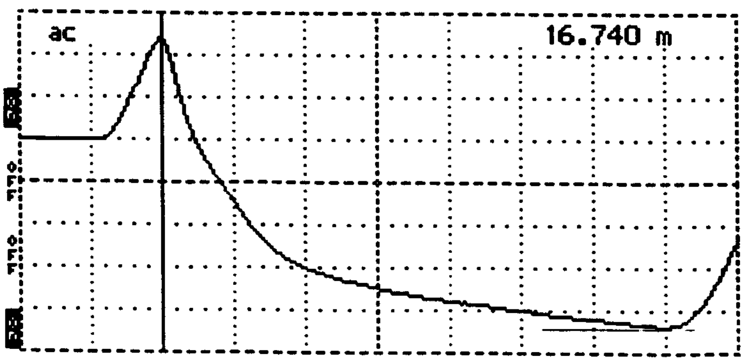


Tektronix 1502B TDR
Date Aug 04/95
Cable #04
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 16.740 m
nce/Div..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 04/95
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: [36] LTPP Section ID: [0801]

Probe Serial Number: 36805 **Date (dd/mm/yy):** 21/08/95

Probe Number 05

Trace 1 - Probe Shorted at Start

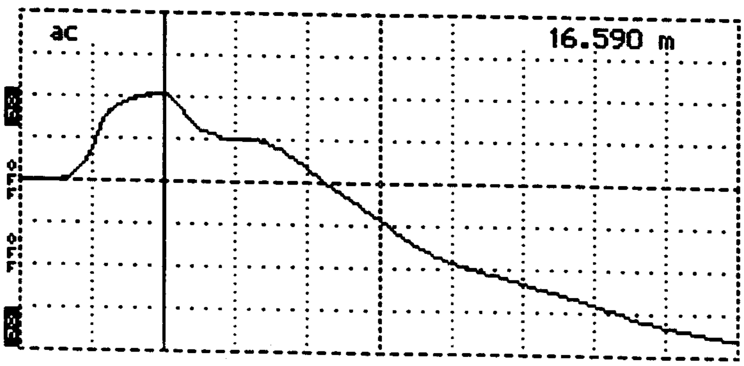
rsor .... 16.400 m
stance/Div ..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
ise Filter ...... 1 avg
wer .... ac

Tektronix 1502B TDR
Date Aug 04/95
Cable #05
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.590 m
nce/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #05
Notes short end

Input Trace
Stored Trace
Difference Trace

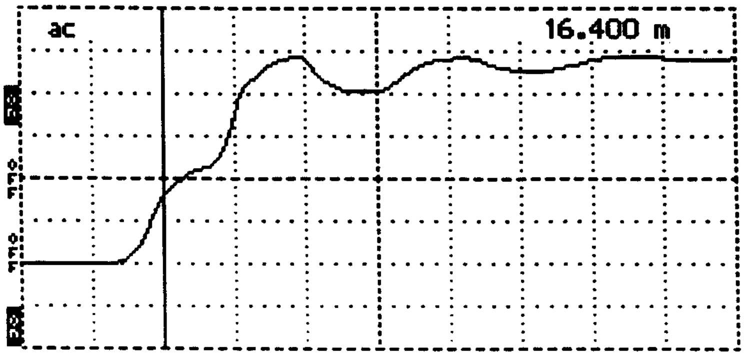
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Number 05

Trace 3 - Probe in Air

rsor .... 16.400 m
stance/Div..... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac

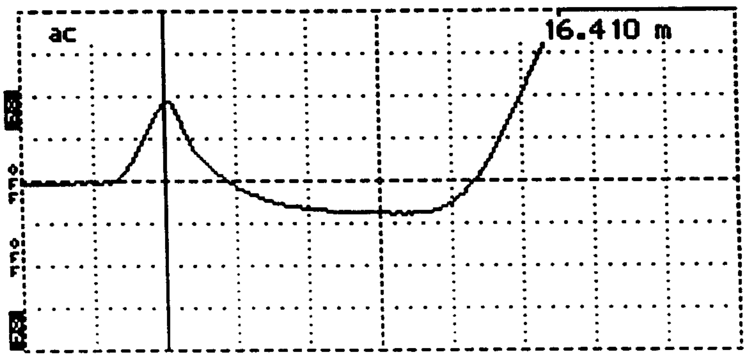


Tektronix 1502B TDR
Date Aug 04/95
Cable #05
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

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

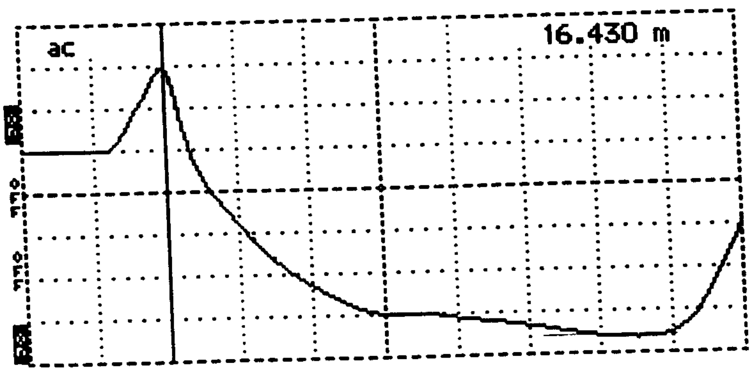


Tektronix 1502B TDR
Date Aug 04/95
Cable #05
Notes Alcohal

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 16.430 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 04/95
Cable #05
Notes Water

Input Trace
Stored Trace
Difference Trace

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

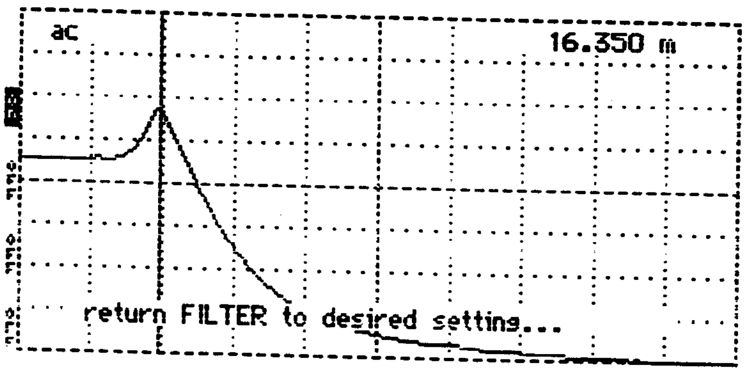
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Serial Number: 36B06 **Date (dd/mm/yy):** 21/08/95

Probe Number 06

Trace 1 - Probe Shorted at Start

sor .... 16.350 m
tance/Div..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
se Filter...... set Δ
ver........... ac

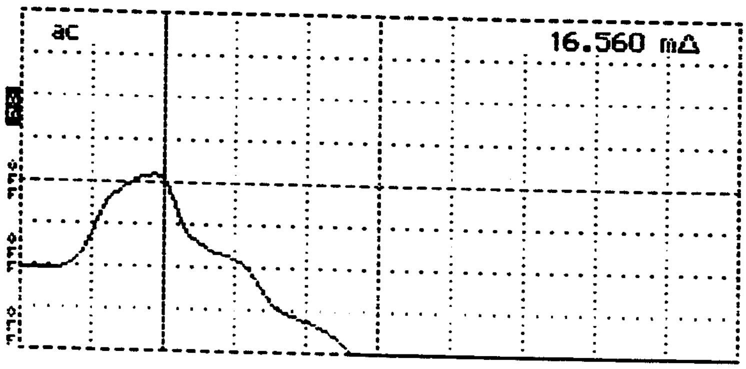


Tektronix 1502B TDR
Date Aug 21/95
Cable # 06
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

r .... 16.560 mΔ
nce/Div..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 21/95
Cable # 06
Notes short end

Input Trace
Stored Trace
Difference Trace

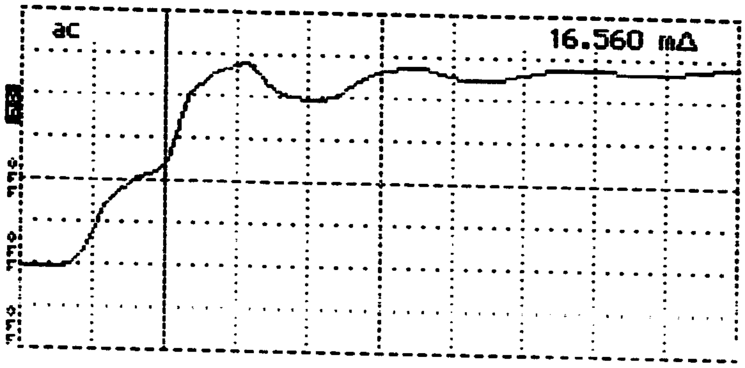
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0 8 2 1]

Probe Number 0 6

Trace 3 - Probe in Air

sor .... 16.560 mΔ
ance/Div..... .25 m/div
rical Scale.... 177 mρ/div
 .... 0.99
e Filter...... 1 avg
er........... ac

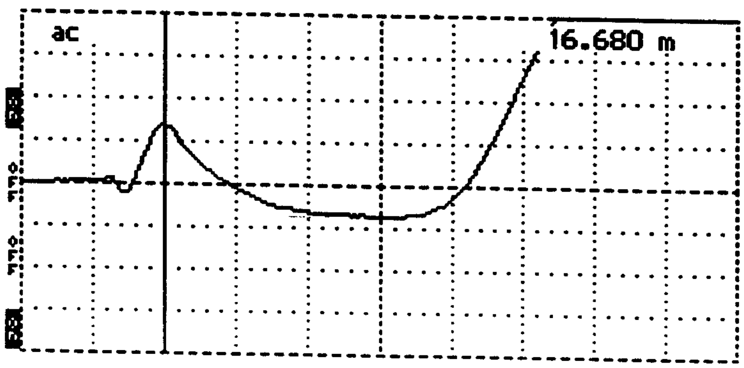


Tektronix 1502B TDR
Date Aug 21/95
Cable #06
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 16.680 m
nce/Div..... .25 m/div
cal Scale.... 100 mρ/div
 .... 0.99
 Filter...... 1 avg
r........... ac

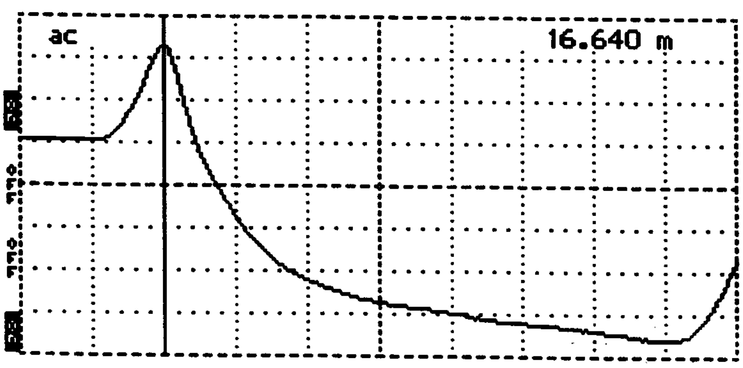


Tektronix 1502B TDR
Date Aug 4/95
Cable #06
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 16.640 m
nce/Div..... .25 m/div
cal Scale.... 74.8 mρ/div
 .... 0.99
 Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #06
Notes Water

Input Trace
Stored Trace
Difference Trace

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

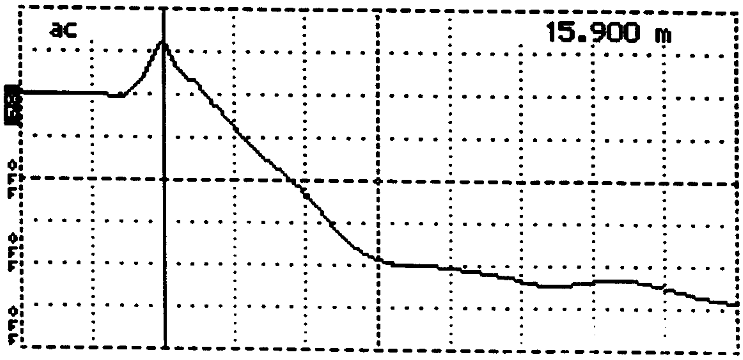
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [0801]

Probe Serial Number: 36B07 **Date (dd/mm/yy):** 21/08/95

Probe Number 07

Trace 1 - Probe Shorted at Start

sor .... 15.900 m
ance/Div..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
se Filter...... 1 avg
er........... ac

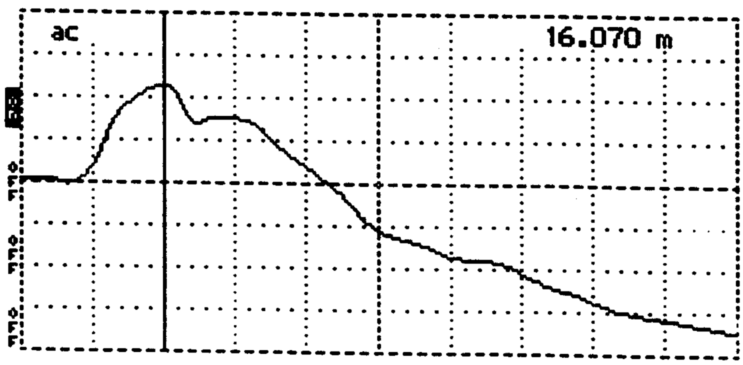


Tektronix 1502B TDR
Date Aug 04/95
Cable #07
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.070 m
ance/Div..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #07
Notes short end

Input Trace
Stored Trace
Difference Trace

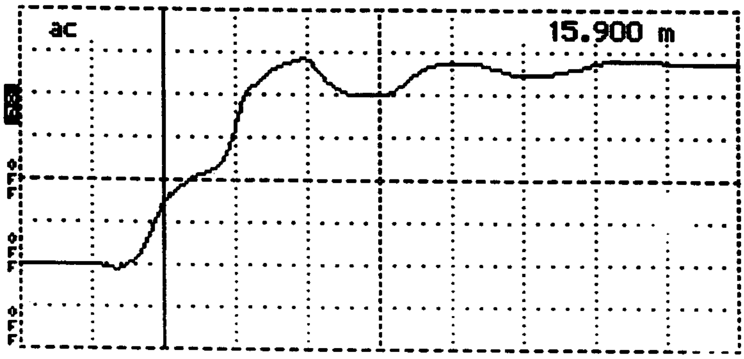
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Number 07

Trace 3 - Probe in Air

sor .... 15.900 m
ance/Div ..... .25 m/div
tical Scale.... 177 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

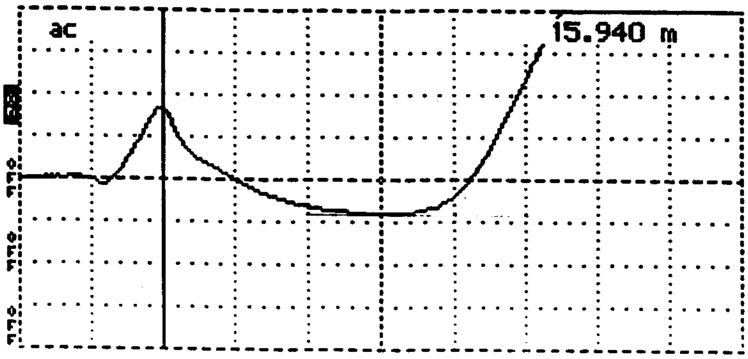


Tektronix 1502B TDR
Date Aug 04/95
Cable #07
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

sor .... 15.940 m
ance/Div ..... .25 m/div
tical Scale.... 100 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

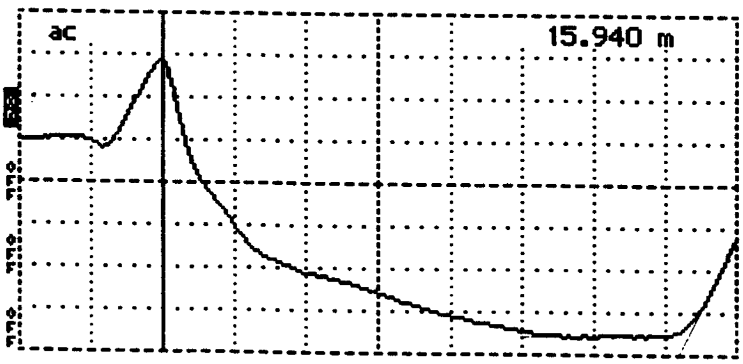


Tektronix 1502B TDR
Date Aug 04/95
Cable #07
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

sor .... 15.940 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 04/95
Cable #07
Notes Water

Input Trace
Stored Trace
Difference Trace

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

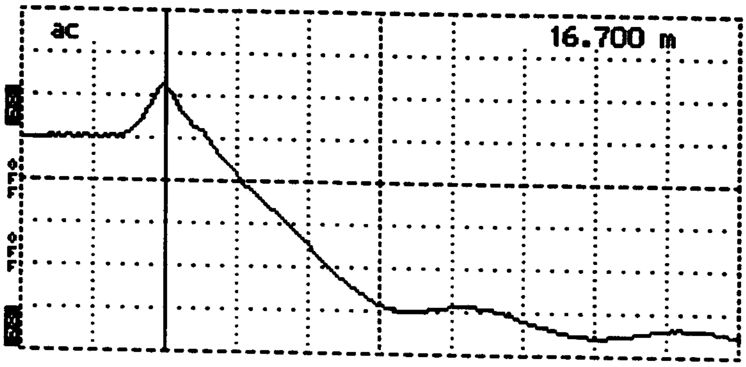
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Serial Number: 36B08 **Date (dd/mm/yy):** 21/08/95

