U.S. Department
of Transportation
**Federal Highway
Administration**

FHWA/LTPP Monitoring Program
Post-Diagnostic Investigation Report
Seasonal Monitoring Section 091803
Groton, Connecticut

Report No. FHWA-TS-07-09-01

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Prepared for:
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15. Supplementary Notes

The report is a cooperative effort between Connecticut Department of Transportation (CTDOT), Long Term Pavement Performance (LTPP) Federal Highway Administration (FHWA) Division and Stantec Consulting LTPP North Atlantic Regional Support Contractor (RSC).

This report is an updated version of Report FHWA-TS-00-09-01, LTPP Seasonal Monitoring Program, Supplemental Data Collection Prior to Site Rehabilitation, Section 091803, Groton, Connecticut, December 2000, providing enhancements to the tables and figures and additional information regarding the core sampling done on this section.

16. Abstract

This report provides a description of the post-diagnostic activities conducted at the Long Term Pavement Performance (LTPP) General Pavement Study (GPS) section 091803, located on northbound RT 117, approximately 1.5 kilometers north of the Center Groton town limits and 5 kilometers north of the Groton city limits. The post-diagnostic survey was conducted to provide supplemental data for evaluation of material properties and condition assessment for the Seasonal Monitoring Program (SMP) instrumentation that was installed on August 19, 1993.

On May 3, 2000 the asphalt surface was removed from the area where the environmental instrumentation was installed. A portable hand held pavement saw was used to cut an area from the edge of the paved shoulder to 0.5 meters on the other side of the existing instrument hole (Station 5+21), to the depth of the granular base (0.189m). The pavement slab was then lifted with the backhoe bucket; broken into moveable pieces and removed from the instrument hole location and trench. A test pit was then excavated to provide access to determine material type and depth, perform nuclear gauge tests, remove material samples for moisture and laboratory tests and examine the sensors previously installed at the test area, for condition and interface with the surrounding soil. On May 4, 2000 Core samples were taken to examine layer thickness and along with the depth and conditions of cracking. Sectional performance data collected and reported on for this section included FWD, MDS, Profile and Elevation.

The report also includes a description of the test site and its location, the instrumentation installed at the site and its operational condition, the sampling of the materials and analysis results, and a summary of the data collected.

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POST DIAGNOSTIC REPORT

Long-Term Pavement Performance

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Post-Diagnostic Report
Seasonal Monitoring Program (SMP)
Connecticut Test Section 091803

1.0 Introduction

The SMP test section 091803 is a GPS-1 experiment, located on northbound RT 117, approximately 1.5 kilometers north of the Center Groton town limits and 5 kilometers north of the Groton city limits as shown in Figure 1. This road is in a rural residential area and consists of one 3.7 m wide lane in each direction with a 0.9 m wide paved outside shoulder.

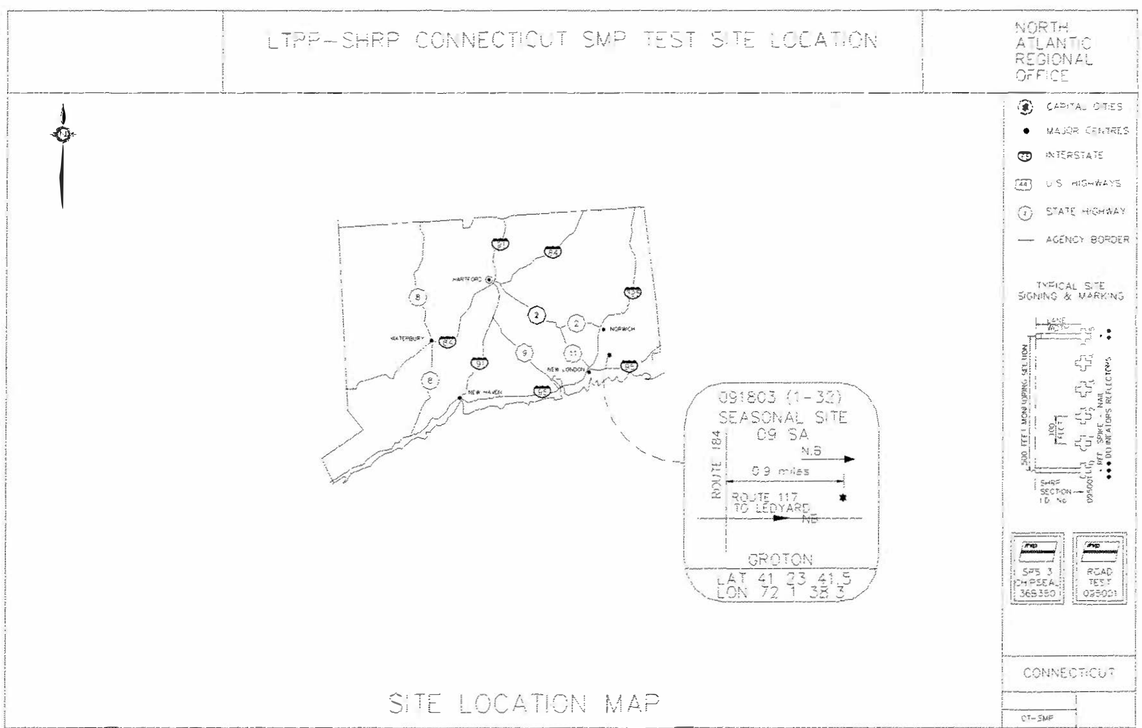

Figure 1: Site Location Map

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The installation of instrumentation on seasonal site 091803 near Groton, Connecticut was performed on August 19, 1993. Details regarding the installation are provided in the FHWA-LTPP report "LTPP Seasonal Monitoring Program – Site Installation and Initial Data Collection, Section 091803, Groton, Connecticut Report No. FHWA-TS-95-09-01, September 1995". Seasonal Monitoring data was collected at this location from October 15, 1993 to June 22, 1995, and from October 8, 1996 to October 16, 1997 at which time SMP activities were suspended. For this LTPP experiment, instrumentation was installed at the north end of the GPS-1 section. The 61 meters between station 3+00 and 5+00 were used to monitor the pavement structural response (Falling Weight Deflectometer), pavement movement (longitudinal/transverse profiles and elevation) and deterioration (longitudinal profiles and distress mapping). Figure A-1, Appendix A provides a visual overview of the sampling and testing location.

The overlay of the LTPP site 091803 on RT 117 near Groton, CT provided the opportunity to do an "out of study" evaluation on the SMP instrumentation originally installed in October 1993. The post diagnostics at this site also included the materials characterization that was incomplete, due to auger refusal during the initial drilling and sampling in 1989. Additionally, core samples were taken for thickness determination at FWD test points near the instrumentation hole and crack propagation points in the area between station 5+00 and 5+50.

This report provides an update to the information previously provided in FHWA-LTPP report "Supplemental Data Collection, Prior to Rehabilitation, Section 091803, Groton, Connecticut, Report number FHWA-TS-00-09-01, December 2000". This report incorporates updates to the tables and additional information on materials and performance indicators as requested by Cheryl Richter, FHWA-LTPP technical coordinator. The report briefly outlines the observations from the instrumentation data collection, condition assessment of the instrumentation, material removal and sampling at the instrumentation hole and pavement performance indicators.

2.0 Preparation and Planning

2.1 Site Investigation

Cheryl Richter (FHWA) and Anne-Marie McDonnell (CT DOT) initiated a post-diagnostic review of LTPP SMP site 091803. The NARO provided the coordination and field activity preparations. LTPP's Technical Service Support Contractor representatives Gary Elkins and Gonzalo Rada provided instructions for the post diagnostics in a memo: "Supplemental Data Collection – Connecticut Test Section 091803" dated April 13, 2000. A copy of the memorandum is provided in Attachment A. Follow-up instructions and arrangements with CT DOT were conducted over the next few weeks with sectional pre-construction FWD and MDS scheduled for May 2 and instrument checks and diagnostics scheduled for May 3. The longitudinal profiles were completed in June 2000. The testing went as planned with the exception of the coring of the surface material at the instrumentation area which was delayed until May 4.

2.2 Site Investigation Group

The post diagnostic review of the site conditions and seasonal instrumentation status was a cooperative effort between Connecticut Department of Transportation Office of Research and Materials, Federal Highway Administration (FHWA) - Long Term Pavement Performance (LTPP) Division, Law/PCS (AKA Mactec) - LTPP's Technical Services Support Contractor (TSSC), and Stantec Consulting - LTPP's North Atlantic Regional Office (NARO). The personnel shown in Table 1 participated at the site excavation and materials, instrumentation observation and removal:

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Table 1: Site Investigation Group

Name	Agency	Task/Job Title
Anne-Marie McDonnell	CT DOT / Research	LTPP Coordinator
John C. Hayman	CT DOT / E.G.P.	Crew Leader
Jim Mackie	CT DOT / E.G.P.	Traffic / Maintenance
David Semmelrock	CT DOT / E.G.P.	Traffic / Maintenance
Roy Duff	CT DOT / E.G.P.	Traffic / Maintenance
Kevin Jones	CT DOT	Backhoe
Charles Purdell	CT DOT / Test Boring	Drilling / Sampling
E. Thomas Budney	CT DOT / Test Boring	Drilling / Sampling
Fred Nashold	CT DOT / D2 Lab	Nuclear Density
Mark Tice	CT DOT / D2 Lab	Material Samples
Brandt Henderson	Stantec / NARO	Field Operations Manager
Jim Vogt	Stantec / NARO	LTPP Data Collection
Bentley Harris	Stantec / NARO	LTPP Data Collection

2.3 Site Assessment and Work Plan

This LTPP GPS-1 site had incomplete materials data as a result of auger refusal during the initial drilling and sampling on July 18, 1989. The pending overlay of this GPS-1 section provided an opportunity to open a test pit to obtain the material and laboratory results missing from the initial sampling, and evaluate the current status of the environmental instrumentation installed on August 18, 1993. Additional core samples were also suggested in the Workplan to examine the details surrounding the cause and mechanisms of distress and measure the variation of thickness of the bound surface layer. A limited study to examine cores at the location of cracking at Falling Weight Deflectometer (FWD) test locations was done outside of the test section at the instrumentation area. As this section was to remain in the LTPP program as a GPS-6 experiment core sampling within the section limits was not practical.

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3.0 Material Sampling and Observation

3.1 Material Sampling at Test Pit Location

The asphalt surface was removed from the area where the environmental instrumentation was installed at Station 5+20. A portable hand held pavement saw was used to cut an area from the edge of the paved shoulder to 0.5 meters on the other side of the existing instrument hole, to the depth of the granular base (0.189m). The pavement slab was then lifted with the backhoe bucket; broken into moveable pieces and removed from the instrument hole location and trench as shown in Figure A-2, Appendix A.

A test pit was then excavated to provide access to determine material type and depth, perform nuclear gauge tests, remove material samples for moisture and laboratory tests, and examine the sensors previously installed at the test area for condition and interface with the surrounding soil. A backhoe was used to remove the soil in layers of approximately 0.3 meters to a depth of 1.5 meters, adjacent to the location of the installed instrumentation. Many larger boulders were encountered in the removal of the subbase material, requiring patience and care in operation on the part of the backhoe operator. Figure A-3, Appendix A provides a photo of the large rocks removed during the excavation. A pick, shovel and scoop were used at the nuclear gauge test and sensor locations to level and remove material. The use of the backhoe made it easy to examine the various material layers, sample the soils and remove the environmental sensors.

To gain access to the materials and sensors below 1.5 meters a portable drill rig with a 225 mm flite auger was used to remove material to a depth of slightly more than 2 meters. The auger operation was slightly hampered by water infiltration from a ground stream that seemed to flow at the interface between the subbase and subgrade layers. Additionally, there was a large rock (sandstone) at the bottom of the subbase that was augered through at the time of installation. Figure A-4, Appendix A provides a photo of the drilling operation.

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3.2 Nuclear Moisture/Density Test Results

Immediately after the removal of the surface layer, a nuclear gauge backscatter density and moisture sample were taken above the instrument hole at 0.191 meters below the surface (adjacent to TDR probe 1). Subsequent to this test, 150 mm direct transmission nuclear gauge samples were taken at:

- 0.191 m below surface adjacent to TDR probe 1
- 0.559 m below surface between TDR probe 2 and 3
- 0.775 m below surface adjacent to TDR probe 4
- 1.070 m below surface adjacent to TDR probe 6

Table 2 provides the results from the nuclear gage tests taken at the instrument hole test pit. The results indicate the density/moisture relationship as being quite variable. The high variability is due to many cobbles and boulders, particularly within the subbase layer. Figure A-5, Appendix A is a photo of the operator performing the backscatter nuclear density test on the base material. Figure A-6, Appendix A is a photo showing how the depth measurements were determined for the moisture/density sampling

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Table 2: Nuclear Moisture/Density Results Taken at Instrument Hole Test Pit

Layer Type	Depth	Probe #	6" Direct Transmission					Remarks
			Nuclear Density		% Water	Dry Density		
			(kg/m³)	(pcf)		(kg/m³)	(pcf)	
Base	0.191	1	2029.5	126.7	7.49	1888.1	117.9	Back Scatter data
			2018.3	126.0	7.30	1881.0	117.4	
			1978.3	123.5	7.68	1837.2	114.7	
			2026.3	126.5	7.36	1887.4	117.8	
		Average	***2013.5***	***125.7***	***7.46***	**1873.7**	**117.0**	
Base	0.191	1	2055.2	128.3	9.11	1883.6	117.6	Top of base, above probe 1, rough surface
			2186.5	136.5	7	2043.5	127.6	
			2335.5	145.8	6.47	2193.6	136.9	
			2228.2	139.1	6.96	2083.2	130	
		Average	***2201***	***137.4***	***7.39***	**2049.5**	**127.9**	
Subbase	0.559	3	1891.8	118.1	12.35	1683.8	105.1	Top of subbase, between probe 2 & 3, tests are taken in trench
			1891.8	118.1	13.17	1671.6	104.4	
			2180.1	136.1	10.02	1981.5	123.7	
			2104.8	131.4	10.36	1907.2	119.1	
		Average	***2000.7***	***124.9***	***11.48***	**1794.7**	**112.0**	
Subbase	0.775	4	2042.4	127.5	9.17	1870.8	116.8	Between probe 4 & 5
			2053.6	128.2	8.72	1888.9	117.9	
			2045.6	127.7	9.47	1868.6	116.7	
			2055.2	128.3	9.37	1879.1	117.3	
		Average	***2048.8***	***127.9***	***9.18***	**1876.5**	**117.1**	
Subbase	1.070	6	1891.8	118.1	9.53	1727.2	107.8	Between probe 6 & 7
			1909.4	119.2	9.38	1745.7	109.0	
			1983.1	123.8	7.49	1844.9	115.2	
			1979.9	123.6	7.70	1838.3	114.8	
		Average	***1941.4***	***121.2***	***8.53***	**1788.8**	**111.7**	

Note: Depths are measured from Pavement Surface (Meters)
All tests are based on one-minute counts
Backscatter – Nuclear gage plate 25mm above soil
Direct Transmission – Nuclear gage on soil and probe set to 150mm
Nuclear Gage – Boart Long Year MC3-Porta-Gage, SN M36120203517

3.3 Proctor Test Results

Table 3 provides the results of the one point Proctor done on May 5, 2000 from the bagged samples sent to the Connecticut DOT laboratory. A slight delay in processing of the samples may have allowed for some moisture loss in the samples, as the moisture determined from the proctor samples was lower than that obtained from the nuclear gage tests, jar samples and TDR results. In this regard the 'insitu value' for the materials could have been slightly different than that reported here, but due to the high variability of the soil (numerous cobbles along with many layer changes) it would be difficult to pinpoint the cause for any differences as recorded.

Table 3: Results of the One Point Proctor

Probe #	Depth	Lab Dry Density		Lab Moisture
		(lb/ft^3)	(kg/m^3)	(%)
1	0.330	139.1	2229	5.8
2	0.437	140.7	2255	5.4
3	0.584	135.0	2163	7.83
4	0.737	NA	NA	NA
5	0.889	135.2	2166	6.0
6	1.041	136.8	2192	6.9
7	1.194	NA	NA	NA
8	1.346	130.5	2091	10.3
9	1.656	NA	NA	NA
10	1.961	NA	NA	NA

Note: Depths are measured from Pavement Surface (meters)
Tested on May 5, 2000 at Nuclear Gage Test Locations
No Proctor Test at Probe 4&7
No Proctor Test at Probe 9&10, to wet to conduct test

3.4 Gravimetric Moisture Sample Results

An extensive number of moisture samples were taken during the excavation of the test pit. Samples were put in jars and zip lock bags for transfer to the Connecticut DOT laboratory. The majority of the samples were taken from the TDR probe location by scooping a sample either above or below the TDR probe onto a metal plate as shown in Figure A-7, Appendix A. Some of the samples were labeled and transferred with the proctor materials while other samples were jarred and

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transferred to the Materials and Research laboratory. Table 4 provides the results of the moisture samples taken mainly at the TDR probe locations. These results are variable for possibly two reasons: 1) the larger stones were not selectively removed from the sample and 2) the soil was not of uniform distribution as extracted from the test pit location. Although the results are variable there is some consistency in that the sampled moistures throughout the layers are grouped as either moderately or very wet.

Table 4: Moisture Samples Taken at TDR Probe Locations (Lab set 1) and Instrument Hole Test Pit (Lab set 2)

Probe #	Depth	Moisture Content (%)			
		Location	At TDR (Lab set 1)	Location	At Instrument Hole (Lab set 2)
1	0.330			Top Bottom	7.26 7.54 & 8.06
2	0.437	Top Bottom	12.4 15.2	Top Bottom	7.19 & 6.35 7.67
3	0.584		6.7	Top Bottom	10.87 & 11.0 14.96
4	0.737	Top Bottom	6.7 11.9	Top Bottom	13.35 13.04 & 11.0
5	0.889		10.4	Top Bottom	9.66 9.60
6	1.041	Top Bottom	8.2 9.3	Top Bottom	8.62 8.88
7	1.194	Top Bottom	10.1 9.6		10.57 & 8.36
8	1.346	Top Bottom	12.4 13.6		11.66 & 12.98
9	1.656		20.2		22.02
10	1.961	Top	19.2 & 13.4		13.09

Note: Depths are measured from Pavement Surface (meters)
Lab set 1 tested on May 9, 2000
Lab set 2 tested on May 5, 2000, with:

- Probe 5 not labeled top or bottom 8.64%
- Probe 6 2 samples labeled 1067m are 7.98% and 6.54%
- Probe 7&8 2 samples not labeled top or bottom
- Probe 9&10 1 sample only

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3.5 Material Laboratory Test Results

The material samples were forwarded to LTPP laboratory contractor (Braun/Intertec) for testing and analysis. Aside from supplementing the initial sampling results (that were incomplete due to auger refusal), these results will be useful in the evaluation of the TDR moisture sensors.

Table 5 summarizes the material properties for the five distinct pavement layers identified from the excavation and drilling done at the test pit located at station 5+20 as part of the post diagnostics conducted on May 3, 2000. Attachment B provides the list of material tests to be completed and a copy of the Laboratory reports produced by Braun/Intertec.

Table 5: Material Properties

Description	Surface	Base	Subbase	Subgrade 1	Subgrade 2
Material (Code)	Dense Graded HMAC (01)	Uncrushed Gravel (304) **BG-55**	Gravel Sand /w Cobbles (303) **BG-02**	Silty Sand /w Gravel (145) **BS-02**	Silty Sand /w Gravel (145) **BS-01**
Thickness (mm)	189	299	1056	264	192
Lab Max Dry Density (kg/m^3)		2259	2259	1778	
Lab Opt Moisture Content (%)		6	5	16	
Specific Gravity		2.8	2.78	2.74	2.73
Bulk Specific Gravity	2.444				
Max Specific Gravity	2.539				
Liquid Limit		0	0	0	24
Plastic Limit		0	0	0	20
Plasticity Index		NP	NP	NP	4
% Passing#200 (washing)		4.2	8.4	44.7	56.1
Avg. Resilient Modulus (MPa)				53.5	
Avg. of Std. Deviation Resilient Modulus				0.09	

Note: The average of Resilient Modulus and the standard deviation are calculated based on 15 sequences applying the Pressure range of 13.8 – 41.4 kPa and the Nominal Maximum Axial Stress range of 13.3 – 68.8 kPa.

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3.6 Core Sample Results

To examine the surface thickness at the FWD test locations and along cracks that had formed in the pavement surface layer, nine 4-inch cores were extracted near the test pit location at the 5+00 end of the GPS section. No samples were possible at the FWD test locations within the section as this site was to remain in the LTPP program as a GPS-6. Figure 2 provides a diagram outlining the location for the 4-inch cores. Cores 25, 26 and 27 were placed at the FWD test spots located at the instrumentation area. Cores 28-30 were placed prior to the instrument hole in the outer wheel path in an area exhibiting fatigue cracking with cores 31-33 placed along a transverse crack that was 2.1 meters north of the instrument hole. Table 6 provides a summary of the core thickness and condition. Figure B-1 through B-10, Appendix B provides photos of the coring operation and the nine cores extracted. The fatigue cracking in the wheel path initiated in the surface and extended to a depth of 12-50mm. The transverse cracks initiated in the surface and extended to a maximum depth of 152mm. The exception was core 33 which separated at the crack location. The core width ranged from 2-12mm with the larger gap at the surface. Spalling was evident on the transverse cracks. The core thickness on average was some 10mm less than that recorded for the test pit (189mm).

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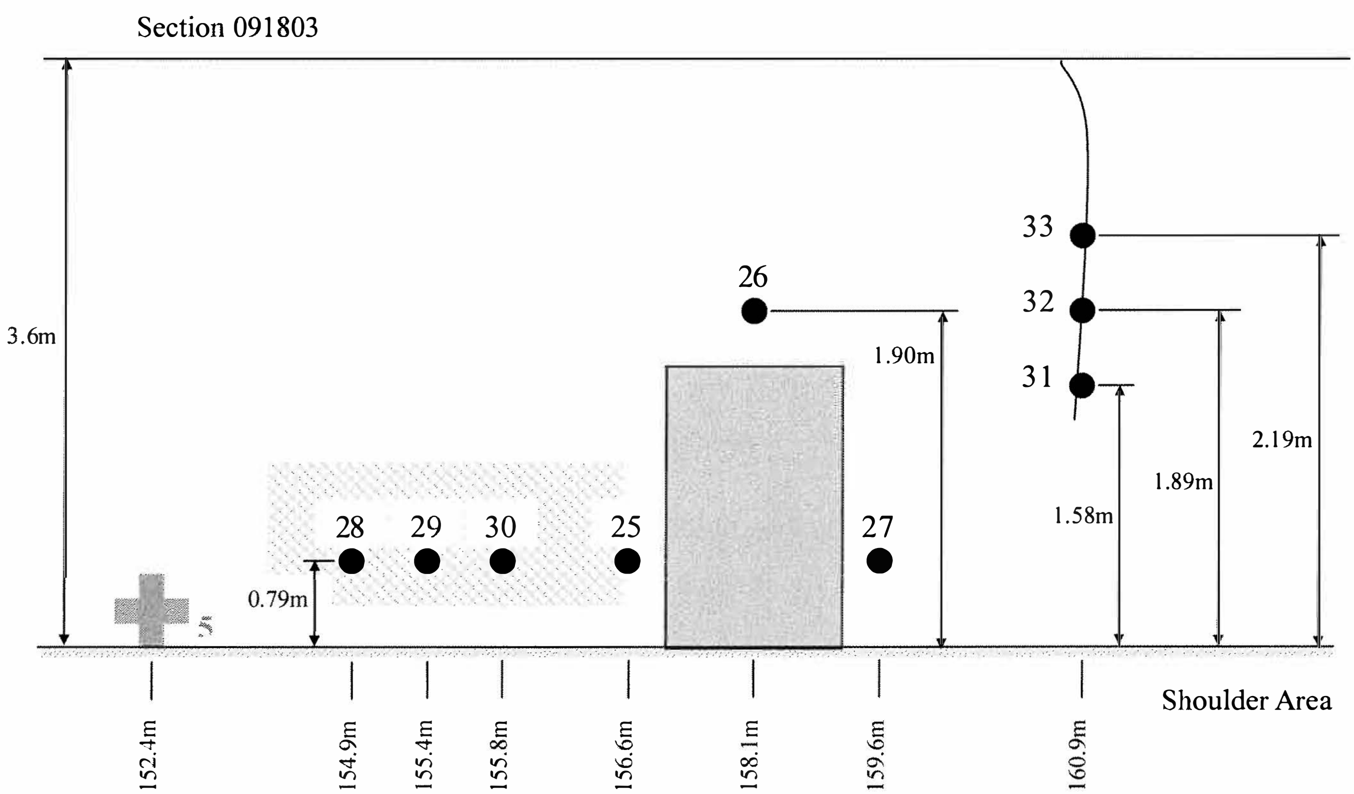

Figure 2: Diagram of Core Sample Locations

Table 6: Results of Core Examination

Date	4-May-00
Core Size (inch)	4

Material Code	700
Material Description	AC

		25	26	27	28	29	30	31	32	33
Core Hole No.		25	26	27	28	29	30	31	32	33
Location (m)		156.6	158.1	159.6	154.9	155.4	155.8	160.9	160.9	160.9
Location Description		Taken from FWD Location			Taken between 152.4m & 158.5m			Taken @ 160.9m		
Offset (m) from Pavement Edge		0.79	1.90	0.79	0.79	0.79	0.79	1.58	1.89	2.19
Average Thickness (mm)		184	178	178	178	178	191	178	171	165
Layer Information	Layer Description	Binder			Binder			Binder		
	Thickness (mm)	102			102			102		
	Layer Description	Surface			Surface			Surface		
	Thickness (mm)	71-76			76			76		

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Table 6: Results of Core Examination Cont...

<table>
<tr><th>Core Hole No.</th><th>General Distress Type</th><th colspan="3">Cracking/Spalling Information</th><th colspan="2">Additional Notes</th></tr>
<tr><td>25</td><td>Start of fatigue cracking</td><td colspan="3">Cracking 26mm down one side of core</td><td colspan="2"></td></tr>
<tr><td>26</td><td></td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>27</td><td>Fatigued FWD location</td><td colspan="3">Sealed cracks - depth of 47mm & 24mm</td><td colspan="2"></td></tr>
<tr><td>28</td><td rowspan="3">Fatigue region - cracking starting at surface</td><td colspan="3">Cracks measured as deep as 12mm</td><td colspan="2"></td></tr>
<tr><td>29</td><td colspan="3">Cracks measured as deep as 50mm</td><td colspan="2"></td></tr>
<tr><td>30</td><td colspan="3">Cracks measured as deep as 44mm</td><td colspan="2"></td></tr>
<tr><td>31</td><td rowspan="3">Transverse crack propagating through entire core</td><td>102mm & 152mm crack depth on side of core</td><td>Cracks 3-4mm wide on surface</td><td>Crack not quite through cores entire depth</td><td colspan="2"></td></tr>
<tr><td>32</td><td>Crack originating at surface</td><td>Crack width 8-13mm at top, 2-3mm at bottom</td><td>Partially spalled</td><td rowspan="2">Material beginning to separate along failure plane</td><td>Core in various pieces</td></tr>
<tr><td>33</td><td colspan="3">Transverse crack spalls off side of core</td><td>Core in various pieces, Broken along failure plane</td></tr>
</table>

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4.0 SMP Data Collection and Instrumentation Removal

4.1 Final SMP Data Collection

Prior to beginning excavation of the materials at the instrumentation hole location the following SMP instrumentation measurements were performed:

1. ***Automated TDR*** - Three sets of Mobile automated TDR measurements initiated at 8:54 am, 9:47 am and 10:03 am. Figure A-8, Appendix A provides a photo of the operators collecting the final set of automated TDR data. All ten TDR sensors were working and provided a good trace. An intermittent trace on the Number 2 TDR sensor was considered a Mobile multiplexer problem and had nothing to do with the cable itself. There appears to be moisture in the connector at the Printed Circuit Board (PCB) mating the cable to the probe for sensors four and eight, but this has little or no affect on the probe output. The first set of TDR traces had the cables improperly connected for multiplexer 1; the probe locations were readjusted to display the probes in the correct order. Appendix C, Figures C-1 through C-3 provide the TDR traces for the three TDR data sets initiated at 8:50, 9:47 and 10:03. Table 7 provides the volumetric moisture content determined from the 3 TDR data sets.

Table 7: Volumetric Moisture Content for the 3 Automated TDR Data Sets

TDR Sensor	Sensor Depth (mm)	Automated Volumetric Moisture Content - May 3, 2000							
		Set 1	Time	Set 2	Time	Set 3	Time	Average	Standard Deviation
1	0.330	19.1	8:54	19.1	9:47	18.5	10:03	18.9	0.3
2	0.437	21.5	8:53	20.3	9:48	20.3	10:04	20.7	0.7
3	0.584	30	8:53	30.6	9:48	30.6	10:04	30.4	0.3
4	0.737	21.5	8:52	22.1	9:49	22.1	10:05	21.9	0.3
5	0.889	13.6	8:51	12.5	9:50	17.2	10:06	14.4	2.5
6	1.041	20.3	8:51	19.7	9:50	19.7	10:06	19.9	0.3
7	1.194	20.3	8:50	20.9	9:51	20.3	10:07	20.5	0.3
8	1.346	28.2	8:54	28.2	9:51	27.6	10:07	28.0	0.3
9	1.656	47.2	8:55	46.8	9:52	47.6	10:08	47.2	0.4
10	1.961	25.8	8:55	27.0	9:52	25.8	10:08	26.2	0.7

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2. ***Manual TDR*** - Two sets of Manual TDR traces were collected by connecting the TDR probe cables directly to the Tektronix cable tester. The traces were printed to provide a permanent record. The second set of Manual TDR measurements were taken just prior to removing the TDR probes from the test pit, to provide moisture values to compare with the soil moisture samples taken from around the TDR probes. The results of the interpretation of these traces are provided in Table 8. A partial set of TDR traces was taken during the removal of the TDR sensors; the results have not been provided with this report. The manual TDR traces and trace interpretation are provided in Figures C-4 through C-7, Appendix C. There appears to be a slight time discrepancy between that of the automated data logger and the manual TDR taken with the Tektronix cable tester. In reviewing this we have decided that the manual trace times recorded were off by 10 minutes. The time provided in the interpretation summary has been adjusted as presented in Figures C-5 and C-7, Appendix C.

Table 8: Volumetric Moisture Content for the 2 Manual TDR Data Sets

TDR Sensor	Sensor Depth (mm)	Manual Volumetric Moisture Content May 3, 2000			
		Set 1	Time	Set 2	Time
1	0.330	23.2	935	23.2	1028
2	0.437	28.9	936	N/A	1100
3	0.584	32.0	937	32.5	1101
4	0.737	25.9	937	25.9	1102
5	0.889	23.2	938	25.9	1103
6	1.041	23.2	939	23.2	1104
7	1.194	25.9	939	24.0	1105
8	1.346	34.9	939	31.0	1106
9	1.656	48.4	940	48.4	1107
10	1.961	27.7	940	27.7	1108

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3. ***Automated Resistivity*** - Mobile automated Resistivity measurements were taken in conjunction with TDR data collection at 8:46 am, 9:39 am (extra), 9:43 am and 9:59 am. The resulting traces and resistance values along with a 100k-resistor reference value are provided in Figures C-8.1 through C-8.4, Appendix C. What appeared as reasonable and very repeatable results were collected from all contact points; based on soil condition and water table depths. Due to the time of year and soil condition these results will have no relevance to frost/thaw conditions at the site, but provide a benchmark for determining when frost and/or thaw has occurred.

4. ***Manual Resistance/Resistivity*** - A set of Manual contact resistance measurements were taken at 9:25 am and a set of Four-Point resistivity measurements at 9:35 am. The measurements and results are provided in Figures C-9.1 and C-9.2, Appendix C for the contact resistance and C-10.1 and C-10.2, Appendix C for the Four-point resisitivity. The resulting traces are similar to those of the automated measurements. As previously mentioned these results provide a benchmark for when frost and/or thaw occurs. These results can also provide insight to change in moisture content of the soil over time.

5. ***Piezometer Benchmark/Water Table*** - The piezometer located at station 4+00 was in excellent condition as is evident from the photo in Figure A-9, Appendix A. The piezometer pipe was stable and had minimal infiltration of fines that would have affected the water depth readings. The depth measured from top of pipe to bottom was 3.064 meters with the two sets of reading taken at 07:20 am and 17:30 pm providing a depth to water of 1.25 meters from the top of the pipe. The water depth from the top of instrument hole is 2.1175 meters. It should be noted that there was a water stream identified in the test pit between the subbase and subgrade layer at 1.55 meters or approximately 0.5 meters above water table level.

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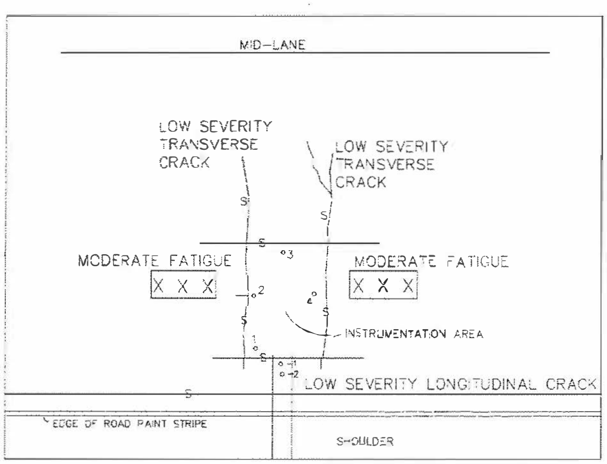
6. ***Instrument Hole Distress*** - Access for the instrument hole at 091803 was through a square block cut from the ACC surface. Over time cracks had formed at the end of the saw cuts and the slab and trench had settled as is shown in Figure 3. The cracks at the instrument hole area were well sealed (see Figure A-1, Appendix A) which would indicate that the conditions surrounding the block would have had little if any effect on the instrumentation.

LTPP SESONAL MONITORING PROGRAM
DATA SHEET SMP-M1 (Page1)
DISTRESS SURVEY OF INSTRUMENTATION AREA

NORTH ATLANTIC REGIONAL OFFICE



MEASUREMENT DEVICE : GEORGIA FAULTMETER

LOCATION	SETTLEMENT, mm			
	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4
INSTRUMENTATION BLOCK/HOLE	-5.8	-4.6	-7.4	0.2
TRENCH	-7.1	-4.7	N/A	N/A

SITE 091803
CONNECTICUT
DISTRESS

PLOTDATE: JAN 05/01

FIGURE A-3 Distress Survey of Instrumentation Area

Figure 3: Distress Survey of Instrumentation area.

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7. ***Temperature*** - The MRC thermistor probe was connected to the CR10 datalogger and the measurements were monitored for approximately one hour. Seventeen of the eighteen MRC thermistor sensors were operational and provided reliable results. The number one MRC thermistor was inoperative, which is typical as this sensor is closest to the surface, and is the least protected from the environmental and traffic impact. The temperatures from the final month (in year 2000) as provided by the MRC thermistor probe are provided in Figure 4.

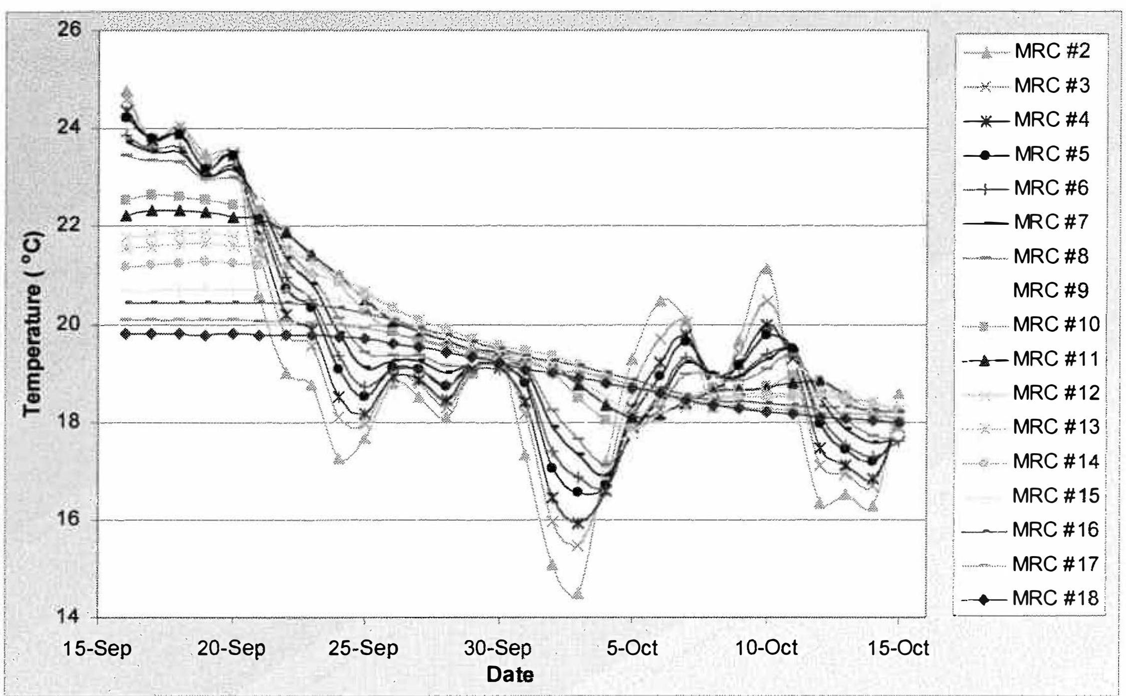

Figure 4: Temperature Profile from the MRC Thermistor Probe

4.2 Sensor Removal and Examination

The TDR sensors were removed one at a time from the top downward as the test pit was excavated and drilling progressed to the bottom of the instrumentation test hole. Measurements were taken from the top of the pavement surface to the top of each sensor (TDR sensor, MRC thermistor probe and ABF resistivity probe). The soil profile did not show any difference between the soil layers or material characteristics at the instrument hole area and the surrounding test pit area. This is rather surprising when you take into consideration the wet weather conditions and installation problems during removal and placement of soil and instrumentation at the installation. Figure 5 provides the profile of the pavement structure and the probe depths from the pavement surface at station 5+20. Table 9 provides the installed location depths for the MRC thermistor sensors, ABF resistivity electrodes (partial) and TDR sensors as measured at the time of the removal. The condition of the sensors and the interface with the surrounding soil is as follows:

- The ten 3-prong 203mm TDR probes, manufactured to FHWA/LTPP specification by FHWA-Turner Fairbanks Laboratory, were in very good condition, but due to the coarse nature of the base/subbase material and the depth and wet conditions of the subgrade, the instrumentation was almost impossible to remove intact. There was no visible corrosion, loose or weak connections observed for any of the connections. Figure A-10, Appendix A provides a photo of a TDR probe damaged during removal from the soil.
- The ABF resistivity probe was removed intact from the instrument hole. The probe was at a depth of 0.220 meters from the pavement surface. The probe electrodes (copper rings) were in good condition with some minor corrosion developing on the rings and cable solder joints.
- The MRC thermistor probe was damaged in the early stages of removal when the backhoe operator tipped the bucket back to remove a large rock as shown in Figure A-11, Appendix A. The height of the probe, as measured from the pavement surface, was 0.215 meters. The probe was firmly matted to the surrounding soil.

