NESMEA UPDATE
October 2014

PAVE IR UPDATE

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Intelligent Systems,
Better Machines!

New QC/QA Technology for Asphalt Contractors/DOTs

Thermal Segregation (unseen enemy)

PAVE-IR Update

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4/2010

Topics

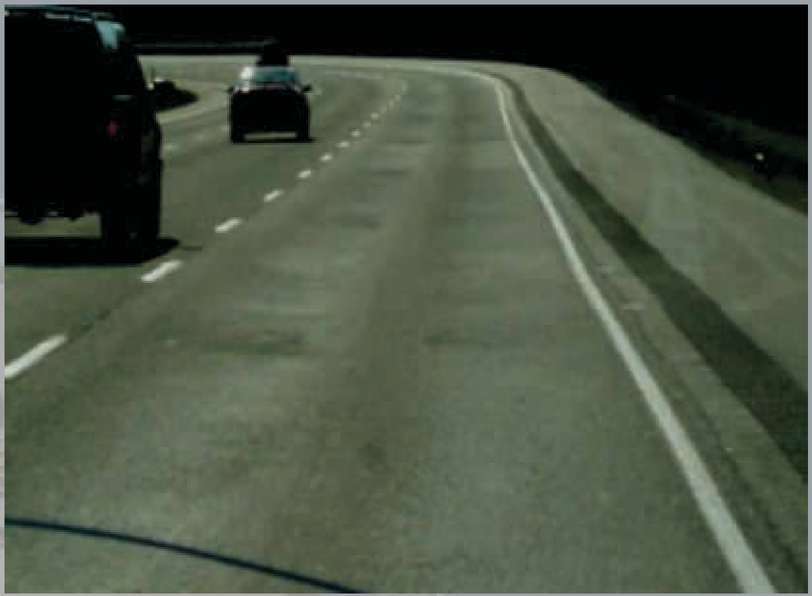
- The Problem
- Time line: A ten year journey on identifying the problem and how to fix it
  - 1995-1996
  - 1998
  - 1999
  - 2000
  - 2001-2006
- Washington DOT study
- 64 Projects

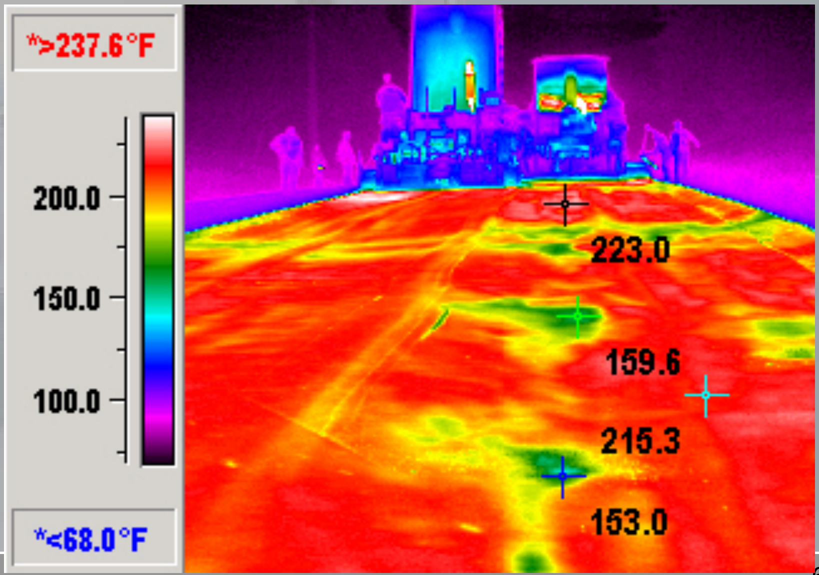
The Problem

- Localized “spots” of coarse surface texture
- Premature failure due to fatigue cracking, raveling, and moisture damage
- Increased roughness

The Problem

- Cooling of mix during transport is not remixed during the laydown process.
- Paver Set-up
- Results in erratic mat temperatures that are not apparent to the laydown crew.





Data Collected

- Haul distance and time
- Weather conditions
- Equipment
  - Type of truck
  - MTV/MTD
  - Paver
  - Roller
- Nuclear density data

- Temperature data
  - Infrared camera
  - Probes
  - Hand held infrared thermometer
- Plant information
  - Temperature of mix
  - Loading operations
- Mat Placement

1998 Conclusions

- None of the 4 projects experienced significant aggregate segregation.
- All 4 projects experienced significant temperature differentials.
- Concentrated areas of significantly cooler HMA generally resulted in lower than desirable compaction of those areas.