Probe Number 08

Trace 1 - Probe Shorted at Start

rsor .... 16.700 m
tance/Div...... .25 m/div
rtical Scale.... 177 mρ/div
.... 0.99
se Filter....... 1 avg
wer............ ac

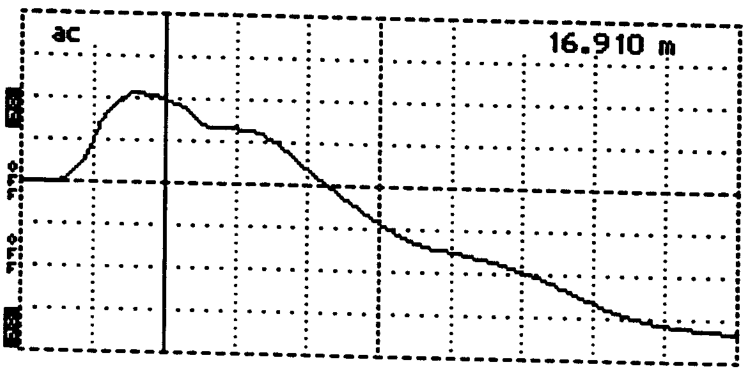


Tektronix 1502B TDR
Date Aug 04/95
Cable #08
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.910 m
nce/Div...... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter....... 1 avg
er............ ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #08
Notes short end

Input Trace
Stored Trace
Difference Trace

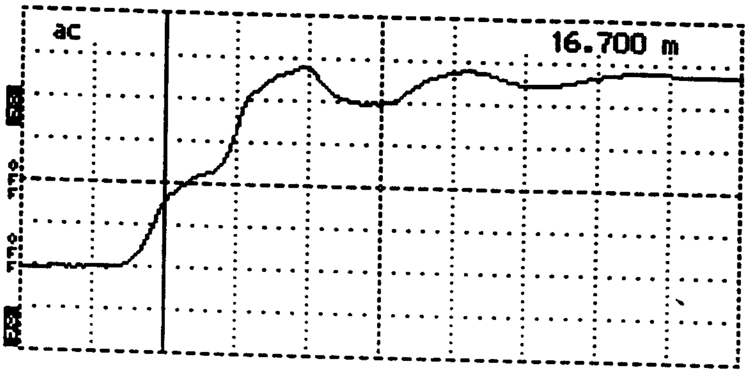
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Number 08

Trace 3 - Probe in Air

sor .... 16.700 m
ance/Div..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er............ ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #08
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

sor .... 16.730 m
ance/Div..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter...... 1 avg
er............ ac

Tektronix 1502B TDR
Date Aug 04/95
Cable #08
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 16.740 m
ce/Div..... .25 m/div
al Scale.... 74.8 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

Tektronix 1502B TDR
Date Aug 04/95
Cable #08
Notes Water

Input Trace
Stored Trace
Difference Trace

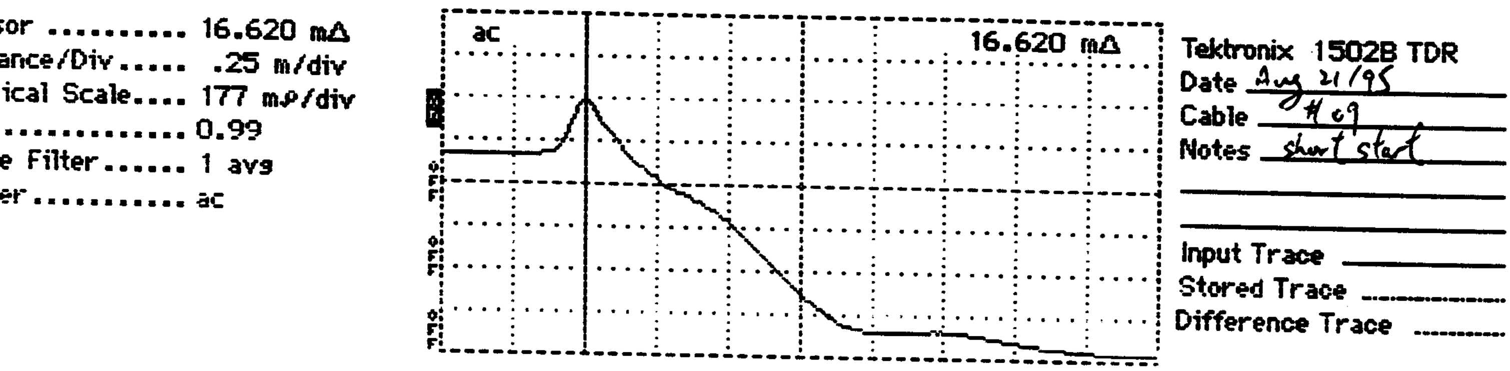
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [08 01]

Probe Serial Number: 36B09 **Date (dd/mm/yy):** 21/08/95

Probe Number 09

Trace 1 - Probe Shorted at Start



Trace 2 - Probe Shorted at End

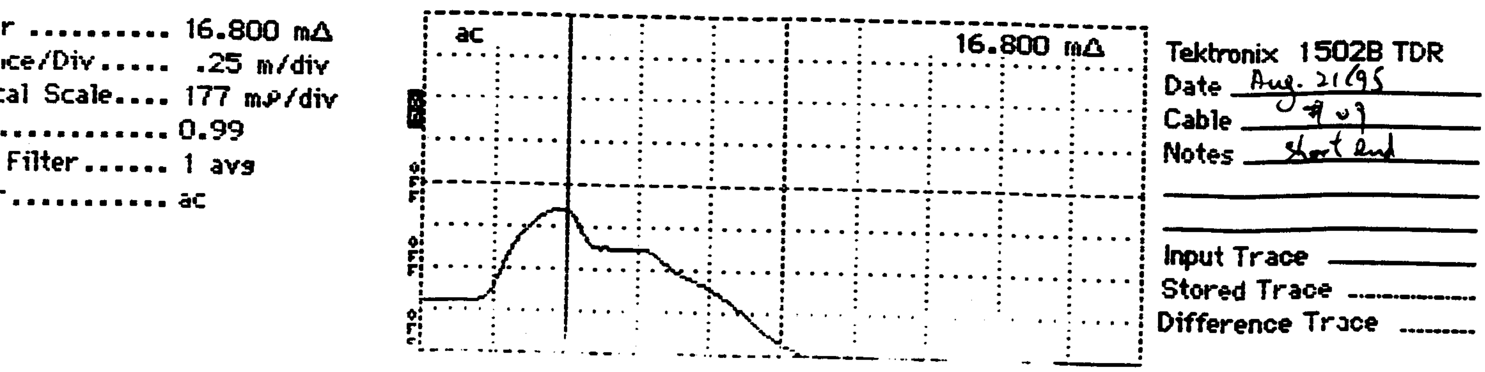


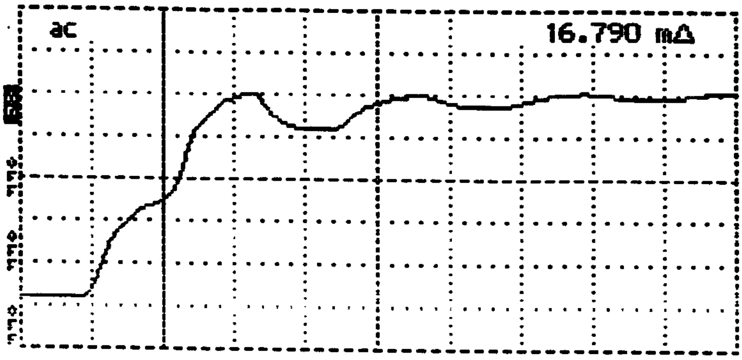
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0301]

Probe Number 09

Trace 3 - Probe in Air

or .... 16.790 mΔ
nce/Div..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
er........... ac

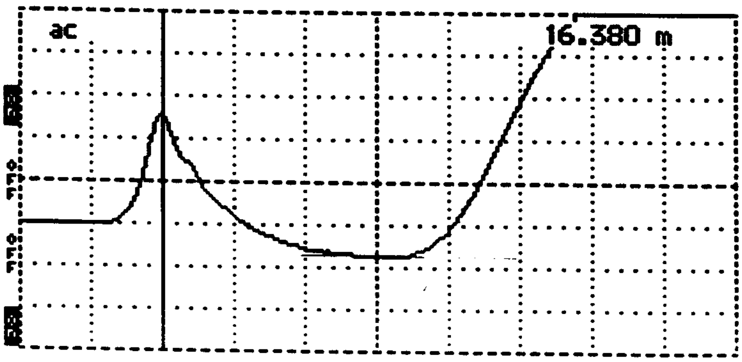


Tektronix 1502B TDR
Date Aug 21/95
Cable #09
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 16.380 m
nce/Div..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

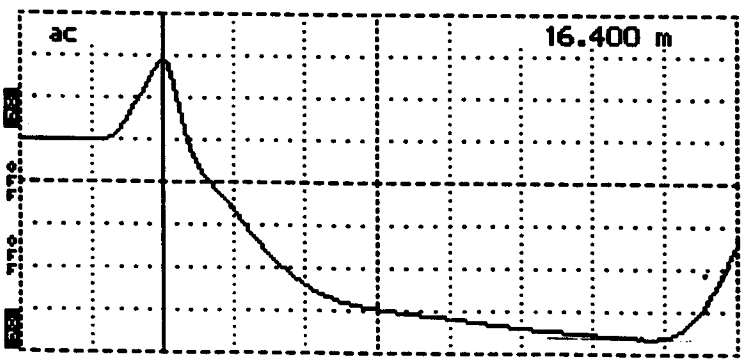


Tektronix 1502B TDR
Date Aug 04/95
Cable #09
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

sor .... 16.400 m
ance/Div..... .25 m/div
tical Scale.... 74.8 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #09
Notes Water

Input Trace
Stored Trace
Difference Trace

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

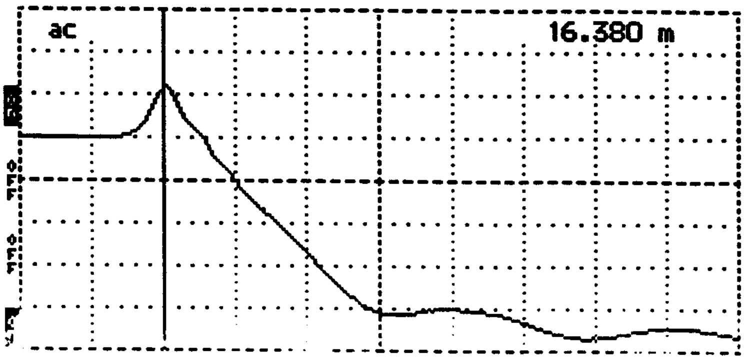
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[36] [0801]

Probe Serial Number: 36810 **Date (dd/mm/yy):** 21/08/95

Probe Number 10

Trace 1 - Probe Shorted at Start

sor .... 16.380 m
ance/Div ..... .25 m/div
ical Scale.... 177 mρ/div
.... 0.99
e Filter...... 1 avg
er .... ac

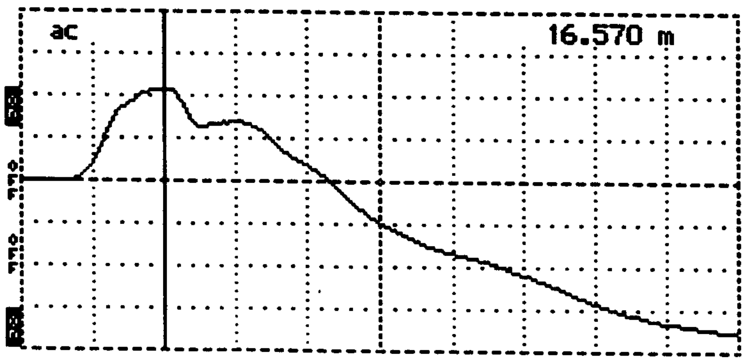


Tektronix 1502B TDR
Date Aug 04/95
Cable #10
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 16.570 m
nce/Div ..... .25 m/div
cal Scale.... 177 mρ/div
.... 0.99
Filter...... 1 avg
r .... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #10
Notes short end

Input Trace
Stored Trace
Difference Trace

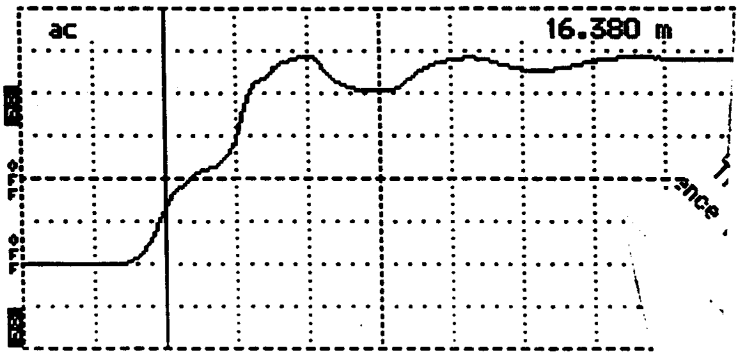
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [36] LTPP Section ID: [0801]

Probe Number 10

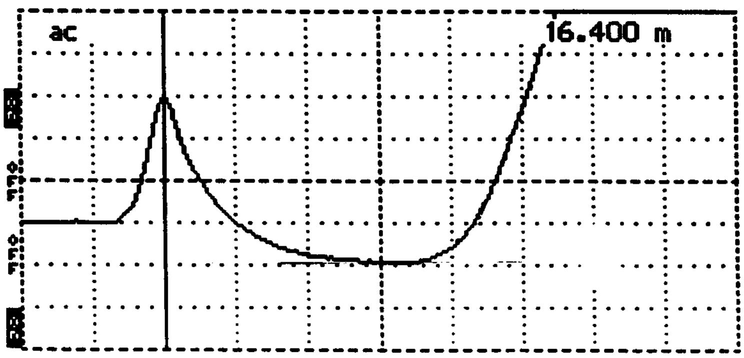
Trace 3 - Probe in Air

r .... 16.380 m
ce/Div ..... .25 m/div
al Scale.... 177 mρ/div
.... 0.99
Filter ...... 1 avg
r........... ac



Trace 4 - Probe in Alcohol

r .... 16.400 m
ce/Div ..... .25 m/div
al Scale.... 74.8 mρ/div
.... 0.99
Filter ...... 1 avg
r........... ac

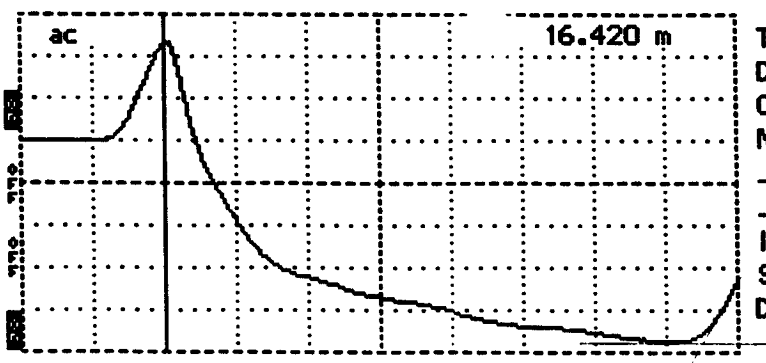


Tektronix 1502B TDR
Date Aug 04/95
Cable #10
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 16.420 m
ce/Div ..... .25 m/div
al Scale.... 74.8 mρ/div
.... 0.99
Filter ...... 1 avg
r........... ac



Tektronix 1502B TDR
Date Aug 04/95
Cable #10
Notes Water

Input Trace
Stored Trace
Difference Trace

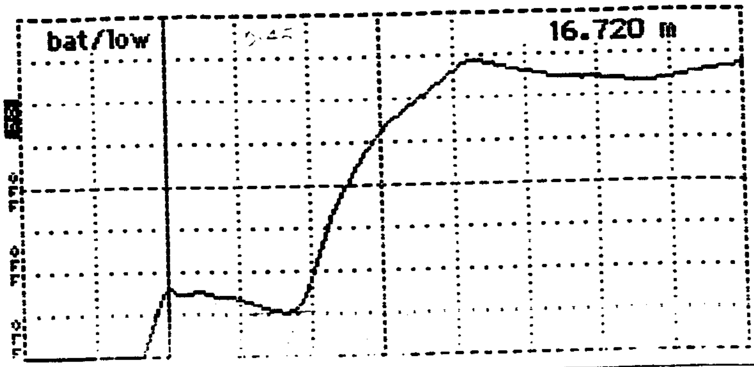
Figure B-1(cont.). TDR Traces Obtained During Calibration

APPENDIX C

Supporting Instrumentation Installation Information

Appendix C contains the following supporting information:

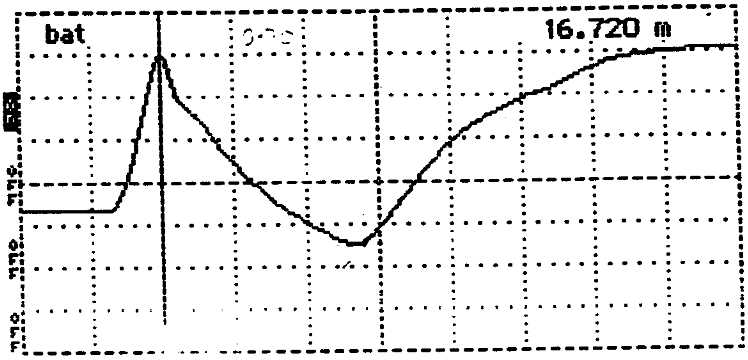
sor .... 16.720 m
tance/Div ..... .25 m/div
rtical Scale.... 96.9 mρ/div
.... 0.99
se Filter ...... 1 avg
wer .... bat/low



Tektronix 1502B TDR
Date Aug 22/95
Cable #01
Notes 360801 (Inst.