Pavement Layer	Depth (mm)	Probe	TDR Depth (mm)	TDR Depth (mm)*	Comments
Asphalt	189				Average Block Depth 189 mm
Medium Brown Gravel	488	TDR 1 TDR 2	335 437	(330) (437)	Assumed Thermistor Probe Depth 214 mm Measured 215mm
Grayish Dark Brown Silty Gravel with Sand (Numerous Cobbles/Boulder)	1544	TDR 3 TDR 4 TDR 5 TDR 6 TDR 7 TDR 8	589 742 894 1046 1199 1351	(584) (737) (889) (1041) (1194) (1346)	Assumed Resistivity Probe Depth 214 Measured 220mm
Black Loam with Traces of Gravel	1808	TDR 9	1656	(1656)	
Light Brown Silt and Sand (Yellowish)	2000	TDR 10	1961	(1961)	

*( ) measured at time of excavation and removal from soil

Figure 5: Profile of Pavement Structure and Probe Depths From Surface, Station 5+20

Table 9: Installed Location of MRC Thermistor Sensors, Resistivity Probe Electrodes and TDR Sensors

Layer	MRC Thermistors		Resistivity Probe Electrodes		TDR Sensors		Remarks
	Channel #	Depth	Electrode #	Depth	Sensor #	Depth	
Surface	1	0.025					Installed in the AC layer
	2	0.095					
	3	0.164					
Base	4	0.240	1	0.250			Installed below the AC layer into the subgrade
	5	0.317	3	0.350	09A01	0.330	
	6	0.393	4	0.400	09A02	0.437	
Subbase	7	0.469	6	0.500			Installed below the AC layer into the subgrade
	8	0.545	7	0.550	09A03	0.584	
	9	0.698	10	0.700	09A04	0.737	
	10	0.850	13	0.850	09A05	0.889	
	11	1.002	17	1.050	09A06	1.041	
	12	1.155	20	1.200	09A07	1.194	
	13	1.307	23	1.350	09A08	1.346	
Subgrade	14	1.460	26	1.500			Installed below the AC layer into the subgrade
	15	1.612	29	1.650	09A09	1.656	
	16	1.764	32	1.800	09A10	1.961	
	17	1.917	35	1.950			
	18	2.069	36	2.000			

Note: Depths are measured from Pavement Surface (m)

5.0 Comparison of Methods for Determining Soil Moisture Content

The moisture values determined through TDR measurements for the LTPP program, have been done by sampling the TDR probes using a 'manual method' to obtain printed trace profiles or in an 'automated mode' using multiplexers to sample and store the data in a CR10 datalogger. Since the interpretation method between the two procedures differs, a comparison of the moisture determined by each method, on data collected at the same time, was done as part of the supplemental data collection.

Table 10 provides the volumetric moisture content for both the manual and automated TDR traces collected on May 3, 2000, using LTPP procedures. The results provide the variation in moisture for both material type and location. In

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general the manual trace interpretation provides slightly higher moisture values than the automated TDR traces. A slight difference between the data sets, as collected at different times, was also observed. This could be the result of a slight change in the TDR waveforms due to the soil being disturbed from the removal of the surface material, changes due to evaporation or the electronic/mechanical efficiency of the Tektronix cable tester. The difference, as a percentage, is provided for data set 2 of both the manual and automated TDR traces in Table 11. These results would indicate that the TDR method for determining moisture content of soil is every bit as reliable as that of the Nuclear or Dry Weight method. The difference between the automated and manual method is more likely due to interpretation than the actual TDR traces as the both sets of traces are produced from 256 data points captured by the Tektronix cable tester.

Table 12 provides a comparison of the TDR gravimetric moisture content determined by converting the volumetric data to % weight using the material density values from the Proctor test results. Table 13 provides a comparison between gravimetric moisture as determined by manual TDR method, The Nuclear method and the moisture from the various material samples that were dried and weighed at the Connecticut DOT laboratories. The soil samples taken at the TDR locations provided a large variation in moisture content. The amount of variability of the sampled material makes it difficult to do a direct comparison between the two methods of determining moisture content. What is evident is the moisture values show a similar change for all 3 methods for the various soils sampled at different depths. Due to the wide variability in soil composition and the number of cobbles and big rocks encountered, the results are probably quite reasonable depending on the location of sample. The results indicate all 3 methods are valid for determining if the soil is moist or wet. The results do not provide the type of information to accurately interpret if the TDR method is providing reasonable gravimetric moisture, in particular, when compared with the laboratory dry weight method.

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Table 10: Volumetric Moisture Content for the TDR Data sets

TDR Sensor	Manual (%vol)				Automated (%vol)					
	Set 1	Time	Set 2	Time	Set 1	Time	Set 2	Time	Set 3	Time
1	23.2	935	23.2	1028	19.1	8:54	19.1	9:47	18.5	10:03
2	28.9	936	N/A	1100	21.5	8:53	20.3	9:48	20.3	10:04
3	32.0	937	32.5	1101	30	8:53	30.6	9:48	30.6	10:04
4	25.9	937	25.9	1102	21.5	8:52	22.1	9:49	22.1	10:05
5	23.2	938	25.9	1103	13.6	8:51	12.5	9:50	17.2	10:06
6	23.2	939	23.2	1104	20.3	8:51	19.7	9:50	19.7	10:06
7	25.9	939	24.0	1105	20.3	8:50	20.9	9:51	20.3	10:07
8	34.9	939	31.0	1106	28.2	8:54	28.2	9:51	27.6	10:07
9	48.4	940	48.4	1107	47.2	8:55	46.8	9:52	47.6	10:08
10	27.7	940	27.7	1108	25.8	8:55	27.0	9:52	25.8	10:08

Table 11: Comparison of Manual and Automated TDR Volumetric Moisture Content

Date: 03/May/2000
Probe Velocity .99
Probe length .203m

Layer type	Layer Description	Probe No.	Depth below surface (mm)	Start time: 0935hrs Manual TDR		Start time: 0947hrs Automated TDR		Differentials	
				Dielectric Constant	(%/vol)	Dielectric Constant	(%/vol)	Dielectric Constant (%diff)	Moisture (%diff)
Base	Medium brown gravel	1	330	12.3	23.2	9.8	19.1	20	18
		2	437	15.8	28.9	10.8	20.3	32	30
Sub-base	Grayish brown silty gravel with Large rock	3	584	17.9	32.0	17.0	30.6	5	4
		4	737	13.9	25.9	11.8	22.1	15	15
		5	889	12.3	23.2	9.2	12.5	25	46
		6	1041	12.3	23.2	10.4	19.7	15	15
		7	1194	13.9	25.9	10.8	20.9	22	19
		8	1346	20.1	34.9	15.0	28.2	25	19
Sub-grade	Black loam	9	1656	35.6	48.4	34.4	46.8	3	3
	Light brown loam	10	1961	17.1	27.7	13.9	27.0	19	3

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Table 12: Gravimetric Moisture Content for the Manual & Automated TDR Data sets

TDR Sensor	Manual (%/wt)		Automated (%/wt)		Moisture Differential (%diff)
	Set 1	Time	Set 2	Time	
1	10.4	935	8.6	947	17
2	12.8	936	9.0	948	30
3	14.8	937	14.1	948	5
4	12.0	937	10.2	949	15
5	10.7	938	5.8	950	46
6	10.6	939	9.0	950	15
7	11.8	939	9.5	951	19
8	16.7	939	13.5	951	19
9	28.9	940	27.9	952	3
10	16.5	940	16.1	952	2

Table 13: Comparison of Manual TDR and Gravimetric Moisture Content at time of TDR Removal of Soil

Date: 03/May/2000
Time: 1038 hrs

Layer type	Layer Description	Probe No.	Depth below surface (mm)	*Laboratory Proctor Results*			*Dry Weight Method*	*TDR Method*		*Nuclear Density Results*	
				Dry density			Probe moisture sample (%/wt)	TDR Moisture content		Probe moisture sample (%/wt)	
				(lb/ft^3)	(kg/cm^3)	(%/wt)		(%/vol)	(%/wt)	Min-Max	Average
Base	Medium brown gravel	1	330	139.1	2229	5.8	7.54-8.06	23.2	10.4	6.47-9.11	7.39
Base	Medium brown gravel	2	437	140.7	2255	5.4	6.35-7.67	28.9	12.8	10.02-13.17	11.48
Sub-base	Grayish brown silty gravel with Large rock	3	584	135.0	2163	7.8	10.87-14.96	32.0	14.8	10.02-13.17	11.48
Sub-base	Grayish brown silty gravel with Large rock	4	737	135.0	2163	N/A	11.0-13.04	25.9	12.0	8.72-9.47	9.18
Sub-base	Grayish brown silty gravel with Large rock	5	889	135.2	2166	6.0	8.64-9.66	23.2	10.7	8.72-9.47	9.18
Sub-base	Grayish brown silty gravel with Large rock	6	1041	136.8	2192	6.9	6.45-8.88	23.2	10.6	7.49-9.53	8.53
Sub-base	Grayish brown silty gravel with Large rock	7	1194	136.8	2192	N/A	8.36-10.57	25.9	11.8	7.49-9.53	8.53
Sub-base	Grayish brown silty gravel with Large rock	8	1346	130.5	2091	10.3	11.66-12.98	34.9	16.7	N/A	N/A
Sub-grade	Black loam	9	1656	110.0	1675	N/A	22.02	48.4	28.9	N/A	N/A
Sub-grade	Light brown loam	10	1961	110.0	1675	N/A	13.09	27.7	16.5	N/A	N/A

Note: Laboratory proctor results from May 5, 2000. Lower moisture value may be due to moisture evaporation from sample.

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6.0 Collection and Reporting on Monitoring Data

As part of the pre rehabilitation testing at this LTPP GPS-1 site, Falling Weight Deflectometer (FWD), Manual Distress Survey (MDS), Transverse & Longitudinal Profiles and Elevation data were collected. In addition to the closeout testing, two sets of FWD data were collected on the seasonal monitoring portion of the section. This data has been added to the LTPP Information Management System (IMS) database. The pavement performance monitoring data has been analyzed, with the exception of the FWD seasonal monitoring data, and historical trends are reported as part of this document. Post construction material sampling and MDS was completed on this section in early July 2000, with FWD and profile data collected in the fall of 2000. This site has remained in the LTPP program as a GPS-6s. The following provides the results of the analysis and reports on the trends in the data from the initial data collected as part of the LTPP program to the last set of data collected as part of the post-diagnostic study.

6.1 Deflection Data Analysis Results

The average normalized temperature corrected deflections for the 40 KN equivalent loading for all the stations were plotted with time. In addition, the results for station 3+00 (91m) have been plotted to show the dispersion represented by an individual test location. The surface deflection trends, as reported from the sensor located under the load plate, are provided for all stations and station 3+00 in Figures 6 and 7 respectively. Similarly, the results representing the subgrade deflection trends, as reported from the sensor located 1.524 meters from the load plate, are provided for all stations and station 3+00 in Figures 8 and 9 respectively. The results, as presented in the Figure 6 through Figure 9, show an increase in deflection indicating the pavement is losing strength as time progresses. The results would indicate that the rate of increase in subgrade deflection is more than rate of increase in surface deflection.

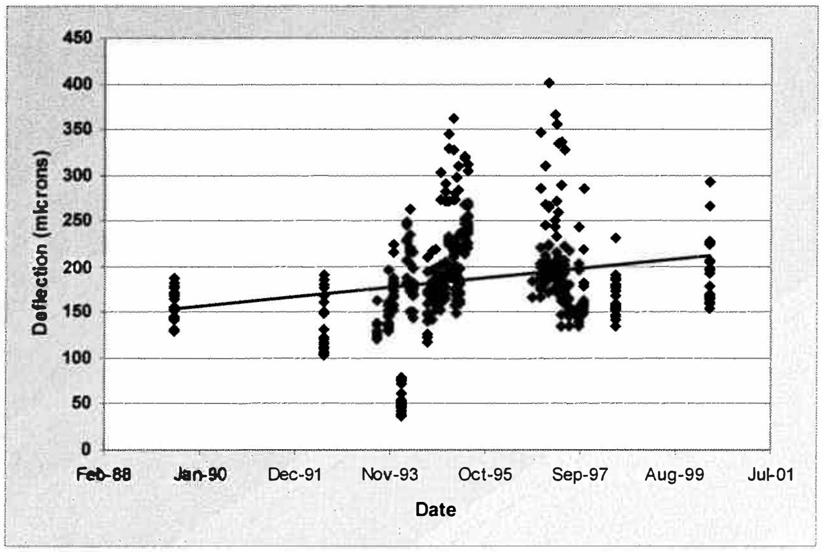

Figure 6: Historical Surface Deflection Trend – All Stations

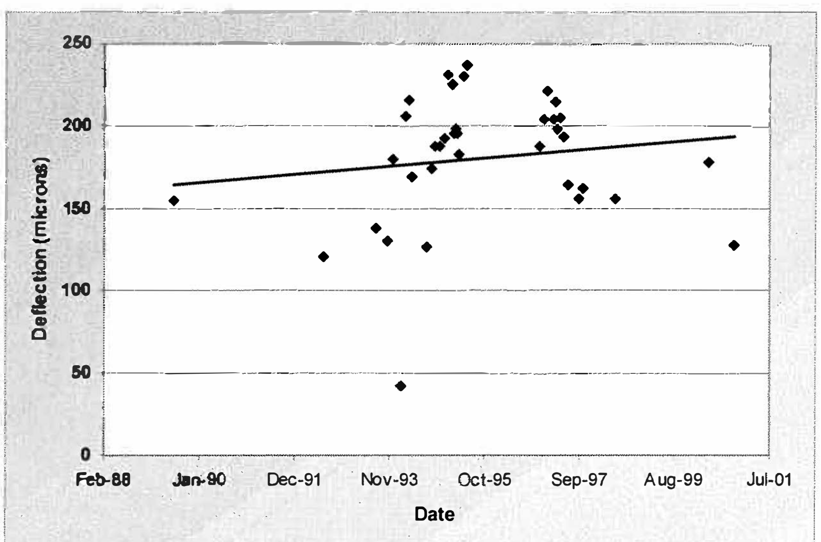

Figure 7: Historical Surface Deflection Trend – Station 3+00

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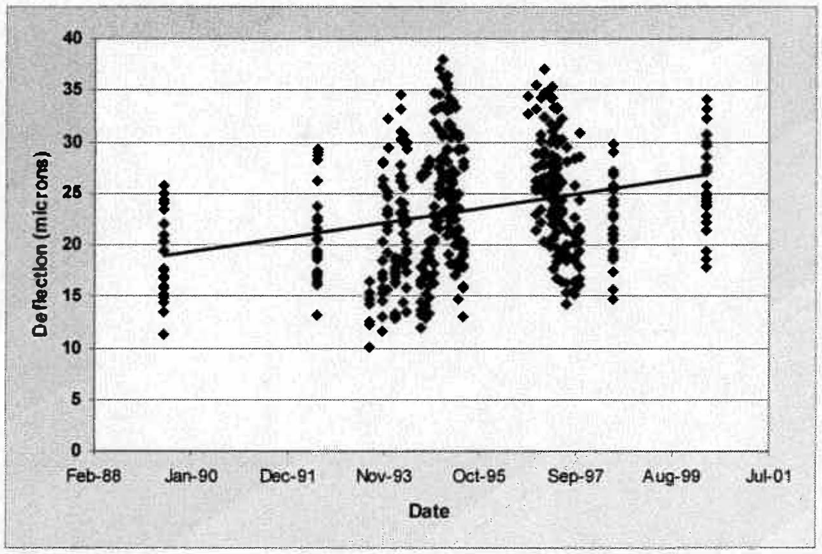

Figure 8: Historical Subgrade Deflection Trend – All Stations

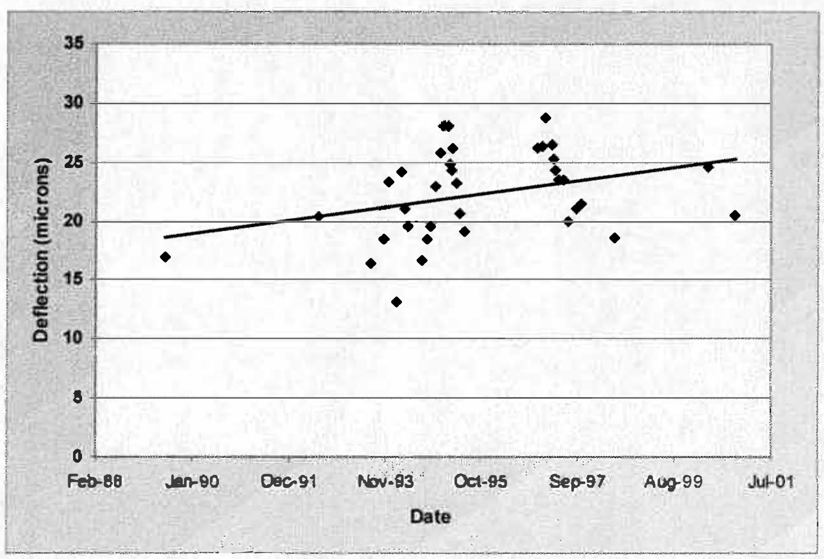

Figure 9: Historical Subgrade Deflection Trend – Station 3+00

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Backcalculation was used to analyze the FWD data and provide the moduli values for the overall pavement structure, the ACC surface layer and the subgrade for all stations and station 3+00 (91m) as reported in Figures 10 through Figure 15. An examination of the results from the overall structure would indicate that there has been some change with time but this change is more evident when examining the details from the surface and subgrade plots. These plots indicate that the pavement structures strength has decreased with time and the rate of decrease in subgrade strength is more than rate of decrease in surface strength. It should be noted that an emergency water service was placed parallel to the northbound lane on November 29, 1994. Blasting was conducted off the shoulder adjacent to the test section to complete this installation. Subsequent to this installation there was some 'arc' shaped cracks identified within the test section limits. It is possible the installation of this pipeline may have had an effect on the pavement performance.

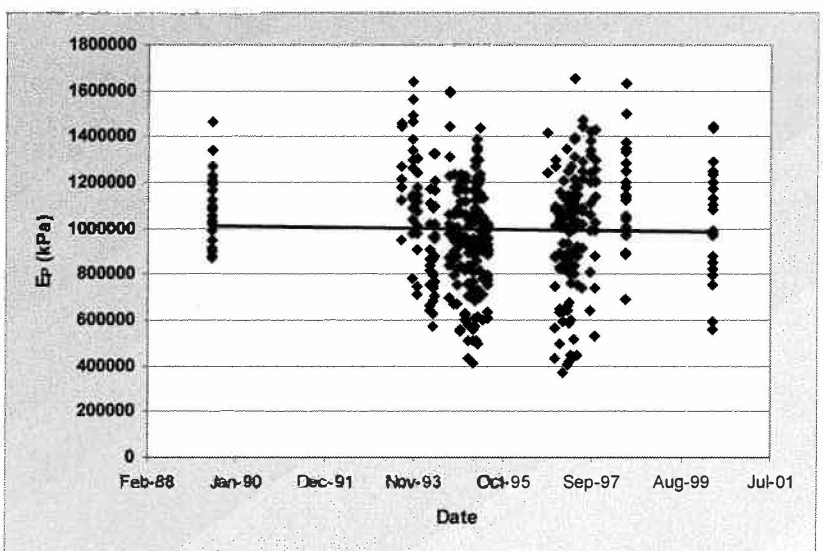

Figure 10: Historical Trend of Overall Pavement Moduli – All Stations

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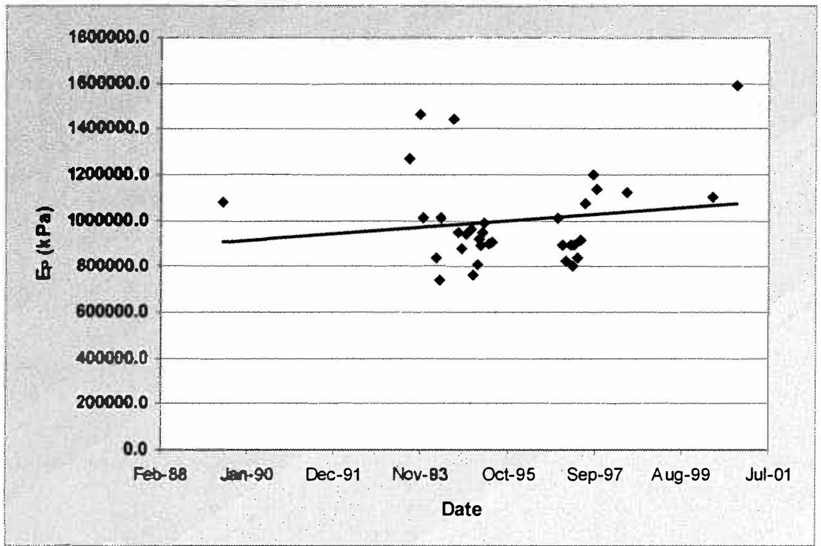

Figure 11: Historical Trend of Overall Pavement Moduli – Station 3+00

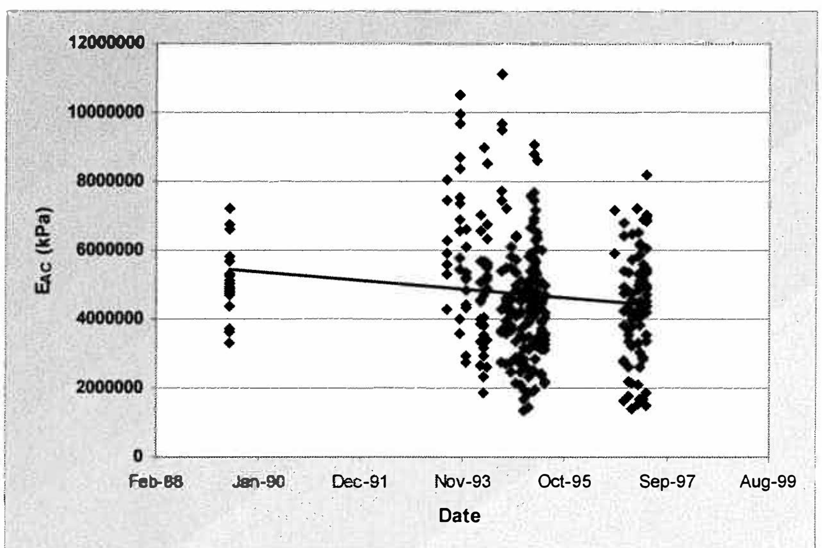

Figure 12: Historical Trend of Surface Moduli – All Stations

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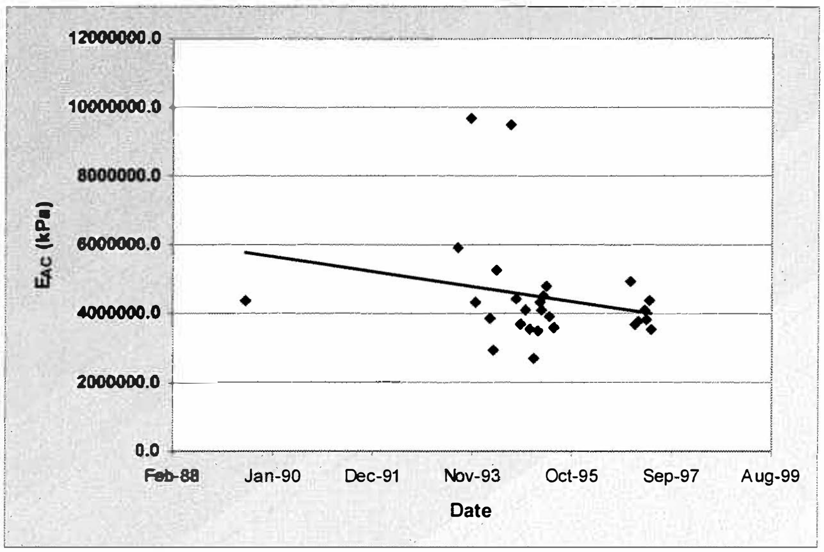

Figure 13: Historical Trend of Surface Moduli – Station 3+00

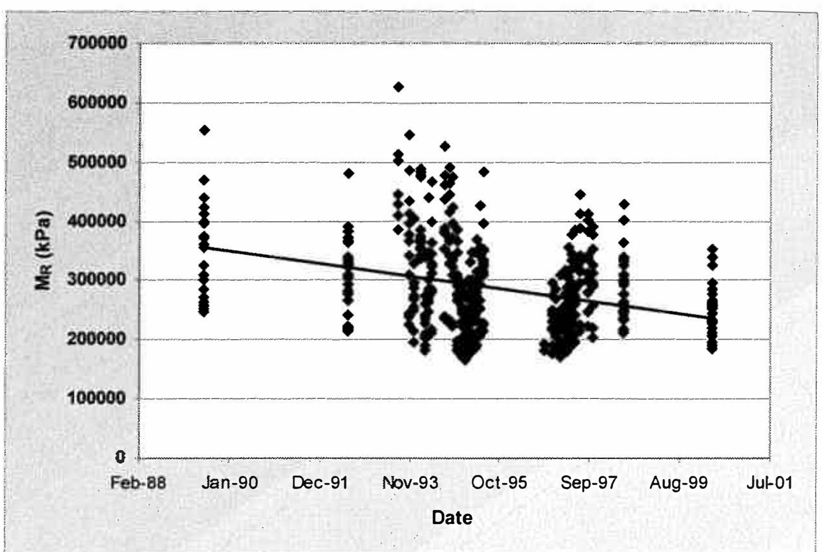

Figure 14: Historical Trend of Subgrade Resilient Moduli – All Stations

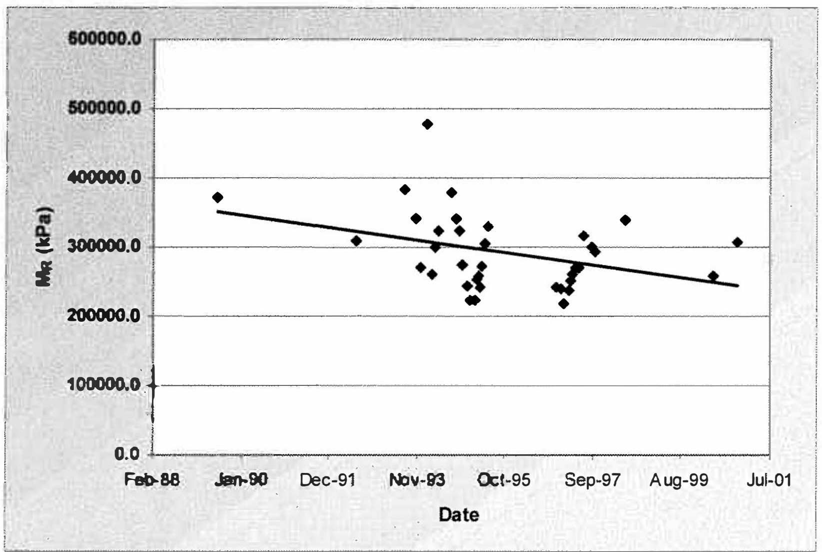

Figure 15: Historical Trend of Subgrade Resilient Moduli – Station 3+00

6.2 MDS Data Analysis Results

The results of the MDS surveys are provided in Figures 16, 17 and 18 for the three distress types evident on the pavement surface of GPS site 091803. The results of the photo interpretations are provided for 1989 through 1992 and the Manual Distress survey results are provided for the remainder of the surveys up to May 2, 2000. Low temperature (transverse cracking) was evident from the initial surveys with longitudinal and fatigue cracking appearing in the 1992 survey and becoming more predominate as time progressed. The majority of the longitudinal and transverse cracks were sealed at the time of the last survey on May 2, 2000.

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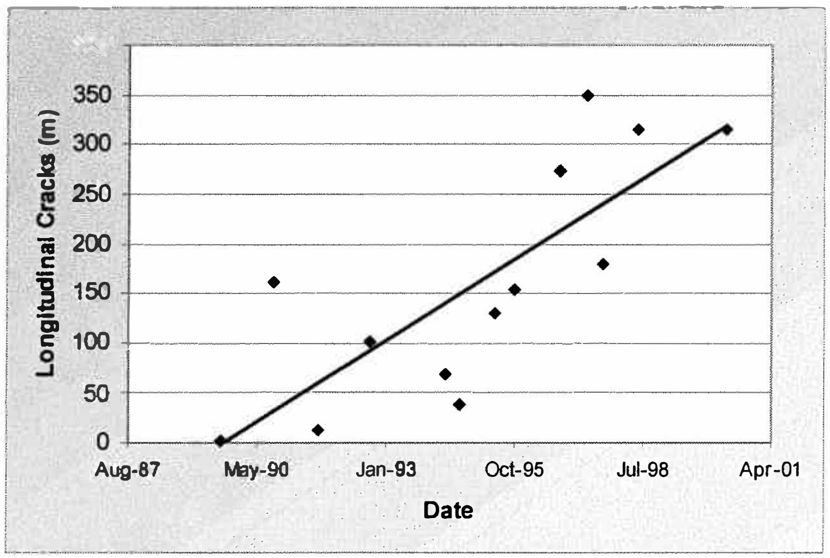

Figure 16: Historical Trend of Longitudinal Cracking

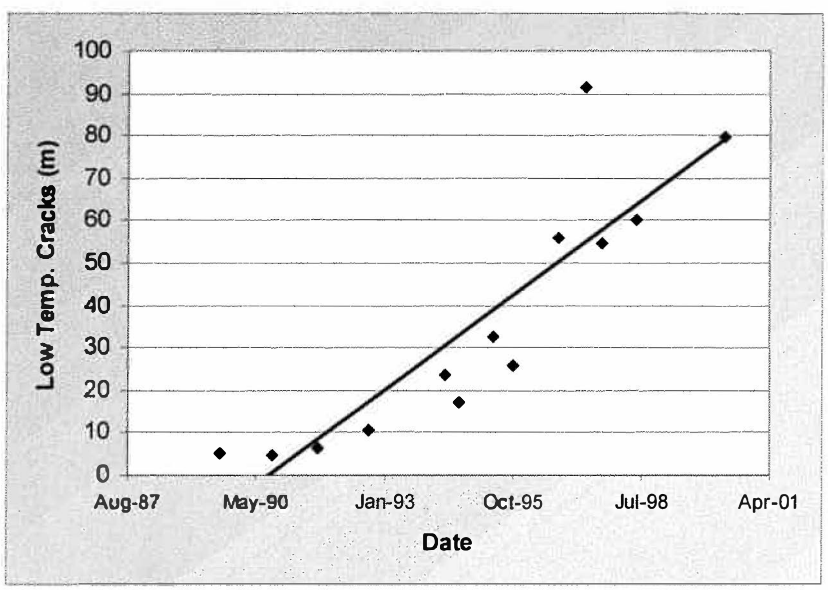

Figure 17: Historical Trend of Transverse Cracking (Low Temperature Cracks)

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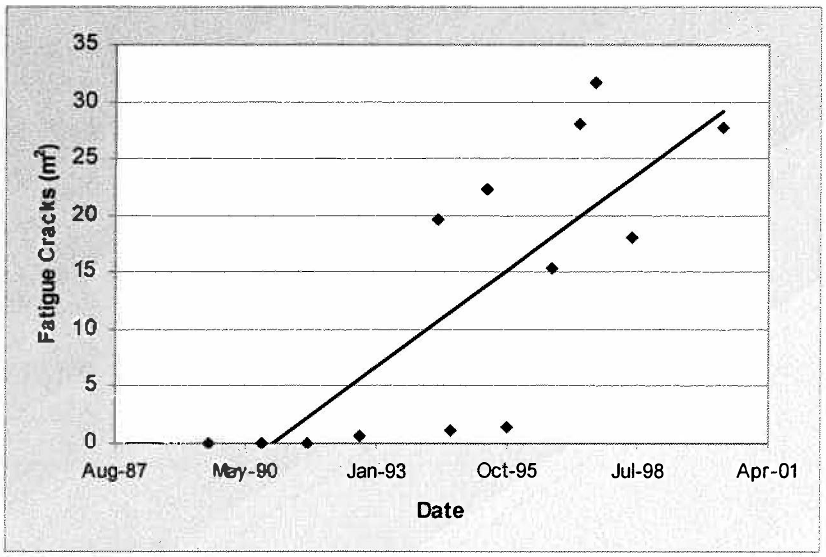

Figure 18: Historical Trend of Fatigue Cracking

6.3 Longitudinal Profile Data Analysis Results

Historical IRI data shows that the pavement roughness remained fairly constant with a slight increase in roughness with IRI's ranging from 1.5 to 1.7 m/km until the time of the rehabilitation in June 2000, at which time the IRI dropped in the range of 1.1 m/km as shown in Figure 19.

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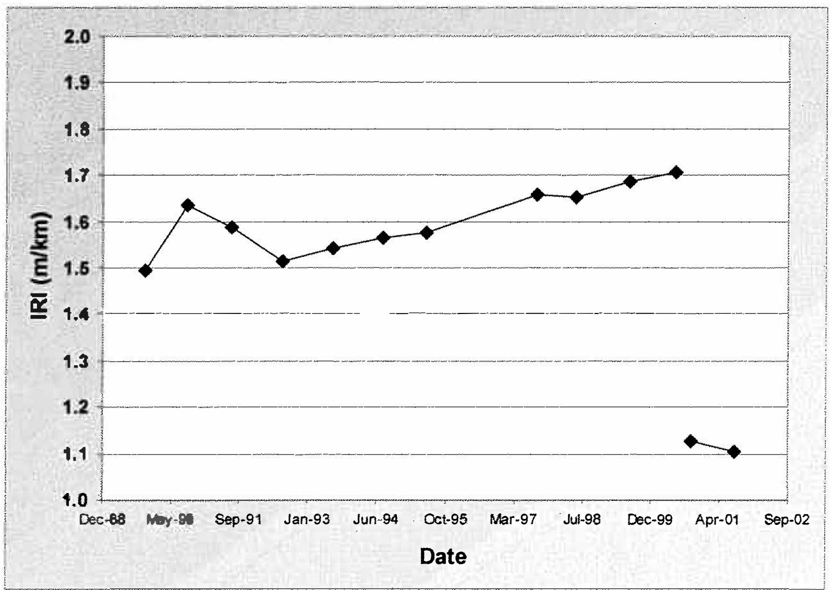

Figure 19. Historical IRI Trend

6.4 Transverse Profile Data Analysis Results

The historical trends in rut depth from the Dipstick® transverse profiles are provided for station 0+00 (0m), 2+50 (75.2m) and 5+00 (152.4m) and the sectional average in Figures 20, 21, 22 and 23 respectively. These results indicate a slight progression in rut depth over time with the right rut in most cases being slightly deeper than the left. Differences are also evident when comparing rut depth on a station-by-station basis. These differences could be the result of the distortion that was evident through the length of the section. The average rut depth for the survey on May 2, 2000 was 6mm in the right wheelpath and 4mm in the left wheelpath, which is only slightly more than the results as recorded from the 1994 survey.

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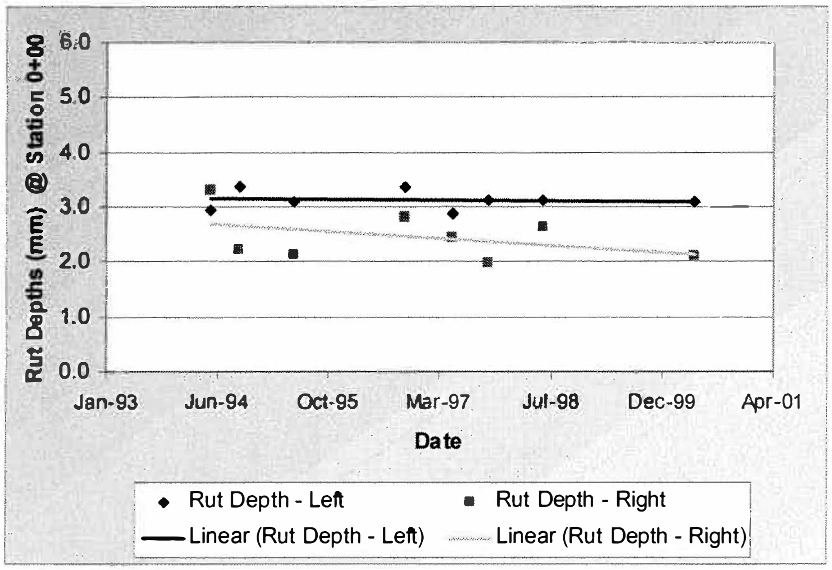

Figure 20. Rut Depths for Station 0+00 (0m)

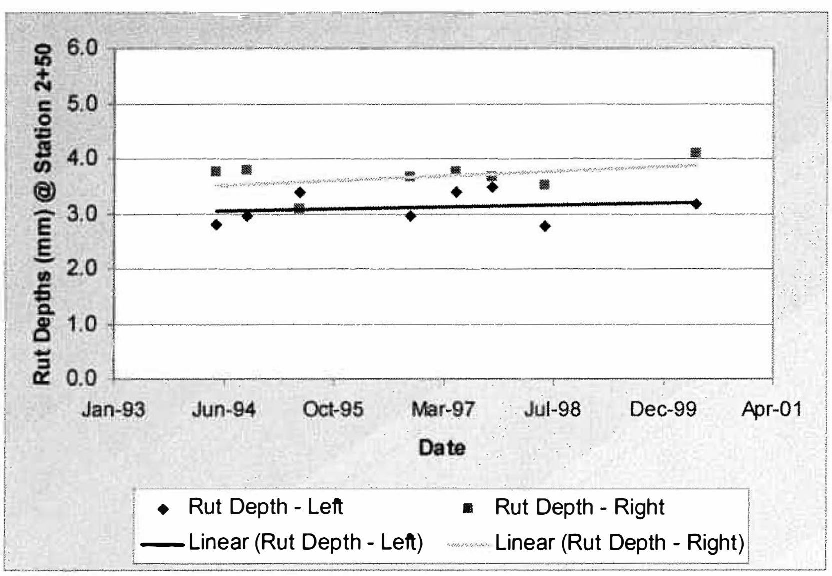

Figure 21. Rut Depths for Station 2+50 (76.2m)

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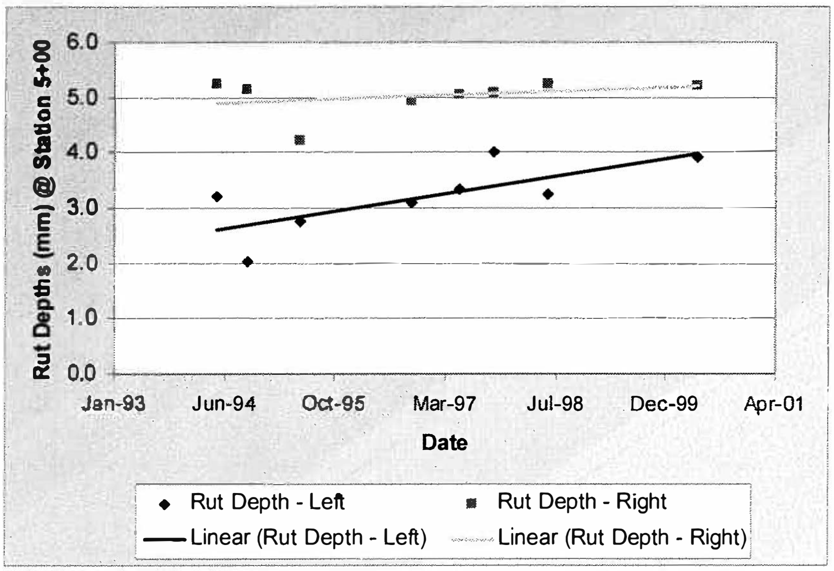

Figure 22. Rut Depths for Station 5+00 (152.4m)

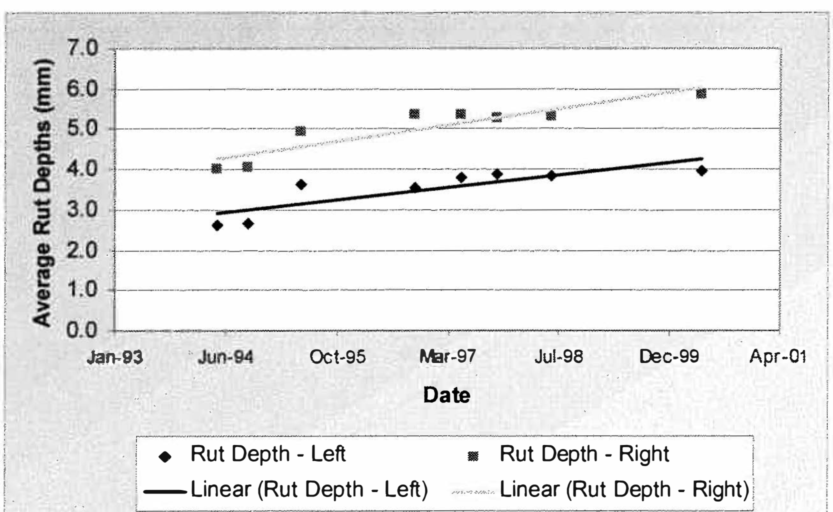

Figure 23. Average Rut Depths for LTPP Section 091803

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6.5 Elevation Data Analysis Results

A Five-Point set of levels, as per SMP guidelines, were taken at the FWD test locations to provide any elevation changes that may have occurred over time on the test section. The data for the May 2, 2000 elevation survey are provided in Figure C-11, Appendix C. Figures 24 and 25 provide the results of the elevation surveys conducted over time for Stations 3+00 (91.4m) at the start of the SMP test location and 5+19 (158.2m) at the instrumentation area. In comparing the results with previous surveys there is a fair amount of scatter in the data but no particular trend, indicating little or no change has taken place over time.