Input Trace
Stored Trace
Difference Trace

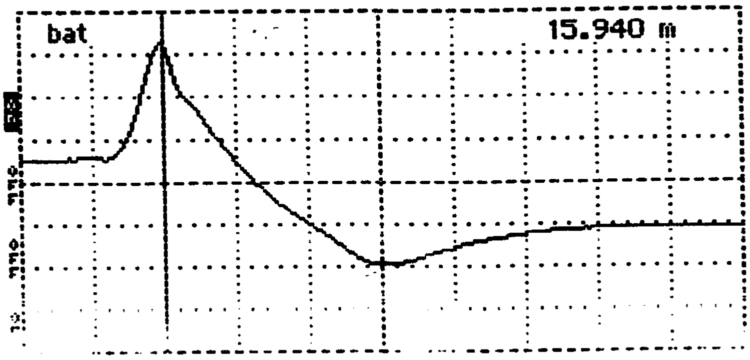
ursor .... 16.720 m
stance/Div ..... .25 m/div
ertical Scale.... 57.7 mρ/div
P 0.99
oise Filter ...... 1 avg
ower .... bat/low



Tektronix 1502B TDR
Date Aug 22/95
Cable #02
Notes 360801 (Inst

Input Trace
Stored Trace
Difference Trace

ursor .... 15.940 m
istance/Div ..... .25 m/div
ertical Scale.... 74.8 mρ/div
P 0.99
loise Filter ...... 1 avg
ower .... bat/low



Tektronix 1502B TDR
Date Aug 22/95
Cable #03
Notes 360801 (Inst

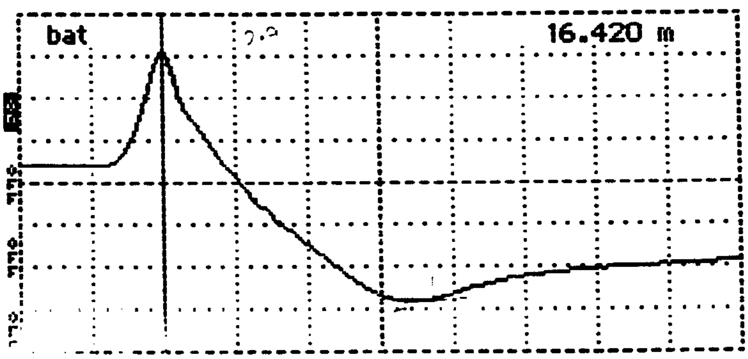
Input Trace
Stored Trace
Difference Trace

Cursor .... 16.730 m
Distance/Div ..... .25 m/div
Vertical Scale.... 74.8 mρ/div
'P 0.99
Noise Filter ...... 1 avg
Power .... bat/low

Tektronix 1502B TDR
Date Aug 22/95
Cable #04
Notes 360801 (Inst

Input Trace
Stored Trace
Difference Trace

Cursor .... 16.420 m
Distance/Div ..... .25 m/div
Vertical Scale.... 74.8 mρ/div
/P 0.99
Noise Filter ...... 1 avg
Power .... bat/low

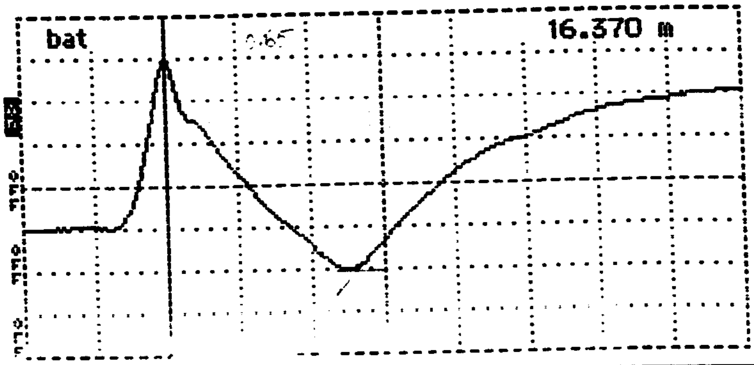


Tektronix 1502B TDR
Date Aug 22/95
Cable #05
Notes 360801 (Inst.

Input Trace
Stored Trace
Difference Trace

Figure C-1. TDR Traces Measured Manually During Installation

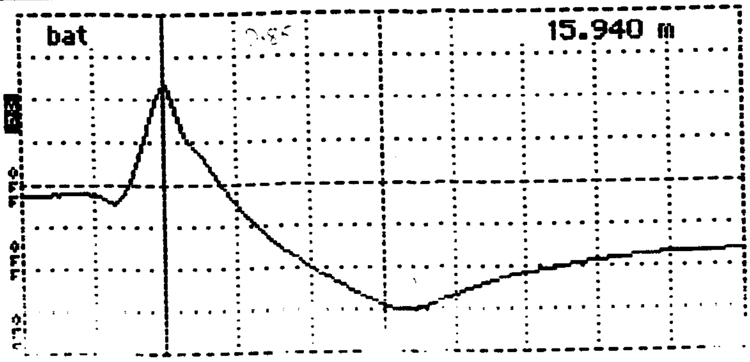
rsor .... 16.370 m
tance/Div ..... .25 m/div
rtical Scale.... 53.0 mρ/div
.... 0.99
ise Filter ...... 1 avg
wer .... bat/low



Tektronix 1502B TDR
Date Aug 22/95
Cable #06
Notes 360801 (Inst.)

Input Trace
Stored Trace
Difference Trace

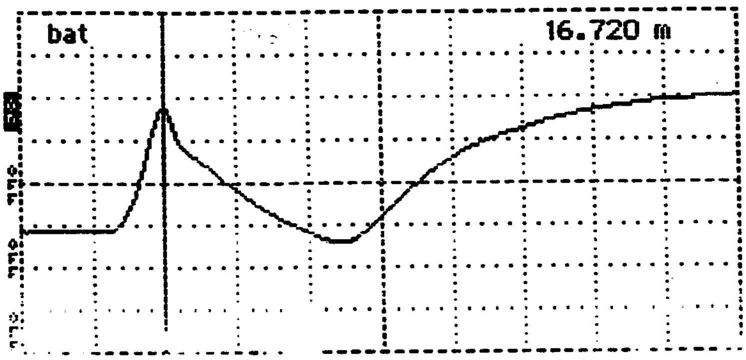
ursor .... 15.940 m
stance/Div ..... .25 m/div
ertical Scale.... 74.8 mρ/div
P 0.99
oise Filter ...... 1 avg
ower .... bat/low



Tektronix 1502B TDR
Date Aug 22/95
Cable #07
Notes 360801 (Inst.)

Input Trace
Stored Trace
Difference Trace

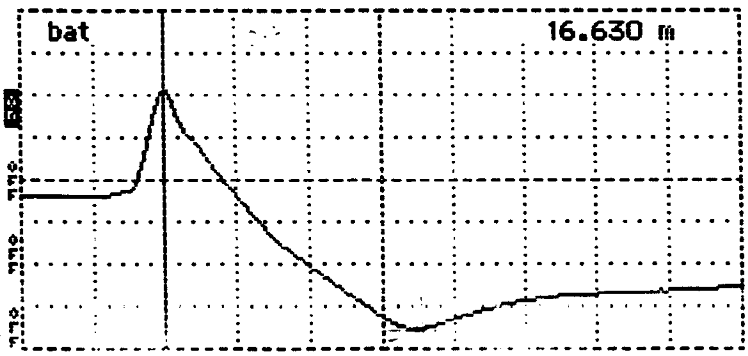
ursor .... 16.720 m
istance/Div ..... .25 m/div
ertical Scale.... 74.8 mρ/div
P 0.99
oise Filter ...... 1 avg
ower .... bat



Tektronix 1502B TDR
Date Aug 22/95
Cable #08
Notes 360801 (Inst.)

Input Trace
Stored Trace
Difference Trace

ursor .... 16.630 m
istance/Div ..... .25 m/div
ertical Scale.... 74.8 mρ/div
P 0.99
oise Filter ...... 1 avg
ower .... bat



Tektronix 1502B TDR
Date Aug 22/95
Cable #09
Notes 360801 (Inst.)

Input Trace
Stored Trace
Difference Trace

Cursor .... 16.420 m
Distance/Div ..... .25 m/div
Vertical Scale.... 79.2 mρ/div
/P 0.99
Noise Filter ...... 1 avg
Power .... bat

Tektronix 1502B TDR
Date Aug 22/95
Cable #10
Notes 360801 (Inst.

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 (%)
36B01	0.24	0.45	5.01	8.05	1920	4.2
36B02	0.39	0.70	12.13	22.91	1920	11.9
36B03	0.54	0.80	15.84	29.02	1920	15.1
36B04	0.70	1.00	24.75	40.05	2045	19.6
36B05	0.84	0.90	20.05	34.80	2045	17.0
36B06	1.00	0.65	10.46	19.82	2045	9.7
36B07	1.13	0.85	17.88	31.97	2045	15.6
36B08	1.30	0.65	10.46	19.82	2045	9.7
36B09	1.61	0.90	20.05	34.80	2045	17.0
36B10	1.92	1.00	24.75	40.05	2045	19.6

Table C-2. Field Measured Moisture Content

LTPP Seasonal Monitoring Study	State Code	[36]
In-Situ Moisture Tests	Test Section Number	[0801]

Weight (gm)	Probe 1*	Probe 2	Probe 3	Probe 4	Probe 5
Weight of Pan + Wet Soil		210	270	315	270
Weight of Pan + Dry Soil		205	255	290	255
Weight of Pan		120	120	120	120
Weight of Dry Soil		85	135	170	135
Weight of Wet Soil		125	150	195	150
Weight of Moisture		5	15	25	15
Wt of Moisture/Dry Wt x 100		5.8	11.1	14.7	11.1

Weight (gm)	Probe 6	Probe 7	Probe 8	Probe 9	Probe 10
Weight of Pan + Wet Soil	200	220	340	245	270
Weight of Pan + Dry Soil	195	215	325	235	245
Weight of Pan	120	120	120	120	120
Weight of Dry Soil	75	95	205	115	125
Weight of Wet Soil	80	100	220	125	150
Weight of Moisture	5	5	15	10	25
Wt of Moisture/Dry Wt x 100	6.7	5.5	7.3	8.7	20.0

Prepared by:	GC	Employer:	PMSL
Date (dd/mm/yy):	22/08/95		

* Note: Probe #1 was placed in Crushed Stone.

Table C-3. Field Measured Dry Density

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [36] LTPP Section ID [0801]

Depth of Representative Sample (from pavement surface): 0.55 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	2035 g	(4.50 lb)
b.	Weight of Mold and Compacted Soil:	4045 g	(8.93 lb)
c.	Weight of Compacted Soil (b-a):	2010 g	(4.43 lb)
d.	Unit Weight of Compacted Soil = (c/943.0) =		2.13 g/cm^3
	= [c/(1/30)] =		(132.9 lb/ft^3)
e.	Dry Density of Compacted Soil = [d/(1+r/100)] =		1.92 g/cm^3
			(119.6 lb/ft^3)

Moisture Content Determination:

m.	Tare Weight of Pan:	120.0 g
n.	Weight of Pan and Moisture Sample:	270.0 g
o.	Weight of Pan and Dry Sample:	255.0 g
p.	Weight of Moisture (n -o):	15.0 g
q.	Weight of Dry Sample (o - m):	135.0 g
r.	Moisture Content by Weight = [(p/q)*100] =	11.1 %

Prepared by:	DS	Employer:	PMSL
Date (dd/mm/yy):	22/08/95		

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [36] LTPP Section ID [0801]

Depth of Representative Sample (from pavement surface): 1.15 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	2040 g	(4.50 lb)
b.	Weight of Mold and Compacted Soil:	4090 g	(9.02 lb)
c.	Weight of Compacted Soil (b-a):	2050 g	(4.52 lb)
d.	Unit Weight of Compacted Soil = (c/943.0) =		2.17 g/cm^3
	= [c/(1/30)] =		(135.6 lb/ft^3)
e.	Dry Density of Compacted Soil = [d/(1+r/100)] =		2.04 g/cm^3
			(127.6 lb/ft^3)

Moisture Content Determination:

m.	Tare Weight of Pan:	120.0 g
n.	Weight of Pan and Moisture Sample:	220.0 g
o.	Weight of Pan and Dry Sample:	195.0 g
p.	Weight of Moisture (n -o):	5.0 g
q.	Weight of Dry Sample (o - m):	75.0 g
r.	Moisture Content by Weight = [(p/q)*100] =	6.3 %

Prepared by:	DS	Employer:	PMSL
Date (dd/mm/yy):	22/08/95		

Sample#	Depth	Tare Wt & #	Wet Weight	Dry Weight	% Moisture
1		A1 37.1	95.6	94.6	2%
2		A2 34.1	129.1	122.4	8
3		A4 31.4	165.5	153.2	10
4		A5 29.8	120.4	110.8	12
5		A13 31.3	132.1	124.2	9
6		A14 33.7	105.4	99.3	9
7		A15 32.8	114.8	107.3	10
8		~~A17 32.3~~	~~110.6~~	~~101.8~~	13
9		A19 33.8	115.3	104.6	15
10		A20 31.3	134.8	117.7	20

TOTAL P.02

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, September 27, 1995

5,1995,270,100,12.27,11.11,0
6,1995,270,100,14.62,15.79,16.98,18.3,18.75
5,1995,270,200,12.26,12.72,0
6,1995,270,200,14.79,15.59,16.59,17.93,18.5
5,1995,270,300,12.27,13.35,0
6,1995,270,300,14.82,15.61,16.44,17.64,18.26
5,1995,270,400,12.26,12.99,0
6,1995,270,400,14.31,15.26,16.21,17.42,18.06
5,1995,270,500,12.26,12.05,0
6,1995,270,500,13.77,14.82,15.87,17.2,17.89
5,1995,270,600,12.26,10.59,0
6,1995,270,600,13.43,14.46,15.53,16.96,17.7
5,1995,270,700,12.26,10.33,0
6,1995,270,700,13.1,14.11,15.22,16.71,17.5
5,1995,270,800,12.26,11.02,0
6,1995,270,800,13.47,14.17,15.04,16.47,17.31
5,1995,270,900,12.26,13.7,0
6,1995,270,900,13.95,14.4,15.06,16.3,17.14
5,1995,270,1000,12.27,16.51,0
6,1995,270,1000,17.06,15.83,15.48,16.22,16.99
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6,1995,270,1100,21.78,19.08,17.11,16.4,16.94
5,1995,270,1200,12.28,18.93,0
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5,1995,270,1300,12.28,19.24,0
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6,1995,270,1400,32.18,27.94,23.72,19.29,18.18
5,1995,270,1500,12.29,20.55,0
6,1995,270,1500,33.38,29.64,25.54,20.58,18.98
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5,1995,270,1700,12.29,21.84,0
6,1995,270,1700,31.44,29.65,27.09,22.74,20.64
5,1995,270,1800,12.29,21.7,0
6,1995,270,1800,28.96,28.31,26.82,23.35,21.32
5,1995,270,1900,12.29,19.62,0
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6,1995,270,2000,22.83,24.02,24.63,23.5,22.07
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5,1995,270,2200,12.27,14.99,0
6,1995,270,2200,19.59,20.98,22.16,22.55,21.97
5,1995,270,2300,12.27,15.47,0
6,1995,270,2300,18.45,19.87,21.18,21.98,21.72
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2,1995,270,2400,21.03,20.62,20.15,19.44,19.16,18.94,18.8,18.81,18.95,19.21,19.54,19.76,20,20.13,20.15,20.18,20.0
7,19.92
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2,19.14,1931,19.46,2221,19.67,2153,19.88,2343,20.01,2251,20.04,2242,20.06,2328,19.97,2120,19.84,2103
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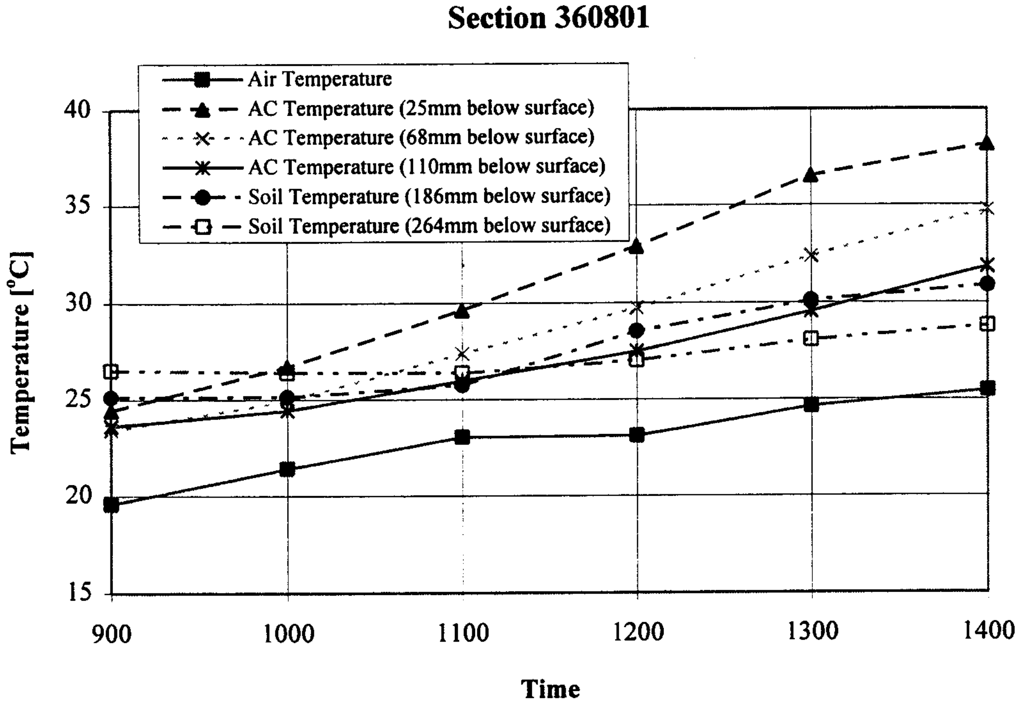


Figure D-1. Air Temperature and First Five Sub-Surface Temperatures From Initial Data Collection, August 23, 1995

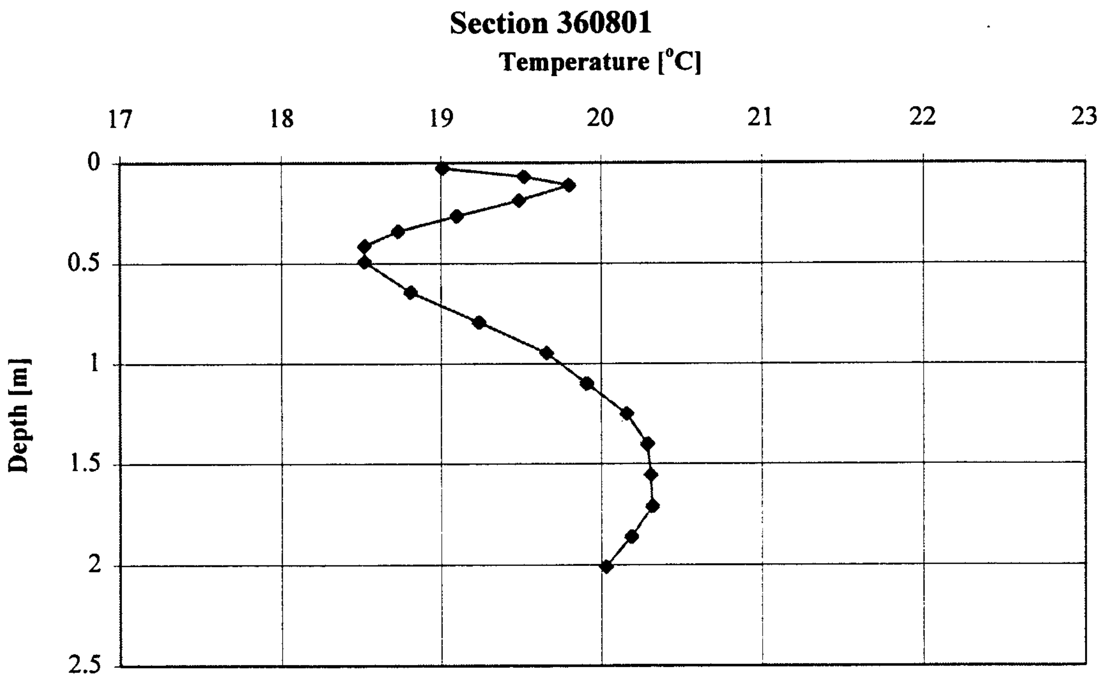


Figure D-2. Average Subsurface Temperature for all 18 Sensors From Initial Data Collection, September 26, 1995