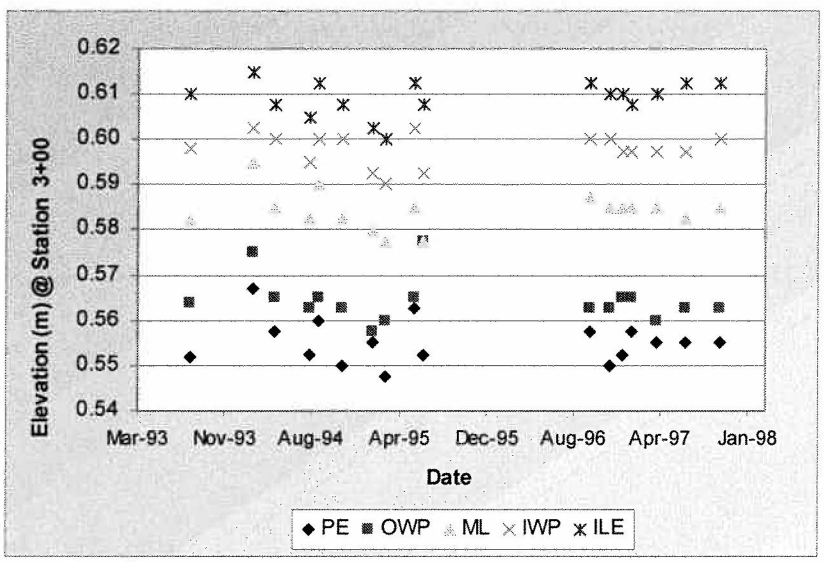

Figure 24: Historical Trends in Elevation Changes – Station 3+00 (91.4m)

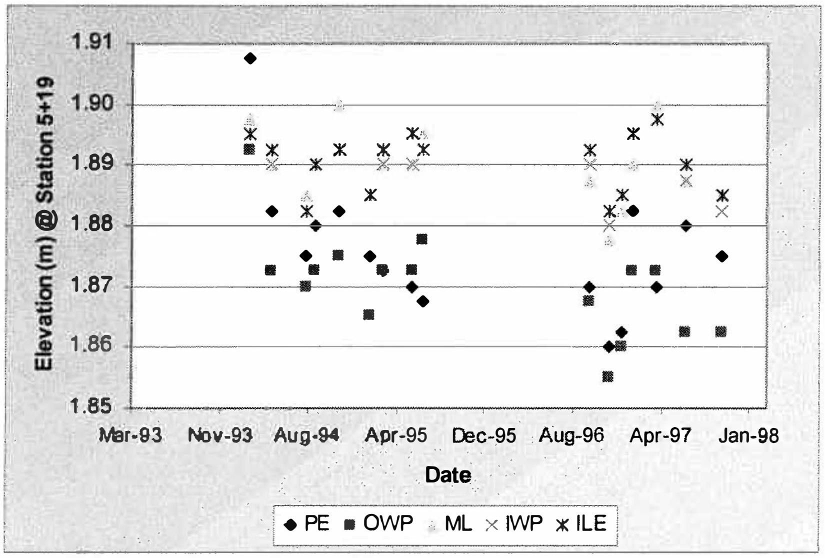

Figure 25: Historical Trends in Elevation Changes – Station 5+19 (158.2m)

7.0 Summary Discussion

1. Supplemental data collection was conducted at the CT SMP site in 2000, some 7 years after original instrumentation installation. This supplemental data was collected prior to the planned rehabilitation in the area of this LTPP SMP site location.
2. Generally, all seasonal/environmental instrumentation was in very good condition and was still in working order at the time of the supplemental data collection, with the exception of the number 1 MRC thermistor sensor near the surface of the ACC, which had failed.
3. Materials data not collected during original LTPP GPS drilling and sampling in 1989 was collected at the time of the supplemental data collection. The results from the testing and analysis of the materials data have been added to

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the IMS database. This provides a significant improvement in the data available for this section.

4. Additional valuable data and information is available for the analysis of seasonal variation of pavement performance from the seasonal, FWD and elevation data that was collected.
5. Data and information is also available for examination and evaluation of equipment and instrumentation performance, in particular to evaluate the determination of moisture values from TDR sensors. It should be noted that due to the high variability in the various material layers there were some fairly large differences in the moisture values depending on the location of sample and the amount of rock and stone present.
6. Cores taken at cracks to aid in identifying distress mechanism and cores to examine surface thickness variation at FWD test locations were taken outside of the 0-500 foot (152.4m) section limits. This information provided insight on the progression of the cracks within the ACC layer. An analysis on the variation in backcalculation results based on thickness variability was not conducted as part of this report. The FWD data and core thickness information is available for future analysis.
7. The monitoring data was used to show the trends in the performance indicators for this section from the time of the original surveys in 1989 up to and including the post-diagnostic survey in May 2000. The FWD results indicate that the structure became weaker over time. The structural weakness was exhibited by increases in roughness, distress and rutting over the length of the section. It should be noted that some of the pavement failure could be attributed to an emergency water service that was installed on November 29, 1994. The pipeline was place of the edge of the northbound lane shoulder. Blasting required during the placement of the pipeline appears to have caused arc or crescent shaped cracks within the section limits. The mill and overlay performed at this site corrected the surface deficiencies but probably would not provide a long-term improvement in the structural capacity, as strengthening improvements could be warranted in the supporting layers. Future monitoring of this section will provide insight into the effectiveness of the rehabilitation strategy.

Appendix A

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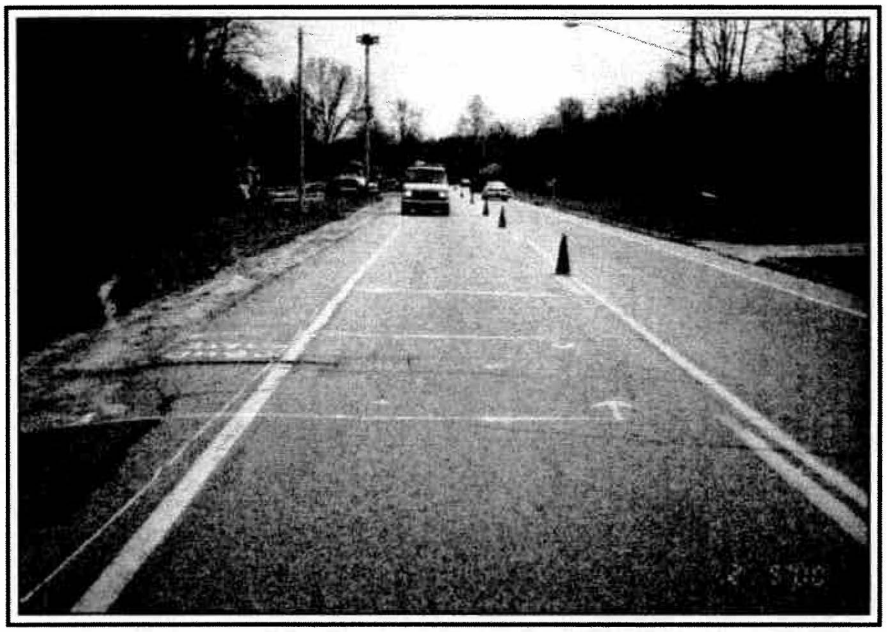

Figure A-1. Site overview

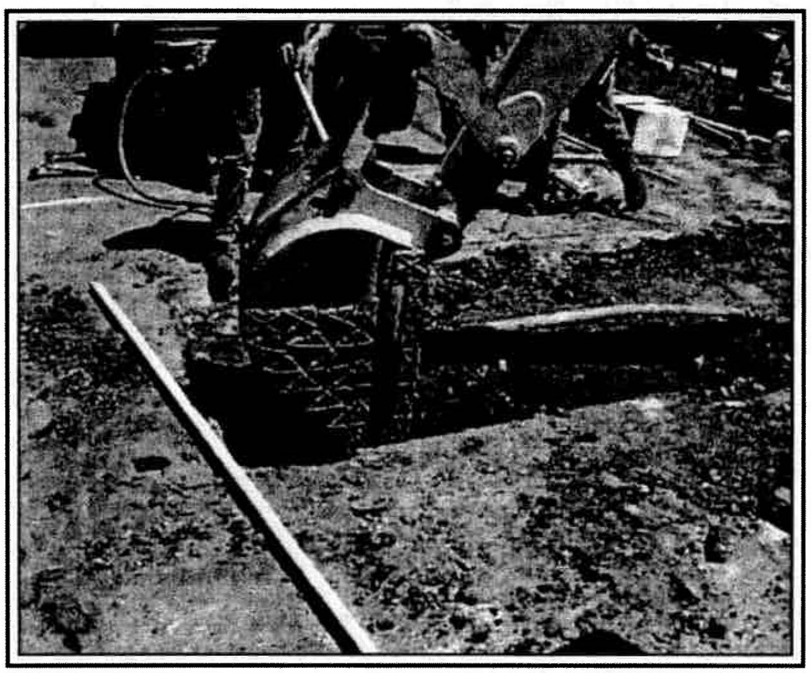

Figure A-2. Pavement slab removal

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Figure A-3. Excavation of rock material

Figure A-4. Drilling operation

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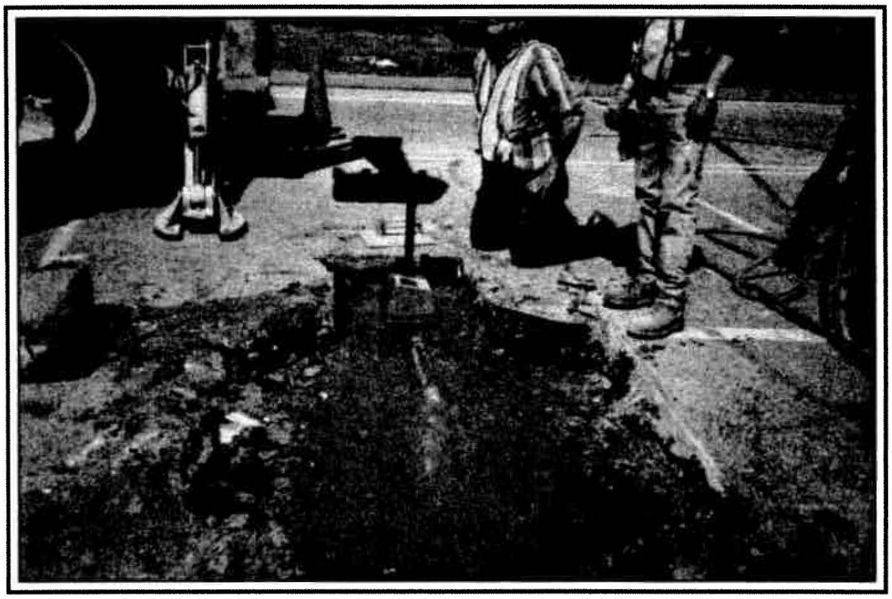

Figure A-5. Nuclear density test of base materials

Figure A-6. Measuring density/moisture sample location

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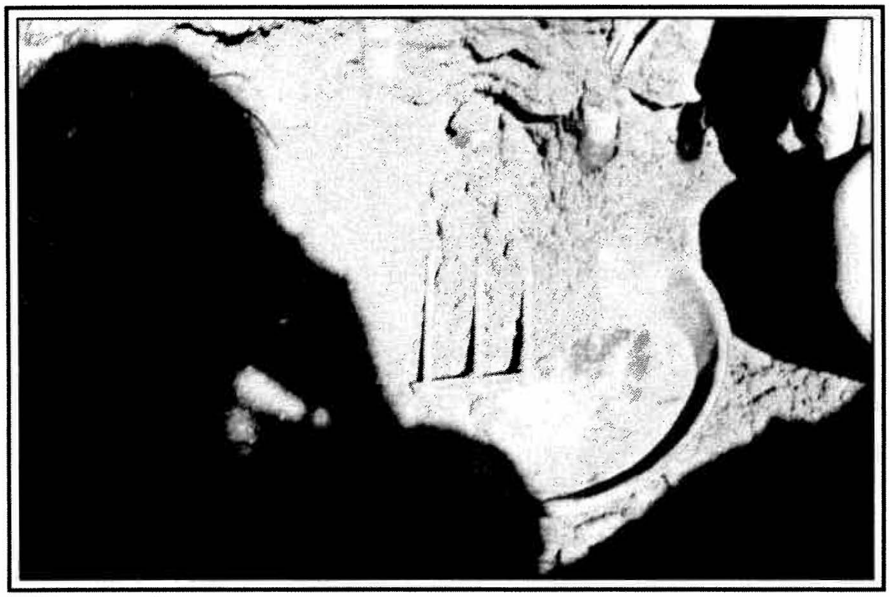

Figure A-7. Moisture sampling at probe location

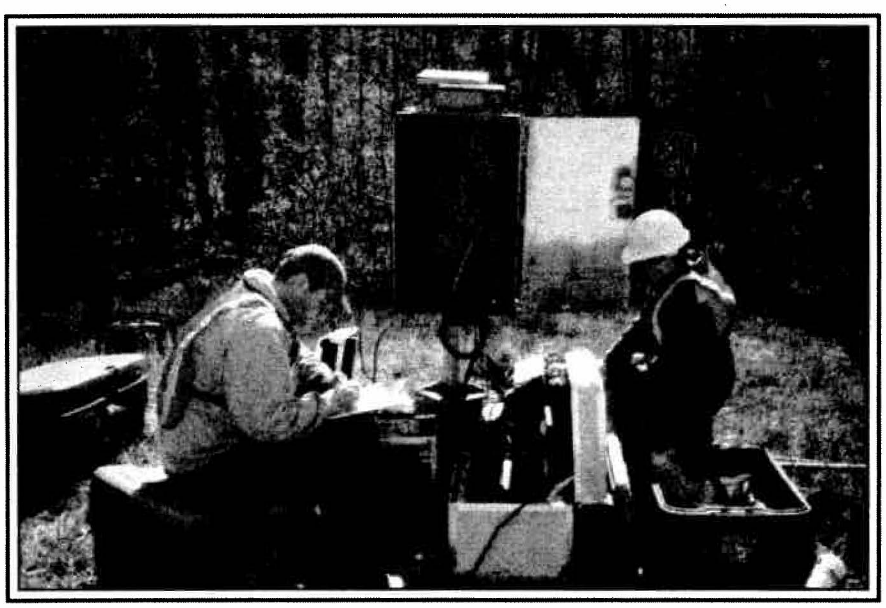

Figure A-8. Final automated data collection

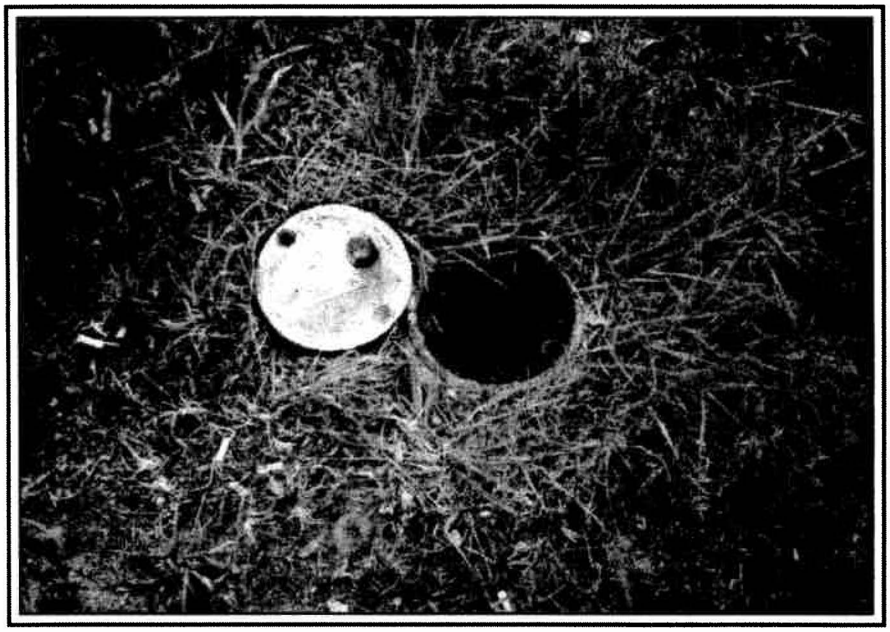

Figure A-9. Location of piezometer

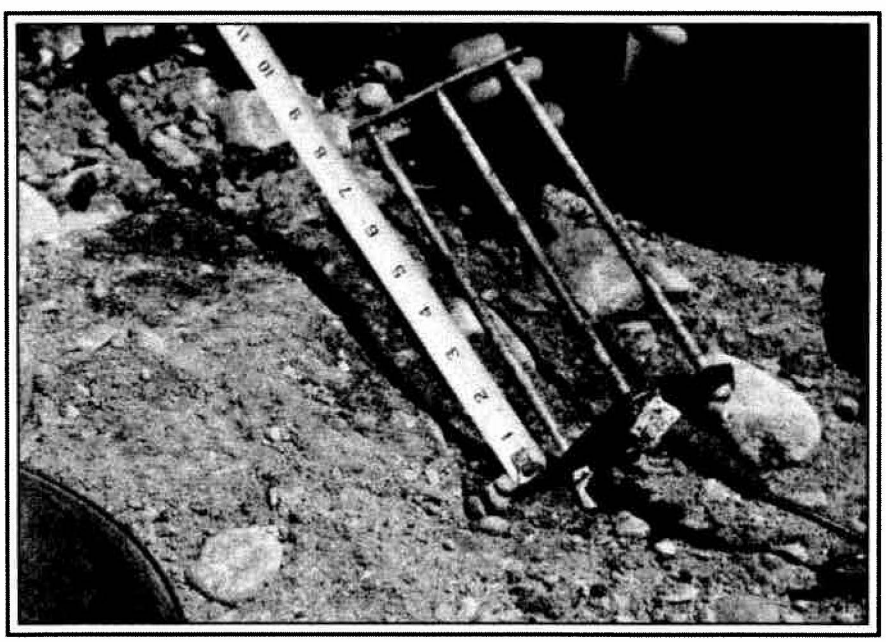

Figure A-10. Damaged TDR probe during excavation

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Figure A-11. MCR thermistor probe damaged during rock removal

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Appendix B

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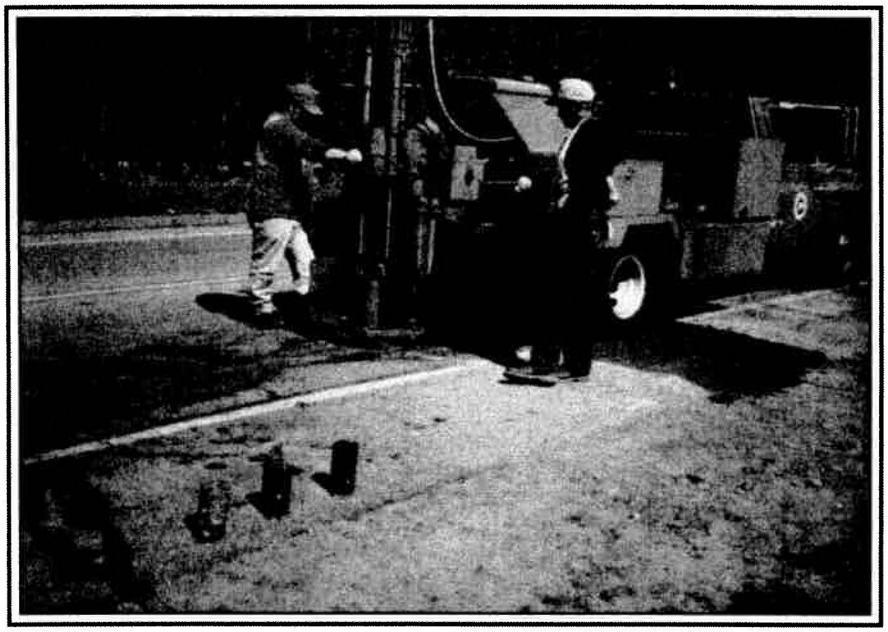

Figure B-1. Coring operation

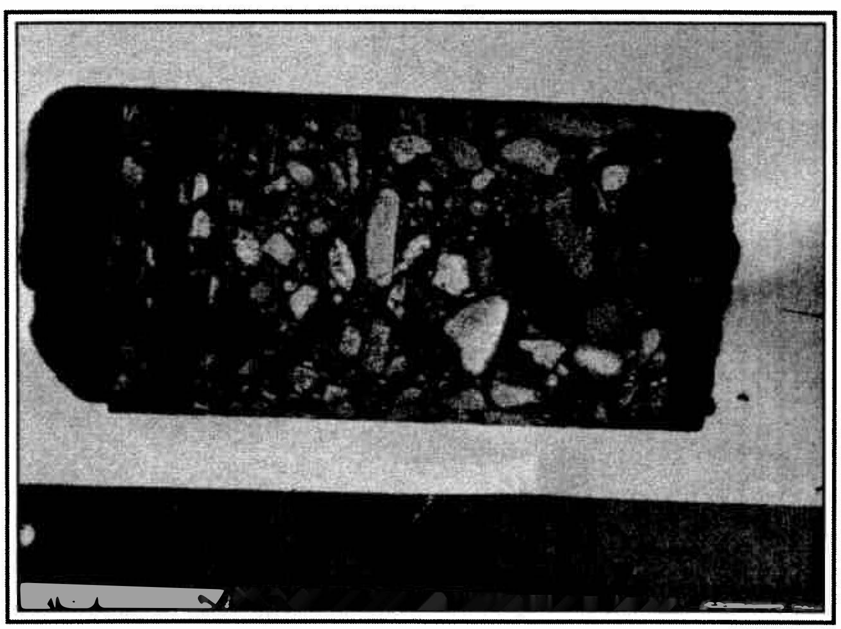

Figure B-2. Core #25

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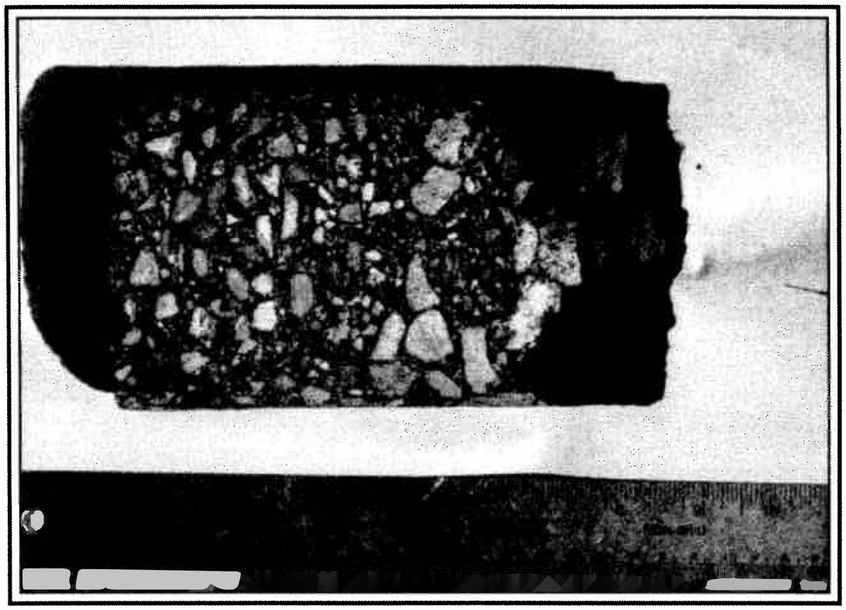

Figure B-3. Core #26

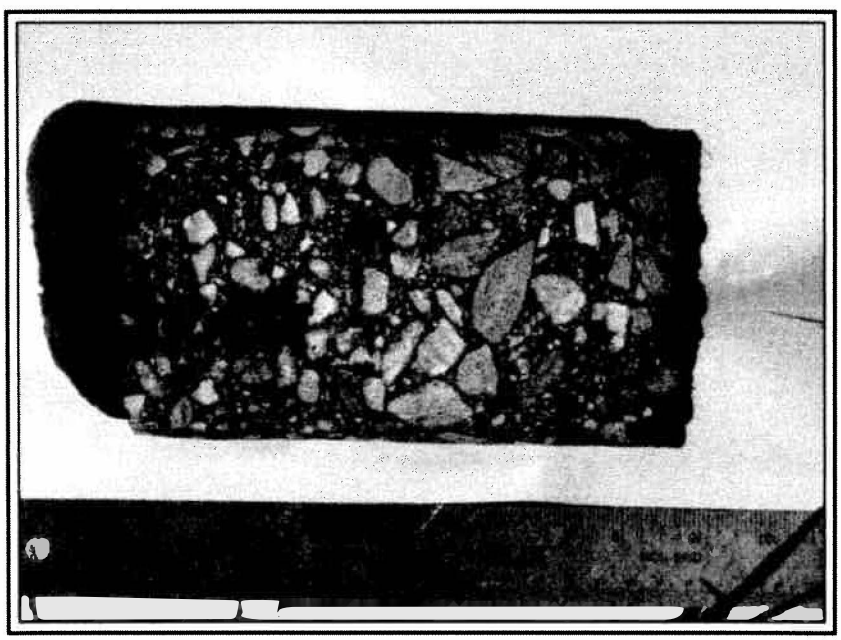

Figure B-4. Core #27

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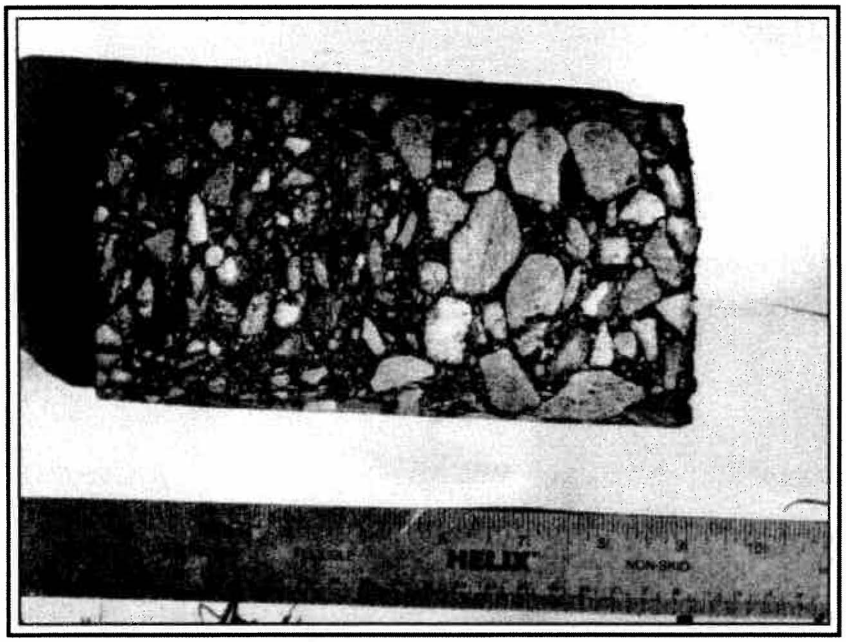

Figure B-5. Core #28

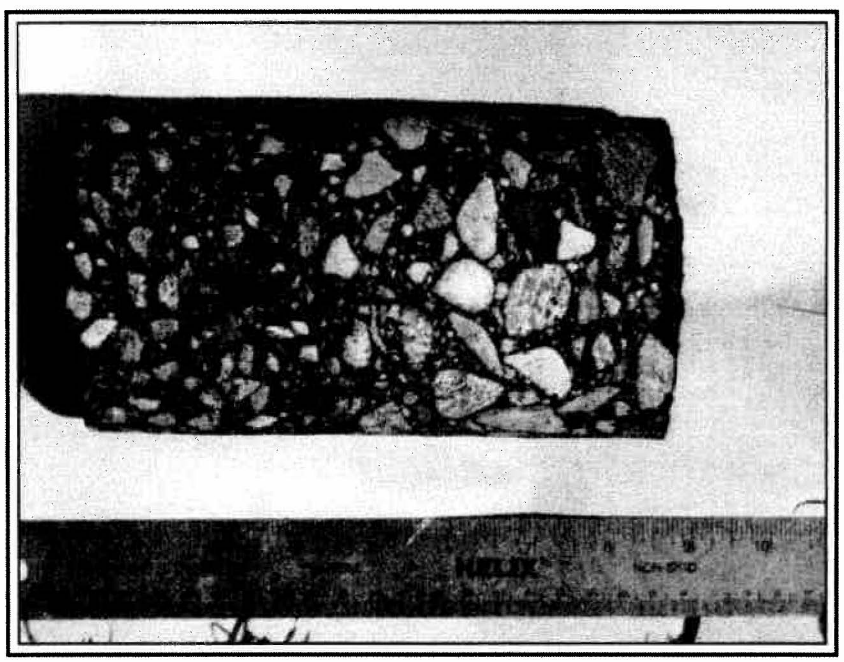

Figure B-6. Core #29

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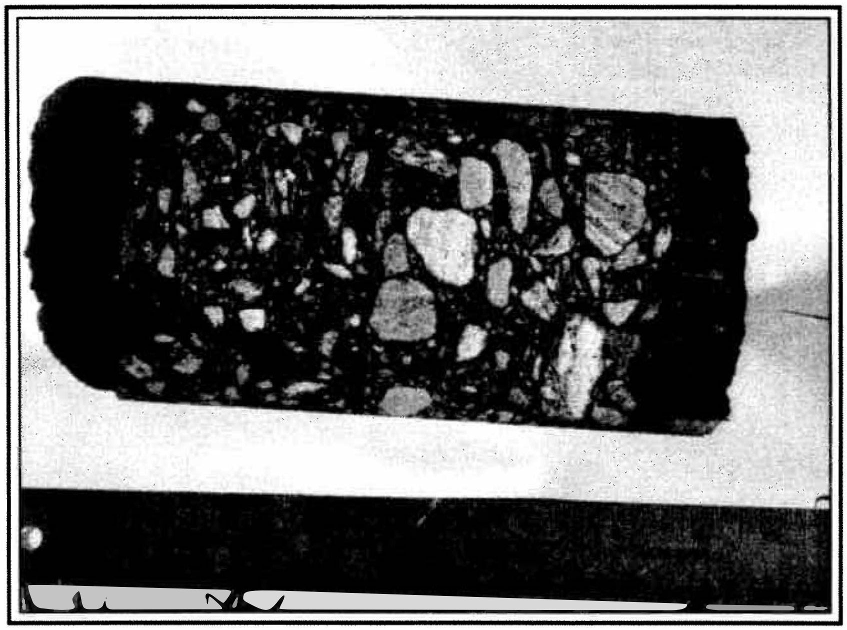

Figure B-7. Core #30

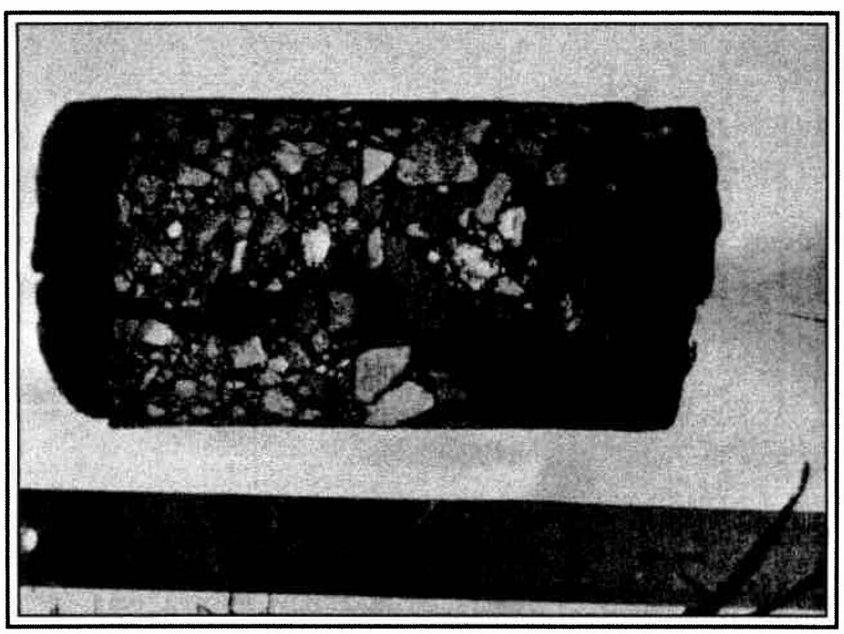

Figure B-8. Core #31

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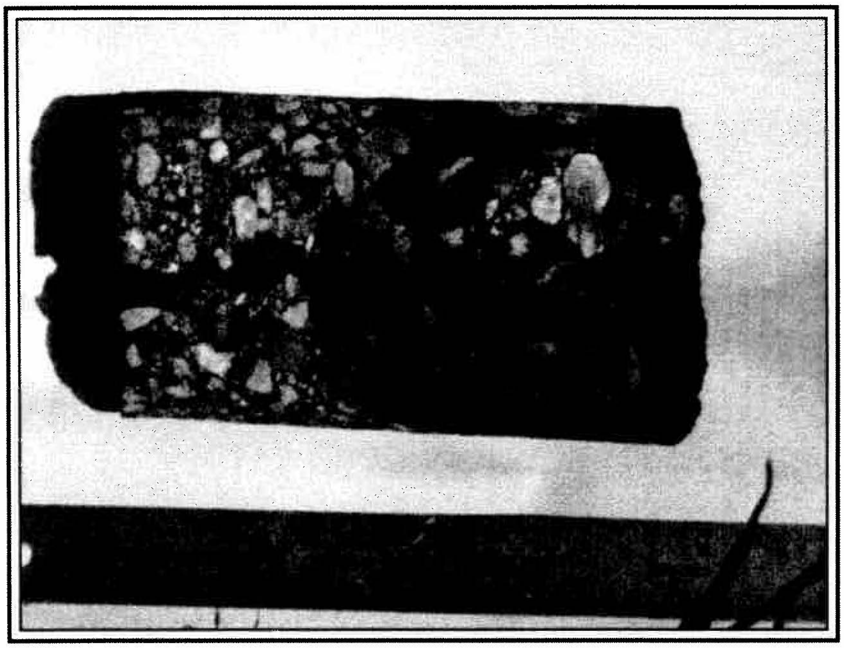

Figure B-9. Core #32

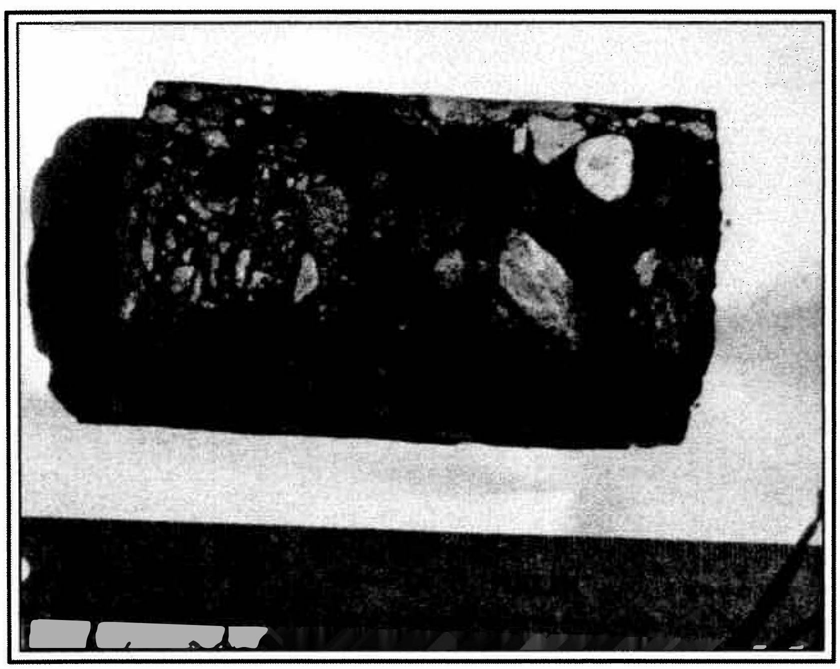

Figure B-10. Core #33

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Appendix C

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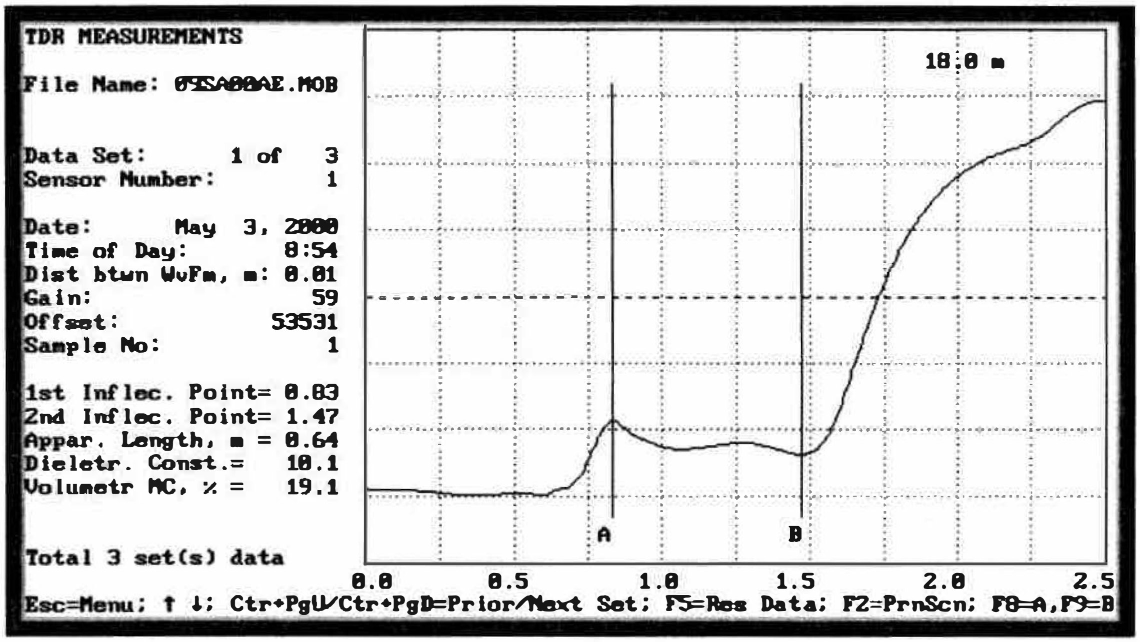