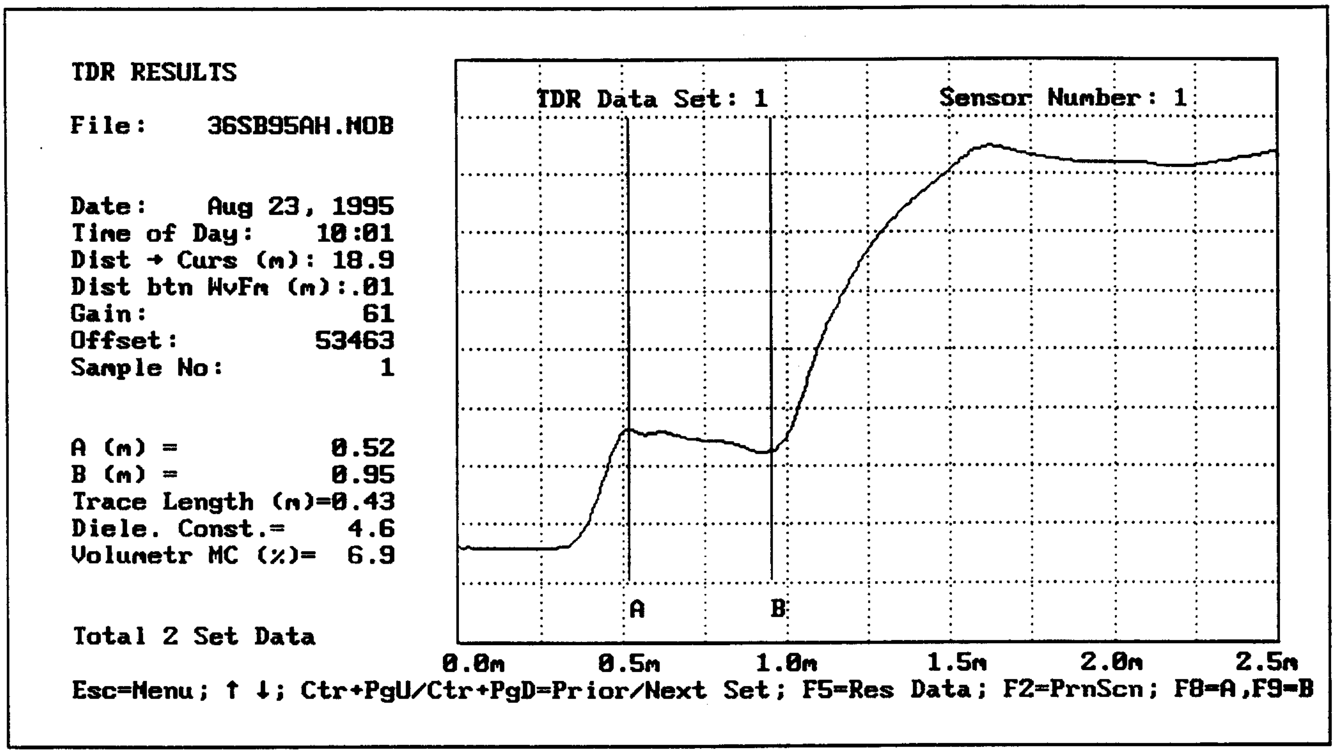


Figure D-3. Initial First Set of TDR Traces Measured with the Mobile Unit

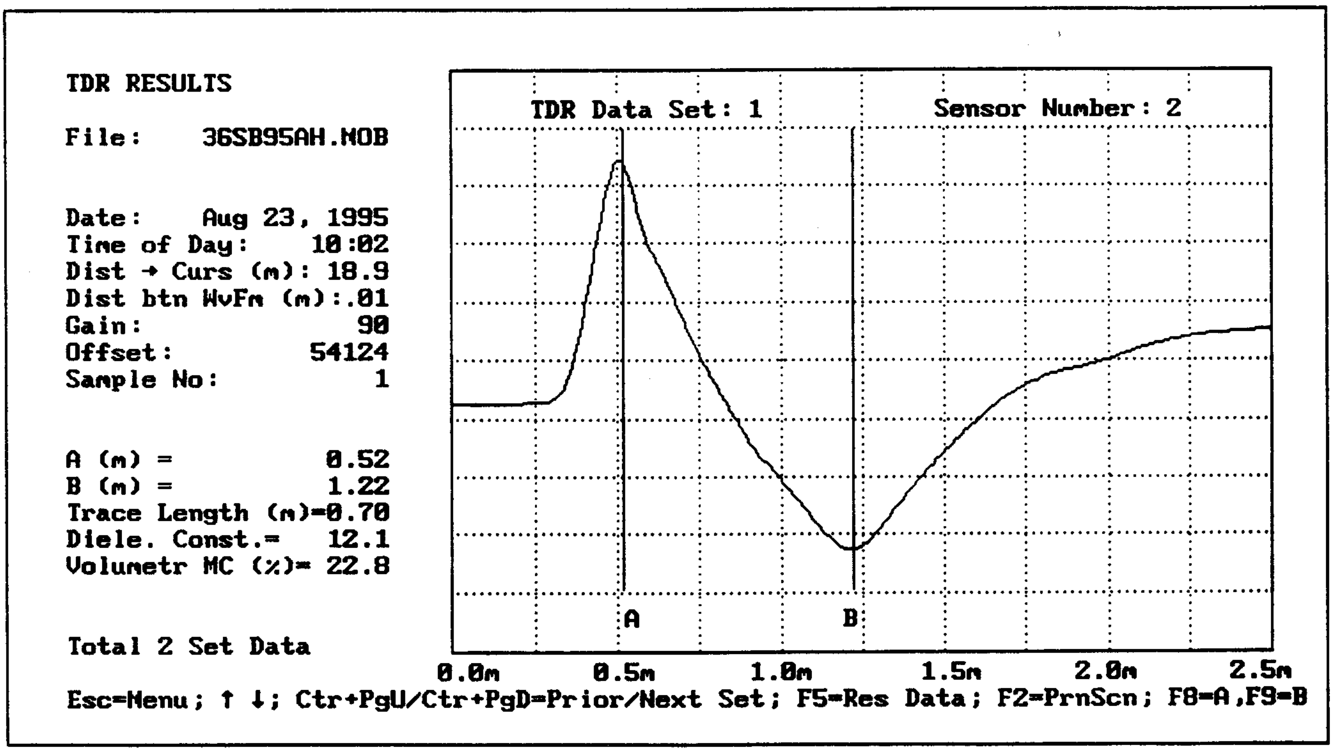


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

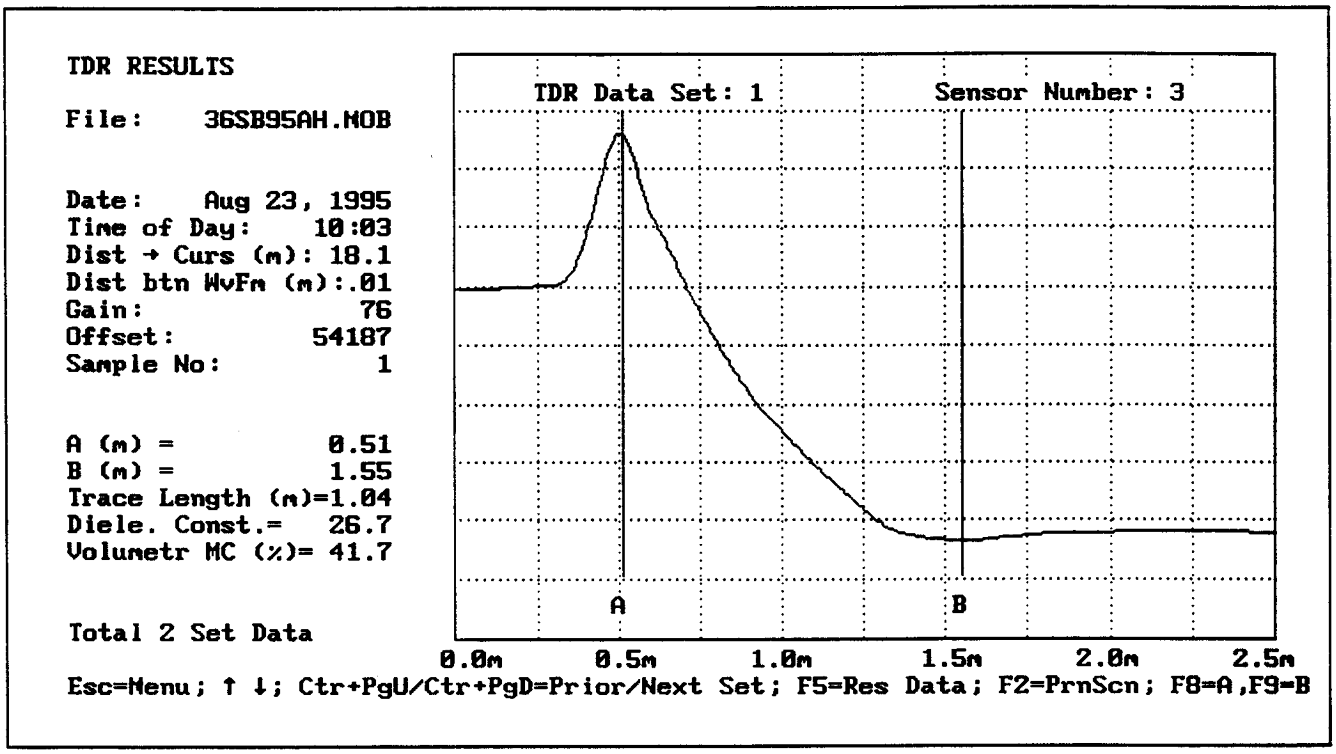


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

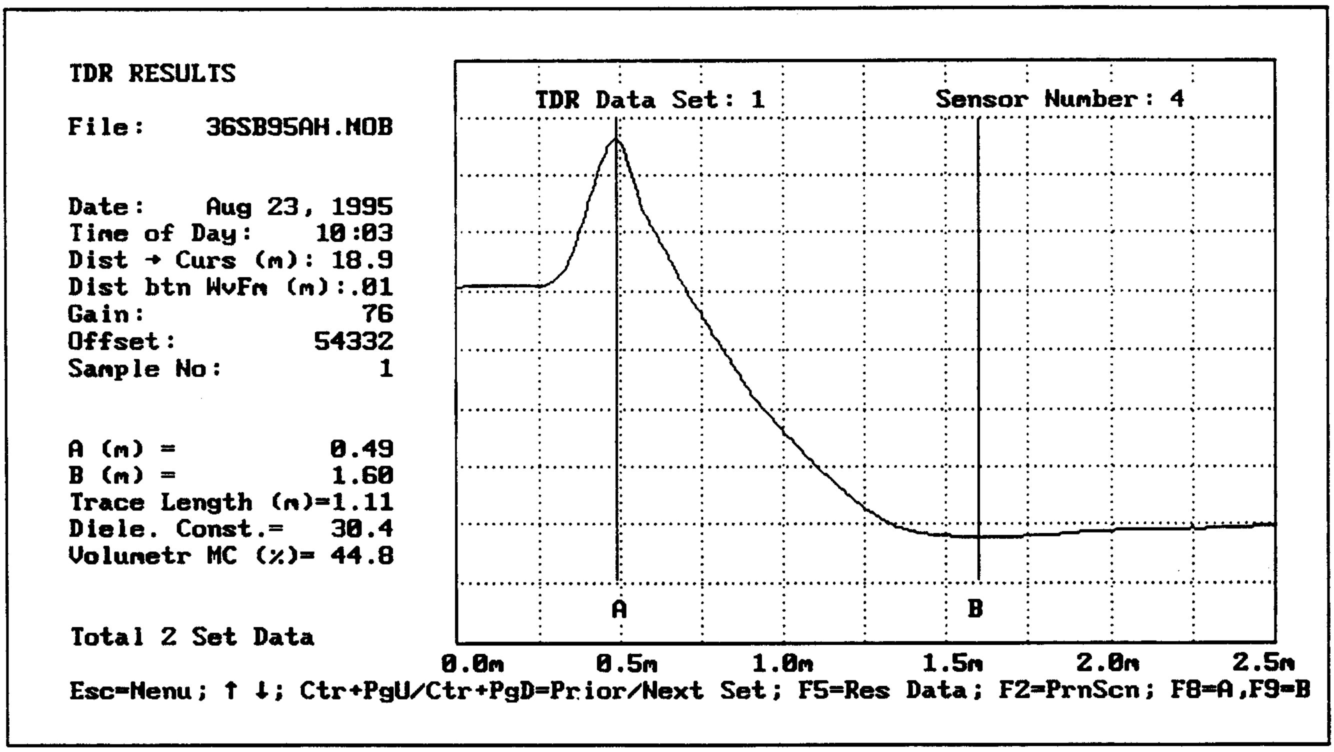


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

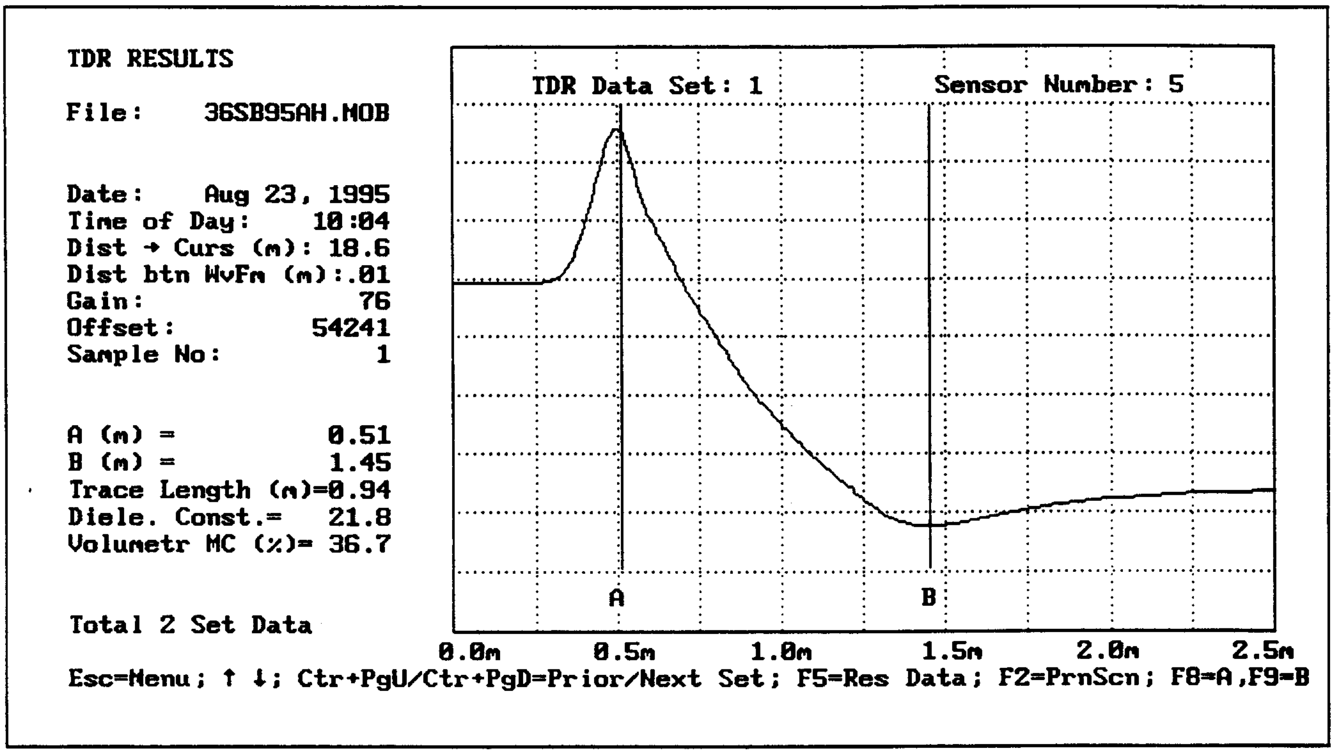


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

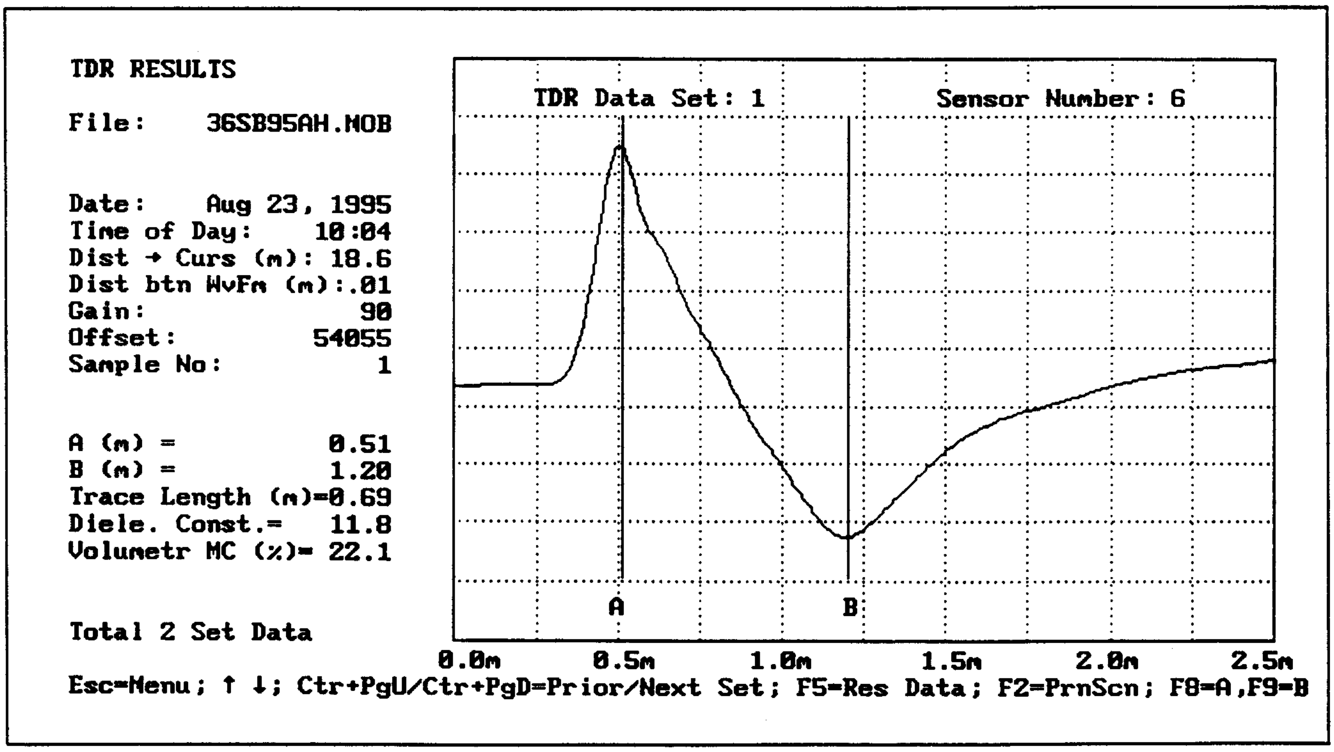


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

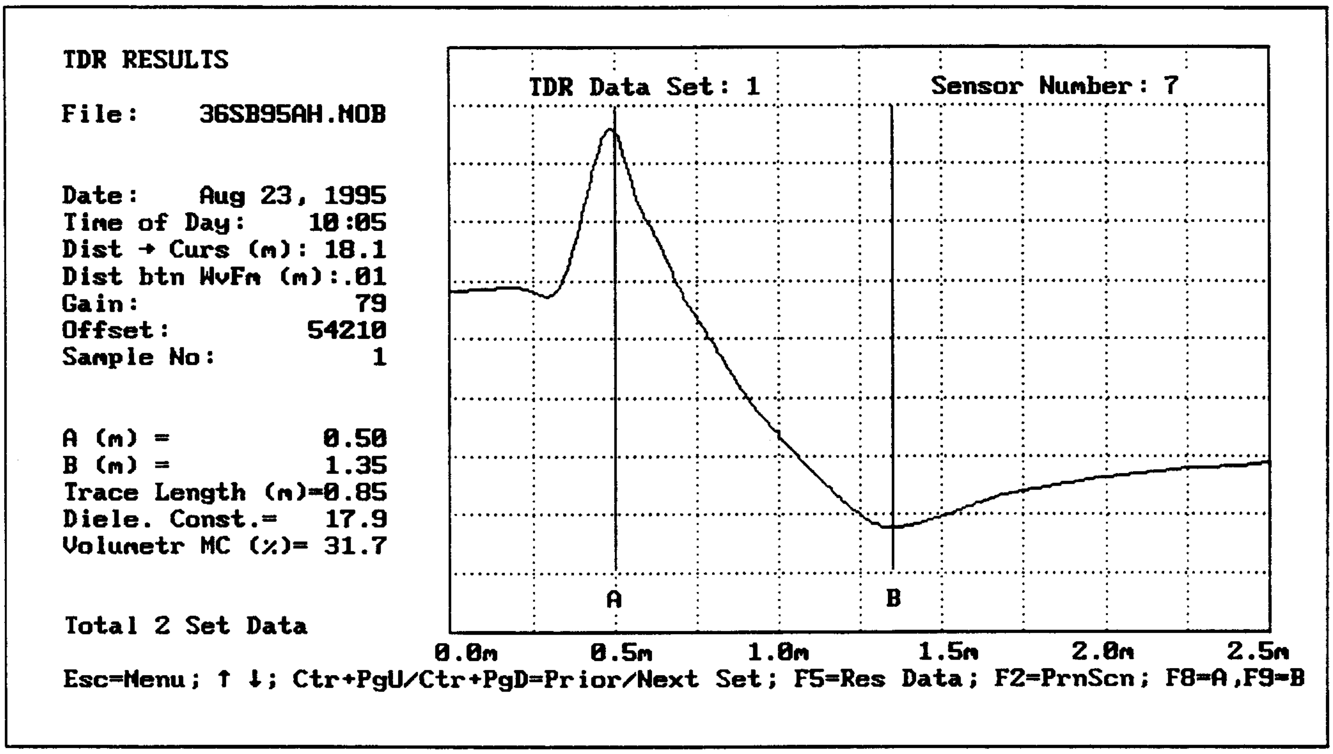


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

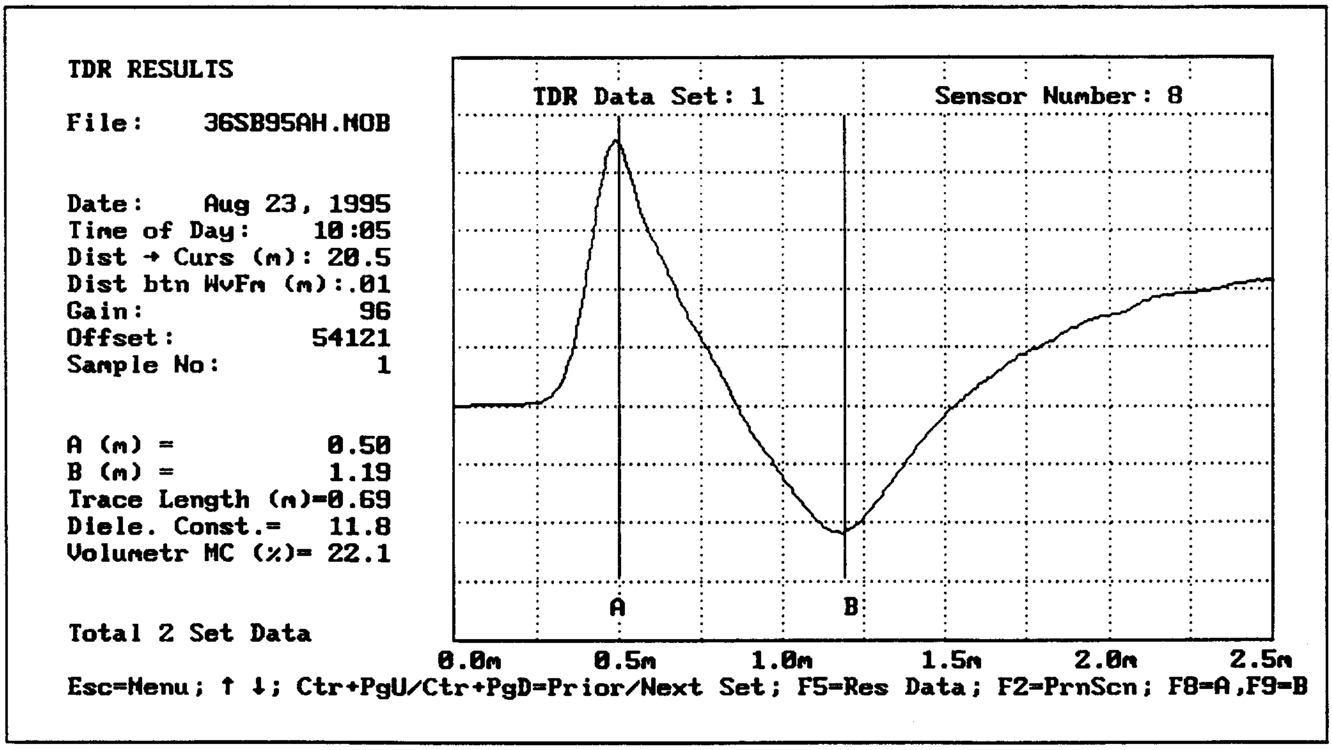


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

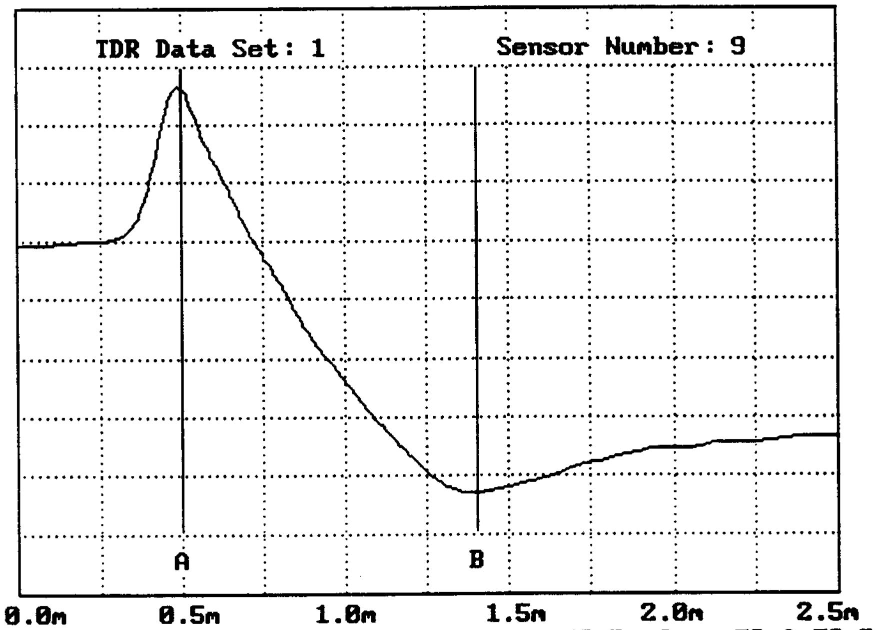
TDR RESULTS

File: 36SB95AH.MOB

Date: Aug 23, 1995
Time of Day: 10:06
Dist → Curs (m): 20.4
Dist btn WvFm (m):.01
Gain: 83
Offset: 54226
Sample No: 1

A (m) = 0.50
B (m) = 1.40
Trace Length (m)=0.90
Diele. Const.= 20.0
Volumetr MC (%)= 34.6

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 First Set of TDR Traces Measured with the Mobile Unit

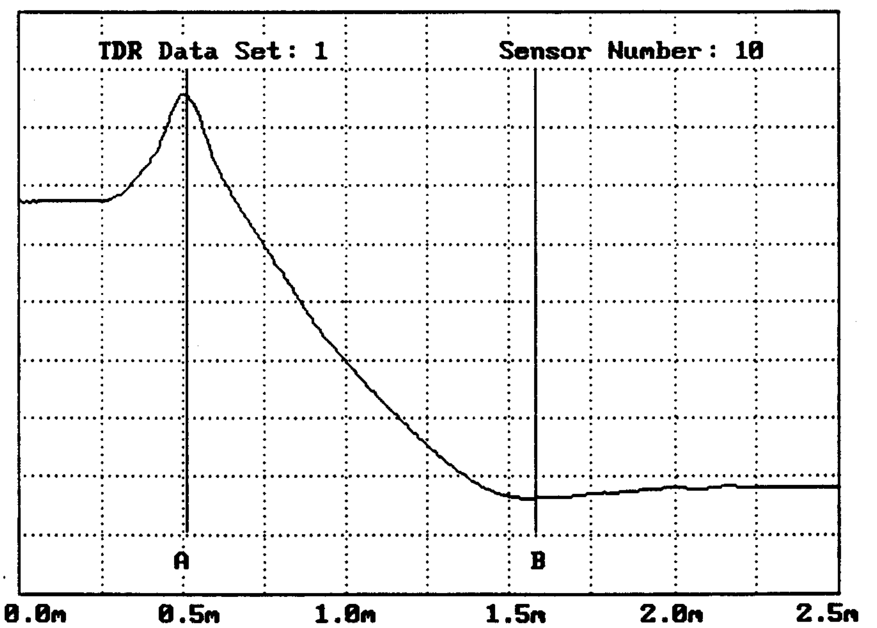
TDR RESULTS

File: 36SB95AH.MOB

Date: Aug 23, 1995
Time of Day: 10:07
Dist → Curs (m): 20.2
Dist btn WvFm (m):.01
Gain: 78
Offset: 54316
Sample No: 1

A (m) = 0.51
B (m) = 1.58
Trace Length (m)=1.07
Diele. Const.= 28.3
Volumetr MC (%)= 43.0

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 First Set of TDR Traces Measured with the Mobile Unit