Figure C-1.1. Automated TDR Trace – Set 1, Probe #1

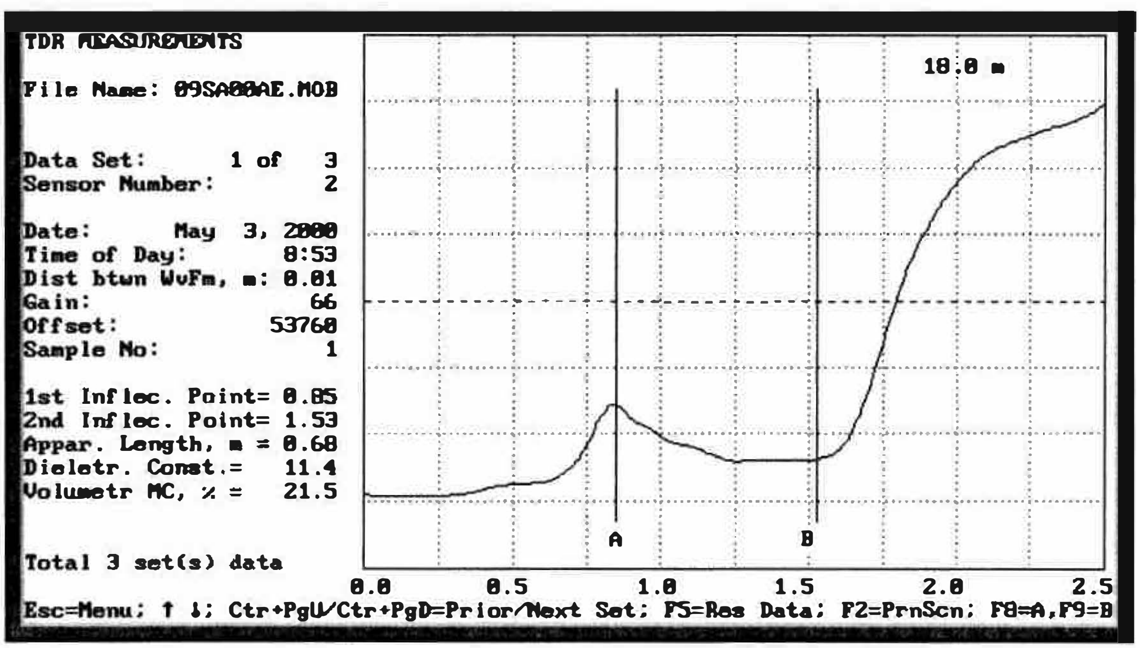

Figure C-1.2. Automated TDR Trace – Set 1, Probe #2

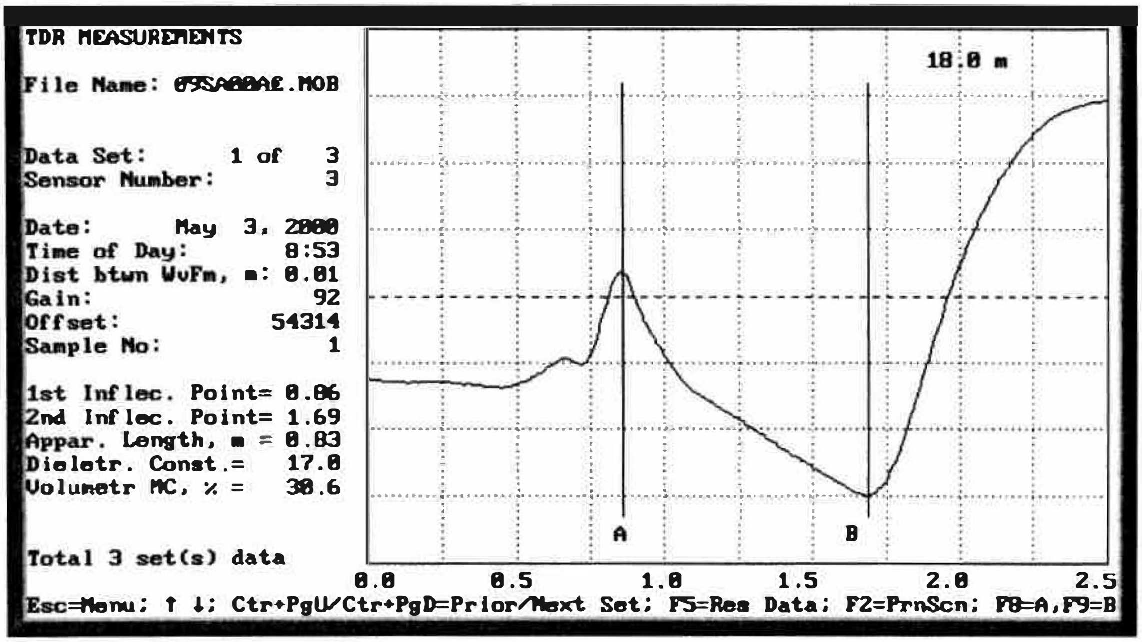

Figure C-1.3. Automated TDR Trace – Set 1, Probe #3

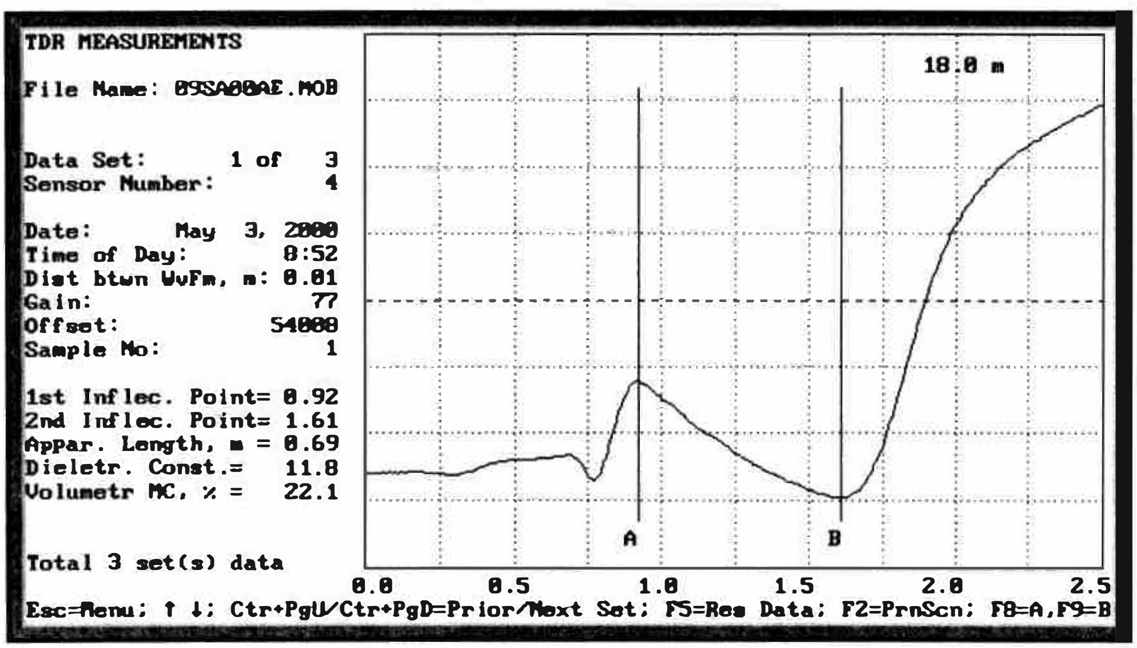

Figure C-1.4. Automated TDR Trace – Set 1, Probe #4

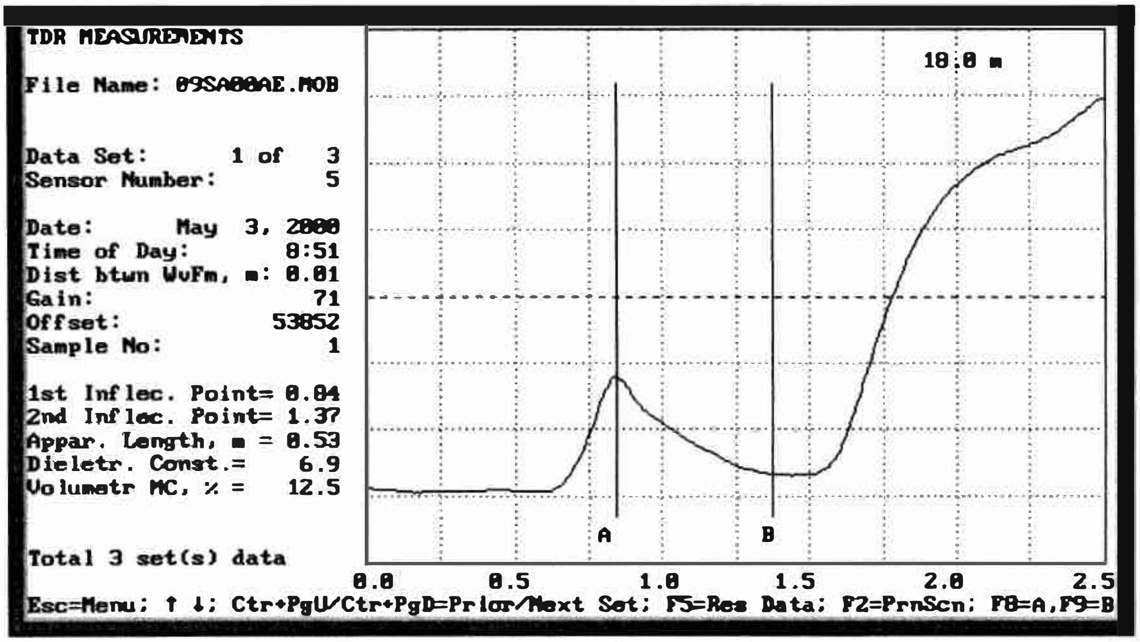

Figure C-1.5. Automated TDR Trace – Set 1, Probe #5

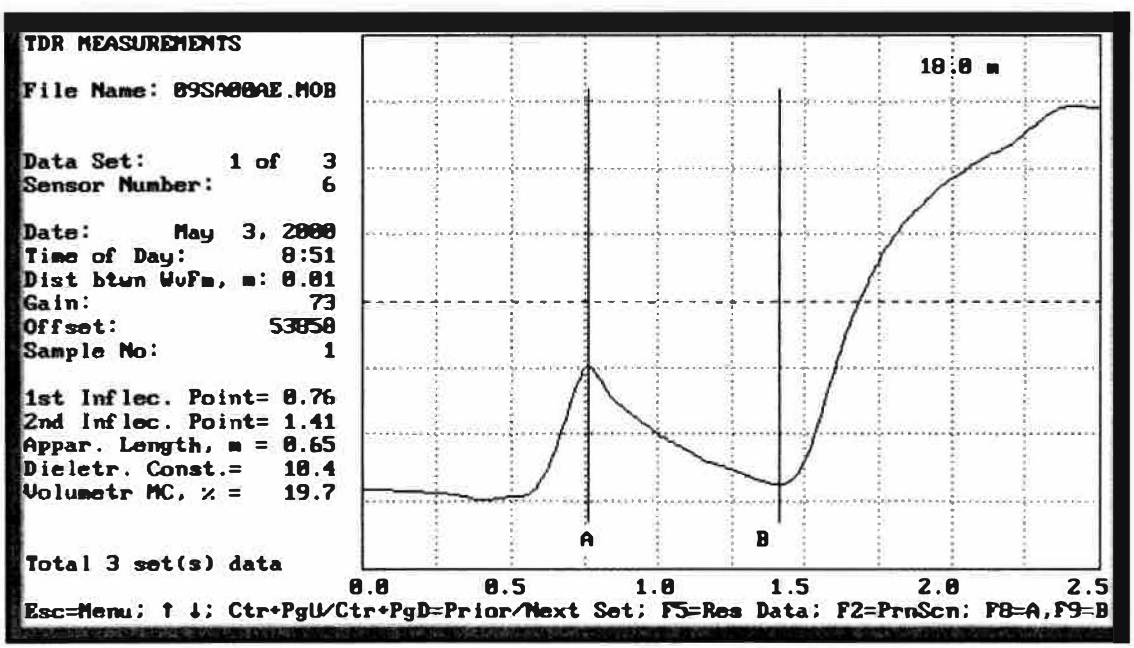

Figure C-1.6. Automated TDR Trace – Set 1, Probe #6

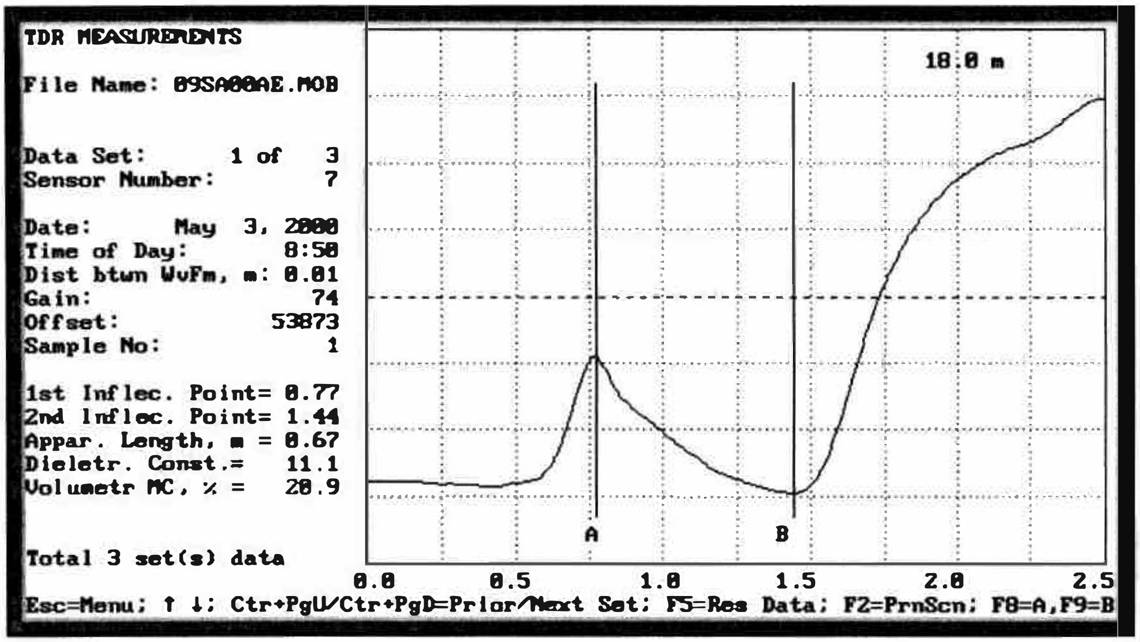

Figure C-1.7. Automated TDR Trace – Set 1, Probe #7

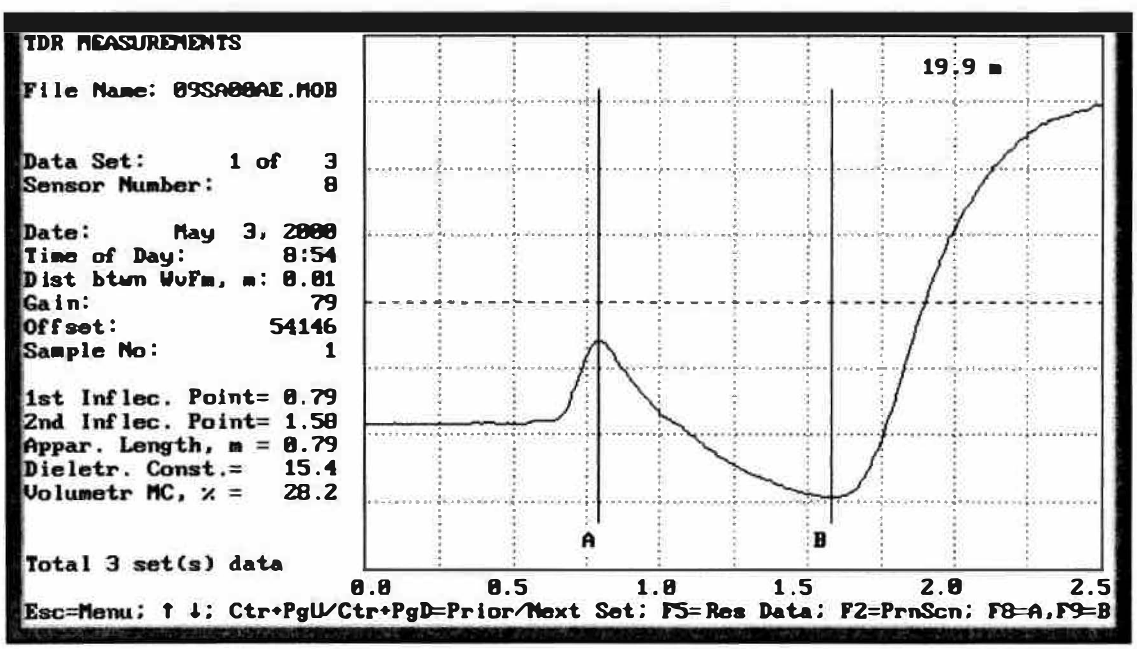

Figure C-1.8. Automated TDR Trace – Set 1, Probe #8

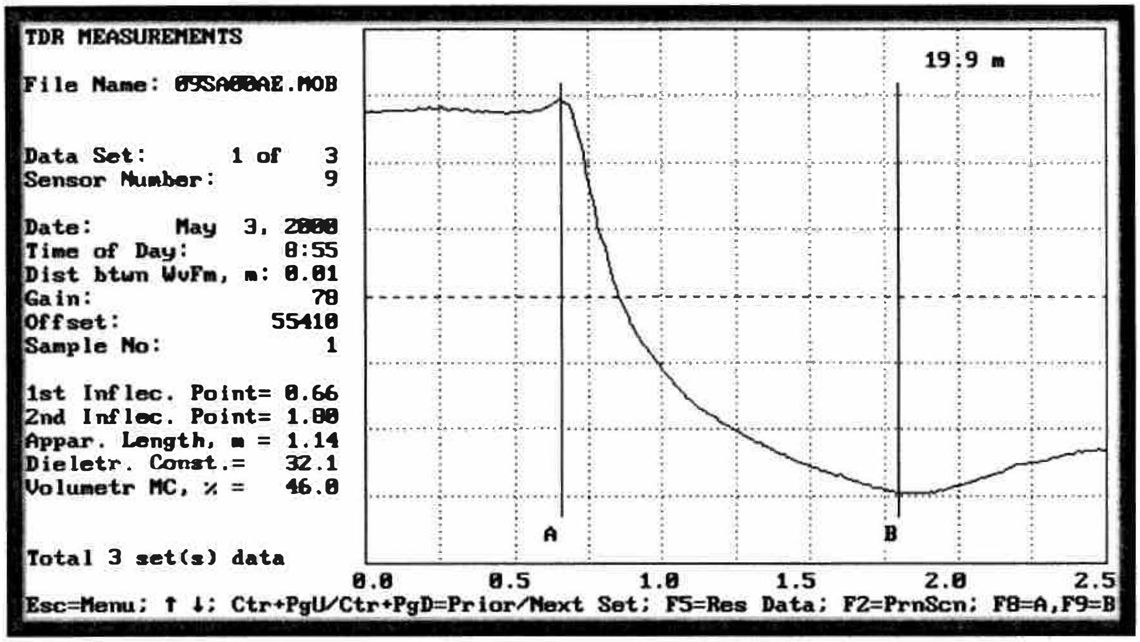

Figure C-1.9. Automated TDR Trace – Set 1, Probe #9

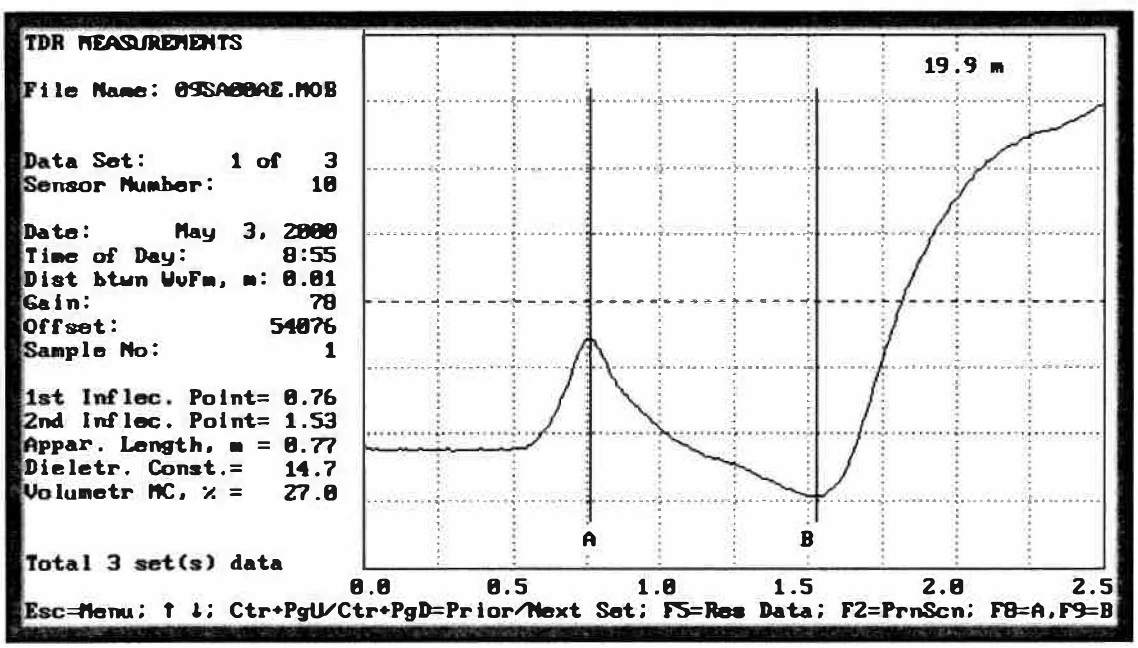

Figure C-1.10. Automated TDR Trace – Set 1, Probe #10

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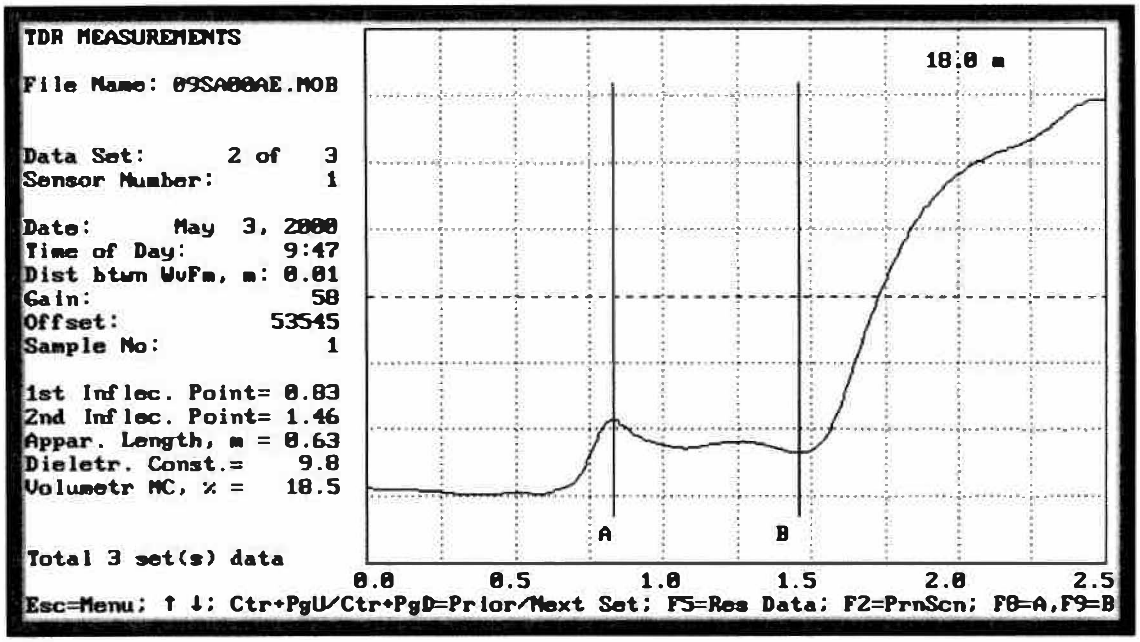

Figure C-2.1. Automated TDR Trace – Set 2, Probe #1

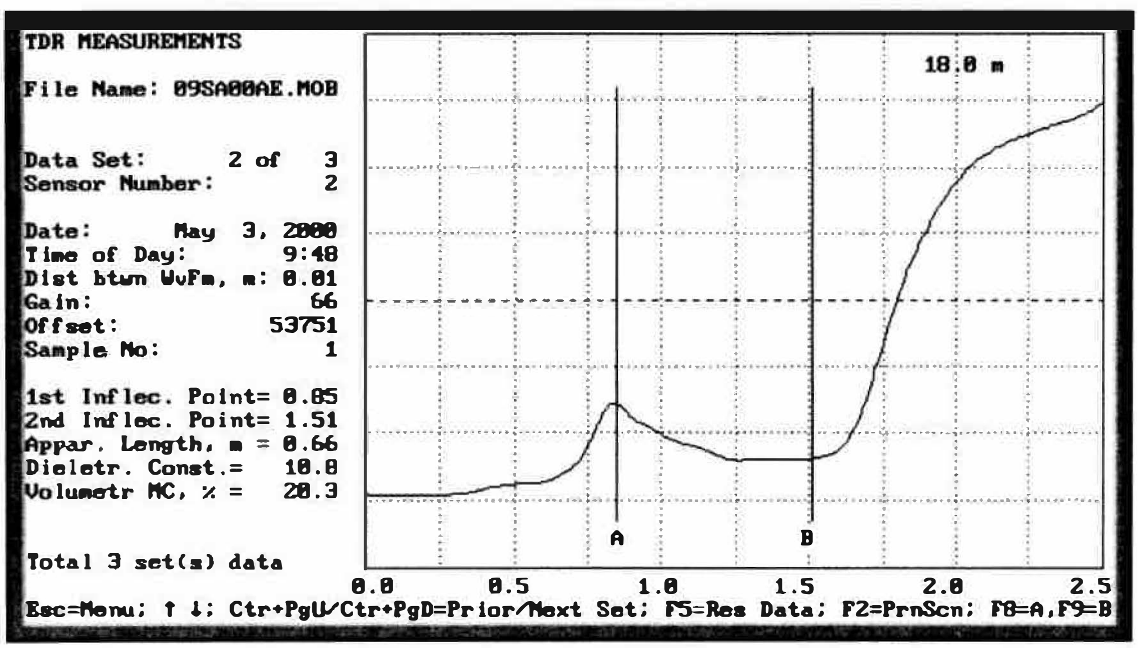

Figure C-2.2. Automated TDR Trace – Set 2, Probe #2

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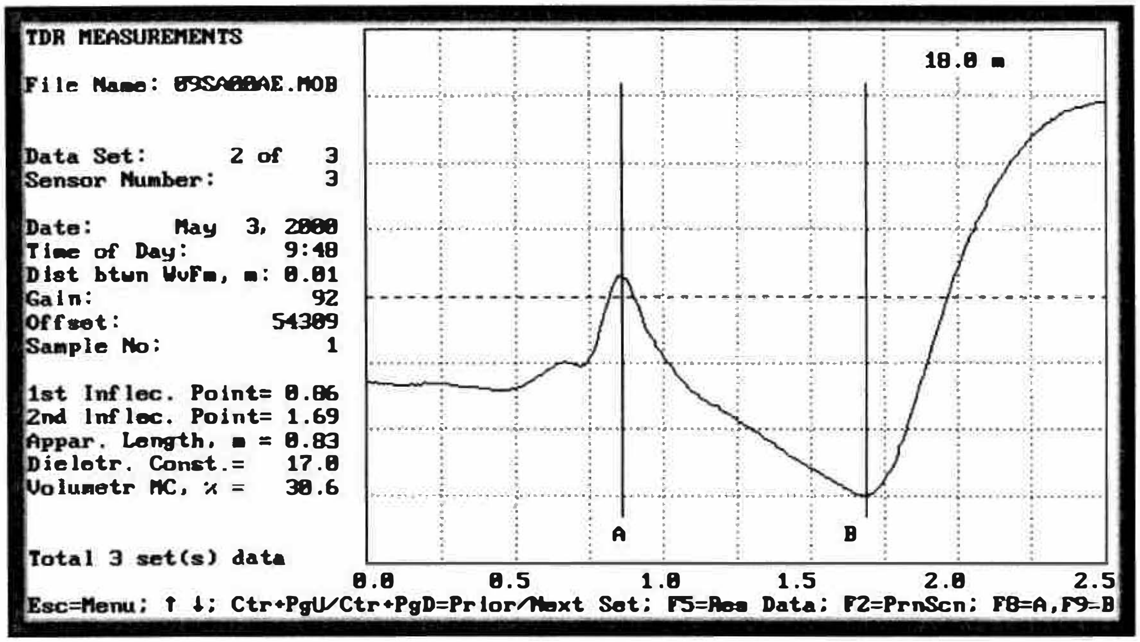

Figure C-2.3. Automated TDR Trace – Set 2, Probe #3

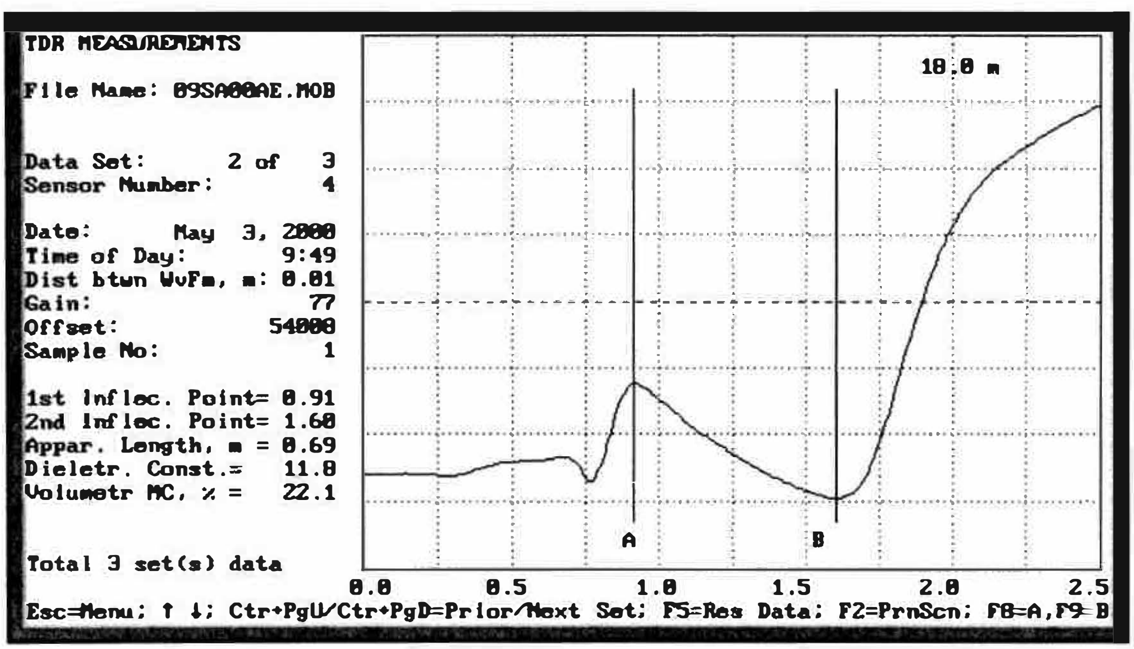

Figure C-2.4. Automated TDR Trace – Set 2, Probe #4

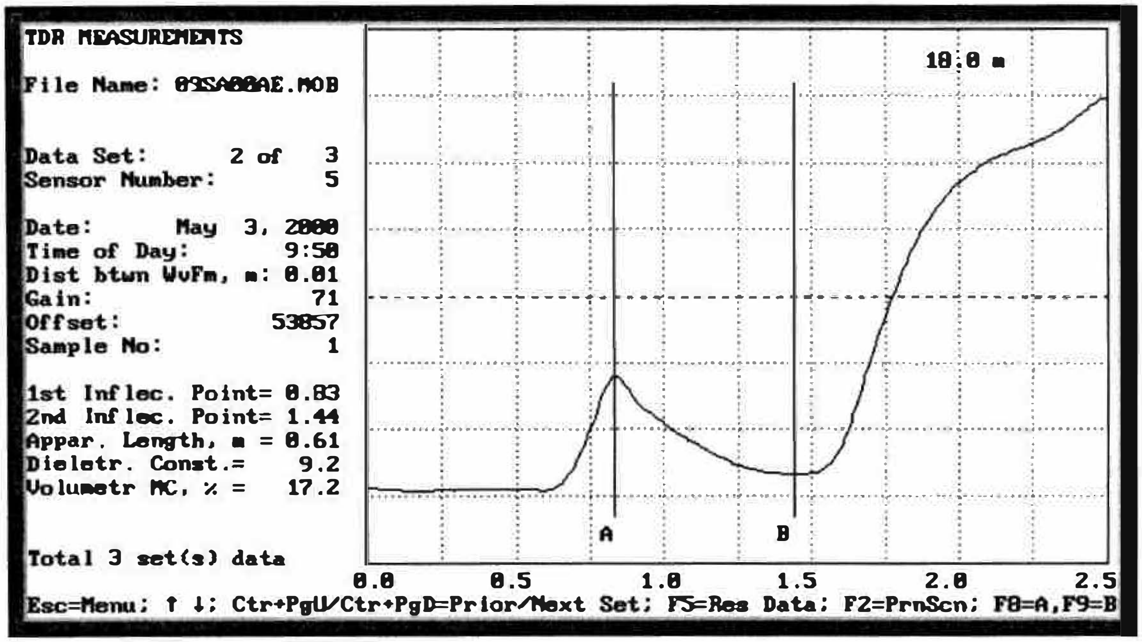

Figure C-2.5. Automated TDR Trace – Set 2, Probe #5

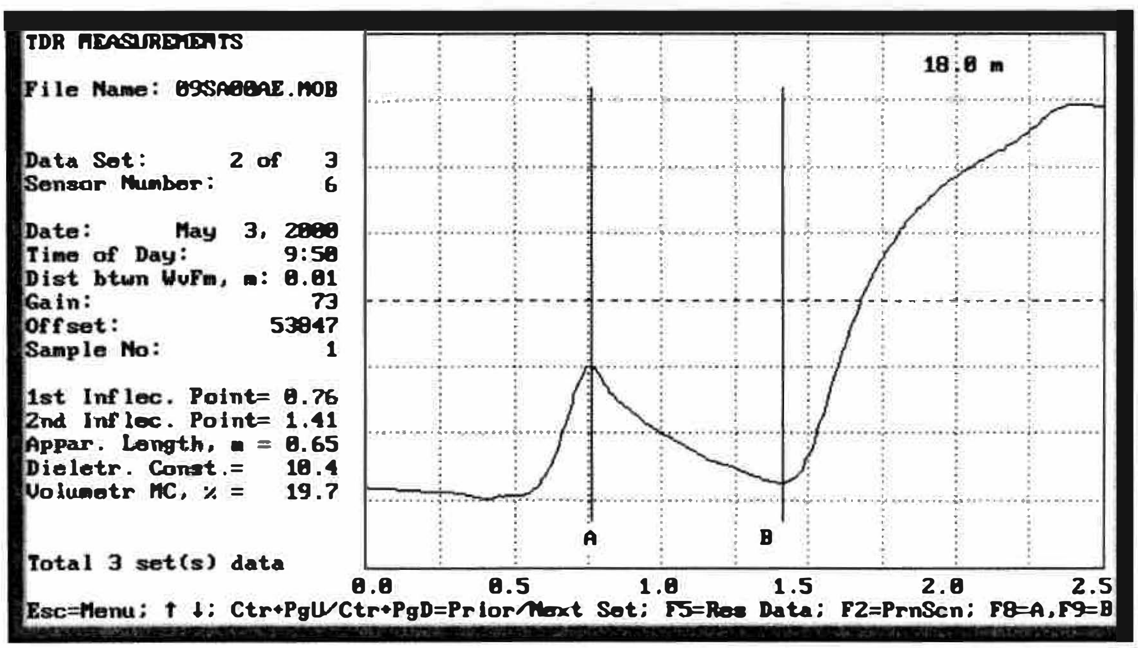

Figure C-2.6. Automated TDR Trace – Set 2, Probe #6

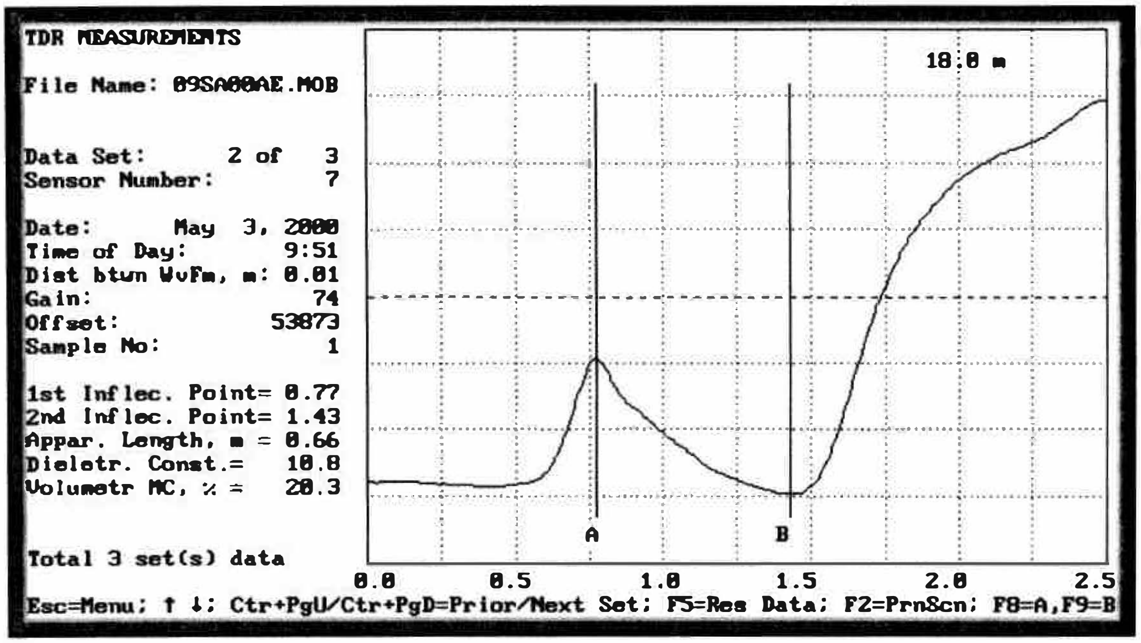

Figure C-2.7. Automated TDR Trace – Set 2, Probe #7

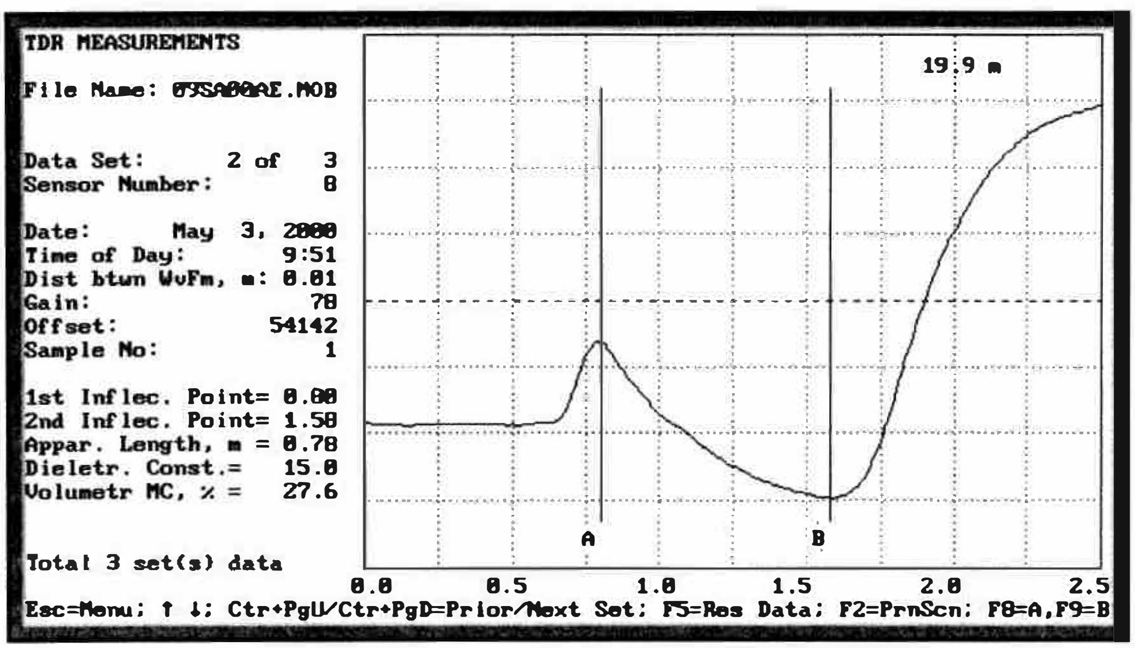

Figure C-2.8. Automated TDR Trace – Set 2, Probe #8

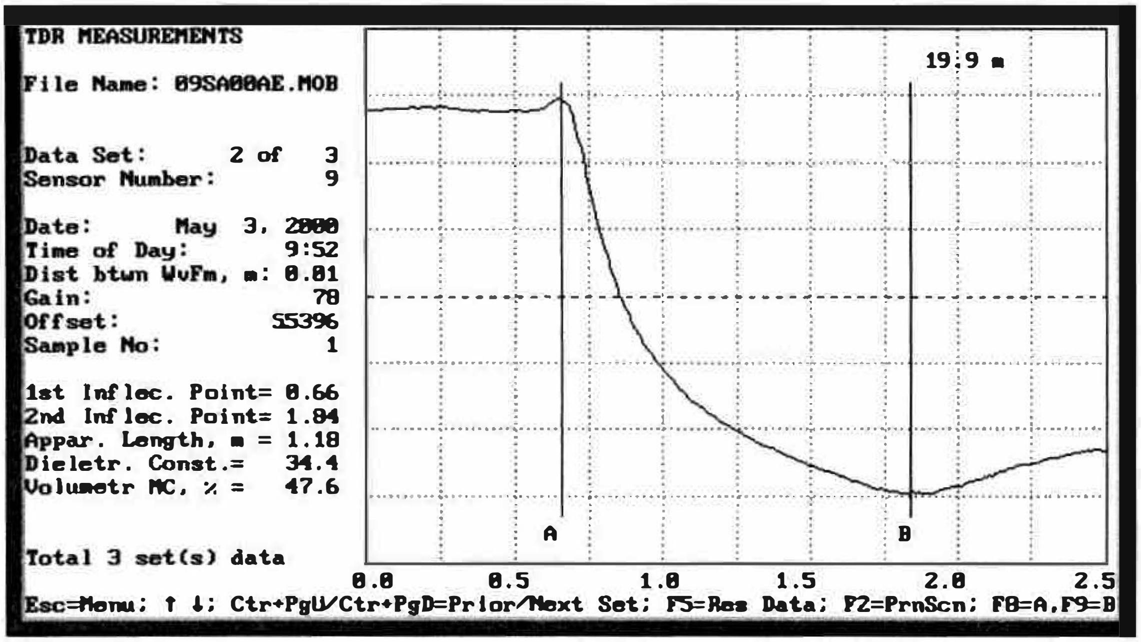

Figure C-2.9. Automated TDR Trace – Set 2, Probe #9

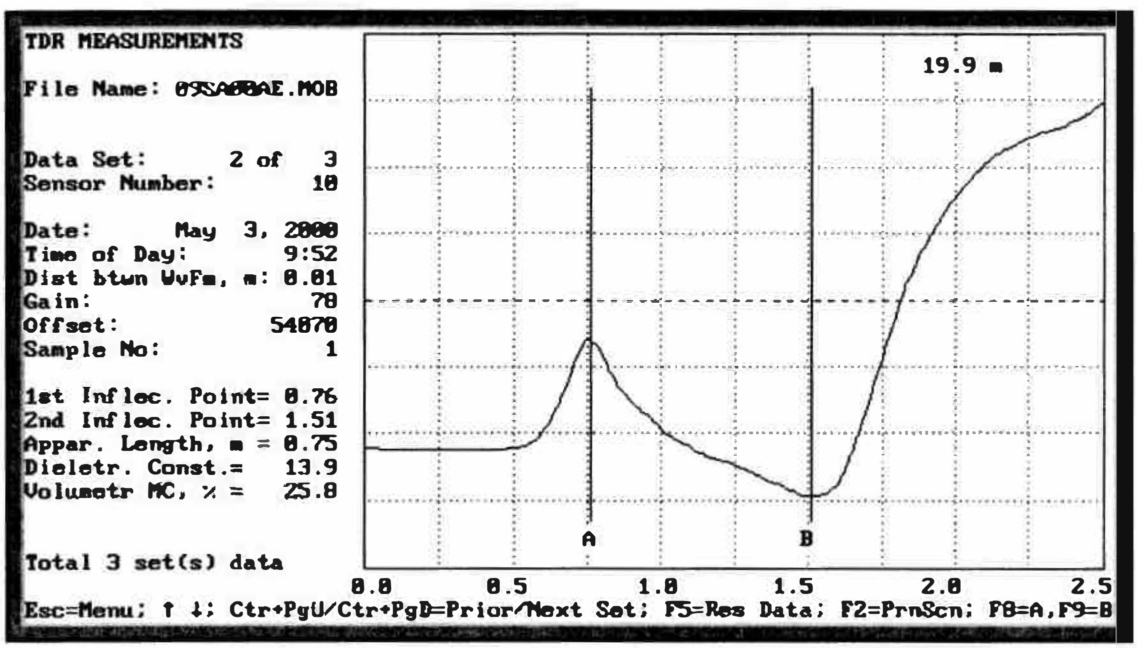

Figure C-2.10. Automated TDR Trace – Set 2, Probe #10

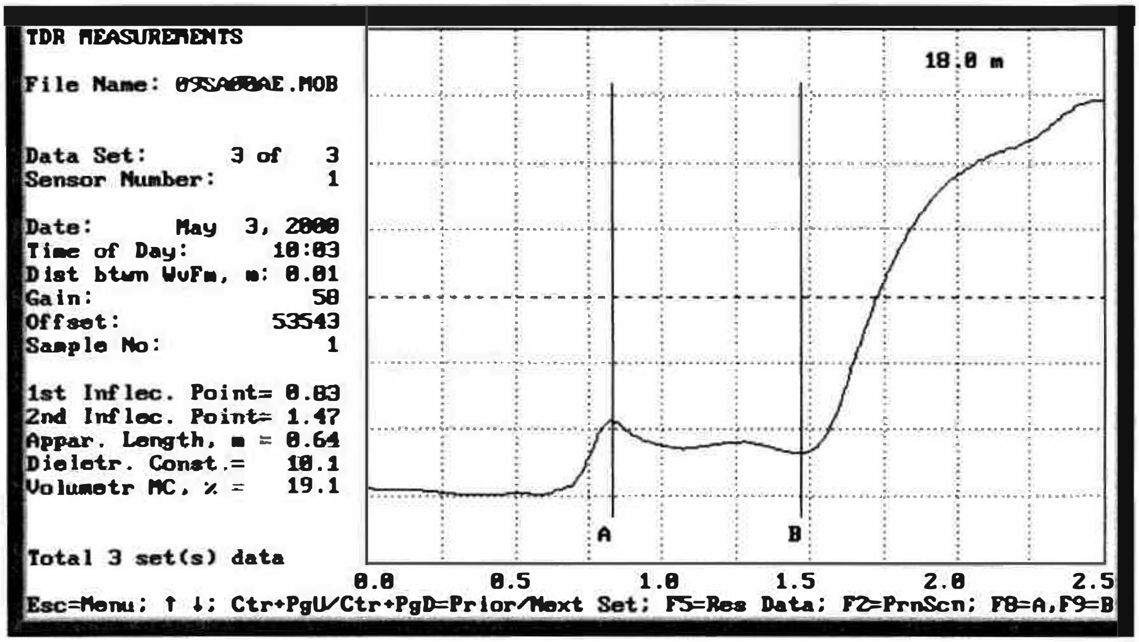

Figure C-3.1. Automated TDR Trace – Set 3, Probe #1

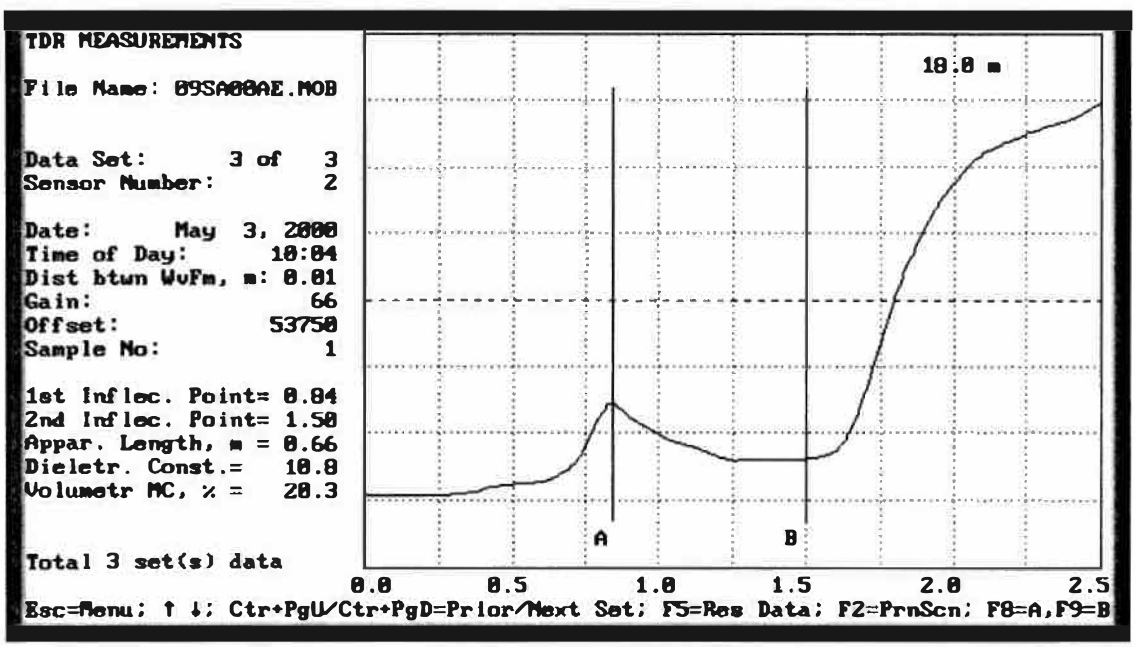

Figure C-3.2. Automated TDR Trace – Set 3, Probe #2

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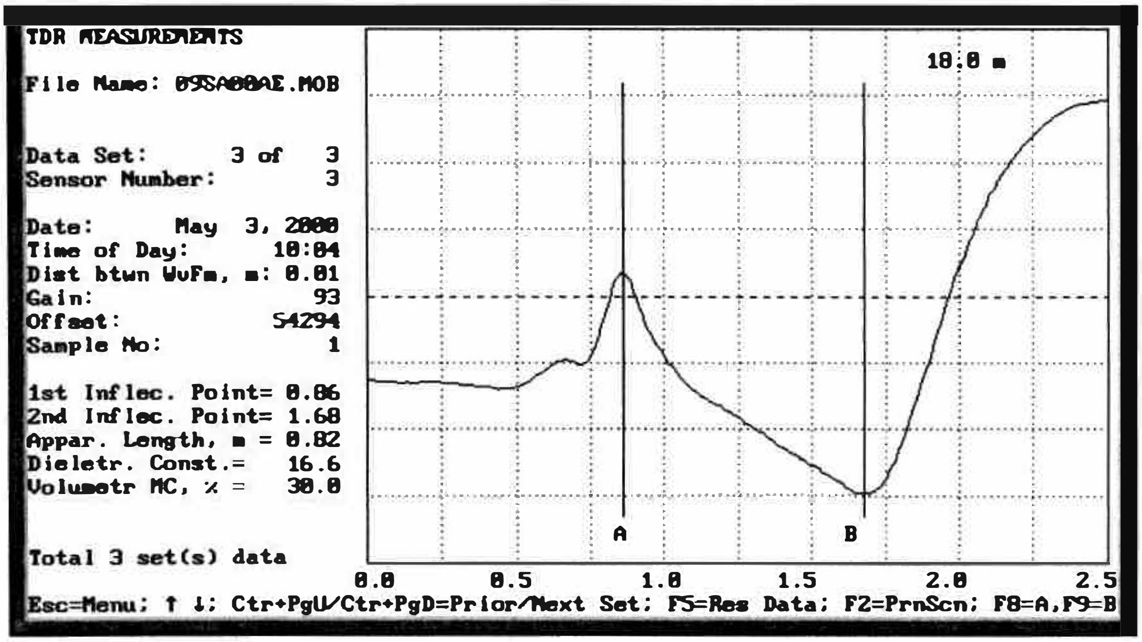

Figure C-3.3. Automated TDR Trace – Set 3, Probe #3

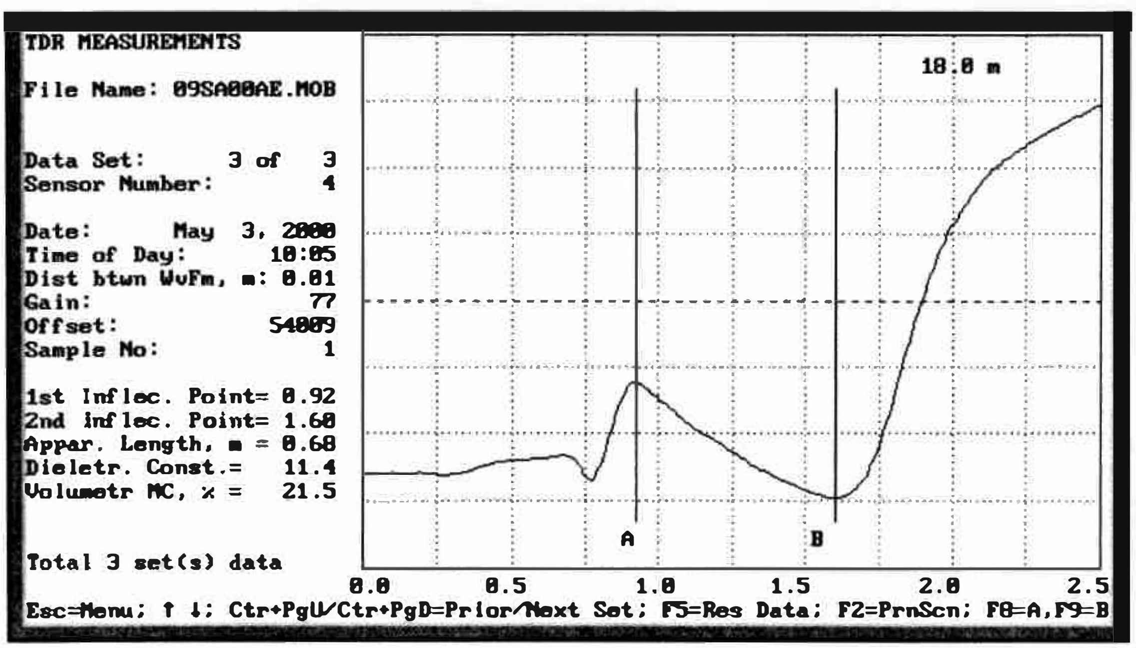

Figure C-3.4. Automated TDR Trace – Set 3, Probe #4

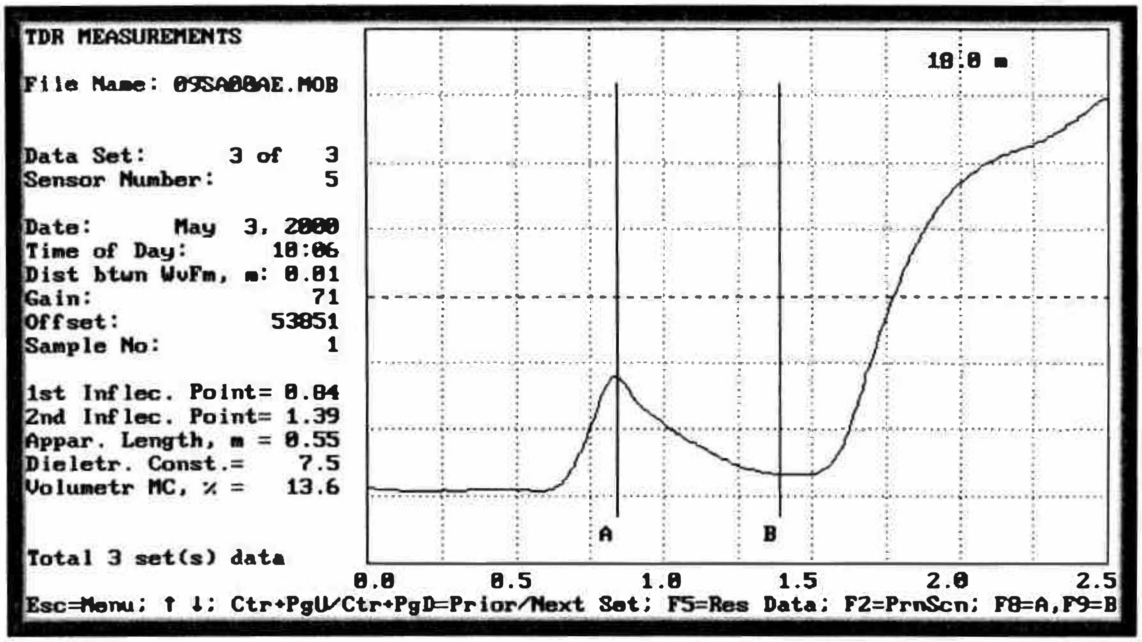

Figure C-3.5. Automated TDR Trace – Set 3, Probe #5

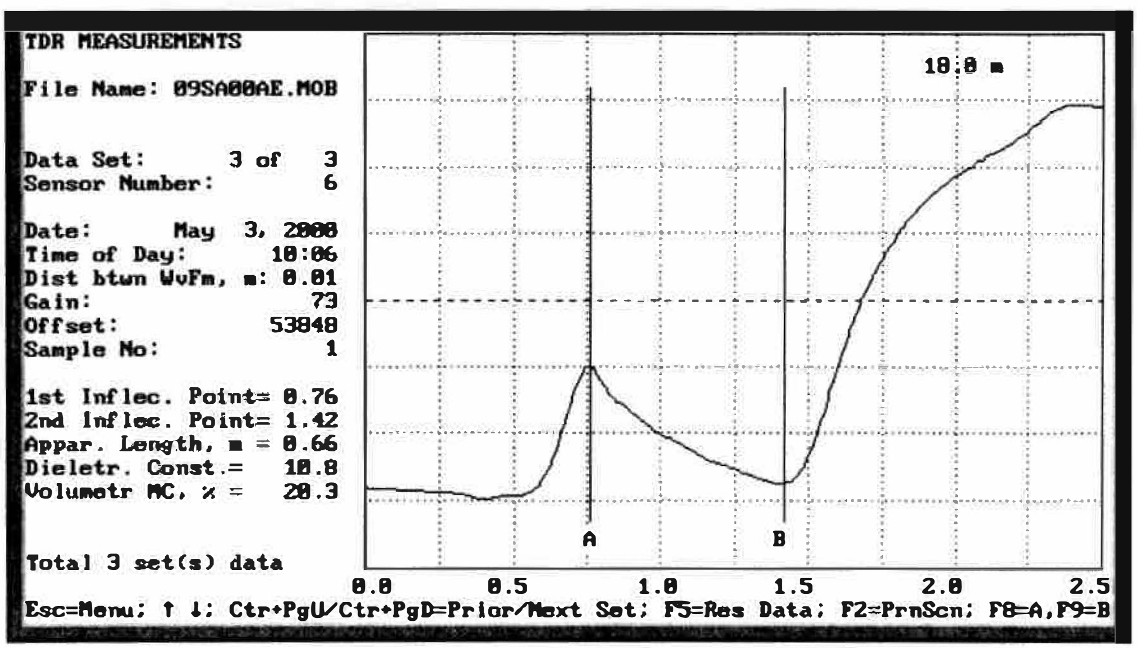

Figure C-3.6. Automated TDR Trace – Set 3, Probe #6

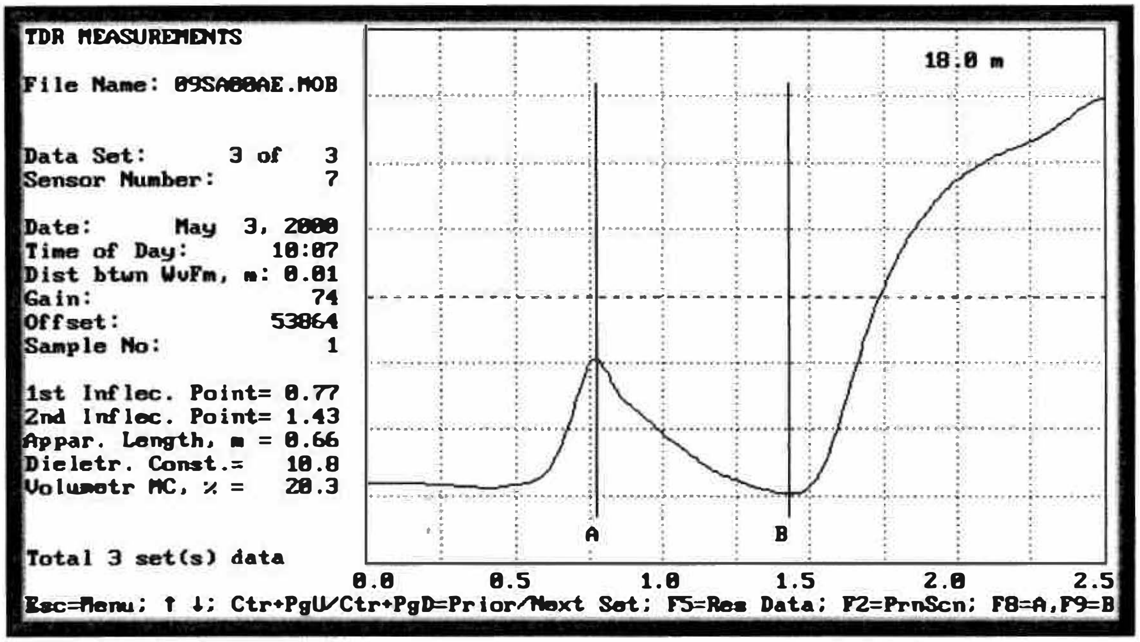

Figure C-3.7. Automated TDR Trace – Set 3, Probe #7

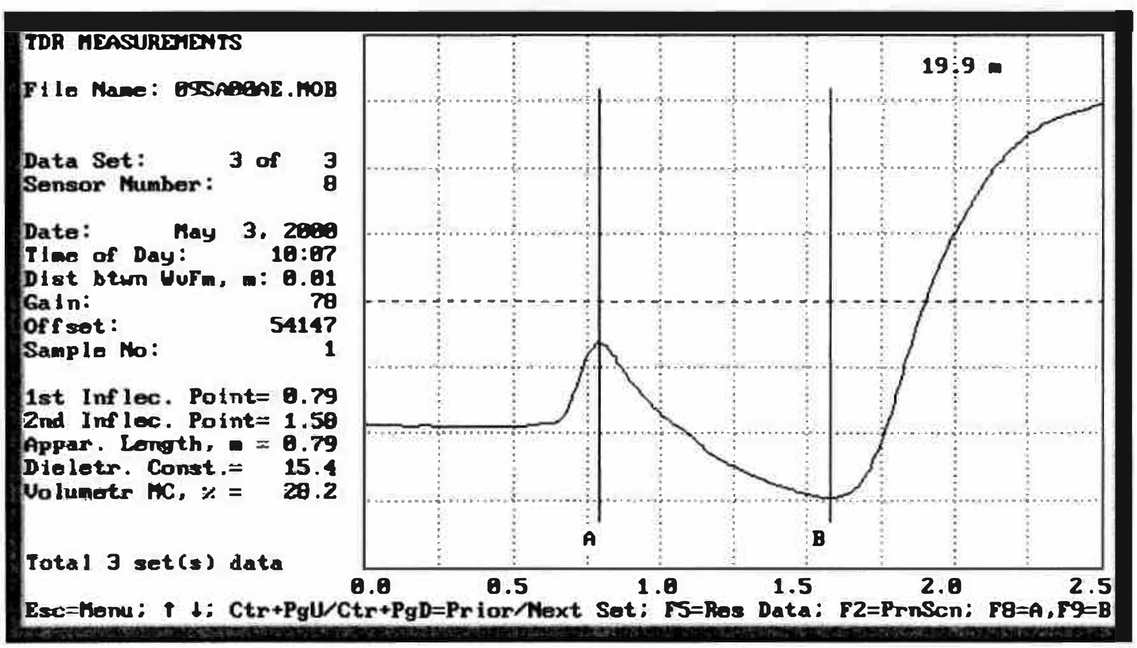

Figure C-3.8. Automated TDR Trace – Set 3, Probe #8

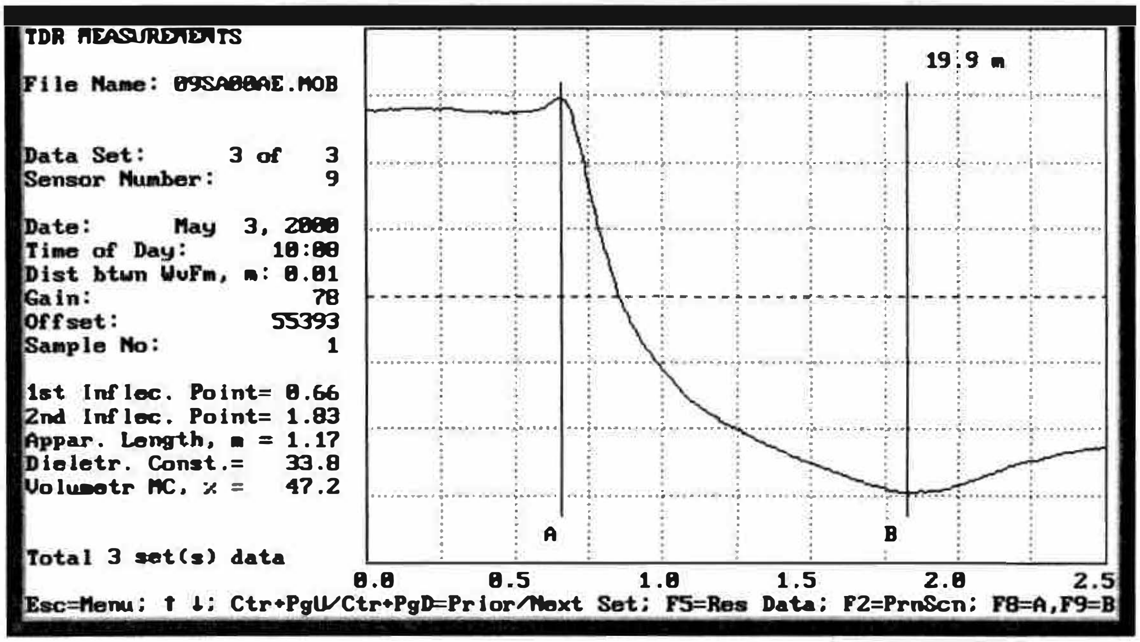

Figure C-3.9. Automated TDR Trace – Set 3, Probe #9

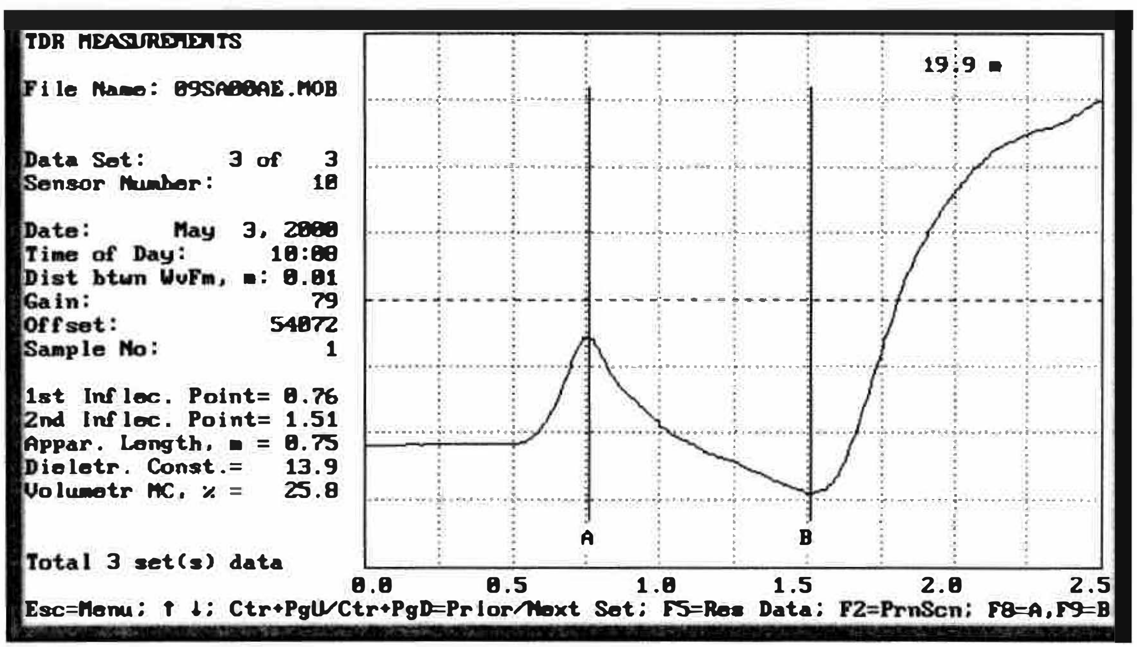

Figure C-3.10. Automated TDR Trace – Set 3, Probe #10

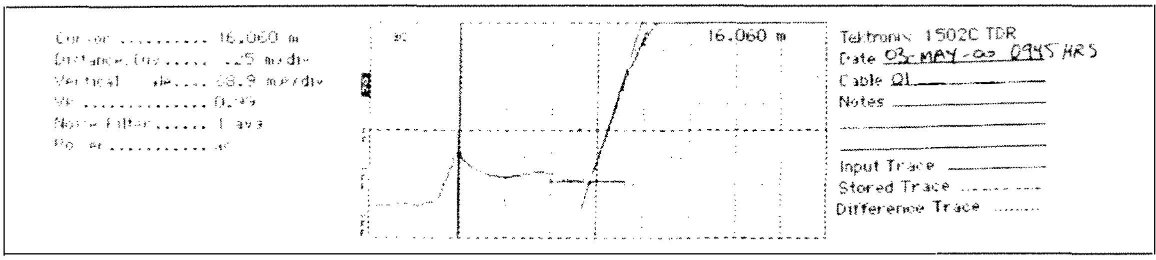

Figure C-4.1. Manual TDR Trace – Set 1, Probe #1

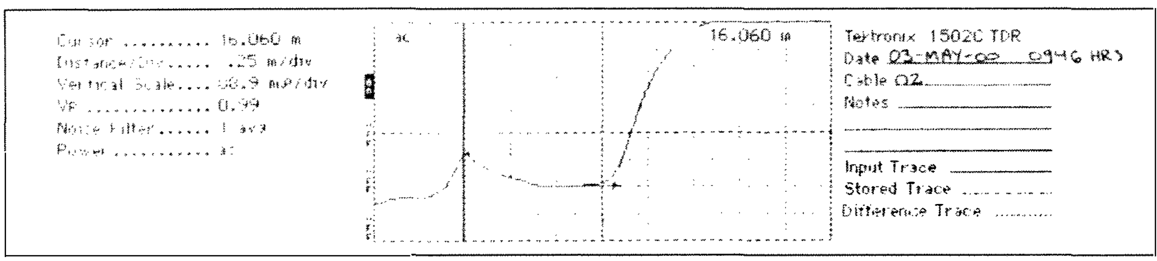

Figure C-4.2. Manual TDR Trace – Set 1, Probe #2

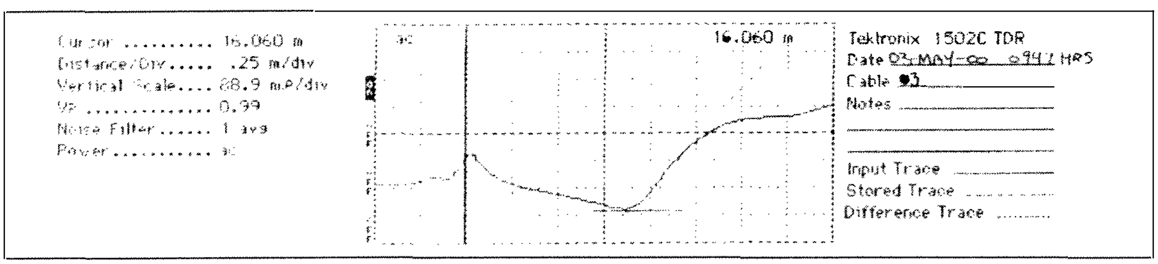

Figure C-4.3. Manual TDR Trace – Set 1, Probe #3

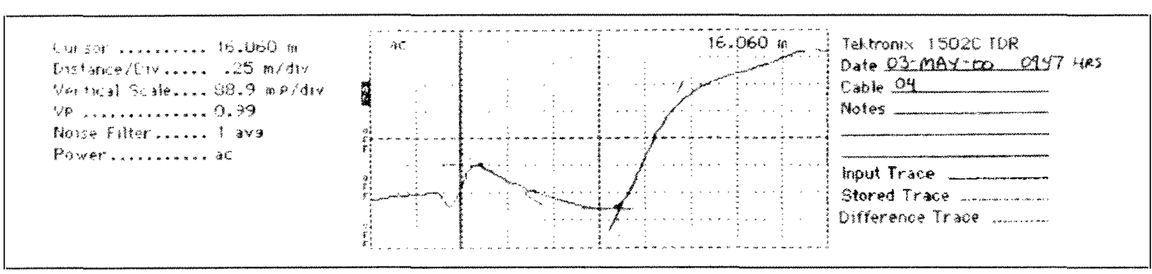

Figure C-4.4. Manual TDR Trace – Set 1, Probe #4

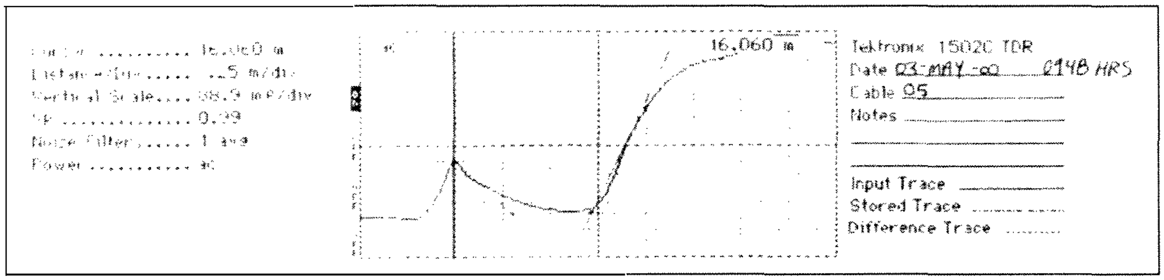

Figure C-4.5. Manual TDR Trace – Set 1, Probe #5

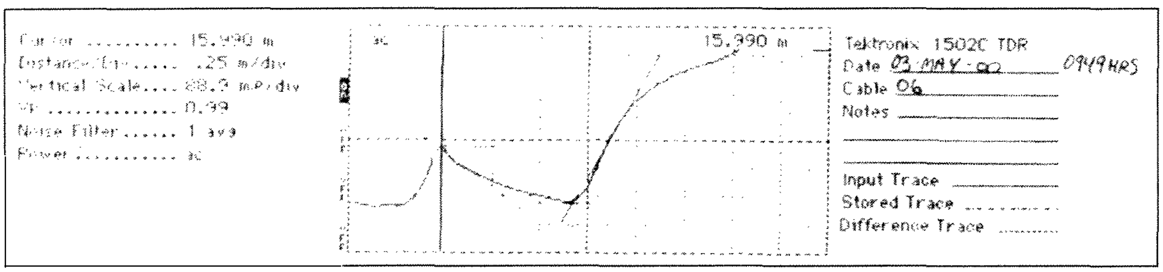

Figure C-4.6. Manual TDR Trace – Set 1, Probe #6

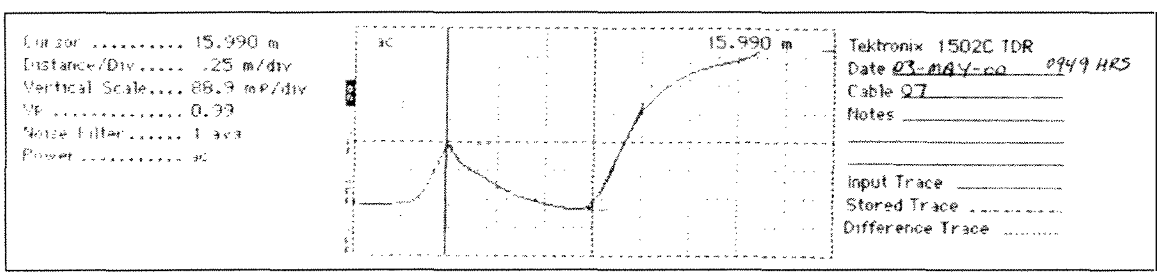

Figure C-4.7. Manual TDR Trace – Set 1, Probe #7

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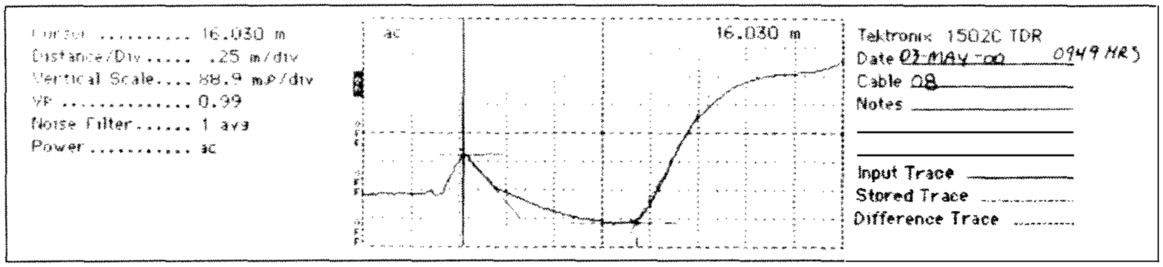

Figure C-4.8. Manual TDR Trace – Set 1, Probe #8

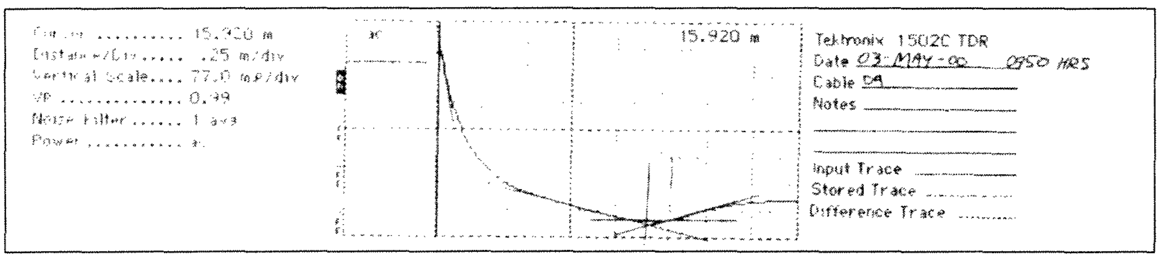

Figure C-4.9. Manual TDR Trace – Set 1, Probe #9

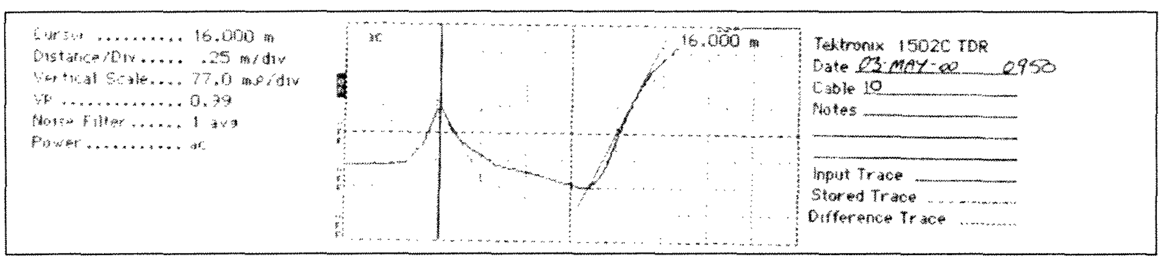

Figure C-4.10. Manual TDR Trace – Set 1, Probe #10

Long-Term Pavement Performance

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LTPP SMP Manual TDR Trace Interpretation Data Sheet SMP-D11.1 Trace Classification, Apparent Length and Dielectric Constant	STATE_CODE [09] SHRP_ID [1803]