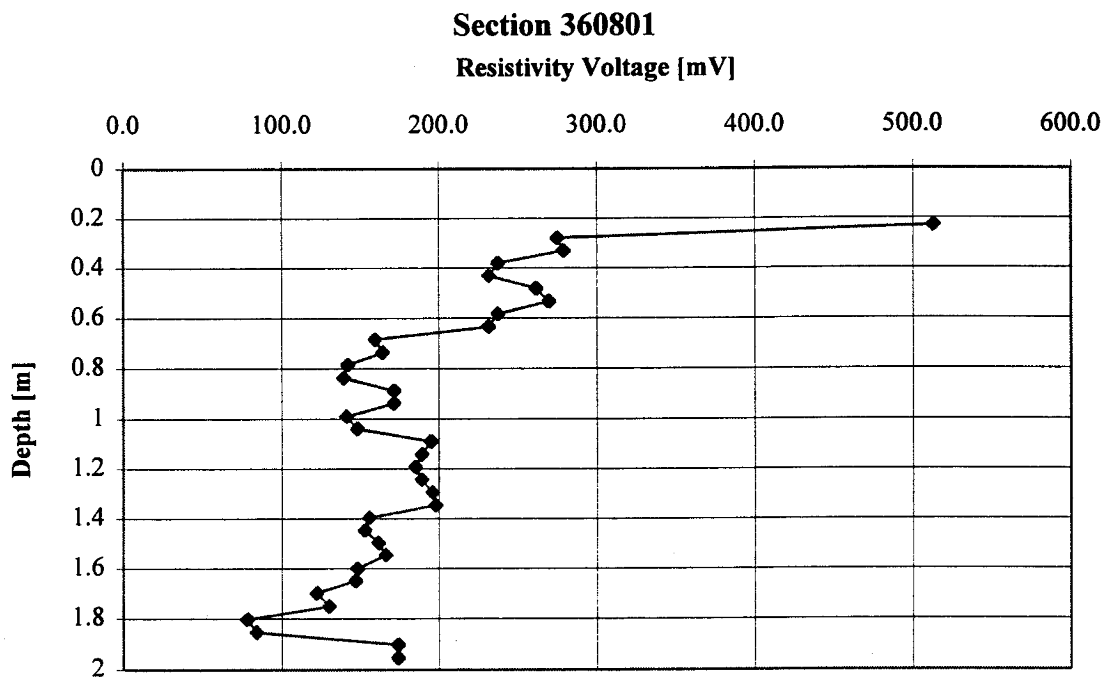


Figure D-4. Voltages Measured Using the Mobile Data System During Initial Data Collection, August 23, 1995

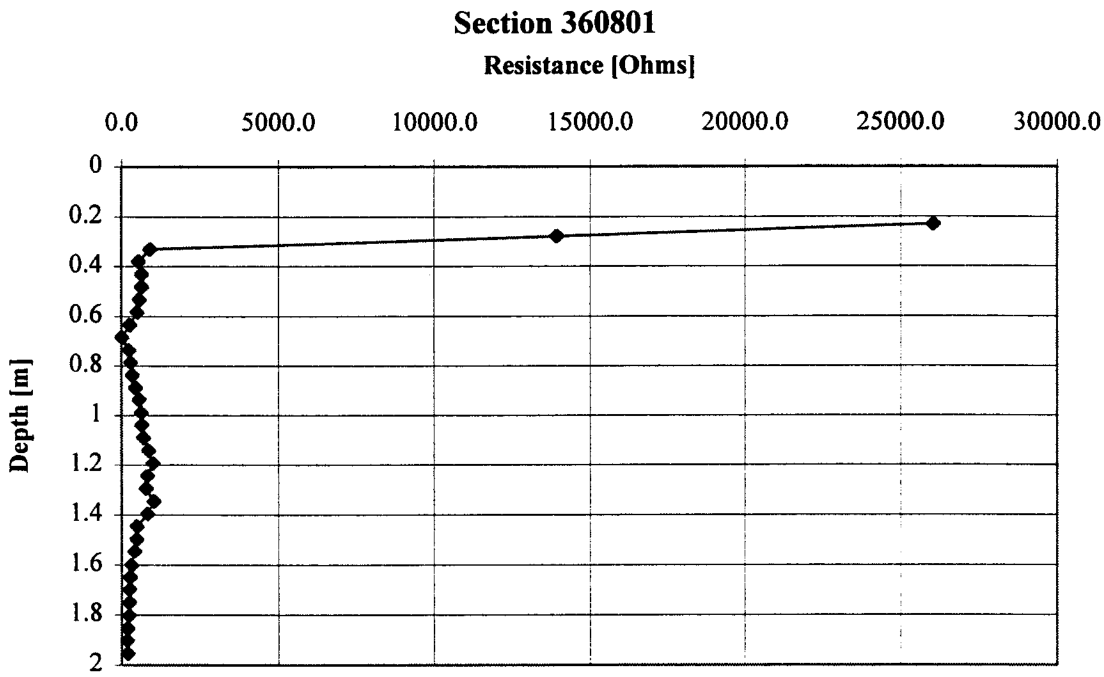


Figure D-5. Manually Collected Contact Resistance
During Initial Data Collection, August 23, 1995

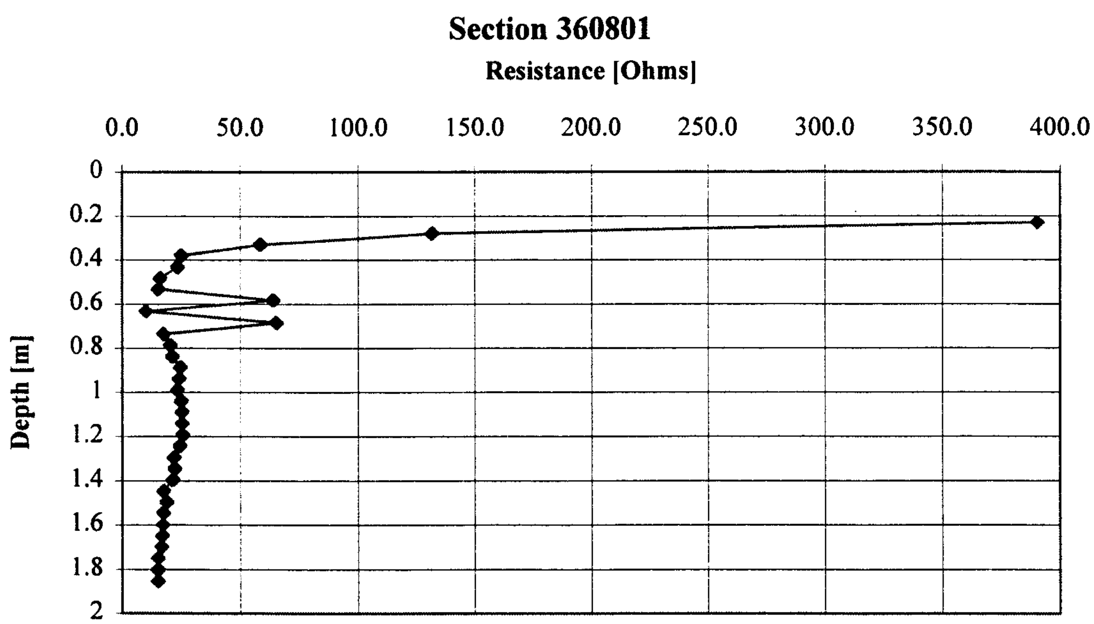


Figure D-6. Manually Collected Four-Point Resistivity
During Initial Data Collection, August 23, 1995

Table D-2. Contact Resistance After Installation

LTPP Seasonal Monitoring Program Data Sheet SMP-D03 Contact Resistance Measurements	Agency Code [36] LTPP Section ID [0801]

Test Position	Switch Settings		Voltage (ACV)		Current (ACA)		Comments
	I1 V1	I2 V2	Range	Reading	Range	Reading	
1	1	2	mV	263.0	μA	10.1	
2	2	3		251.2		18.0	
3	3	4		120.5		130.9	
4	4	5		87.4		159.3	
5	5	6		97.6		151.0	
6	6	7		97.8		149.5	
7	7	8		90.1		156.9	
8	8	9		83.1		165.6	
9	9	10		50.6		190.3	
10	10	11		1.5		226.1	
11	11	12		44.8		192.3	
12	12	13		54.7		182.7	
13	13	14		60.8		176.9	
14	14	15		74.9		164.9	
15	15	16		87.2		152.2	
16	16	17		93.3		146.4	
17	17	18		94.4		146.0	
18	18	19		99.5		142.6	
19	19	20		113.5		130.7	
20	20	21		123.0		121.3	
21	21	22		110.4		132.2	
22	22	23		107.5		136.6	
23	23	24		125.7		121.6	
24	24	25		111.3		133.3	
25	25	26		79.6		159.9	
26	26	27		77.9		161.1	
27	27	28		69.6		166.8	
28	28	29		56.4		176.3	
29	29	30		49.8		181.1	
30	30	31		46.9		184.3	
31	31	32		46.6		186.6	
32	32	33		44.4		188.2	
33	33	34		37.8		191.6	
34	34	35		35.7		193.0	
35	35	36		37.3		191.6	
Prepared by:		SC		Employer:		PMSL	
Date (dd/mm/yy):		23/08/95					

Table D-3. Four-Point Resistivity After Installation

LTPP Seasonal Monitoring Program Data Sheet SMP-D04 Four-Point Resistivity Measurements	Agency Code [36] LTPP Section ID [0801]

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	6.4	µA	16.4	
2	2	3	4	5		2.4		18.2	
3	3	4	5	6		6.7		114.5	
4	4	5	6	7		3.7		146.4	
5	5	6	7	8		3.5		148.1	
6	6	7	8	9		2.4		148.8	
7	7	8	9	10		2.6		168.4	
8	8	9	10	11		10.9		170.8	
9	9	10	11	12		1.7		167.7	
10	10	11	12	13		12.2		186.6	
11	11	12	13	14		3.1		176.9	
12	12	13	14	15		3.3		161.1	
13	13	14	15	16		3.3		154.4	
14	14	15	16	17		3.7		149.8	
15	15	16	17	18		3.5		144.4	
16	16	17	18	19		3.2		136.7	
17	17	18	19	20		3.2		127.4	
18	18	19	20	21		3.2		126.1	
19	19	20	21	22		3.5		136.9	
20	20	21	22	23		3.1		119.9	
21	21	22	23	24		2.8		113.7	
22	22	23	24	25		3.2		145.2	
23	23	24	25	26		3.1		138.2	
24	24	25	26	27		2.8		129.6	
25	25	26	27	28		2.8		159.7	
26	26	27	28	29		3.1		163.5	
27	27	28	29	30		2.9		165.0	
28	28	29	30	31		3.0		173.2	
29	29	30	31	32		3.0		176.7	
30	30	31	32	33		3.0		179.3	
31	31	32	33	34		2.8		183.7	
32	32	33	34	35		2.8		183.1	
33	33	34	35	36		2.8		183.6	

Prepared by:	SC	Employer:	PMSL
Date (dd/mm/yy):	23/08/95		

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

Seasonal Uniformity Survey	Falling Weight Deflectometer
Site Number: 360801	Data Collection and
Date Surveyed: August 22 - August 23, 1995	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	Subg modulus (psi)	Subg modulus std dev	Effective SN	SN std dev	
-13 to 200 **August 22** @ 0758	15.07	1.06	1.09	0.11	20588	2144	3.13	0.13	79.8
-17 to 200 **August 23** @ 0755	14.67	1.05	1.10	0.12	19329	1763	3.24	0.15	78.2
-17 to 200 **August 23** @0958	16.10	1.06	1.09	0.13	20211	2535	3.02	0.12	91.1
-17 to 200 **August 23** @1154	17.28	1.02	1.08	0.13	21003	2914	2.85	0.11	102.1
-17 to 200 **August 23** @1313	18.10	1.13	1.07	0.14	21653	3228	2.76	0.12	108.1

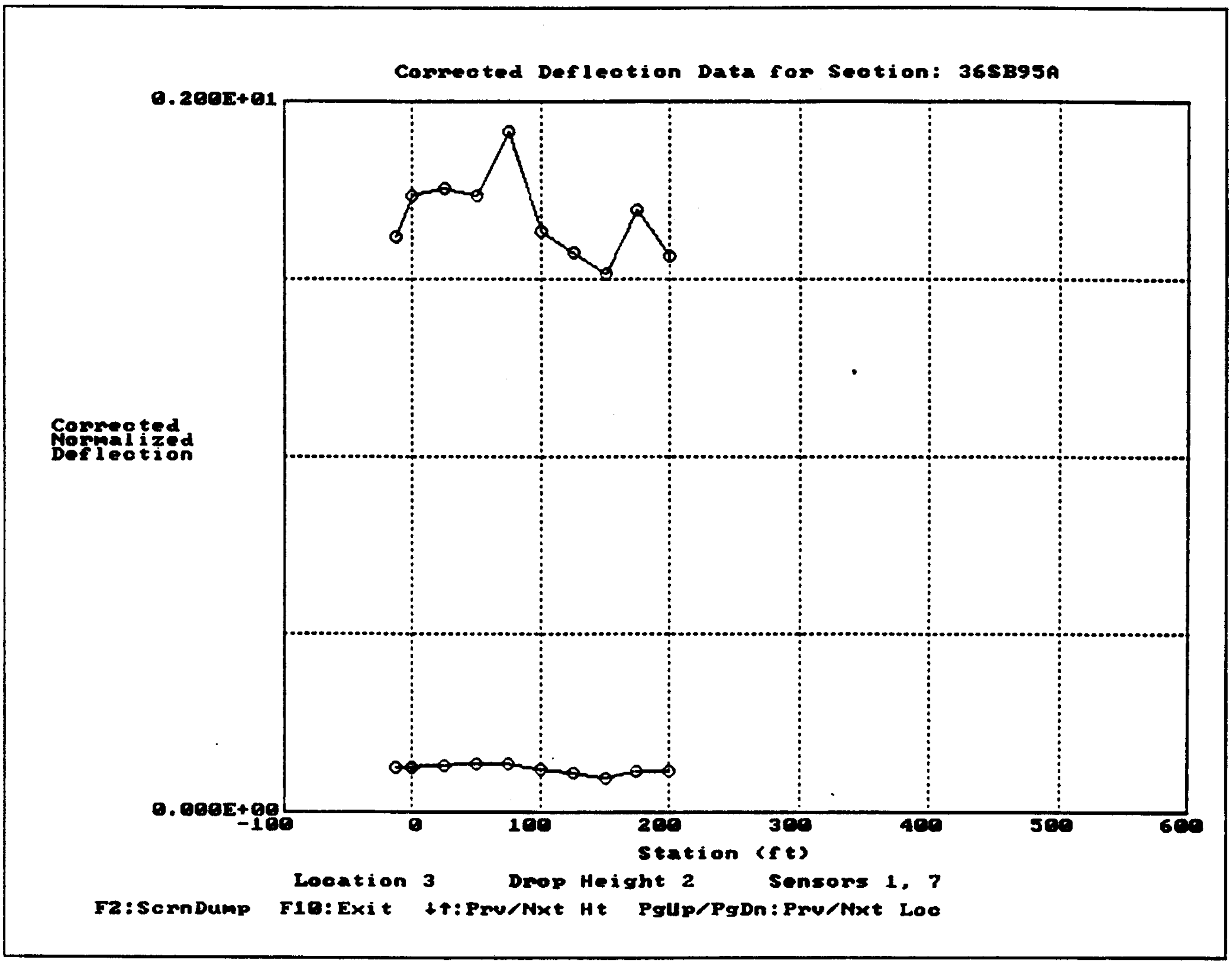


Figure D-7. Deflection Profiles from FWDCHECK
(Test Date and Time August 22, 1995 @ 0758)

Table D-5. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 22, 1995 @ 0758)

Flexible Pavement Thickness Statistics - 36SB95A - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-13	20334	3.20
	0	19609	3.10
	25	20661	3.00
	50	18750	3.15
	75	21009	2.85
	100	21220	3.15
	125	21304	3.20
	150	25187	3.10
	175	16778	3.30
	200	21030	3.25
Subsection 1	Overall Mean	20588	3.13
	Standard Deviation	2144	0.13
	Coeff of Variation	10.41%	4.14%