Supplemental Data Collection

SMP Date (dd/mmm/yyyy): [03/May/2000] TDR Time (hhmm) [0945]

Figure C-5 Manual TDR Trace Interpretation

TDR No.	Probe Length Pl (m)	Distance/Division Settings	Distance/Division Units	Propagation Velocity Setting, V_p	Trace Type	Conductivity (Low/High)	Apparent Length L_a (m) (0.2 - 1.85m) Analysis	Min.	Max.	Dielectric Constant $e = [L_a/(V_p * Pl)]^2$ Analysis	Min.	Max
1	0.203	0.25	m	0.99	1		0.70			12.3		
2	0.203	0.25	m	0.99	1		0.80			15.8		
3	0.203	0.25	m	0.99	1		0.85			17.9		
4	0.203	0.25	m	0.99	1		0.75			13.9		
5	0.203	0.25	m	0.99	1		0.70			12.3		
6	0.203	0.25	m	0.99	1		0.70			12.3		
7	0.203	0.25	m	0.99	1		0.75			13.9		
8	0.203	0.25	m	0.99	1		0.90			20.1		
9	0.203	0.25	m	0.99	4		1.20			35.6		
10	0.203	0.25	m	0.99	1		0.83			17.1		

Trace Type: 1-Classic; 2-Shorted, 3-Open; 4-Rounded, 5-Irregular, 6-Uninterpretable

Were interpretation comments entered on Data Sheet SMP-D 11 2? N

Interpreter Lenny Michie Date (dd/mmm/yyyy): [02/Jan/2001]

Employer: STANTEC

Figure C-5. Manual TDR Trace Interpretation – Set 1

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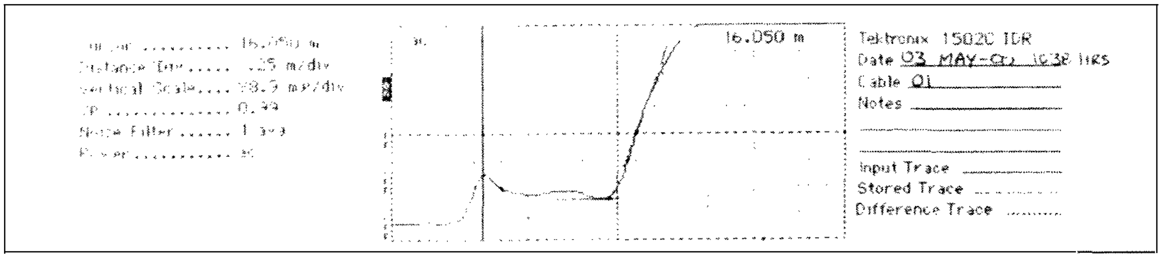

Figure C-6.1. Manual TDR Trace – Set 2, Probe #1

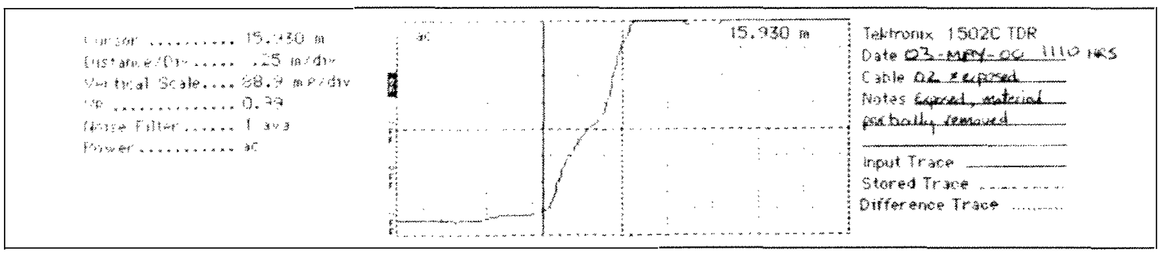

Figure C-6.2. Manual TDR Trace – Set 2, Probe #2

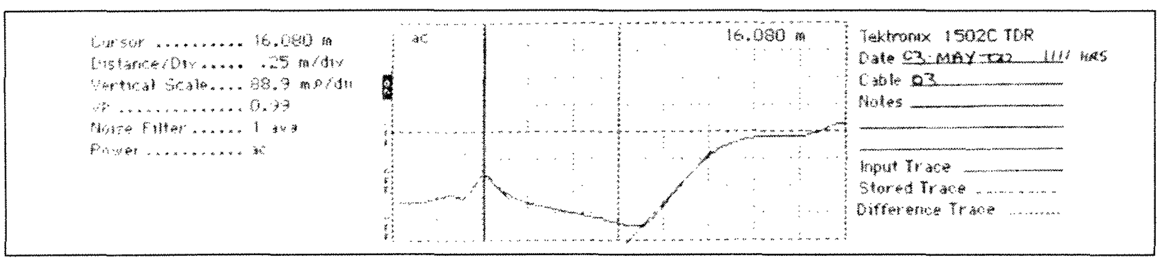

Figure C-6.3. Manual TDR Trace – Set 2, Probe #3

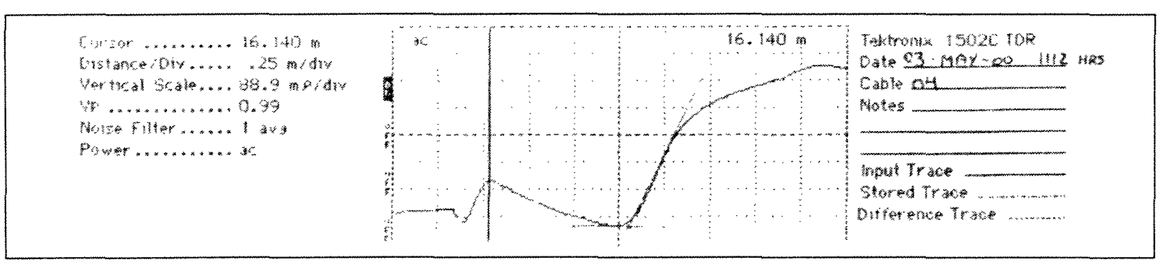

Figure C-6.4. Manual TDR Trace – Set 2, Probe #4

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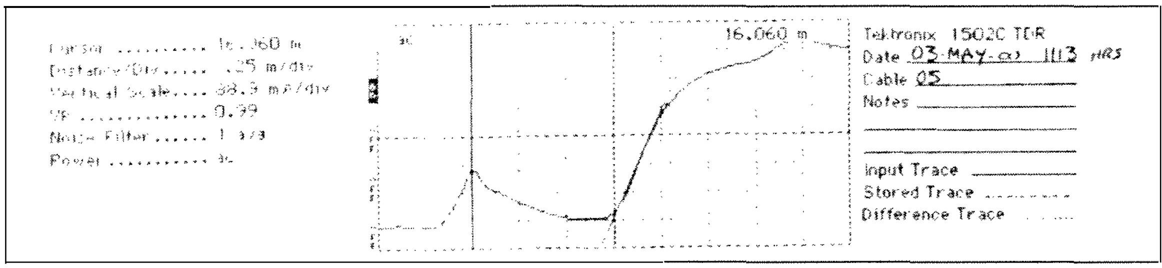

Figure C-6.5. Manual TDR Trace – Set 2, Probe #5

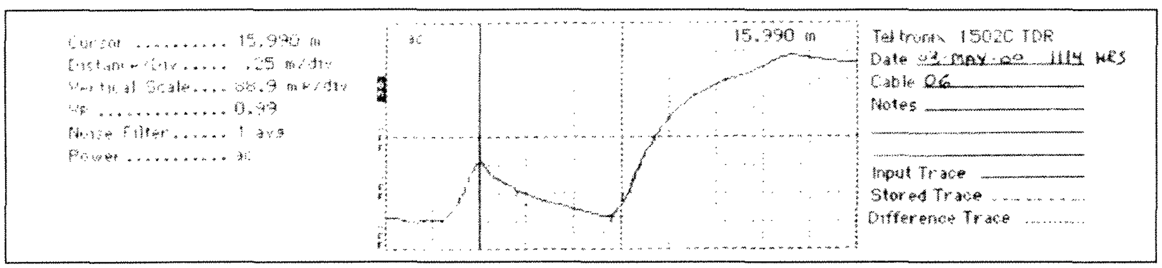

Figure C-6.6. Manual TDR Trace – Set 2, Probe #6

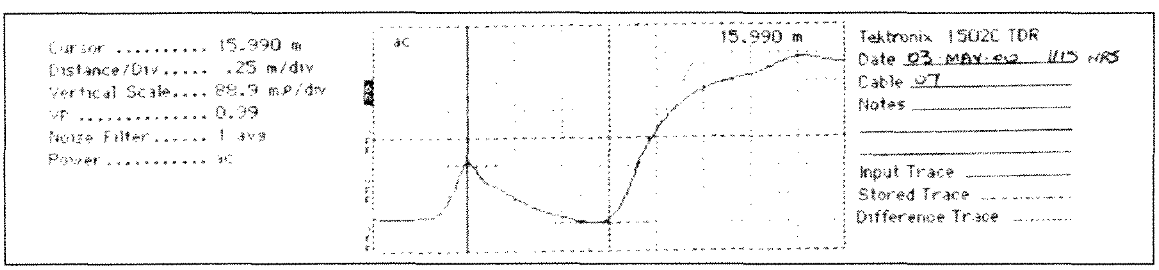

Figure C-6.7. Manual TDR Trace – Set 2, Probe #7

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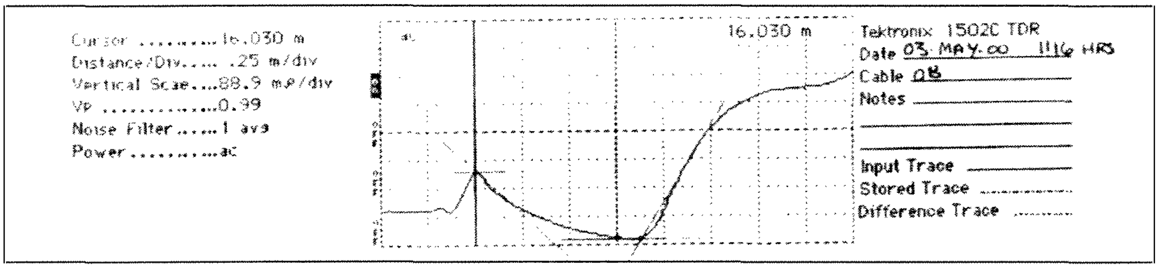

Figure C-6.8. Manual TDR Trace – Set 2, Probe #8

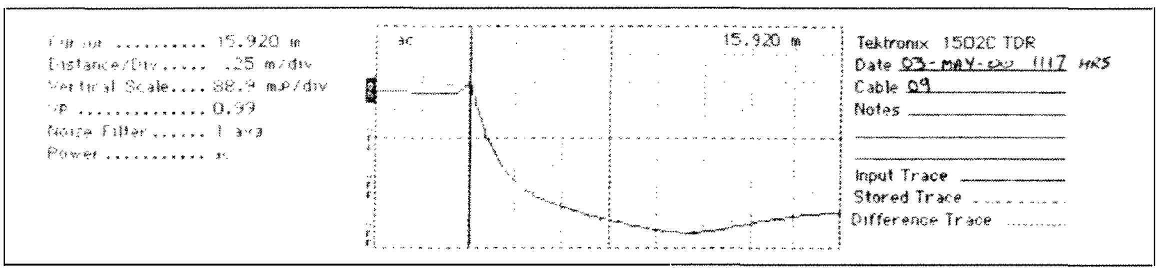

Figure C-6.9. Manual TDR Trace – Set 2, Probe #9

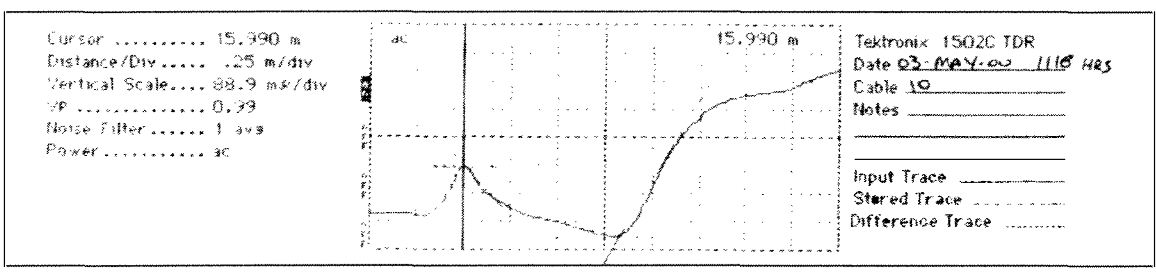

Figure C-6.10. Manual TDR Trace – Set 2, Probe #10

LTPP SMP Manual TDR Trace Interpretation Data Sheet SMP-D11.1 Trace Classification, Apparent Length and Dielectric Constant	STATE_CODE [09] SHRP_ID [1803]

Supplemental Data Collection

SMP Date (dd/mmm/yyyy): [03/May/2000]   TDR Time (hhmm): [1038]

Figure. C-7 Manual TDR Trace Interpretation

TDR No	Probe Length PL (m)	Distance/Division Settings	Distance/Division Units	Propagation Velocity Setting, V_p	Trace Type	Conductivity (Low/High)	Apparent Length L_a (m) (0.2 - 1.85m) Analysis	Min	Max.	Dielectric Constant $\varepsilon = [L_a / (V_p * PL)]^2$ Analysis	Min	Max.
1	0.203	0.25	m	0.99	1		0.70			12.3		
2	0.203	0.25	m	0.99	[illegible]		N/A			N/A		
3	0.203	0.25	m	0.99	1		0.86			18.3		
4	0.203	0.25	m	0.99	1		0.75			13.9		
5	0.203	0.25	m	0.99	1		0.78			15.9		
6	0.203	0.25	m	0.99	1		0.70			12.3		
7	0.203	0.25	m	0.99	1		0.72			12.8		
8	0.203	0.25	m	0.99	1		0.83			17.1		
9	0.203	0.25	m	0.99	4		1.20			35.6		
10	0.203	0.25	m	0.99	1		0.78			15.1		

Trace Type: 1-Classic; 2-Shorted; 3-Open; 4-Rounded; 5-Irregular; 6-Uninterpretable

Were interpretation comments entered on Data Sheet SMP-D11.2? N

Interpreter: Lonny Michie   Date (dd/mmm/yyyy): [02/Jan/2001]

Employer: STANTEC

Figure C-7. Manual TDR Trace Interpretation – Set 2

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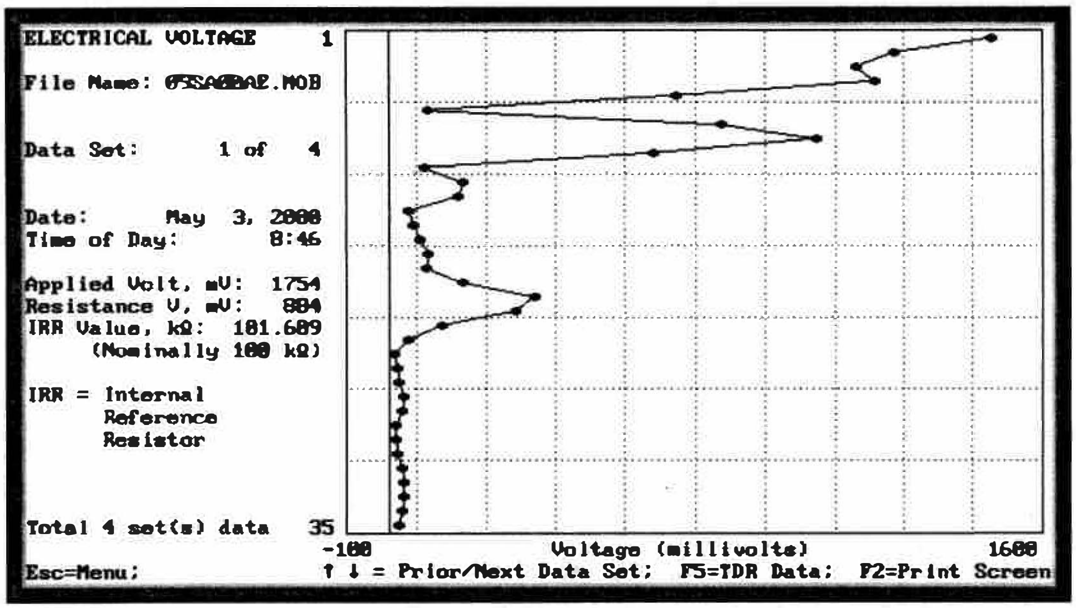

Figure C-8.1. First set of mobile voltage measurements

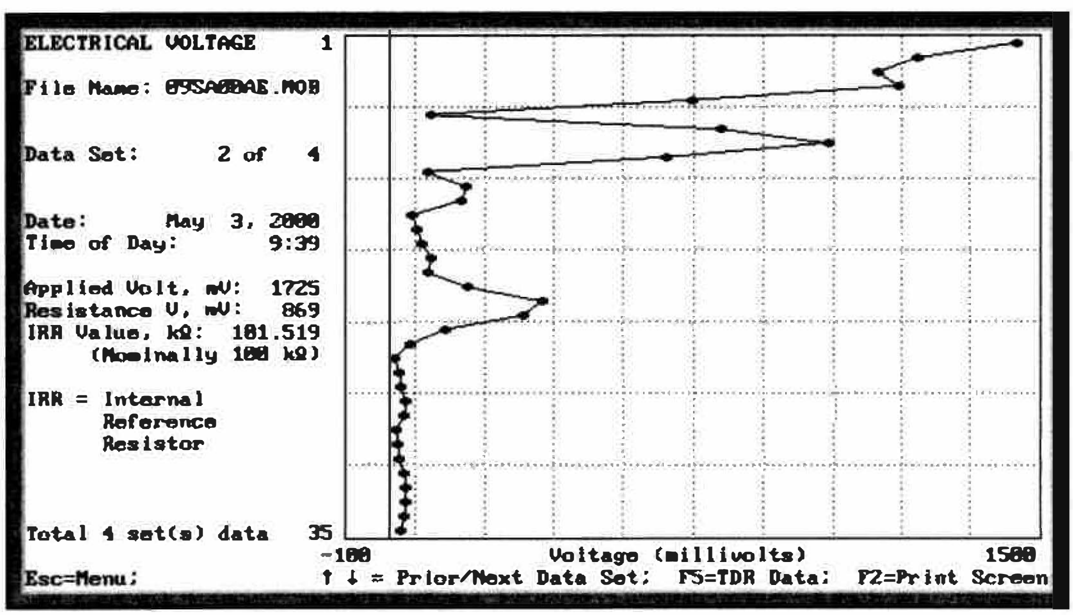

Figure C-8.2. Second set of mobile voltage measurements

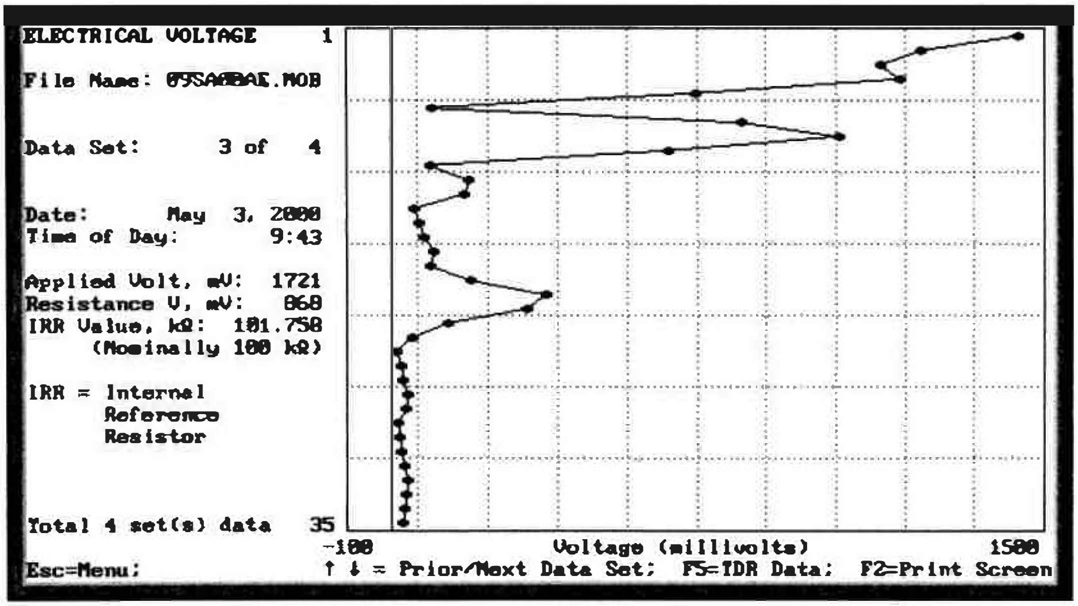

Figure C-8.3. Third set of mobile voltage measurements

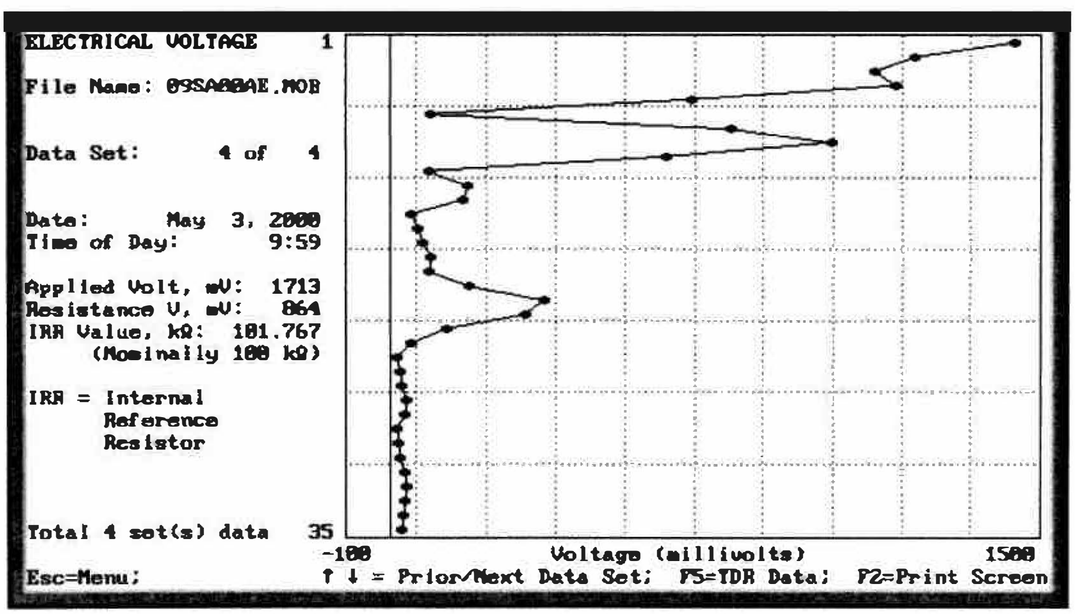

Figure C-8.4. Fourth set of mobile voltage measurements

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LTPP Seasonal Monitoring Program	State Code	[09]
Data Sheet R2		
Contact Resistance Measurements	Test Section Number	[1803]

1. Date (Month- Day- Year	[05-02-00]
2. Time Measurements Began (Military)	[0925]
3. Comments	[CT Forensic Study]

Test	Voltage (ACV)		Current (ACA)		Ohms
Position	Setting	Reading	Setting	Reading	
1	mv	339	uA	13.5	25111
2	mv	337.2	uA	14.4	23417
3	mv	335.9	uA	15	22393
4	mv	336.3	uA	14.8	22723
5	mv	330.1	uA	13.3	24820
6	mv	271	uA	61.1	4435
7	mv	332.5	uA	21.9	15183
8	mv	335.6	uA	16.5	20339
9	mv	329.1	uA	19.4	16964
10	mv	268.9	uA	62.3	4316
11	mv	298.4	uA	38.9	7671
12	mv	295.5	uA	41.5	7120
13	mv	233.9	uA	91.1	2568
14	mv	249.9	uA	77.1	3241
15	mv	264	uA	64	4125
16	mv	276.6	uA	54.7	5057
17	mv	272.8	uA	57.1	4778
18	mv	295.9	uA	39.7	7453
19	mv	317.8	uA	23.2	13698
20	mv	314.3	uA	25.7	12230
21	mv	278.2	uA	54.1	5142
22	mv	212.7	uA	109.3	1946
23	mv	116.8	uA	188.1	621
24	mv	164.5	uA	147.7	1114
25	mv	181	uA	133.1	1360
26	mv	206.3	uA	112.6	1832
27	mv	197.9	uA	118.7	1667
28	mv	147.5	uA	161.4	914
29	mv	159.6	uA	151.8	1051
30	mv	176	uA	137.8	1277
31	mv	199.5	uA	114.8	1738
32	mv	212.5	uA	106.8	1990
33	mv	210.9	uA	107	1971
34	mv	200.3	uA	115.6	1733
35	mv	182.9	uA	129.2	1416

Prepared By : BRH/BH	Employer: Stantec

Figure C-9.1 Manual contact resistance measurement

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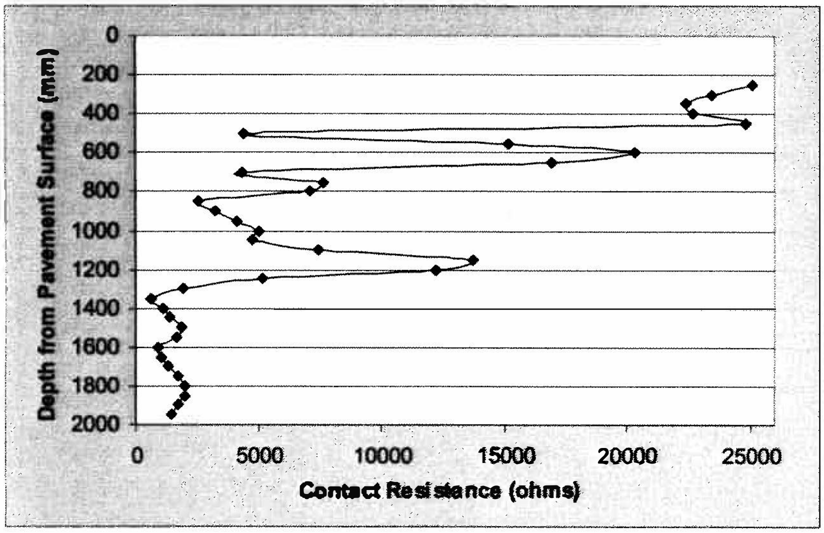

Figure C-9.2 Manual contact resistance results

Long-Term Pavement Performance

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LTPP Seasonal Monitoring Program	State Code	[09]
Data Sheet R2		
Four-Point Resistivity Measrements	Test Section Number	[1803]

1. Date (Month- Day- Year	[05-02-00]
2. Time Measurements Began (Military)	[0935]
3. Comments	[CT Forensic Study]

Test	Voltage (ACV)		Current (ACA)		Ohms
Position	Setting	Reading	Setting	Reading	
1	mv	32.7	uA	11.4	1802
2	mv	24.1	uA	11.8	1283
3	mv	32.5	uA	17.3	1180
4	mv	29.2	uA	17.1	1073
5	mv	3.8	uA	14	171
6	mv	32.8	uA	16.8	1227
7	mv	18.5	uA	68.7	169
8	mv	28.1	uA	18.8	939
9	mv	5.4	uA	15.8	215
10	mv	12.4	uA	65.7	119
11	mv	15.3	uA	72.1	133
12	mv	6.7	uA	36.1	117
13	mv	12.5	uA	65.2	120
14	mv	11	uA	59.6	116
15	mv	10.9	uA	63.3	108
16	mv	6.1	uA	36.6	105
17	mv	8.3	uA	24.6	212
18	mv	11.6	uA	48.7	150
19	mv	12	uA	39.1	193
20	mv	7.3	uA	31	148
21	mv	7.2	uA	64.2	70
22	mv	9	uA	89.5	63
23	mv	13.6	uA	155	55
24	mv	11.1	uA	119	59
25	mv	10.3	uA	136.4	47
26	mv	11	uA	139.6	50
27	mv	8	uA	109.8	46
28	mv	10.2	uA	138.2	46
29	mv	10.2	uA	119.1	54
30	mv	11.4	uA	117.1	61
31	mv	10.8	uA	110	62
32	mv	12.4	uA	107.9	72
33	mv	10.1	uA	112.7	56

Prepared By : BRH/BH	Employer: Stantec

Figure C-10.1 Manual four point resistance measurement

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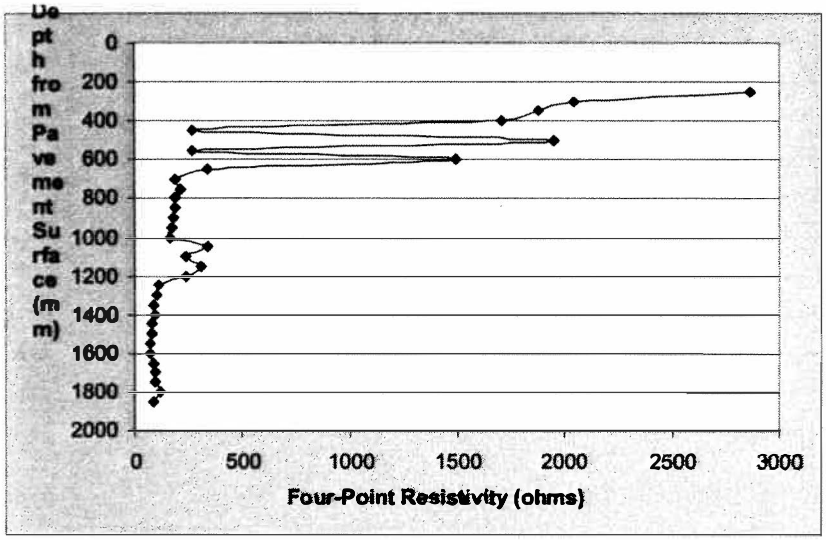

Figure C-10.2 Manual four point resistivity results

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LTPP Seasonal Monitoring Program Data Sheet SMP-D08 Elevation Measurements - AC	Agency Code [09] LTPP Section ID [1803]

Type of Instrument: Laser Level

Start Time (Military) 0835

BM	Station	BS	HI	IFS	FS	Elevation	Close
Piez.	3+96					1.0000	1.0000

Station	PE .30m	OWP 0.91m	ML 1.83m	IWP 2.73m	ILE 3.35m	Comments
3+00	0.5525	0.5600	0.5850	0.5975	0.6100	
3+25	0.7025	0.7100	0.7300	0.7475	0.7650	
3+50	0.8975	0.8925	0.8975	0.8975	0.9050	
3+75	1.0225	1.0250	1.0350	1.0325	1.0475	
4+00	1.1675	1.1725	1.1850	1.1975	1.2050	
4+25	1.3325	1.3350	1.3500	1.3575	1.3650	
4+50	1.4875	1.4900	1.5025	1.5150	1.5225	
4+75	1.6175	1.6225	1.6400	1.6500	1.6550	
5+00	1.7875	1.7800	1.7925	1.7900	1.7925	move 3" due to nail
5+14	1.8575	1.8575	1.8650	1.8650	1.8650	
5+19	1.8725	1.8675	1.8925	1.8900	1.8900	
5+24	1.9000	1.9025	1.9125	1.9150	1.9175	

Prepared by: JV Employer: Stantec

Figure C-11. Surface elevation measurement

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Attachment A

APR 2 6 2000

FM, BH, [illegible] D7, DA

Long-Term Pavement Performance

LTPP Technical Support Services Contractor - c/o LAW PCS - 1575 Delucchi Lane, #201 Reno, NV 89502 - Tel 775-825-5885 - Fax 775-825-7477

MEMORANDUM

TO:	Cheryl Richter
FROM:	Gary E. Elkins and Gonzalo Rada GRR
DATE:	April 13, 2000
SUBJECT:	Supplemental Data Collection - Connecticut Test Section 091803 FHWA Contract No. DTFH61-97-C-00002 LAW PCS Project No. 10900-7-0714-02-102
PAPER FILE:	Pavement Instrumentation/Seasonal Monitoring/SMP IMS Issues
CC:	A. Lopez, L. Rodriguez, M. Symons, H. Zhou, B. Henderson, F. Meyer

Introduction

LTPP GPS-1 test section 091803, located in Groton Conecticut, is scheduled for rehabilitation. This test section was included in the Seasonal Monitoring Program (SMP) Phase I study. Prior to rehabilitation of the test section, Connecticut DOT has offered to perform additional sampling and testing at the site to supplement the previously collected information. An overview of supplemental data collection needs and field procedures are presented in this memorandum. This data collection activity is in addition to the standard LTPP pavement performance measurements to be performed prior to the rehabilitation construction event.

Data Needs

- Specific gravity measurements are needed on the unbound granular materials surrounding the Time Domain Reflectometry (TDR) probes. This information is useful for estimation of moisture contents from the TDR measurements.
- In-situ dry density of material adjacent to the TDR probes. Although difficult to measure, this value is used to convert volumetric moisture contents estimated from the TDR measurements to gravimetric contents that can be compared to laboratory determined values.
- "Ground truth" moisture contents at TDR probe locations coupled with TDR measurements. A matched set of TDR measurements and gravimetric moisture contents from the material surrounding the TDR probes will permit evaluation of the accuracy of the estimated moisture contents from the TDR measurements. Also during installation, a complete set of matching TDR and gravimetric moisture content measurements was not obtained.

- Materials characterization of the subgrade layer(s). During the standard GPS materials sampling and testing performed under SHRP, because of the presence of rocks and cobbles in the subbase material, material samples of the subgrade layer(s) were not obtained. The only information available on these layers is the visual classification performed during site verification and instrumentation placement. (Note: there appears to be two distinct layers of material beneath the subbase in which TDR probes are located.)
- Distress mechanism investigation. As a test section goes out of service, in some instances, it is useful to perform different types of measurements to investigate the distress formation mechanism. For example, if a test section has rutting, then a transverse trench could be used to identify the layers contributing to the permanent deformation.
- Within section layer thicknesses. One unknown for GPS test sections is the variation in layer thicknesses along the test section. This information can be used to refine FWD backcalculation and as a measure of construction variability.

Pavement Structure

The pavement layer structure and location of the TDR probes are shown in Figure 1, which was obtained from the SMP Instrumentation Installation Report prepared for this site.

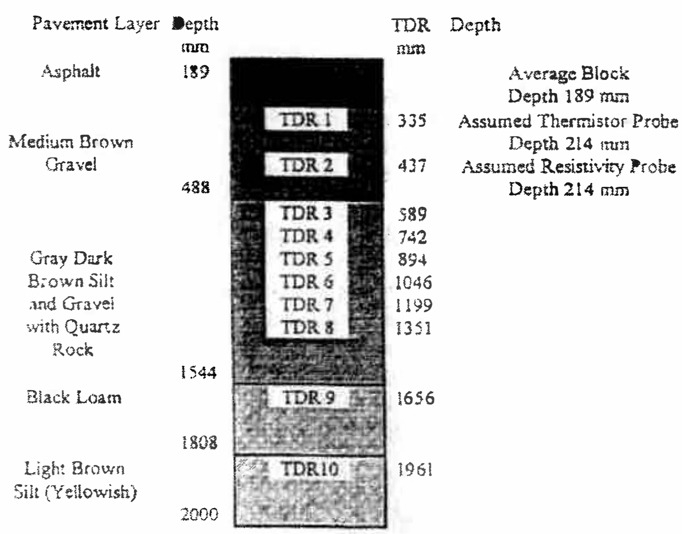

Figure 1. Profile of pavement structure and SMP probe depths for test section 091803.

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SMP Instrumentation Measurements

Unlike many of the other supplemental data collection to be performed during this exercise, the data collected from these measurements can and should be entered into the IMS. Just prior to beginning excavation of the materials at the instrumentation hole location, we recommend that the following SMP instrumentation measurements he performed:

1. Three sets of automated TDR measurements using the LTPP mobile data acquisition unit. These measurements can be performed in sequential order at the start of the work day.

2. As part of the standard LTPP mobile data acquisition, automated resistivity measurements should also be obtained. Although it is not anticipated that the site will contain frost lenses when this work is performed, the purpose of these measurements are to provide comparative data to the first set of measurements in order to evaluate the performance of the resistivity probe. Manual electrical resistivity measurements are not proposed.

3. One set of manual TDR measurements. Since the interpretation methods between automated and manual TDR measurements differ, the interpretation of the manually collected will provide a good indicator of change and comparison of the difference between the two methods.

4. Water table depth measurement.

These measurements should be possible since, except for the water table depth, they are all performed using the mobile data acquisition unit. Since this SMP site was previously deactivated, issues concerning air, rainfall and pavement gradient temperature measurements measured by the instrumentation previously installed on-site are not considered an issue.

Materials Sampling at SMP Instrumentation

In order to obtain the material samples and perform material tests to provide supplemental data for the TDR measurements, an excavation will be required next to the instrumentation location located at station 5+21. There are two approaches to this excavation. The first approach would be to use a backhoe to excavate a small test pit adjacent to the instrumentation hole large enough for a person to stand in order to obtain material samples from around the TDR probes and perform measurements. The second approach utilizes an auger boring adjacent to the instrumentation.

During the excavation and sampling process, efforts should be made to remove some of the TDR and other SMP probes to examine them, note their general condition and take pictures. The intent of this procedure is to provide indications of the likely longevity of these types of probes and the likely corrosion mechanisms that affect their performance. Particular attention should be given to sensors which have failed in order to discover why they failed.

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Test Pit

Constructing a small test pit directly adjacent to the instrumentation hole, following the general LTPP procedures, is the preferred option. Carefully constructing a hole larger enough for a person to stand in is the only way to attempt a measurement of the in-situ density and moisture content using a nuclear gauge at the approximate TDR depths as the hole is deepened. By performing in-situ density measurements with a nuclear gauge, material samples from the base and subbase layer for laboratory moisture content-density relations tests would not be needed. It also permits acquisition of a larger volume of material from the subgrade layers which include the relatively thin black loam layer in which TDR 9 is located and the light brown silt layer in which TDR 10 is positioned. It will also improve the ability to extract material samples from around the TDR probes for moisture content tests.

Some concerns over using a test pit excavation include increased pavement repair size, trench safety regulations, and equipment availability as compared to the augur boring option. However, due to the presence of rocks and cobbles in the subbase, the test pit option may require less time since the back hoe can remove the larger size material and afford easier access for hand removal of problem "large" rocks.

The field work associated with the test pit option would include the following general steps:

1. Remove AC material above instrumentation hole and in test pit. It is desired that the removal of the AC layer be performed without the use of a water cooled saw cut. Depending on equipment availability and site conditions, a backhoe maybe able to remove the AC material in the vicinity of the instrumentation hole. If a water cooled saw is used, then consideration should be given to cutting a larger hole than necessary to reduce the impact of the cooling water on the moisture content of the base layer.

2. Perform nuclear gauge measurements on the base material. Since LTPP standard practice is to use the extension rod for these tests, one density test should be performed on the base layer.

3. Hand excavate material from around the TDR probes and obtain samples for laboratory moisture and specific gravity tests.

4. In the test pit, carefully remove base material to the surface of the subbase.

5. Perform nuclear gauge density measurements on the surface of the subbase.

6. Hand excavate the material from the adjacent instrumentation hole down to TDR 3. Capture moisture and specific gravity samples.

7. Within the subbase layer, excavate the hole in 1 foot increments. For each excavation increment, perform a nuclear density measurement on the bottom of the pit and hand excavate and capture material samples from around the TDR probes. (Although some of

the probes in this portion of the hole are spaced at 6" intervals, the 1' interval is suggested to increase speed of the excavation. The density profile is also not expected to change dramatically.

8. Once the black loam layer is reached, perform nuclear gauge measurements on its surface.

9. Obtain a bulk sample of material from the black loam layer. Approximately 200 lbs is required for all standard LTPP subgrade material tests.

10. Hand excavate material in the instrumentation hole and obtain moisture and specific gravity samples from around TDR 9.

11. When the light brown silt layer is reached, repeat steps 8-10.

12. After completion of sampling and testing, fill test pit in lifts and compact.

Since this test section is scheduled for overlay, the destructive nature of some of these procedures are not judged to be as critical as if the test section had to be put back into service with a surface patch for a long period of time.

Augur Boring

The augur option is less intrusive since a smaller volume of material is removed and thus requires less pavement repair material. However, it does not afford the ability to attempt in-situ density measurements, makes large rock and cobble removal more difficult, limits the amount of material that can be obtained from the subgrade, and increases the difficulty in obtaining "good" samples of materials from around the TDR probes. In spite of these difficulties, this method is considered viable.

For the augur option, the largest size augur available is desired. A 10" diameter, hollow stem auger was used to excavate the instrumentation hole. Of primary concern is the amount of material that can be obtained from the black loam subgrade layer. Obviously, the smaller the augur, the less material. For LTPP standard testing, three augur borings were used to obtain adequate amounts of materials; however, in the general situation, the base layered tended to be the controlling factor in the need for three borings.

The field work associated with the augur option includes the following general steps:

1. Remove AC material above instrumentation hole and in test pit. It is desired that the removal of the AC layer be performed **without** the use of a water cooled saw cut. Depending on equipment availability and site conditions, a backhoe maybe able to remove the AC material in the vicinity of the instrumentation hole. If a water cooled saw is used, then consideration should be given to cutting a larger hole than necessary to reduce the impact of the cooling water on the moisture content of the base layer.

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2. Obtain an uncontaminated sample of the base material from the augur hole for the moisture- density relation test.

3. Augur into the subbase layer. Obtain one sample from the top of the layer and one near the bottom of the layer for moisture-density relation test.

4. Augur into the black loam layer, and if possible, capture 200 lbs of material for the standard battery of LTPP subgrade tests.

5. Augur into the light brown silt layer, and if possible, capture 200 lbs of material for the standard battery of LTPP subgrade tests.

6. Using a fabricated side hole material sampling device, starting with TDR 10 and progressing upward to TDR 7, obtain samples of material from the instrumentation hole in the general location of each TDR probe.

7. Starting from the surface of the base layer, hand excavate material from the instrumentation hole and obtain material samples for moisture content and specific gravity at each TDR location. Excess material from the instrumentation hole can be deposited into the augur hole.

8. Once the maximum practical extent of hand excavation is reached, use the side-hole material sampling device to obtain moisture and specific gravity samples from the remaining TDR probe locations.

9. After completion of sampling and testing, fill the augur hole lifts and compact.

Subgrade Material Characterization

It is proposed that the material characterization of the subgrade layers be performed on samples obtained only at the SMP instrumentation location. The standard LTPP practice is to obtain samples from each end of the test section. The concern over not sampling the section approach is the amount of time required to complete the excavation at the SMP instrumentation hole, and the difficulty imposed by the presence of rocks and cobbles in the subbase layer. If all of the field material sampling operations were to be performed within a single day, an additional drill rig might be required.

If the augur option is selected for the excavation at the instrumentation hole, then sample size is a concern for the black loam layer. One way to reduce the needed size of this sample is to omit the resilient modulus test. (We are not sure if Connecticut DOT has the necessary equipment to perform the LTPP P-46 test.) From the perspective of what is needed for SMP instrumentation interpretations, although preferred, the resilient modulus test of this relatively thin subsurface layer could be omitted.

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The following are the standard battery of material characterization tests on GPS subgrade materials:

Material Type, SHRP Test Designation, and Properties	Test Method	SHRP Protocol
SS01. Sieve Analysis	AASHTO T27-88I	P-51
SS02. Hydrometer to .001mm	AASHTO T88-86	P-42
SS03. Atterberg Limits	AASHTO T89-87I T90-87I	P-43
SS04. Classification/Type of Subgrade Soils	AASHTO M145-82 ASTM D2488-84	P-52
SS05. Moisture-Density Relations	AASHTO T99-86 T180-86	P-44
SS07. Resilient Modulus	AASHTO 274-82	P-46
SS09. Natural Moisture Content	AASHTO T265-86	P-49

Distress Mechanism Investigation

One of the ideas that has been discussed within the LTPP program for many years is the investigation of distress mechanisms. The concept is that after a test section has gone out of service, or is scheduled of rehabilitation, a "forensic" type of investigation should be performed to examine the details surrounding the causes and mechanisms of distress. Due to funding constraints, LTPP has not developed a formal program for these type of investigations.

To perform this type of investigation, we recommend that as a first step a site inspection be performed by LTPP and highway agency representatives. The purpose of this inspection is to note site specific distresses and likely causative factors. The result of this activity is an investigation plan. Some of the types of investigations and field tests that have been suggested for this type of work include:

- Crack cores. By coring through a crack it may be possible to determine the location of the crack starting point and if it extends completely through the bound surface layer.
- Rut trenches. If rutting is the major distress, transverse trenches at selected locations can be used to determine which layer in the pavement structure contributed to the rutting mechanism.
- Drainage evaluation. Depending on the specific features of the site, drainage evaluation can provide very valuable supplemental information on likely distress mechanisms. On sites with in-pavement drainage features, it could also lead to the need for further functional drainage evaluation tests, such as video inspection of edge drains.

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- Joint seal evaluation. If a PCC pavement has exhibited suspected moisture related distresses at the joints, such as pumping, depending on nature of the pavement structure, use of the Iowa PCC joint vacuum device might be indicated to evaluate condition of the seals.

While this approach is based on "what failed", equally important and more difficult to addressed is the investigation of "what worked" and why. Similar to diagnosing problems with a car from a manufacturers viewpoint, knowing what worked, requires understanding of what did not work. Hence, in the case of superior performing pavements, it may be deemed prudent to conduct addition exploratory tests to discover an unknown factor.

Thickness Variation

If a test section is scheduled to go out of service, that is, no longer be monitored as part of the LTPP program, then measurements of the variation in the thickness of the bound surface layers is important. The concept is to obtain cores at the FWD test points within the test section. This reduces coring costs and provides significant information that can be used to improve the results from the backcalculation of FWD basin tests (i.e. non load transfer, corner, and edge tests on rigid pavements) and to quantify construction variability. First priority is to obtain thicknesses in the wheel path locations. Second priority is at the middle lane, basin test, locations.

It is our present understanding that this site is proposed for monitoring continuation after rehabilitation. If the site is accepted for monitoring continuation, then this type of destructive sampling within the test section should not be performed. An on-site inspection maybe useful in evaluating the impact of the pipeline buried, in circa 1997, along the edge of the shoulder on the performance of this section. It is also noted that the agency has collected significant WIM traffic data on this site and has committed to reinstall the WIM scale after rehabilitation.

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Attachment B

Original Copy FILE GC BH, BA AL

Long-Term Pavement Performance
LTPP Testing Contractor - P.O. Box 39108 - Minneapolis, Minnesota 55439-0108 - Tel 952-941-5600 - Fax 952-941-4151

September 22, 2000

Project BADX-00-1264

Dr. William Phang
FHWA-LTPP North Atlantic RCOC
ITX Stanley Limited
415 Lawrence Bell Drive, Suite 3
Amherst, NY 14221

Dear Dr. Phang:

Re: Laboratory Test Assignments, LTPP Laboratory Testing, Connecticut Site 091803

The attached sheet lists the tests requested by the Connecticut Department of Transportation for the site listed below. This testing was performed under a separate contract with the Connecticut Department of Transportation. Test results are being submitted in the same envlope as this letter and L04 sheet.

Enclosed L04 Sheet

State	Site Identification	Field Set	Sheets
Connecticut	GPS 091803	3	1

If you have questions regarding the assignments, please call me at (320) 253-9940 or Dave Clauson at (952) 942-4836.

Sincerely,

Bruce M. Thorson, PE
Project Manager

Attachments:
L04 Sheet (See Table)

c: Dave Clauson (letter only)
Braun Intertec Corporation

bmt:bjf\fhwa\L04ltr.al5

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GPS LABORATORY TESTING DATA SHEET
SHREP-LTPP LABORATORY MATERIAL HANDLING AND TESTING — Sheet 1 of 1
LABORATORY TEST ASSIGNMENTS
LAB DATA SHEET LO4

LABORATORY PERFORMING TEST: BRAUN INTERTEC

LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION: NA — STATE ABR: CT — STATE CODE: 09

GPS EXPERIMENT NUMBER: 1 — SHRP SECTION ID: 091803 — FIELD SET NUMBER: 3

SAMPLED BY: CT DOT — DATE SAMPLED: 5/3/00

LAYER NUMBER	LAYER DESC CODE	LAYER TYPE	SAMPLE LOCATION NO.	LTPP SAMPLE NO.	TEST SECTION NO.	LAB TEST NO.	LAB CONTROL NO.	LTPP TEST DESIGNATION	LTPP PROTOCOL	TEST DATE SCHED
1	7	SS	BA4	BS01	3	2	12260	✓ SS01	P51 ✓	Sieve
1	7	SS	BA4	BS01	3	2	12260	✓ SS02	P42 ✓	Hydro
1	7	SS	BA4	BS01	3	2	12260	✓ SS03	P43 ✓	Atterberg
1	7	SS	BA4	BS01	3	2	12260	✓ SS04	P52 ✓	Class
1	7	SS	BA4	BS01	3	2	12260	✓ T100	(spec. grav.)	✓
1	7	SS	BA5	BS02	3	2	12261	✓ SS01	P51 ✓	Sieve
1	7	SS	BA5	BS02	3	2	12261	✓ SS02	P42 ✓	Hydro
1	7	SS	BA5	BS02	3	2	12261	✓ SS03	P43 ✓	Atterberg
1	7	SS	BA5	BS02	3	2	12261	✓ SS04	P52 ✓	Class
1	7	SS	BA5	BS02	3	2	12261	✓ SS05	P55 ✓	Moisture
1	7	SS	BA5	BS02	3	2	12261	SS07	P46 ✓	Resilient
1	7	SS	BA5	BS02	3	2	12261	✓ T100	(spec. grav.)	✓
2	6	GS	BA4	BG02	3	2	12262	✓ SS02	P42 ✓	Hydro
2	6	GS	BA4	BG02	3	2	12262	✓ T100	(spec. grav.)	✓
2	6	GS	BA4	BG02	3	2	12262	✓ UG01	P41 ✓	} Sieve
2	6	GS	BA4	BG02	3	2	12262	✓ UG02	P41 ✓	
2	6	GS	BA4	BG02	3	2	12262	✓ UG05	P44 ✓	Moisture
2	6	GS	BA4	BG02	3	2	12262	✓ UG08	P47 ✓	Class
3	5	GB	TP*	BG55	3	2	12263	✓ SS02	P42 ✓	Hydro
3	5	GB	TP*	BG55	3	2	12263	✓ T100	(spec. grav.)	✓
3	5	GB	TP*	BG55	3	2	12263	✓ UG01	P41 ✓	} Sieve
3	5	GB	TP*	BG55	3	2	12263	✓ UG02	P41 ✓	
3	5	GB	TP*	BG55	3	2	12263	✓ UG05	P44 ✓	Moisture
3	5	GB	TP*	BG55	3	2	12263	✓ UG08	P47 ✓	Class

NOTES: COLUMN 1. Layer number 1 is the subgrade soil, the last layer is the existing pavement surface layer.

GENERAL REMARKS: Forensic testing performed under contract w/CT DOT.

SUBMITTED BY, DATE: 8/18/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
FHWA-LTPP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING, 150 LAWRENCE BELL DRIVE, SUITE 3, AMHERST, NY 14221

FHWA-LTPP Materials Testing Contractor Form LO4, March 1994

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September 22, 2000

Project BADX-00-1264

Dr. William Phang
FHWA-LTPP North Atlantic RCOC
ITX Stanley Limited
415 Lawrence Bell Drive, Suite 3
Amherst, NY 14221

Dear Dr. Phang:

Re: Nonmodulus Tests Completed on LTPP Samples from Site/Project 0918 in Connecticut

The following table lists nonmodulus tests completed on samples from Site/Project 0918 in Connecticut. The data sheets are enclosed. Copies of the test results are also being sent to the Connecticut DOT. Copies of the list are being sent to the FHWA Contracting Officer's Technical Representative (COTR) and the FHWA Technical Assistance Contractor (TAC).

Nonmodulus Tests on Samples From Site/Project 0918

GPS/SPS	State/Province		Project	Section(s)	Field Set	Data Sheets
	Abbrev.	Code				
GPS/SPS	CT	09	18	3	3	T41(1),T42(2+4),T43(1), T43(1),T44(1+2),T47, T51,T52,T55(1+1) extra tests on BG02 & BG55

If you have questions, please call me at (320) 253-9940 or Dave Clauson at (612) 942-4836.

Sincerely,

Bruce M. Thorson, PE
Project Manager

Enclosures:
(See Table)

bmt:bmt\fhwa\data1000.na

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SPS LABORATORY TESTING DATA SHEET

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
GRADATION
LAB DATA SHEET T41

SHEET NO 1 OF 1

UNBOUND GRANULAR BASE / SUBBASE LAYERS
SHRP TEST DESIGNATION UG01,UG02 / SHRP PROTOCOL P41

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA   STATE ABR : CT   STATE CODE : 09

SPS EXPERIMENT NUMBER : 1   SPS PROJECT CODE : 18

SAMPLED BY : CT DOT   FIELD SET NUMBER : 3

DATE SAMPLED : 5/3/00

1. LAYER NUMBER (FROM LAB SHEET LO4)	2	3
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	TP*
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BG02	BG55
7.% PASSING #200 SIEVE BY WASHING (Section 9.3.1 of Protocol P41)	8.4	4.2
8. GRADATION (Section 9.3.2 of Protocol P41) % PASSING SIEVE SIZE STANDARD (mm)		
3 in. (75.0)	91	95
2 in. (50.0)	89	90
1 1/2 in. (37.5)	83	86
1 in. (25.0)	75	78
3/4 in. (19.0)	69	73
1/2 in. (12.5)	62	65
3/8 in. (9.5)	57	59
#4 (4.75)	49	49
#10 (2.00)	43	40
#40 (0.425)	28	24
#80 (0.180)	18	13
#200 (0.075)	10.6	6.5
9. COMMENTS (Section 9.4 of Protocol P41) (a) CODE	64	64
(b) NOTE		
(c) WEIGHT OF TEST SAMPLE,lbs MOISTURE CONTENT, %	56	55
10. TEST DATE	8/14/00	8/14/00
SAMPLE IDENTIFICATION	12262	12263

NOTE: 1. RESULTS OF TEST SHEETS T41 AND T43 ARE USED FOR CLASSIFICATION AND DESCRIPTION ON TEST SHEET T47.
2. ATTACH A CUMULATIVE PARTICLE SIZE GRADATION CURVE WITH FORM T41 (SECTION 9.3.3 OF PROTOCOL P41.

GENERAL REMARKS: Specific gravity: BG02=2.78, BG55=2.80

SUBMITTED BY, DATE
8/18/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING 150 LAWRENCE BELL DRIVE SUITE 3 AMHERST, NY 14221

Form T41, February 1991

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SPS LABORATORY TESTING DATA SHEET

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
HYDROMETER ANALYSIS
LAB DATA SHEET T42

SHEET NO 1 OF 2

SUBGRADE LAYER
SHRP TEST DESIGNATION SS02 / SHRP PROTOCOL P42
LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA   STATE ABR : CT   STATE CODE : 09
SPS EXPERIMENT NUMBER : 1   SPS PROJECT CODE : 18
SAMPLED BY : CT DOT   FIELD SET NUMBER : 3
DATE SAMPLED : 5/3/00

1. LAYER NUMBER (FROM LAB SHEET LO4)	1	1
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER(Enter an asterisk as the third digit)	BA4	BA5
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BS01	BS02
7. PARTICLE SIZE DISTRIBUTION (Section 9.3.1 of Protocol P42)		
(a) LARGER THAN 2 mm, %	10	19
(b) COARSE SAND, 2 TO 0.42 mm, %	12	12
(c) FINE SAND, 0.42 TO 0.074 mm, %	19	19
(d) SILT, 0.074 TO 0.002 mm, %	51.0	43.3
(e) CLAY, SMALLER THAN 0.002 mm, %	7.7	6.6
(f) COLLOIDS, SMALLER THAN 0.001 mm. %		
8. GRADATION (Section 9.3.2 (a) of Protocol P42, Test Sheet T51; see note 1) % PASSING SIEVE SIZE STANDARD (mm)		
3 in. (75.0)	100	100
2 in. (50.0)	100	100
1 1/2 in. (37.5)	100	100
1 in. (25.0)	100	95
3/4 in. (19.0)	99	94
1/2 in. (12.5)	97	90
3/8 in. (9.5)	96	88
#4 (4.75)	93	84
#10 (2.00)	90	81
#40 (0.425)	78	69
#80 (0.180)	68	60
#200 (0.075)	58.7	49.9
9. HYDROMETER ANALYSIS (Section 9.3.2 of (b) of Protocol P42; see note 2) % SMALLER THAN		
0.02 mm	29.7	23.7
0.002 mm	7.7	6.6
0.001 mm		
10. COMMENTS (Section 9.4 of Protocol P42) (a) CODE	48	48
(b) NOTE		
(c) HYGROSCOPIC MOISTURE CONTENT		
11. TEST DATE	8/18/00	8/18/00
SAMPLE IDENTIFICATION	12260	12261

NOTE: 1. RESULTS OF TEST SHEET T51 ARE ALSO REPORTED OF TEST SHEET T42 (ITEM NO. 6 OF FORM T42).
2. ATTACH A CUMULATIVE PARTICLE SIZE GRADATION CURVE OF COMBINED SIEVE AND HYDROMETER ANALYSIS (SECTION 9.3.3 OF PROTOCOL P42).

GENERAL REMARKS:

SUBMITTED BY, DATE
8/21/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING 415 LAWRENCE BELL DRIVE SUITE 3 AMHERST, NY 14221

Form T42, February 1991

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SPS LABORATORY TESTING DATA SHEET

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
HYDROMETER ANALYSIS
LAB DATA SHEET T42

SHEET NO 2 OF 2

SUBGRADE LAYER

SHRP TEST DESIGNATION SS02 / SHRP PROTOCOL P42

LABORATORY PERFORMING TEST: BRAUN INTERTEC

LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA   STATE ABR : CT   STATE CODE : 09

SPS EXPERIMENT NUMBER : 1   SPS PROJECT CODE : 18

SAMPLED BY : CT DOT   FIELD SET NUMBER : 3

DATE SAMPLED : 5/3/00

1. LAYER NUMBER (FROM LAB SHEET LO4)	2	3
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER(Enter an asterisk as the third digit)	BA4	TP*
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BG02	BG55
7. PARTICLE SIZE DISTRIBUTION (Section 9.3.1 of Protocol P42)		
(a) LARGER THAN 2 mm, %	57	60
(b) COARSE SAND, 2 TO 0.42 mm, %	15	16
(c) FINE SAND, 0.42 TO 0.074 mm, %	17	18
(d) SILT, 0.074 TO 0.002 mm, %	9.1	4.9
(e) CLAY, SMALLER THAN 0.002 mm, %	1.5	1.6
(f) COLLOIDS, SMALLER THAN 0.001 mm. %		
8. GRADATION (Section 9.3.2 (a) of Protocol P42, Test Sheet T51; see note 1) % PASSING SIEVE SIZE STANDARD (mm)		
3 in. (75.0)	91	95
2 in. (50.0)	89	90
1 1/2 in. (37.5)	83	86
1 in. (25.0)	75	78
3/4 in. (19.0)	69	73
1/2 in. (12.5)	62	65
3/8 in. (9.5)	57	59
#4 (4.75)	49	49
#10 (2.00)	43	40
#40 (0.425)	28	24
#80 (0.180)	18	13
#200 (0.075)	10.6	6.5
9. HYDROMETER ANALYSIS (Section 9.3.2 of (b) of Protocol P42; see note 2) % SMALLER THAN		
0.02 mm	5.2	4.7
0.002 mm	1.5	1.6
0.001 mm		
10. COMMENTS (Section 9.4 of Protocol P42)		
(a) CODE	48	48
(b) NOTE		
(c) HYGROSCOPIC MOISTURE CONTENT		
11. TEST DATE	8/18/00	8/18/00
SAMPLE IDENTIFICATION	12262	12263

NOTE: 1. RESULTS OF TEST SHEET T51 ARE ALSO REPORTED OF TEST SHEET T42 (ITEM NO. 6 OF FORM T42).
2. ATTACH A CUMULATIVE PARTICLE SIZE GRADATION CURVE OF COMBINED SIEVE AND HYDROMETER ANALYSIS (SECTION 9.3.3 OF PROTOCOL P42).

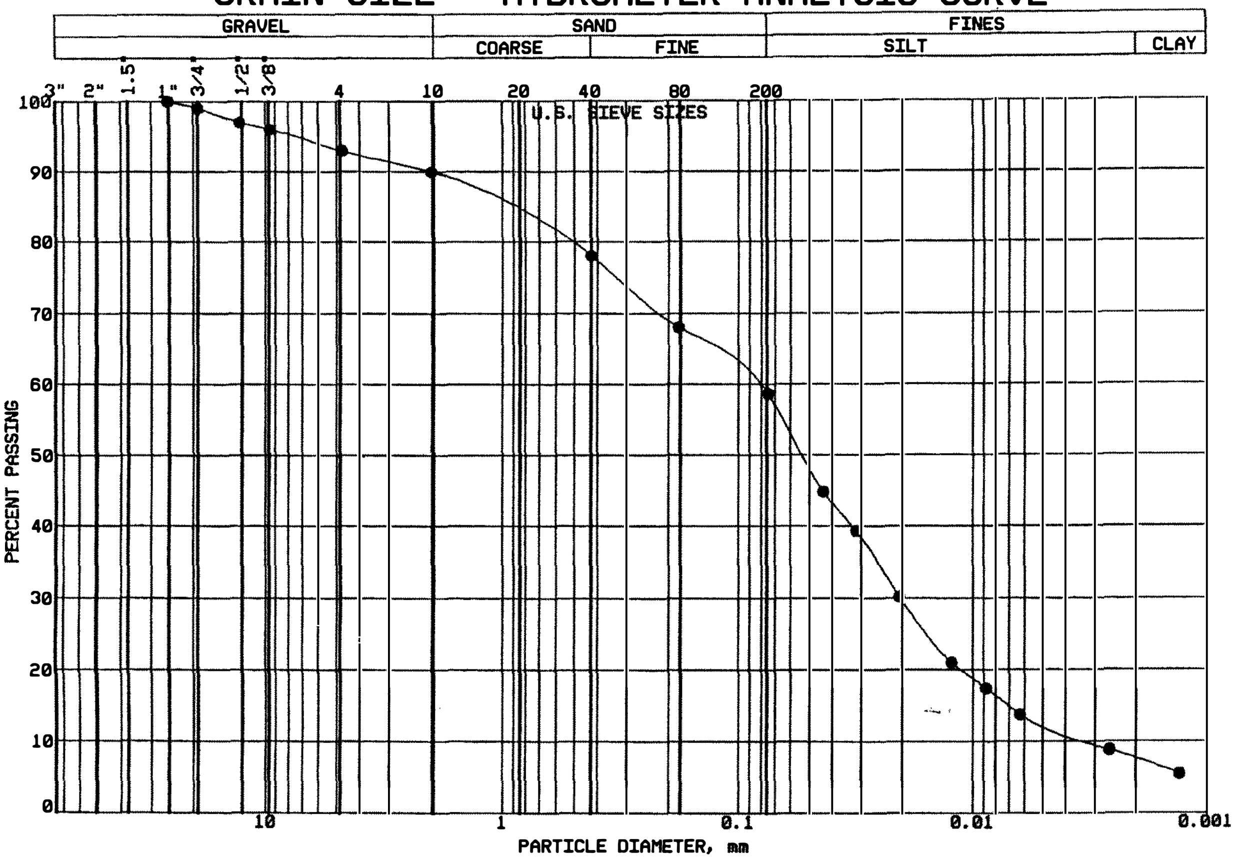
GENERAL REMARKS:

SUBMITTED BY, DATE
8/21/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING 415 LAWRENCE BELL DRIVE SUITE 3 AMHERST, NY 14221

Form T42, February 1991

GRAIN SIZE - HYDROMETER ANALYSIS CURVE



BRAUN INTERTEC

PROJECT NO:	BADX-94-900	% <.02mm	29.7%	GRAVEL	10.0%
PROJECT NAME:	FHWA Lab Testing	COARSE SAND	%	SAND	31.3%
SITE ID:	BS01	FINE SAND	%	SILT	51.0%
SAMPLE ID:	12260	COLLOIDS	%	CLAY	7.7%
				Cc=	
				Cu=	

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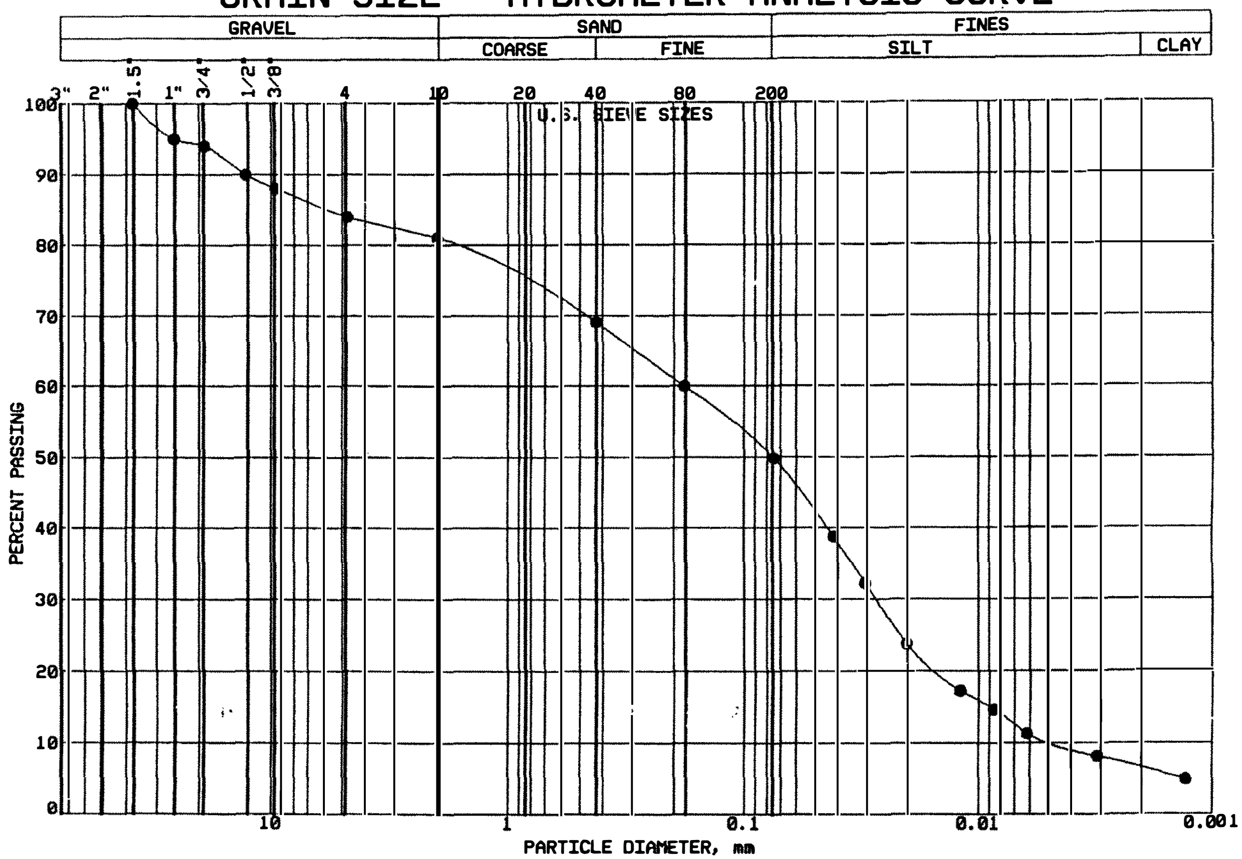
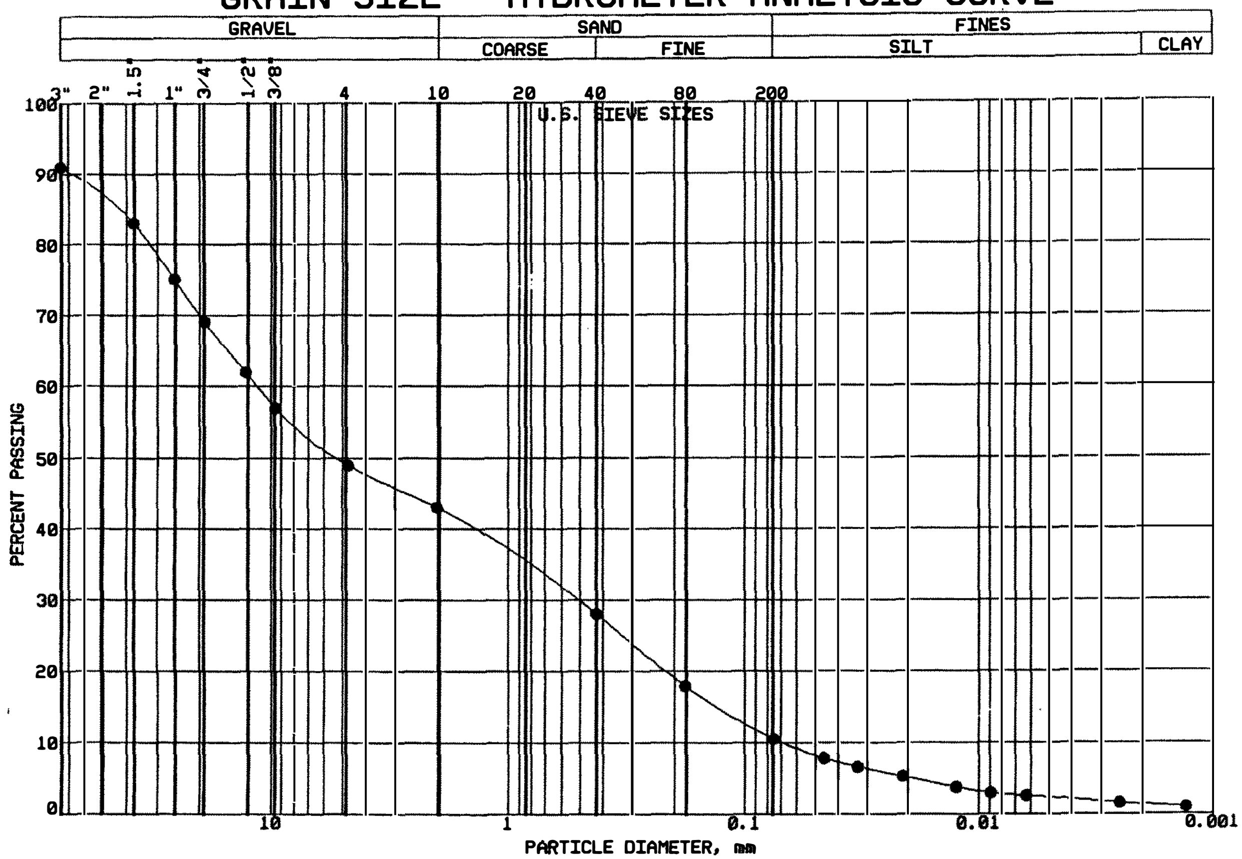
GRAIN SIZE - HYDROMETER ANALYSIS CURVE



BRAUN INTERTEC

PROJECT NO:	BADX-94-900	% <.02mm	23.7%	GRAVEL	19.0%
PROJECT NAME:	FHWA Lab Testing	COARSE SAND	%	SAND	31.1%
SITE ID:	BS02	FINE SAND	%	SILT	43.3%
SAMPLE ID:	12261	COLLOIDS	%	CLAY	6.6%
				Cc=	
				Cu=	

GRAIN SIZE - HYDROMETER ANALYSIS CURVE



BRAUN INTERTEC

PROJECT NO:	BADX-94-900	% <.02mm	5.2%	GRAVEL	48.0%
PROJECT NAME:	FHWA Lab Testing	COARSE SAND	%	SAND	32.4%
SITE ID:	BG02	FINE SAND	%	SILT	9.1%
SAMPLE ID:	12262	COLLOIDS	%	CLAY	1.5%
				Cc=	
				Cu=	

Attachment B-10

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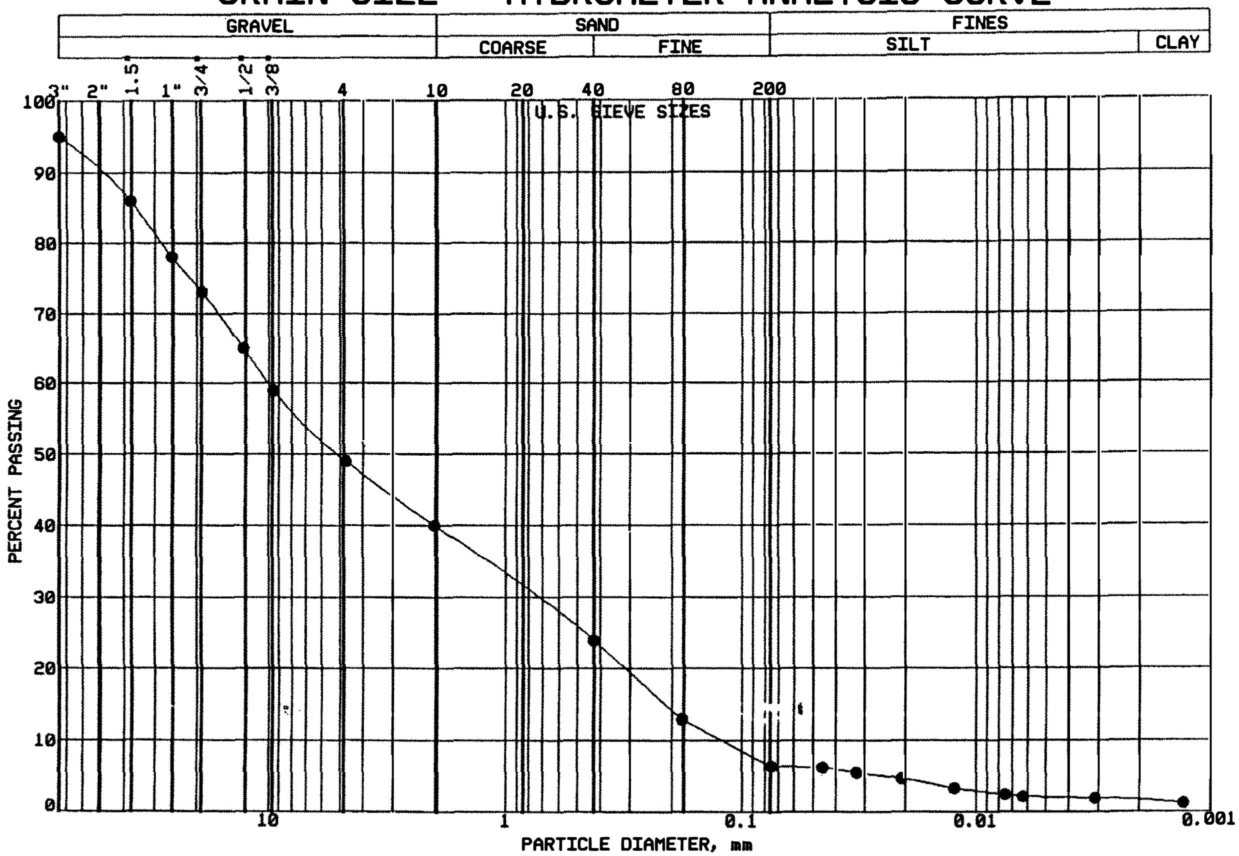
GRAIN SIZE - HYDROMETER ANALYSIS CURVE



BRAUN
INTERTEC

PROJECT NO:	BADX-94-9	% <.02mm	4.7%	GRAVEL	55.0%
PROJECT NAME:	FHWA Lab Testing	COARSE SAND	%	SAND	33.5%
SITE ID:	BG55	FINE SAND	%	SILT	4.9%
SAMPLE ID:	12263	COLLOIDS	%	CLAY	1.6%
				Cc=	
				Cu=	

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*** SPS LABORATORY TESTING DATA SHEET ***

SHRP-LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
ATTERBERG LIMITS
LAB DATA SHEET T43

SHEET NO 1 OF 1

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
SHRP TEST DESIGNATION UG04, SS03 / SHRP PROTOCOL P43

LABORATORY PERFORMING TEST: BRAUN INTERTEC

LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION :	NA	STATE ABR :	CT	STATE CODE :	09
SPS EXPERIMENT NUMBER :	1			SPS PROJECT CODE :	18
SAMPLED BY :	CT DOT			FIELD SET NUMBER :	3
DATE SAMPLED :	5/3/00				

LAYER MATERIAL:	SS		SS
1. LAYER NUMBER (FROM LAB SHEET LO4)	1		1
2. TEST SECTION NO.	3		3
3. SAMPLING AREA NO.			
4. SHRP LABORATORY TEST NUMBER	2		2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4		BA5
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BS01		BS02
7. TEST RESULTS (Section 5.3 of protocol P43)			
SHRP TEST DESIGNATION:	SS03		SS03
(a) LIQUID LIMIT (LL), %	24		
(b) PLASTIC LIMIT (PL), %	20		
(c) PLASTICITY INDEX (PI)	4		NP
8. COMMENTS (Section 5.3 of Protocol P43) (a) CODE		67	69
(b) NOTE			
9. TEST DATE	8/18/00		8/18/00
LAB CONTROL NUMBER	12260		12261

NOTE: 1. RESULTS OF TEST SHEETS T41 AND T43 ARE USED FOR CLASSIFICATION AND DESCRIPTION ON TEST SHEET T47.

GENERAL REMARKS:

SUBMITTED BY

[signature] 8/21/00

DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE

[signature]

SHRP REPRESENTATIVE

AFFILIATION: STANTEC CONSULTING
415 LAWRENCE BELL DRIVE
SUITE 3
AMHERST, NY 14221

Form T43, February 1991

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SPS LABORATORY TESTING DATA SHEET

SHRP-LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
ATTERBERG LIMITS
LAB DATA SHEET T43

SHEET NO 1 OF 1

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
SHRP TEST DESIGNATION UG04, SSO3 / SHRP PROTOCOL P43

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA   STATE ABR : CT   STATE CODE : 09
SPS EXPERIMENT NUMBER : 1   SPS PROJECT CODE : 18
SAMPLED BY : CT DOT   FIELD SET NUMBER : 3
DATE SAMPLED : 5/3/00

LAYER MATERIAL:	GS	GB
1. LAYER NUMBER (FROM LAB SHEET LO4)	2	3
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	TP*
6. SHRP SAMPLE NUMBER (Enter an asterisk as the third and fourth digit)	BG02	BG55
7. TEST RESULTS (Section 5.3 of protocol P43) SHRP TEST DESIGNATION:	UG04	UG04
(a) LIQUID LIMIT (LL), %		
(b) PLASTIC LIMIT (PL), %		
(c) PLASTICITY INDEX (PI)	NP	NP
8. COMMENTS (Section 5.3 of Protocol P43) (a) CODE	67	67
(b) NOTE		
9. TEST DATE	8/18/00	8/18/00
LAB CONTROL NUMBER	12262	12263

NOTE: 1. RESULTS OF TEST SHEETS T41 AND T43 ARE USED FOR CLASSIFICATION AND DESCRIPTION ON TEST SHEET T47.