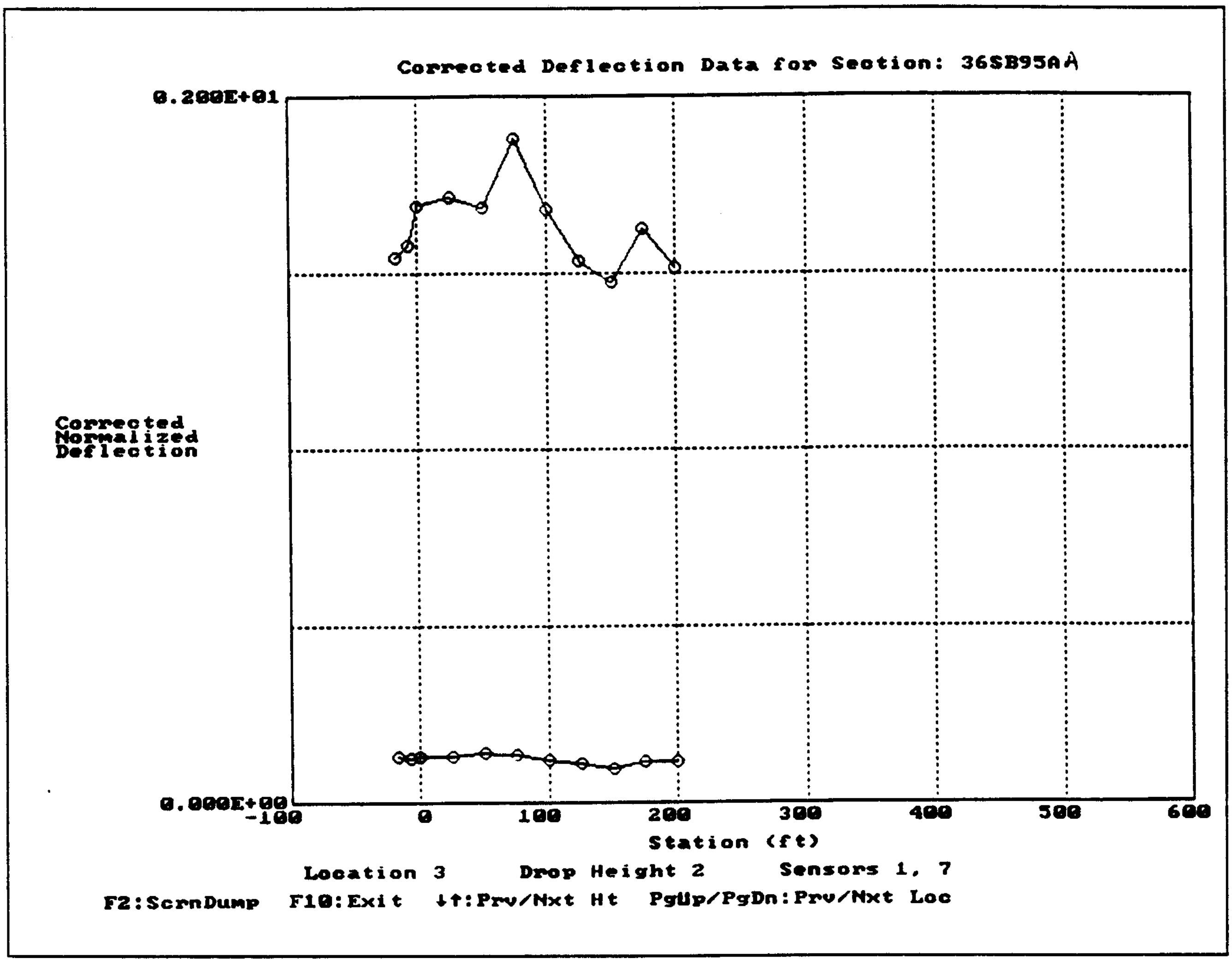


Figure D-8. Deflection Profiles from FWDCHECK
(Test Date and Time August 23, 1995 @ 0755)

Table D-6. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 23, 1995 @ 0755)

Flexible Pavement Thickness Statistics - 36SB95AA - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-17	18588	3.40
	-7	18655	3.35
	0	18557	3.20
	25	18889	3.15
	50	18285	3.20
	75	19896	2.90
	100	19806	3.15
	125	20514	3.30
	150	23485	3.25
	175	16346	3.40
	200	19602	3.35
Subsection 1	Overall Mean	19329	3.24
	Standard Deviation	1763	0.15
	Coeff of Variation	9.12%	4.51%

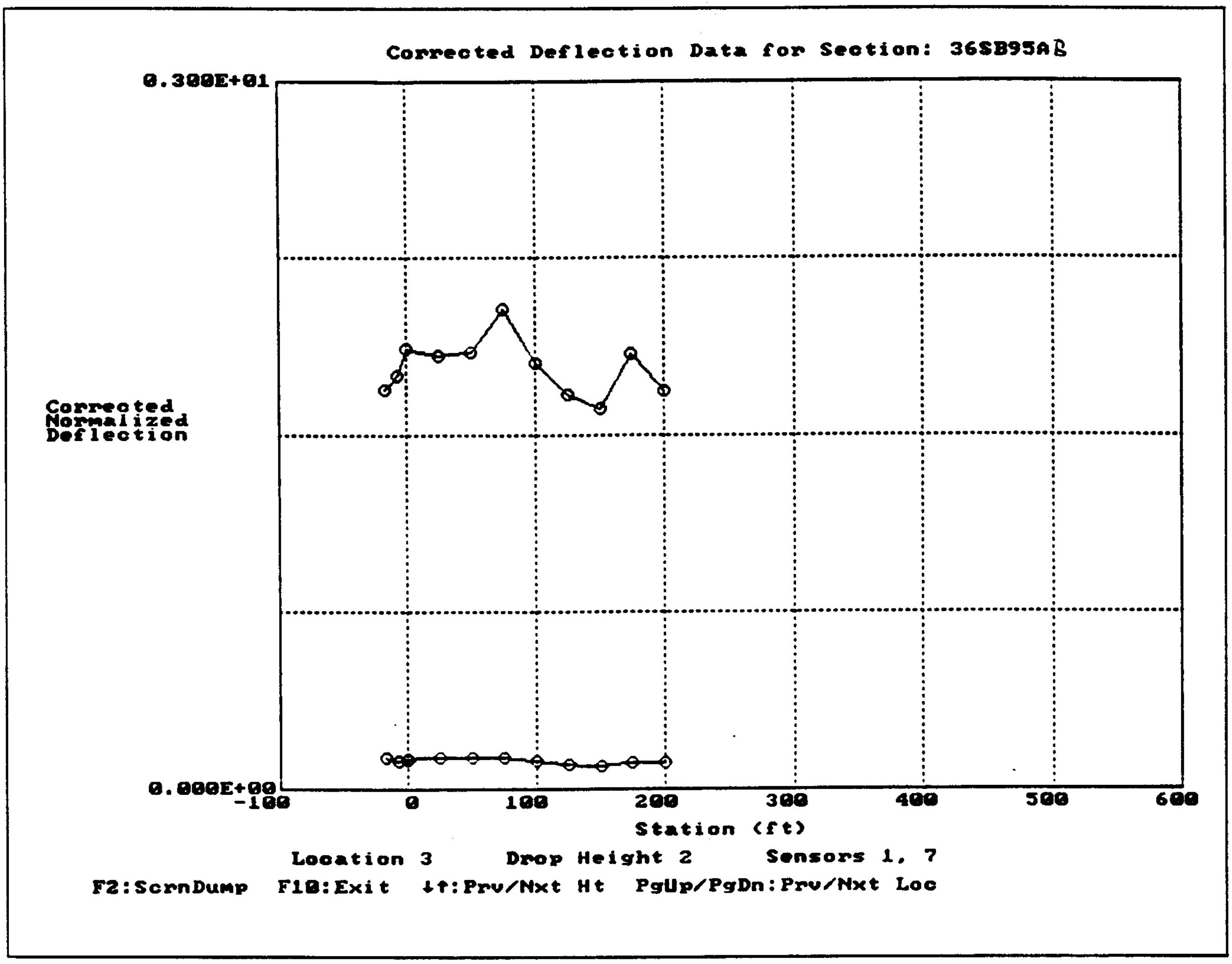


Figure D-9. Deflection Profiles from FWDCHECK
(Test Date and Time August 23, 1995 @ 0958)

Table D-7. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 23, 1995 @ 0958)

Flexible Pavement Thickness Statistics - 36SB95AB - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-17	18713	3.20
	-7	18463	3.10
	0	18423	3.00
	25	20136	2.95
	50	18872	3.00
	75	20976	2.75
	100	21198	2.95
	125	21913	3.05
	150	26007	3.00
	175	16361	3.15
	200	21255	3.05
Subsection 1	Overall Mean	20211	3.02
	Standard Deviation	2535	0.12
	Coeff of Variation	12.54%	3.94%

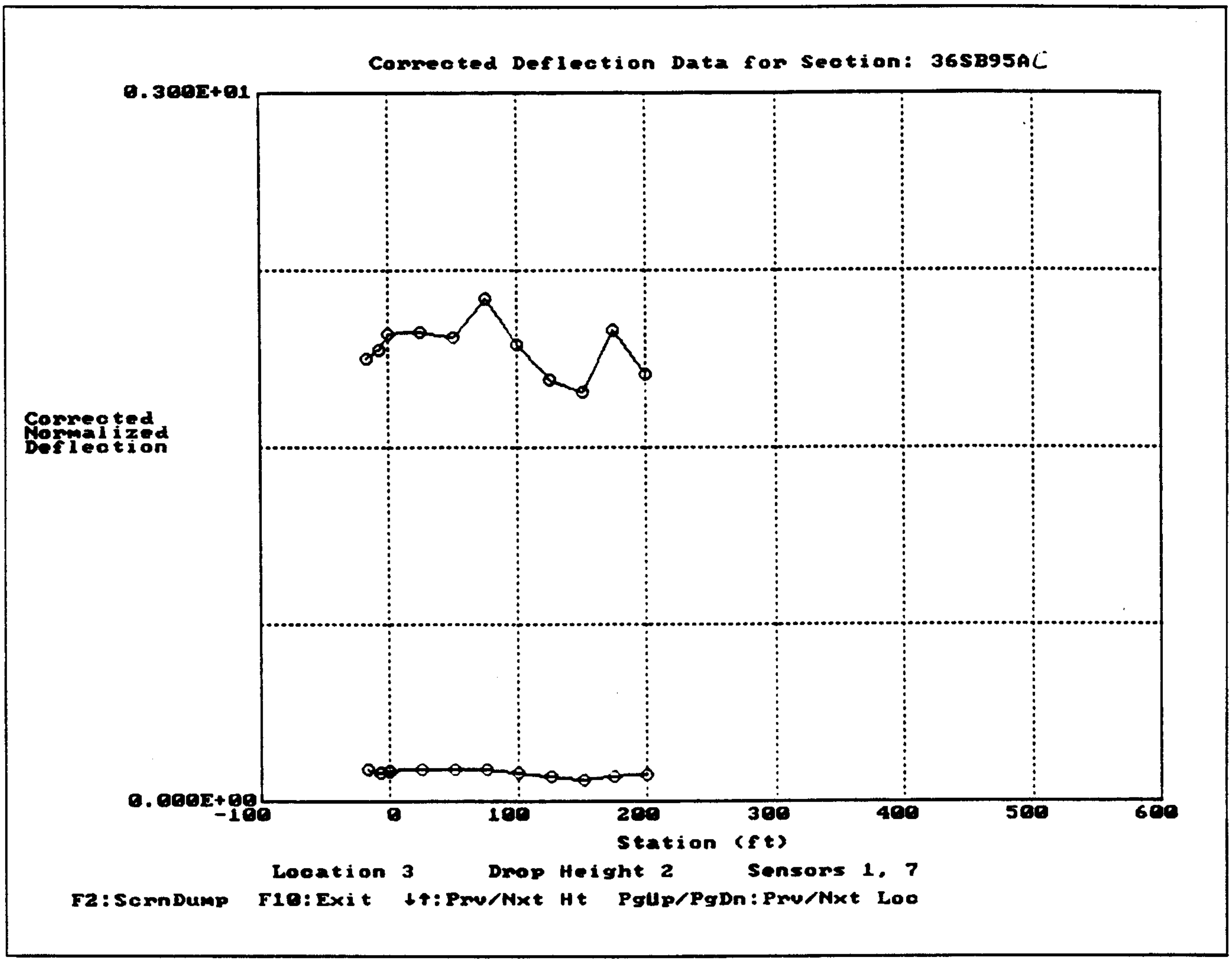


Figure D-10. Deflection Profiles from FWDCHECK
(Test Date and Time August 23, 1995 @ 1154)

Table D-8. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 23, 1995 @ 1154)

Flexible Pavement Thickness Statistics - 36SB95AC - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-17	19125	2.95
	-7	19340	2.90
	0	18829	2.90
	25	20786	2.80
	50	19825	2.85
	75	22640	2.60
	100	22576	2.75
	125	23657	2.90
	150	27248	2.80
	175	16409	3.00
	200	20591	2.95
Subsection 1	Overall Mean	21003	2.85
	Standard Deviation	2914	0.11
	Coeff of Variation	13.88%	3.95%

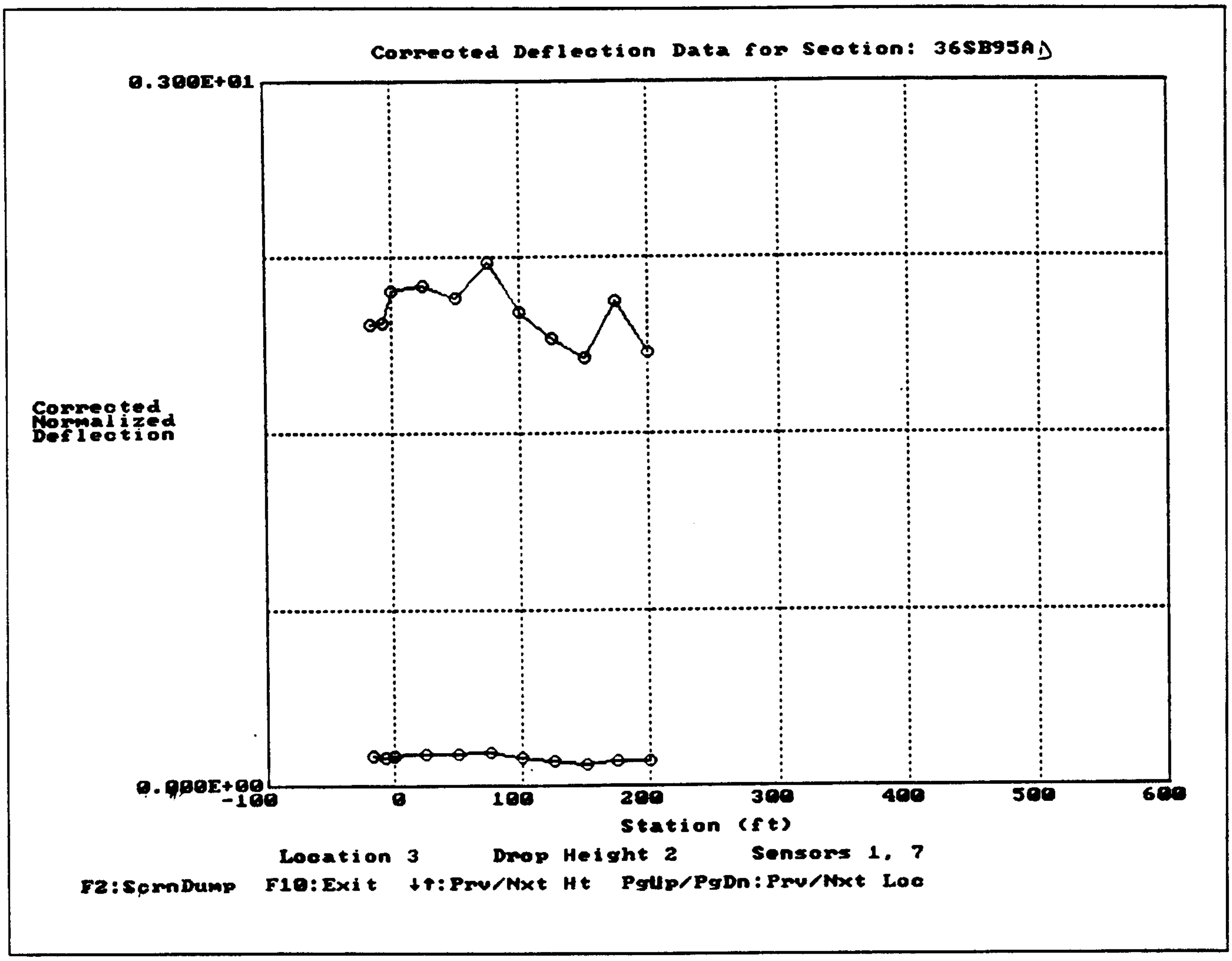


Figure D-11. Deflection Profiles from FWDCHECK
(Test Date and Time August 23, 1995 @ 1313)

Table D-9. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time August 23, 1995 @ 1313)

Flexible Pavement Thickness Statistics - 36SB95AD - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-17	18833	2.90
	-7	19323	2.85
	0	19614	2.75
	25	21293	2.65
	50	20329	2.75
	75	23811	2.50
	100	23109	2.70
	125	24109	2.75
	150	28767	2.70
	175	17039	2.90
	200	21958	2.90
Subsection 1	Overall Mean	21653	2.76
	Standard Deviation	3228	0.12
	Coeff of Variation	14.91%	4.50%

Table D-10. Surface Elevation Measurements

LTPP Seasonal Monitoring Study	State Code		[36]
Surface Elevation Measurements	Test Section Number		[0801]

Survey Date	August 23, 1995
Surveyed By	DS/AL
Surface Type	A/C
Benchmark	Observation Piezometer - 1.000 meters - assumed

STATION	PE m offset 0.30m	OWP m offset 0.91m	ML m offset 1.83m	IWP m offset 2.74m	ILE m offset 3.35m
0-17	1.2850	1.2975	1.3200	1.3350	1.3425
0-12	1.2775	1.2975	1.3175	1.3300	1.3400
0-07	1.2750	1.2900	1.3125	1.3300	1.3375
0+00	1.2725	1.2875	1.3050	1.3225	1.3325
0+25	1.2650	1.2800	1.3000	1.3150	1.3250
0+50	1.2625	1.2800	1.2975	1.3125	1.3225
0+75	1.2675	1.2850	1.3000	1.3175	1.3275
1+00	1.3000	1.3150	1.3325	1.3475	1.3575
1+25	1.3100	1.3275	1.3450	1.3625	1.3650
1+50	1.3100	1.3250	1.3400	1.3550	1.3650
1+75	1.2975	1.3125	1.3350	1.3500	1.3575
2+00	1.2975	1.3125	1.3325	1.3500	1.3600

PE	Pavement Edge
OWP	Outer Wheel Path
ML	Mid Lane
IWP	Inner Wheel Path
ILE	Inner Lane Edge

APPENDIX E

Photographs

Figure E-1. Augering the Weather Station Post Hole

Figure E-2. Digging the Trench

Figure E-3. Assembling the Piezometer

Figure E-4. Completed Piezometer Access

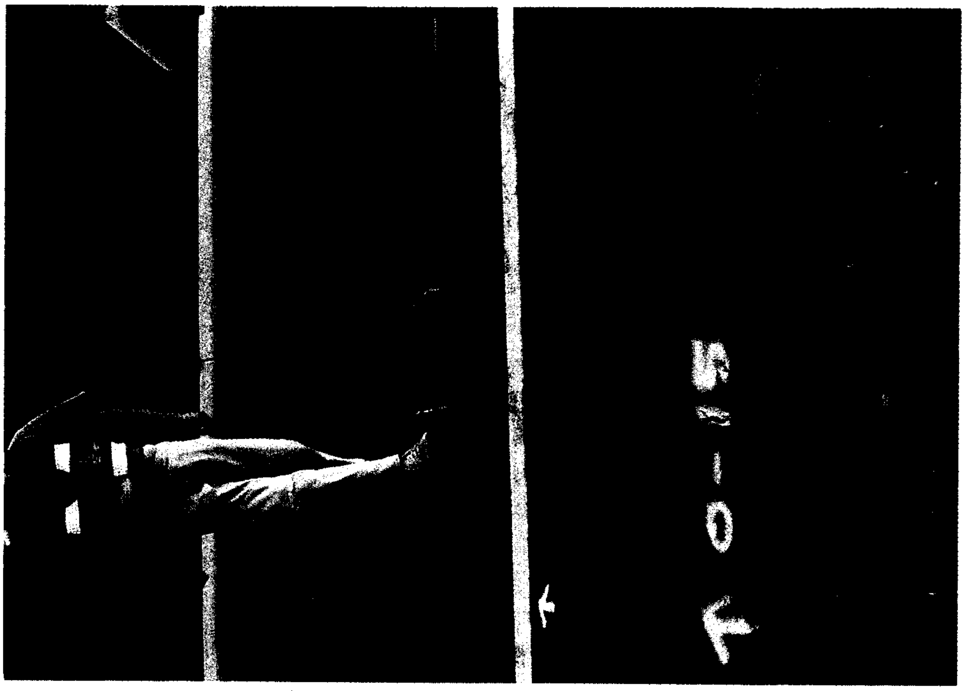


Figure E-5. Proposed Instrument Hole Location

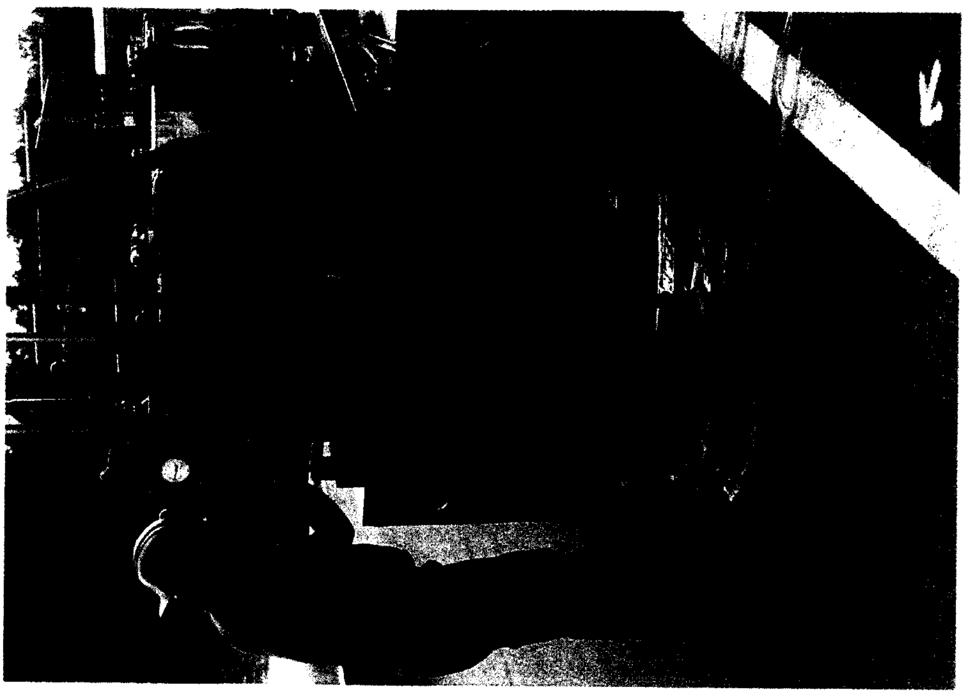


Figure E-6. Coring the Instrument Hole

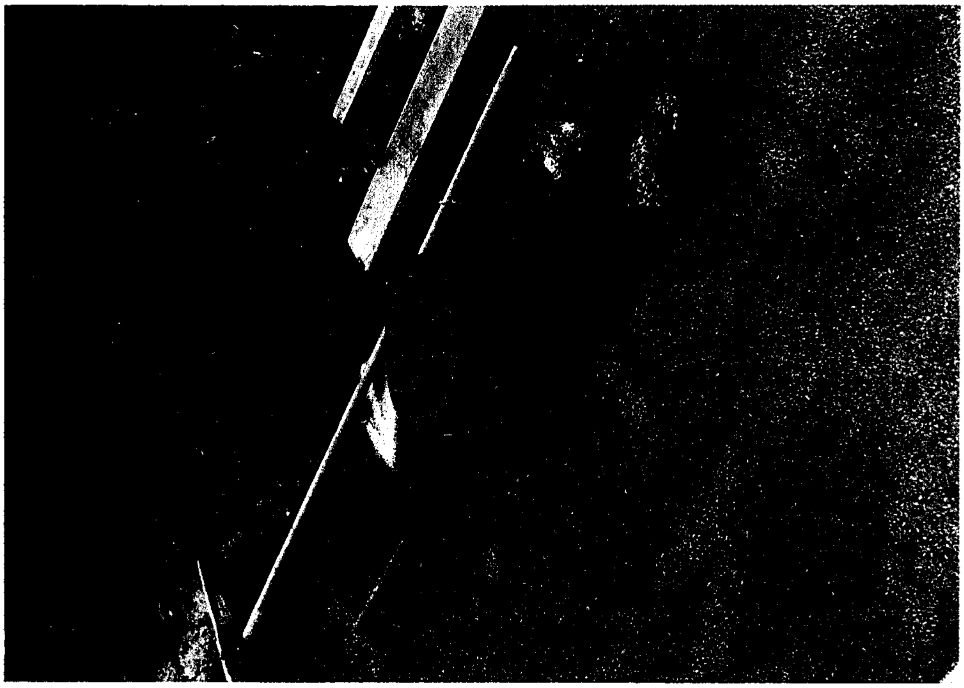


Figure E-7. Asphalt Core Removed from the Instrumentation Hole

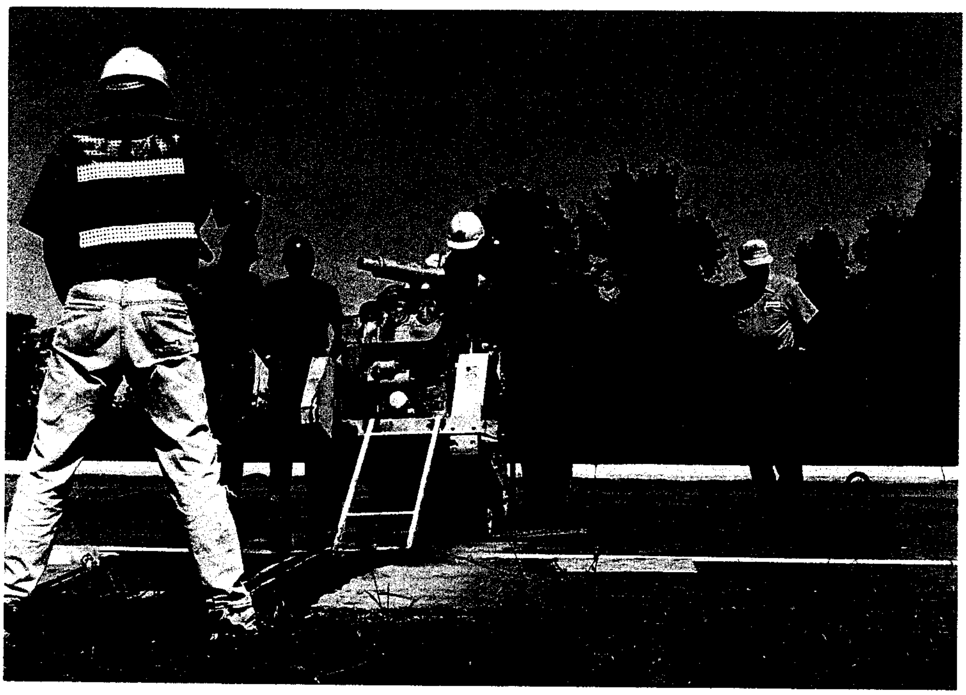


Figure E-8. Sawcutting the Trench

Figure E-9. Augering the Instrument Hole

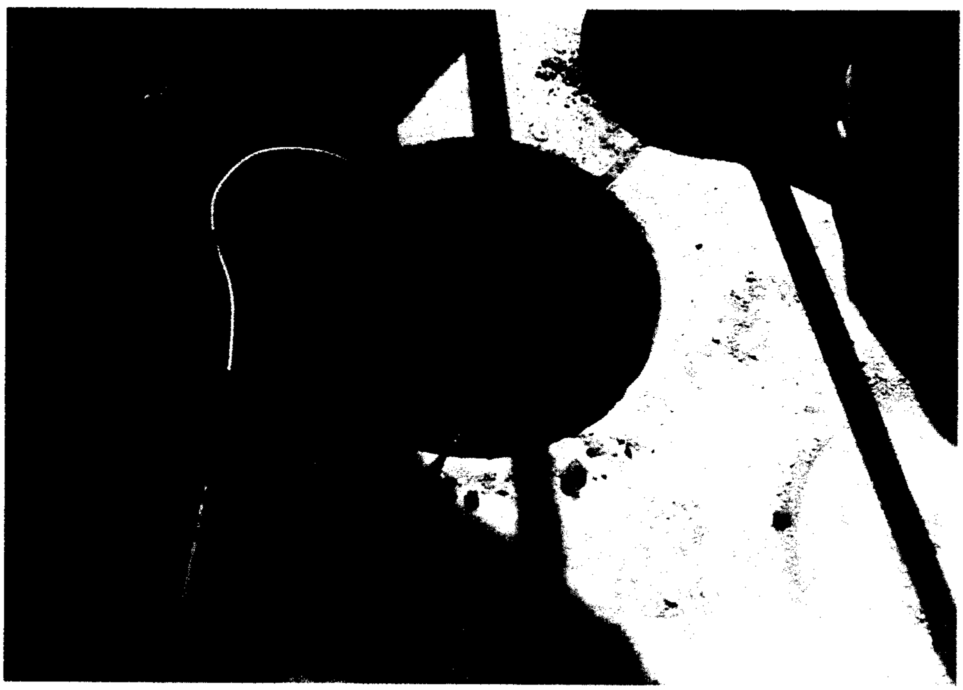


Figure E-10. Placing Instrumentation in the Hole

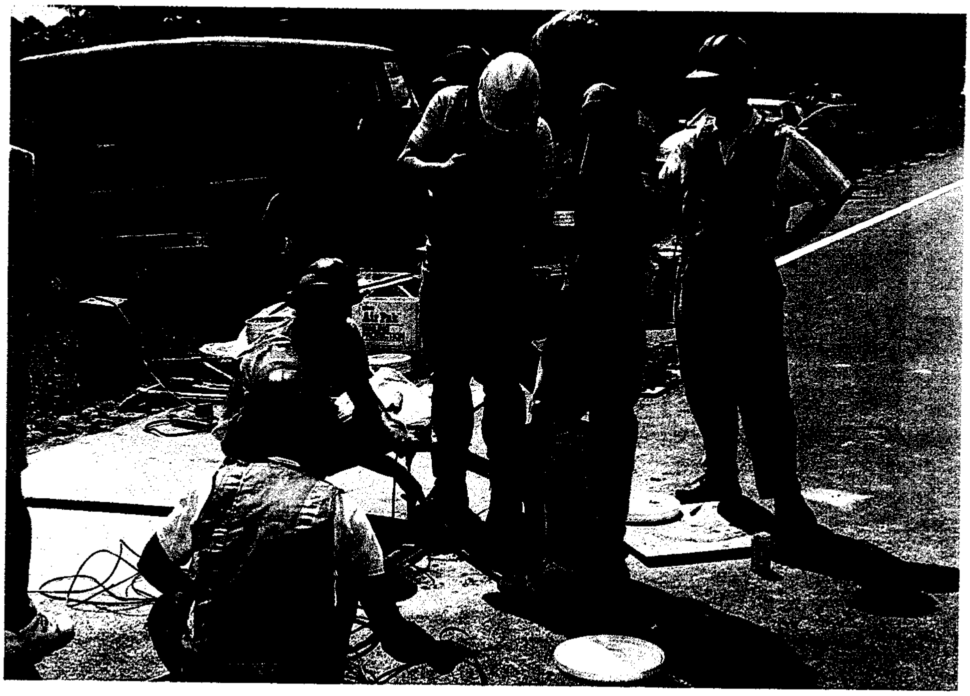


Figure E-11. Compacting the Instrumentation Hole

Figure E-12. Instrument Hole and Cable Conduit

Figure E-13. Completed Weather Station and Equipment Cabinet

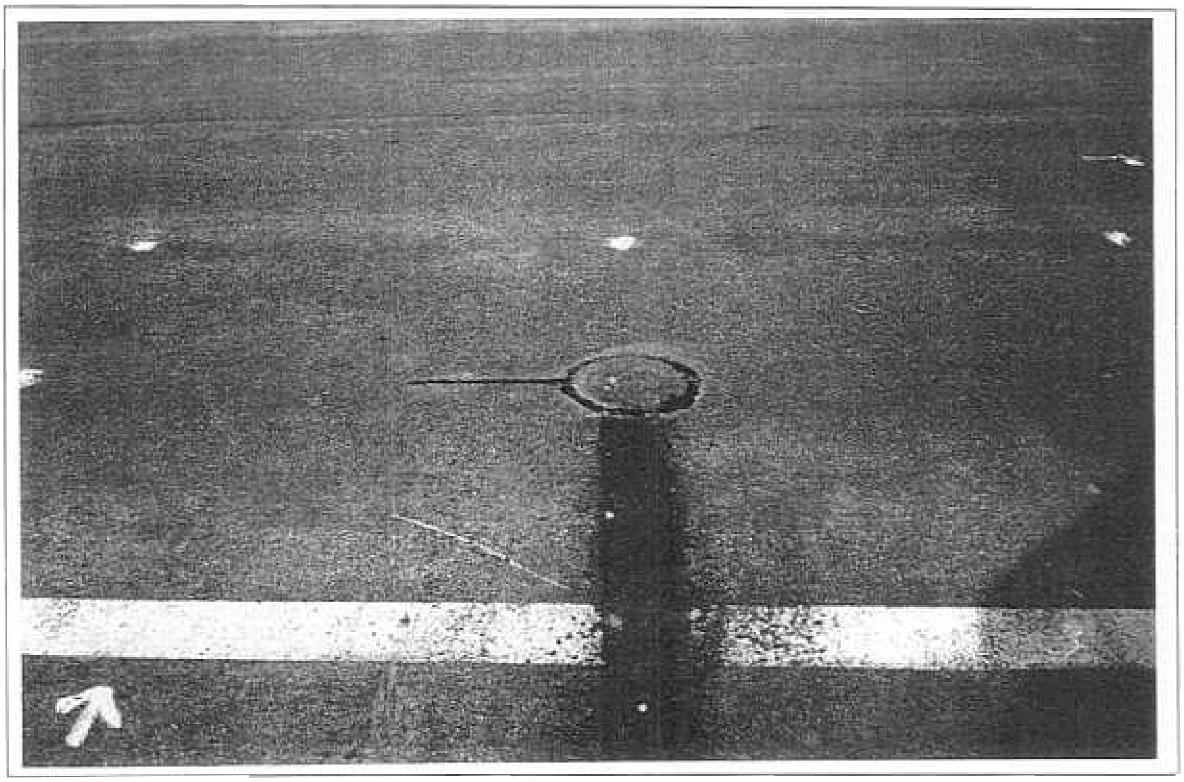


Figure E-14. Instrument Hole and Trench Area Two Months After Installation