GENERAL REMARKS: EXTRA TESTS

SUBMITTED BY
8/21/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE

SHRP REPRESENTATIVE
AFFILIATION:

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SPS LABORATORY TESTING DATA SHEET

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
MOISTURE-DENSITY RELATIONS
LAB DATA SHEET T44

SHEET NO 1 OF 1

UNBOUND GRANULAR BASE/SUBBASE LAYERS
SHRP TEST DESIGNATION UG05 / SHRP PROTOCOL P44

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA   STATE ABR : CT   STATE CODE : 09
SPS EXPERIMENT NUMBER : 1   SPS PROJECT CODE : 18
SAMPLED BY : CT DOT   FIELD SET NUMBER : 3
DATE SAMPLED : 5/3/00

1. LAYER NUMBER (FROM LAB SHEET LO4)	2	3
LAYER MATERIAL:	GS	GB
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	TP*
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BG02	BG55
7. TEST RESULTS (Section 10.3 of Protocol P44)		
(a) METHOD USED (B OR D)	D	D
(b) OPTIMUM MOISTURE CONTENT(OMC),%	5	6
(c) MAXIMUM DENSITY (MD), PCF	141	141
8. COMMENTS (Section 10.4 of Protocol P44)		
(a) CODE	64 75 78	64 75 78
(b) NOTE		
9. TYPE OF RAMMER FACE (If other than that described in section 10.5 of Protocol P44)	SECTOR	SECTOR
10. TEST DATE	8/21/00	8/22/00
SAMPLE IDENTIFICATION	12262	12263

NOTE: 1. INCLUDE THE OPTIMUM MOISTURE CONTENT CURVE WITH TEST SHEET T44 (SECTION 10.3.6 OF PROTOCOL P44).

GENERAL REMARKS:

SUBMITTED BY
9/5/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING
415 LAWRENCE BELL DRIVE
SUITE 3
AMHERST, NY 14221

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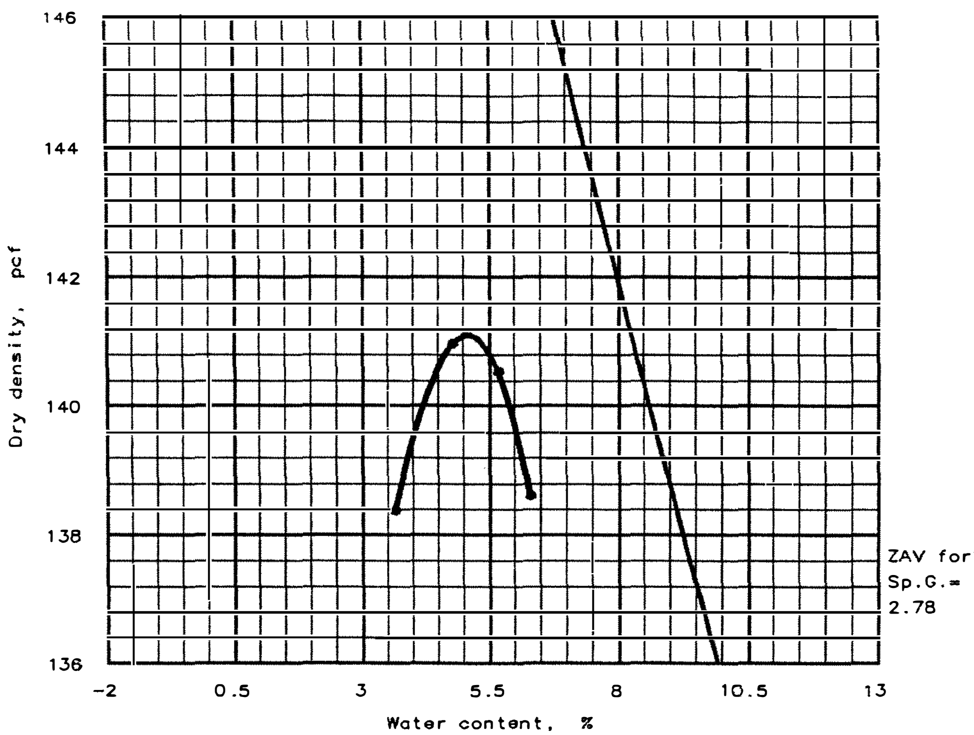
MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: SHRP P44 Method D, Modified

Elev/ Depth	Date Tested	Date Sampled	Sampled By	As Received Moisture	Preparation Method	Rammer Type
	8/15/00				moist	automatic

Size of Oversize	Percent Oversize	Percent on 3/4	Percent 3/4 to 3/8	Percent 3/8 to #4	Natural Moisture	Specific Gravity
3/4 in		100	0	0		2.78

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 141.0 pcf Optimum moisture = 5.0 %	Aggregate Subbase

Project No.: BATX-00-1264
Project: 091803
Location: 8G02
Test No.: 12262
Date: 8/21/2000

Remarks:
Specific gravity was determined

MOISTURE-DENSITY RELATIONSHIP TEST
BRAUN INTERTEC

Fig. No. 394

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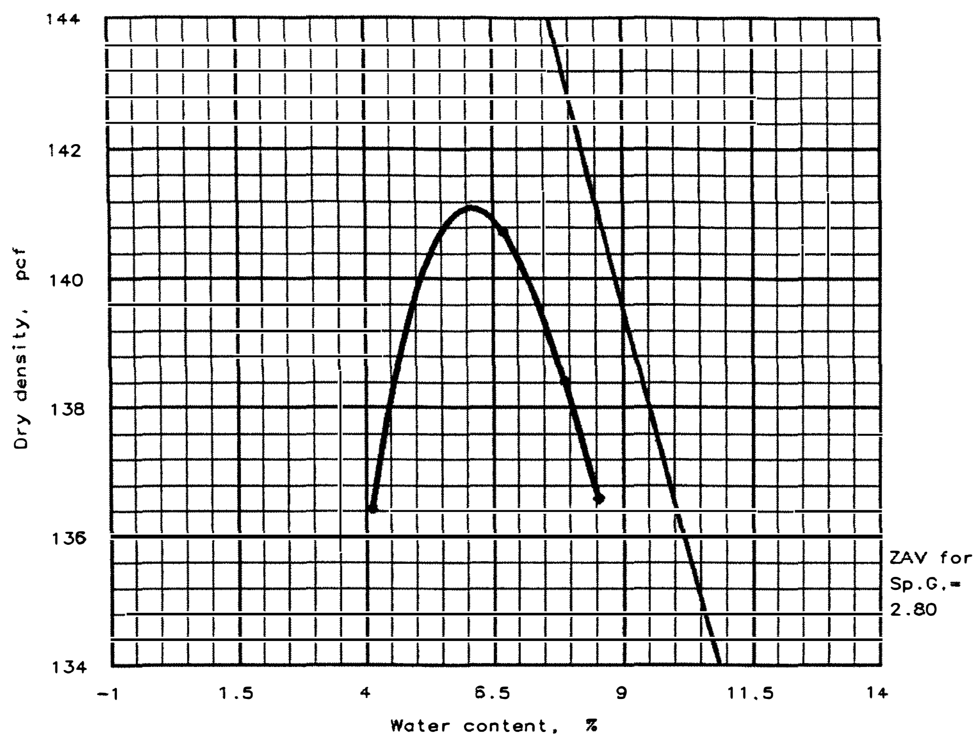
MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: SHRP P44 Method D, Modified

Elev/ Depth	Date Tested	Date Sampled	Sampled By	As Received Moisture	Preparation Method	Rammer Type
	8/22/00				moist	automatic

Size of Oversize	Percent Oversize	Percent on 3/4	Percent 3/4 to 3/8	Percent 3/8 to #4	Natural Moisture	Specific Gravity
3/4 in		100	0	0		2.80

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 141.0 pcf Optimum moisture = 6.0 %	Aggregate Base

Project No.: BATX-00-1264
Project: 091803
Location: BG55
Test No.: 12263
Date: 8/22/00

Remarks:
Specific gravity was determined

MOISTURE-DENSITY RELATIONSHIP TEST
BRAUN INTERTEC

Fig. No. 419

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**************************** SPS LABORATORY TESTING DATA SHEET ****************************

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
CLASSIFICATION AND DESCRIPTION
LAB DATA SHEET T47

SHEET NO 1 OF 1

UNBOUND GRANULAR BASE/SUBBASE LAYERS
SHRP TEST DESIGNATION UG08 / SHRP PROTOCOL P47

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION : NA | STATE ABR : CT | STATE CODE : 09
SPS EXPERIMENT NUMBER : 1 | SPS PROJECT CODE : 18
SAMPLED BY : CT DOT | FIELD SET NUMBER : 3
DATE SAMPLED : 5/3/00
LAYER TYPE : GS

1. LAYER NUMBER (FROM LAB SHEET LO4)	2	3
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO. (SA-)		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	TP*
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BG02	BG55
7. VISUAL-MANUAL DESCRIPTION (Section 11.3.1 of Protocol P47)		
(a) RANGE OF PARTICLE SIZE	48%GVL-32%SND	55%GVL-34%SND
(b) MAXIMUM PARTICLE SIZE	COBBLES	COBBLES
(c) COLOR DESCRIPTION	GRAY	BROWN
(d) CODES-OTHER PROPERTIES (Table D.2 of Appendix D, LTPP Lab Guide)	1201 2101 1302 2301 1501 1701 1803	1201 2102 1302 2301 1501 1701 1803
8. VISUAL-MANUAL CLASSIFICATION (Section 11.3.2 of Protocol P47)	303	304
9. Mr MATERIAL TYPE (Section 11.3.3 of Protocol P47)	1	1
10. COMMENTS (Section 11.4 of Protocol P47)		
(a) CODE		
(b) NOTE		
11. TEST DATE	8/18/00	8/18/00
SAMPLE IDENTIFICATION	12262	12263

GENERAL REMARKS:

SUBMITTED BY, DATE
8/21/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING
415 LAWRENCE BELL DRIVE
SUITE 3
AMHERST, NY 14221

Form T47, February 1991

Long-Term Pavement Performance

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** SPS LABORATORY TESTING DATA SHEET **

SHRP-LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA — SHEET NO 1 OF 1
SIEVE ANALYSIS OF SUBGRADE SOILS
LAB DATA SHEET T51

SUBGRADE SOILS
SHRP TEST DESIGNATION SS01 / SHRP PROTOCOL P51

LABORATORY PERFORMING TEST:__________
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION :	NA	STATE ABR :	CT	STATE CODE :	09
SPS EXPERIMENT NUMBER :	1			SPS PROJECT CODE :	18
SAMPLED BY :	CT DOT			FIELD SET NUMBER :	3
DATE SAMPLED :	5/3/00				

1. LAYER NUMBER (FROM LAB SHEET LO4)	1	1
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	BA5
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BS01	BS02
7.% PASSING #200 SIEVE BY WASHING (Section 9.3.1 of Protocol P51)	56.1	44.7
8. GRADATION (Section 9.3.2 of Protocol P51) % PASSING SIEVE SIZE STANDARD (mm)		
3 in. (75.0)	100	100
2 in. (50.0)	100	100
1 1/2 in. (37.5)	100	100
1 in. (25.0)	100	95
3/4 in. (19.0)	99	94
1/2 in. (12.5)	97	90
3/8 in. (9.5)	96	88
#4 (4.75)	93	84
#10 (2.00)	90	81
#40 (0.425)	78	69
#80 (0.180)	68	60
#200 (0.075)	58.7	49.9
9. COMMENTS (Section 9.4 of Protocol P51)		
(a) CODE		
(b) NOTE		
(c) WEIGHT OF TEST SAMPLE,lbs MOISTURE CONTENT, %	12	11
10. TEST DATE	8/14/00	8/14/00
SAMPLE IDENTIFICATION	12260	12261

NOTE: 1. RESULTS OF TEST SHEETS T51 AND T43 ARE USED FOR CLASSIFICATION AND DESCRIPTION ON TEST SHEET T52.
2. ATTACH A CUMULATIVE PARTICLE SIZE GRADATION CURVE WITH FORM T51 (SECTION 9.3.3 OF PROTOCOL P51)

GENERAL REMARKS: Specific gravity: BS01 = 2.73 , BS02 = 2.74

SUBMITTED BY, DATE
8/18/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE: STANTEC CONSULTING
AFFILIATION: 415 LAWRENCE BELL DRIVE
SUITE 3
AMHERST, NY 14221

Form T51, February 1991

Long-Term Pavement Performance

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*** SPS LABORATORY TESTING DATA SHEET**

SHRP-LTPP LABORATORY MATERIALHANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
CLASSIFICATION AND DESCRIPTION
LAB DATA SHEET T52

SHEET NO 1 OF 1

SUBGRADE SOILS
SHRP TEST DESIGNATION SS04 / SHRP PROTOCOL P52

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION :	NA	STATE ABR :	CT	STATE CODE :	09
SPS EXPERIMENT NUMBER :	1			SPS PROJECT CODE :	18
SAMPLED BY :	CT DOT			FIELD SET NUMBER :	3
DATE SAMPLED :	5/3/00				

1. LAYER NUMBER (FROM LAB SHEET LO4)	1	1
2. TEST SECTION NO.	3	3
3. SAMPLING AREA NO. (SA-)		
4. SHRP LABORATORY TEST NUMBER	2	2
5. LOCATION NUMBER (Enter an asterisk as the third digit)	BA4	BA5
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)	BS01	BS02
7. VISUAL-MANUAL DESCRIPTION (Section 11.3.1 of Protocol P52)		
(a) RANGE OF PARTICLE SIZE	10%GVL-31%SND	19%GVL-31%SND
(b) MAXIMUM PARTICLE SIZE	1"	1 1/2"
(c) COLOR DESCRIPTION	BROWN	BROWN
(d) CODES-OTHER PROPERTIES (Table D.2 of Appendix D, LTPP Lab Guide)	1101 1901 1202 2103 1302 2301 1704 1802	1101 2102 1202 2301 1302 1704 1802
8. VISUAL-MANUAL CLASSIFICATION (Section 11.3.2 of Protocol P52)	145	145
9. AASHTO CLASSIFICATION CODE (Section 11.3.3 of Protocol P52)	510	510
10. Mr MATERIAL TYPE (Section 11.3.3 of Protocol P52)	2	2
11. COMMENTS (Section 11.4 of Protocol P52)		
(a) CODE		
(b) NOTE		
12. TEST DATE	8/18/00	8/18/00
SAMPLE IDENTIFICATION	12260	12261

NOTE: 1. RESULTS OF TEST SHEET T51 AND T43 ARE USED FOR CLASSIFICATION AND DESCRIPTION ON TEST SHEET T52.

GENERAL REMARKS:

SUBMITTED BY, DATE
8/21/00
DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE
SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING 415 LAWRENCE BELL DRIVE SUITE 3 AMHERST NY 14221

Form T52, February 1991

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*** SPS LABORATORY TESTING DATA SHEET ***

SHRP-LTPP LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
MOISTURE-DENSITY RELATIONS
LAB DATA SHEET T55

SHEET NO 1 OF 1

SUBGRADE SOILS
SHRP TEST DESIGNATION SS05 / SHRP PROTOCOL P55

LABORATORY PERFORMING TEST: BRAUN INTERTEC
LABORATORY IDENTIFICATION CODE: 2711

LTPP REGION :	NA	STATE ABR :	CT	STATE CODE :	09
SPS EXPERIMENT NUMBER :	1			SPS PROJECT CODE :	18
SAMPLED BY :	CT DOT			FIELD SET NUMBER :	3
DATE SAMPLED :	5/3/00				

1. LAYER NUMBER (FROM LAB SHEET LO4)		1
2. TEST SECTION NO.		3
3. SAMPLING AREA NO.		
4. SHRP LABORATORY TEST NUMBER		2
5. LOCATION NUMBER (Enter an asterisk as the third digit)		BA5
6. SHRP SAMPLE NUMBER(Enter an asterisk as the third and fourth digit)		BS02
7. TEST RESULTS (Section 10.3 of Protocol P55)		
(a) METHOD USED (B OR D)		D
(b) OPTIMUM MOISTURE CONTENT(OMC),%		16
(c) MAXIMUM DENSITY (MD), PCF		111
8. COMMENTS (Section 10.4 of Protocol P55)		
(a) CODE	75	78
(b) NOTE		
9. TYPE OF RAMMER FACE (If other than that described in section 10.5 of Protocol P55)		
10. TEST DATE		9/6/00
SAMPLE IDENTIFICATION		1 61

NOTE: 1. INCLUDE THE OPTIMUM MOISTURE CONTENT CURVE WITH TEST SHEET T55 (SECTION 10.3.6 OF PROTOCOL P55).

GENERAL REMARKS:

SUBMITTED BY

9/6/00

DAVID CLAUSON
BRAUN INTERTEC

CHECKED AND APPROVED, DATE

SHRP REPRESENTATIVE
AFFILIATION: STANTEC CONSULTING
415 LAWRENCE BELL DRIVE
SUITE 3
AMHERST, NY 14221

Form T55, February 1991

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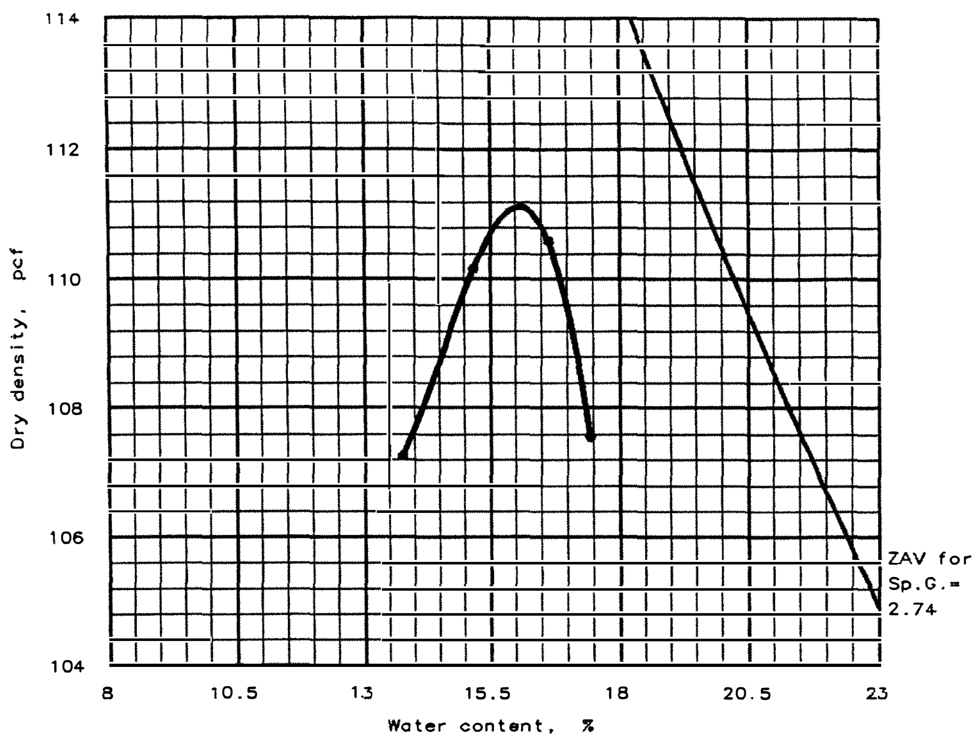
MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: SHRP P55 Method D, Standard

Elev/ Depth	Date Tested	Date Sampled	Sampled By	As Received Moisture	Preparation Method	Rammer Type
	9/06/00				moist	manual

Size of Oversize	Percent Oversize	Percent on 3/4	Percent 3/4 to 3/8	Percent 3/8 to #4	Natural Moisture	Specific Gravity
3/4 in		100	0	0		2.74

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 111.0 pcf Optimum moisture = 16.0 %	Subgrade

Project No.: BADX-00-1264
Project: 091803
Location: 8S02
Test No.: 12261
Date: 9/06/00

Remarks:
Specific gravity was determined

MOISTURE-DENSITY RELATIONSHIP TEST
BRAUN INTERTEC

Fig. No. 458

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BRAUN
INTERTEC

Fax Transmittal

To: MR. Alfred Lip

Fax Number: (716) 632 - 4808

From: Amy EngA

Phone Number: (952) 942-1781

Date: Oct. 17, 2000

Number of Pages: 9

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Braun Intertec Corporation
6801 Washington Avenue South
Minneapolis, MN 55439-0108

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SPS LABORATORY TESTING DATA SHEET

LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
MATERIALS AND SUBGRADE SOILS
LABORATORY DATA SHEET T46A - RECOMPACTED SAMPLES

SHEET NO. 1 OF 1

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: Braun Intertec Inc.	BRAUN SAMPLE / FILE ID: NA12261 /NA107
LABORATORY IDENTIFICATION CODE:	2711
SAMPLES FROM: SHRP REGION NA, STATE CT	STATE CODE: 09
LTPP EXPT. NO.: 1	SHRP SECTION ID.: 091803
SAMPLED BY: CT DOT (DRILLING AND SAMPLING CONTRACTOR/AGENCY)	FIELD SET NO.: 3
SAMPLING DATE: 05/03/2000	

1. LAYER NUMBER (FROM LAB SHEET L04)	1
2. LAYER TYPE (1 = subgrade, 2 = base/subgrade)	1
3. SAMPLING AREA NO. (SA-)	
4. SHRP LABORATORY TEST NUMBER	2
5. LOCATION NUMBER	BA3
6. SHRP SAMPLE NUMBER	B502
7. MATERIAL TYPE (Type 1 or Type 2)	2
8. TEST INFORMATION	
PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)	N
TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)	N
TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)	15
9. SPECIMEN INFO.:	
SPEC. DIAM., mm	
TOP	72.4
MIDDLE	72.4
BOTTOM	72.4
AVERAGE	72.4
MEMBRANE THICKNESS (1), mm	1.27
MEMBRANE THICKNESS (2), mm	0.00
NET DIAM., mm	71.1
HEIGHT OF SPECIMEN, CAP AND BASE, mm	207.3
HEIGHT OF CAP AND BASE, mm	63.5
INITIAL LENGTH L, mm	143.8
INITIAL AREA, A, mm^2	3973
INITIAL VOLUME, A*L, mm^3	571115
10. SOIL SPECIMEN WEIGHT:	
INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	1106.30
FINAL WEIGHT OF CONTAINER AND WET SOILS, grams	0.00
WEIGHT OF WET SOIL USED, grams	1108.90
11. SOIL PROPERTIES:	
IN SITU MOISTURE CONTENT (NUCLEAR), %	
IN SITU WET DENSITY (NUCLEAR), kg/m^3	
or	
OPTIMUM MOISTURE CONTENT, %	16.0
MAX. DRY DENSITY, kg/m^3	1778.0
95% MAX. DRY DENSITY, kg/m^3	1689.1
12. SPECIMEN PROPERTIES:	
COMPACTION MOISTURE CONTENT, %	15.8
MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	15.5
COMPACTION DRY DENSITY, kg/m^3	1674.9
13. QUICK SHEAR TEST	
STRESS-STRAIN PLOT ATTACHED (Y = YES OR N = NO)	Y
TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), kPa	147
SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	N
14. COMMENTS (Section 10.4 of Protocol P46)	
(a) CODE	
(b) NOTE	0
15. TEST DATE	09/19/2000

GENERAL REMARKS:

SUBMITTED BY, DATE: [signature]
LABORATORY CHIEF
Affiliation: Braun Intertec Inc.

CHECKED AND APPROVED, DATE: [signature]
Affiliation: STANTEC CONSULTING, 415 LAWRENCE BELL DRIVE, SUITE 1, AMHERST, NY 14221

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SPS LABORATORY TESTING DATA SHEET

,ORATORY IDENTIFICATION CODE	2711
.TE CODE	09
(P SECTION ID	091803
LD SET NO	3
(ER NUMBER	1
(ER TYPE (1 = subgrade, 2 = base/subbase)	1
IPLING AREA NO. (SA-)	0
(P LABORATORY TEST NUMBER	2
CATION NUMBER	BA5
RP SAMPLE NUMBER	BS02
TERIAL TYPE	2
ST DATE	09/19/2000
SILIENT MODULUS TESTING	
N SAMPLE / FILE ID	NA1226F

LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
AMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov Def. LVDT #1 Reading	Recov Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
IGNATION	S3	Scyclic	cl	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg		Mr
UNIT	kPa	kPa	---	N	N	N	kPa	kPa	kPa	mm	mm	mm	mm/mm	Mpa
ECISION	---.-	---.-	-	----.-	----.-	---.-	---.-	---.-	---.-	-.-----	-.-----	-.-----	-.-----	---
QUENCE 1	41.4	13.4	1	53.2	49.5	3.7	13.4	12.5	0.9	0.02357	0.02271	0.02314	0.00016	77
			2	53.6	49.9	3.7	13.5	12.6	0.9	0.02364	0.02271	0.02310	0.00016	78
			3	52.5	48.8	3.7	13.2	12.3	0.9	0.02333	0.02248	0.02279	0.00016	77
			4	53.0	49.2	3.8	13.3	12.4	1.0	0.02333	0.02271	0.02298	0.00016	77
			5	53.2	49.6	3.7	13.4	12.5	0.9	0.02349	0.02248	0.02294	0.00016	78
	COLUMN AVERAGE			53.1	49.4	3.7	13.4	12.4	0.9	0.02347	0.02262	0.02299	0.00016	77.7
	STANDARD DEV.			0.4	0.4	0.1	0.1	0.1	0.0	0.00014	0.00013	0.00014	0.00000	0.4

SPS LABORATORY TESTING DATA SHEET

SHEET NO 3 OF 8

N SAMPLE / FILE ID: NA12261

LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 2	41.4	27.6	1	109.9	99.6	10.3	27.7	25.1	2.6	0.05178	0.05124	0.05139	0.00036	70
			2	109.6	99.3	10.3	27.6	25.0	2.6	0.05201	0.05108	0.05147	0.00036	70
			3	110.0	99.7	10.3	27.7	25.1	2.6	0.05209	0.05124	0.05151	0.00036	70
			4	109.9	99.5	10.3	27.6	25.0	2.6	0.05201	0.05116	0.05151	0.00036	70
			5	109.7	99.4	10.3	27.6	25.0	2.6	0.05193	0.05108	0.05147	0.00036	70
	COLUMN AVERAGE			109.8	99.5	10.3	27.6	25.0	2.6	0.05196	0.05116	0.05147	0.00036	69.9
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00012	0.00008	0.00005	0.00000	0.1
LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 3	41.4	41.3	1	164.1	149.0	15.1	41.3	37.5	3.8	0.08806	0.08612	0.08709	0.00061	62
			2	164.0	148.8	15.1	41.3	37.5	3.8	0.08806	0.08612	0.08705	0.00061	62
			3	163.8	148.7	15.1	41.2	37.4	3.8	0.08790	0.08604	0.08697	0.00060	62
			4	164.3	149.2	15.1	41.3	37.5	3.8	0.08806	0.08612	0.08709	0.00061	62
			5	164.0	148.9	15.1	41.3	37.5	3.8	0.08798	0.08604	0.08701	0.00061	62
	COLUMN AVERAGE			164.0	148.9	15.1	41.3	37.5	3.8	0.08801	0.08609	0.08704	0.00061	61.9
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00007	0.00004	0.00005	0.00000	0.1
OLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
QUENCE 4	41.4	55.0	1	218.2	197.5	20.7	54.9	49.7	5.2	0.12363	0.12061	0.12212	0.00085	59
			2	218.7	198.0	20.8	55.0	49.8	5.2	0.12387	0.12069	0.12228	0.00085	59
			3	218.6	197.8	20.8	55.0	49.8	5.2	0.12371	0.12046	0.12209	0.00085	59
			4	218.4	197.7	20.8	55.0	49.7	5.2	0.12379	0.12077	0.12228	0.00085	58
			5	218.4	197.8	20.7	55.0	49.8	5.2	0.12379	0.12061	0.12220	0.00085	59
	COLUMN AVERAGE			218.5	197.7	20.7	55.0	49.8	5.2	0.12376	0.12063	0.12219	0.00085	58.5
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00009	0.00011	0.00009	0.00000	0.1

Worksheet T46 - Page 3, July 1993

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N SAMPLE / FILE ID: NA12261

.UMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 5	41.4	68.8	1	273.7	248.4	25.3	68.9	62.5	6.4	0.15805	0.15495	0.15650	0.00109	57
			2	273.2	248.2	25.0	68.8	62.5	6.3	0.15798	0.15503	0.15650	0.00109	57
			3	273.7	248.5	25.2	68.9	62.5	6.3	0.15797	0.15511	0.15654	0.00109	57
			4	273.7	248.3	25.4	68.9	62.5	6.4	0.15790	0.15480	0.15635	0.00109	57
			5	273.5	248.3	25.2	68.8	62.5	6.3	0.15790	0.15503	0.15642	0.00109	57
	COLUMN AVERAGE			273.6	248.3	25.2	68.8	62.5	6.3	0.15796	0.15498	0.15646	0.00109	57.4
	STANDARD DEV.			0.2	0.1	0.1	0.0	0.0	0.0	0.00006	0.00012	0.00008	0.00000	0.0
LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 6	27.6	13.5	1	53.5	49.7	3.8	13.5	12.5	1.0	0.02519	0.02434	0.02473	0.00017	73
			2	53.7	49.8	3.9	13.5	12.5	1.0	0.02543	0.02434	0.02488	0.00017	72
			3	53.6	49.6	4.0	13.5	12.5	1.0	0.02535	0.02434	0.02477	0.00017	73
			4	53.4	49.5	4.0	13.4	12.4	1.0	0.02543	0.02426	0.02477	0.00017	72
			5	54.0	50.1	3.9	13.6	12.6	1.0	0.02535	0.02442	0.02488	0.00017	73
	COLUMN AVERAGE			53.7	49.7	3.9	13.5	12.5	1.0	0.02535	0.02434	0.02480	0.00017	72.5
	STANDARD DEV.			0.2	0.2	0.1	0.1	0.1	0.0	0.00009	0.00005	0.00007	0.00000	0.2
OLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
QUENCE 7	27.6	27.0	1	107.6	100.2	7.4	27.1	25.2	1.9	0.06077	0.05976	0.06023	0.00042	60
			2	107.1	99.9	7.3	27.0	25.1	1.8	0.06070	0.05953	0.06011	0.00042	60
			3	107.5	100.2	7.4	27.1	25.2	1.9	0.06085	0.05976	0.06023	0.00042	60
			4	107.4	100.2	7.2	27.0	25.2	1.8	0.06070	0.05961	0.06007	0.00042	60
			5	107.4	99.9	7.4	27.0	25.1	1.9	0.06093	0.05976	0.06023	0.00042	60
	COLUMN AVERAGE			107.4	100.1	7.3	27.0	25.2	1.8	0.06079	0.05969	0.06018	0.00042	60.2
	STANDARD DEV.			0.2	0.2	0.1	0.0	0.0	0.0	0.00010	0.00011	0.00008	0.00000	0.1

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N SAMPLE / FILE ID: NA12261

LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 8	27.6	40.7	1	161.8	149.0	12.8	40.7	37.5	3.2	0.10209	0.10085	0.10139	0.00071	53
			2	161.3	148.5	12.9	40.6	37.4	3.2	0.10185	0.10077	0.10123	0.00070	53
			3	161.6	148.8	12.8	40.7	37.4	3.2	0.10193	0.10100	0.10139	0.00071	53
			4	161.9	149.1	12.8	40.7	37.5	3.2	0.10216	0.10085	0.10143	0.00071	53
			5	161.7	148.9	12.8	40.7	37.5	3.2	0.10209	0.10077	0.10139	0.00071	53
	COLUMN AVERAGE			161.7	148.9	12.8	40.7	37.5	3.2	0.10202	0.10085	0.10137	0.00071	53.1
	STANDARD DEV.			0.2	0.2	0.0	0.1	0.1	0.0	0.00013	0.00009	0.00008	0.00000	0.1
LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
QUENCE 9	27.6	54.6	1	217.0	198.7	18.4	54.6	50.0	4.6	0.14294	0.14162	0.14224	0.00099	51
			2	216.6	198.1	18.5	54.5	49.9	4.6	0.14278	0.14146	0.14212	0.00099	50
			3	216.8	198.4	18.4	54.6	49.9	4.6	0.14294	0.14162	0.14228	0.00099	50
			4	217.1	198.8	18.4	54.6	50.0	4.6	0.14294	0.14178	0.14232	0.00099	51
			5	216.9	198.4	18.4	54.6	49.9	4.6	0.14286	0.14162	0.14224	0.00099	50
	COLUMN AVERAGE			216.9	198.5	18.4	54.6	49.9	4.6	0.14289	0.14162	0.14224	0.00099	50.5
	STANDARD DEV.			0.2	0.2	0.0	0.1	0.1	0.0	0.00007	0.00011	0.00007	0.00000	0.0
OLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
QUENCE 10	27.6	68.3	1	271.3	247.6	23.7	68.3	62.3	6.0	0.18565	0.18231	0.18398	0.00128	49
			2	271.0	247.3	23.8	68.2	62.2	6.0	0.18572	0.18239	0.18406	0.00128	49
			3	271.4	247.7	23.7	68.3	62.3	6.0	0.18580	0.18247	0.18414	0.00128	49
			4	271.4	247.7	23.7	68.3	62.3	6.0	0.18588	0.18231	0.18410	0.00128	49
			5	271.1	247.4	23.7	68.2	62.3	6.0	0.18580	0.18239	0.18410	0.00128	49
	COLUMN AVERAGE			271.3	247.5	23.7	68.3	62.3	6.0	0.18577	0.18238	0.18407	0.00128	48.6
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.1	0.0	0.00009	0.00006	0.00006	0.00000	0.0

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SPS LABORATORY TESTING DATA SHEET

SHEET NO. 6 OF 8

N SAMPLE / FILE ID: NA12261

LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 11	13.8	13.3	1	53.1	49.2	3.9	13.4	12.4	1.0	0.03969	0.03798	0.03876	0.00027	46
			2	52.8	48.9	3.9	13.3	12.3	1.0	0.03953	0.03790	0.03864	0.00027	46
			3	52.8	48.8	4.0	13.3	12.3	1.0	0.03961	0.03798	0.03876	0.00027	46
			4	53.1	49.1	4.0	13.4	12.4	1.0	0.03961	0.03798	0.03876	0.00027	46
			5	52.7	48.8	3.9	13.3	12.3	1.0	0.03953	0.03790	0.03868	0.00027	46
	COLUMN AVERAGE			52.9	49.0	3.9	13.3	12.3	1.0	0.03960	0.03795	0.03872	0.00027	45.7
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00006	0.00004	0.00005	0.00080	0.1
LUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UENCE 12	13.8	26.3	1	104.0	98.2	5.8	26.2	24.7	1.5	0.09627	0.09341	0.09476	0.00066	37
			2	104.5	98.7	5.8	26.3	24.8	1.5	0.09620	0.09348	0.09476	0.00066	38
			3	104.7	98.9	5.8	26.4	24.9	1.5	0.09620	0.09341	0.09480	0.00066	38
			4	104.2	98.4	5.9	26.2	24.7	1.5	0.09635	0.09340	0.09480	0.00066	38
			5	104.8	99.0	5.8	26.4	24.9	1.5	0.09627	0.09348	0.09488	0.00066	38
	COLUMN AVERAGE			104.4	98.6	5.8	26.3	24.8	1.5	0.09626	0.09344	0.09480	0.00066	37.6
	STANDARD DEV.			0.3	0.3	0.0	0.1	0.1	0.0	0.00006	0.00004	0.00005	0.00000	0.1
OLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
QUENCE 13	13.8	40.2	1	159.6	148.1	11.5	40.2	37.3	2.9	0.14984	0.14782	0.14883	0.00104	36
			2	159.7	148.2	11.5	40.2	37.3	2.9	0.14991	0.14782	0.14883	0.00104	36
			3	159.7	148.2	11.5	40.2	37.3	2.9	0.14976	0.14782	0.14879	0.00103	36
			4	159.4	147.9	11.5	40.1	37.2	2.9	0.14983	0.14782	0.14879	0.00103	36
			5	159.7	148.2	11.5	40.2	37.3	2.9	0.14999	0.14759	0.14879	0.00103	36
	COLUMN AVERAGE			159.6	148.1	11.5	40.2	37.3	2.9	0.14987	0.14777	0.14881	0.00104	36.0
	STANDARD DEV.			0.1	0.2	0.0	0.0	0.0	0.0	0.00009	0.00010	0.00002	0.00000	0.0

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SPS LABORATORY TESTING DATA SHEET

I SAMPLE/ FILE ID NA12261

:UMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
IENCE 14	13.8	54.5	1	216.3	199.4	16.8	54.4	50.2	4.2	0.19743	0.19503	0.19623	0.00136	37
			2	216.8	200.0	16.8	54.5	50.3	4.2	0.19735	0.19503	0.19619	0.00136	37
			3	216.3	199.5	16.8	54.4	50.2	4.2	0.19743	0.19503	0.19615	0.00136	37
			4	216.9	200.0	16.8	54.6	50.3	4.2	0.19758	0.19510	0.19634	0.00137	37
			5	216.4	199.4	16.9	54.4	50.2	4.3	0.19735	0.19503	0.19615	0.00136	37
	COLUMN AVERAGE			216.5	199.7	16.8	54.5	50.2	4.2	0.19743	0.19504	0.19621	0.00136	36.8
	STANDARD DEV.			0.3	0.3	0.0	0.1	0.1	0.0	0.00009	0.00003	0.00008	0.00000	0.0
:UMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
JENCE 15	13.8	68.0	1	269.7	247.5	22.2	67.9	62.3	5.6	0.25022	0.24549	0.24781	0.00172	36
			2	270.1	247.9	22.2	68.0	62.4	5.6	0.25037	0.24541	0.24789	0.00172	36
			3	270.1	247.9	22.2	68.0	62.4	5.6	0.25029	0.24588	0.24805	0.00173	36
			4	270.1	247.9	22.3	68.0	62.4	5.6	0.25053	0.24580	0.24816	0.00173	36
			5	270.2	248.1	22.2	68.0	62.4	5.6	0.25045	0.24580	0.24812	0.00173	36
	COLUMN AVERAGE			270.0	247.8	22.2	68.0	62.4	5.6	0.25037	0.24567	0.24801	0.00173	36.2
	STANDARD DEV.			0.2	0.2	0.0	0.1	0.1	0.0	0.00012	0.00021	0.00015	0.00000	0.0

IITTED BY, DATE

IRATORY CHIEF

ation Braun Intertec Corporation

CHECKED AND APPROVED, DATE

Affiliation

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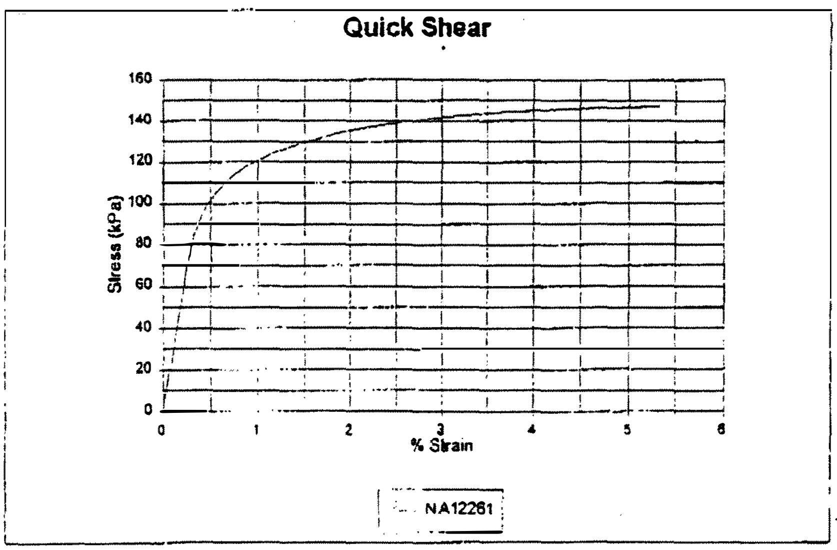
SPS LABORATORY TESTING DATA SHEET

SHEET NO. 5 OF 5

1. LABORATORY IDENTIFICATION CODE	2711
2. STATECODE	09
3. SHRP SECTION ID	091803
4. FIELD SET NO	3
5. LAYER NUMBER	1
6. LAYER TYPE (1 = subgrade, 2 = base/subbase)	1
7. SAMPLING AREA NO. (SA-)	15
8. SHRP LABORATORY TEST NUMBER	2
9. LOCATION NUMBER	BA5
10. SHRP SAMPLE NUMBER	BS02
11. MATERIAL TYPE	2
12. TEST DATE	09/19/2000
13. BRAUN SAMPLE / FILE ID	NA12261



14. TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), kPA	147
15. SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	N