1998 Conclusions (cont.)

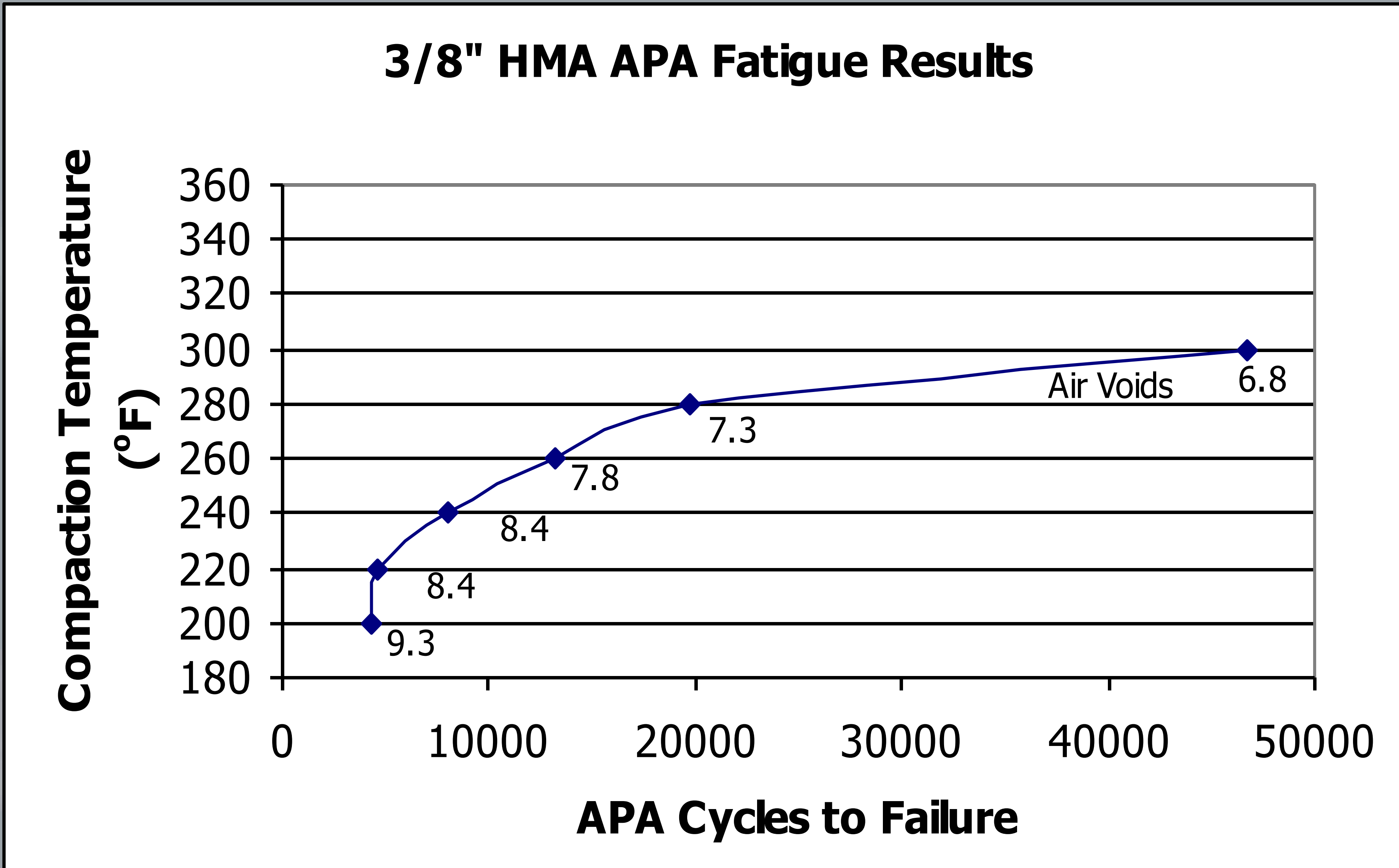
- Concentrated areas of cooler HMA commonly occur during construction (based on this study and others).
- Good rolling practices can partially offset temperature differential related compaction problems.
- MTVs not specifically examined.
- Temperature differentials are easily identified by infrared imaging.

1999 Study Objectives

- Investigate the effectiveness of different MTVs and remixing devices/methods
- Investigate other possible mitigation techniques
- Reexamine criteria for when and where to use MTV‘s
- 64 Projects Studies

Effects on Pavement

- Same as insufficient compaction
  - Increased raveling and moisture damage
  - Reduced fatigue life
  - Increased roughness
- One percent increase in air voids results in a minimum of 10% reduction in pavement life (a rule of thumb)
- 25º F Differential=1 to 2% more air voids



Courtesy of PTI and Ron Collins

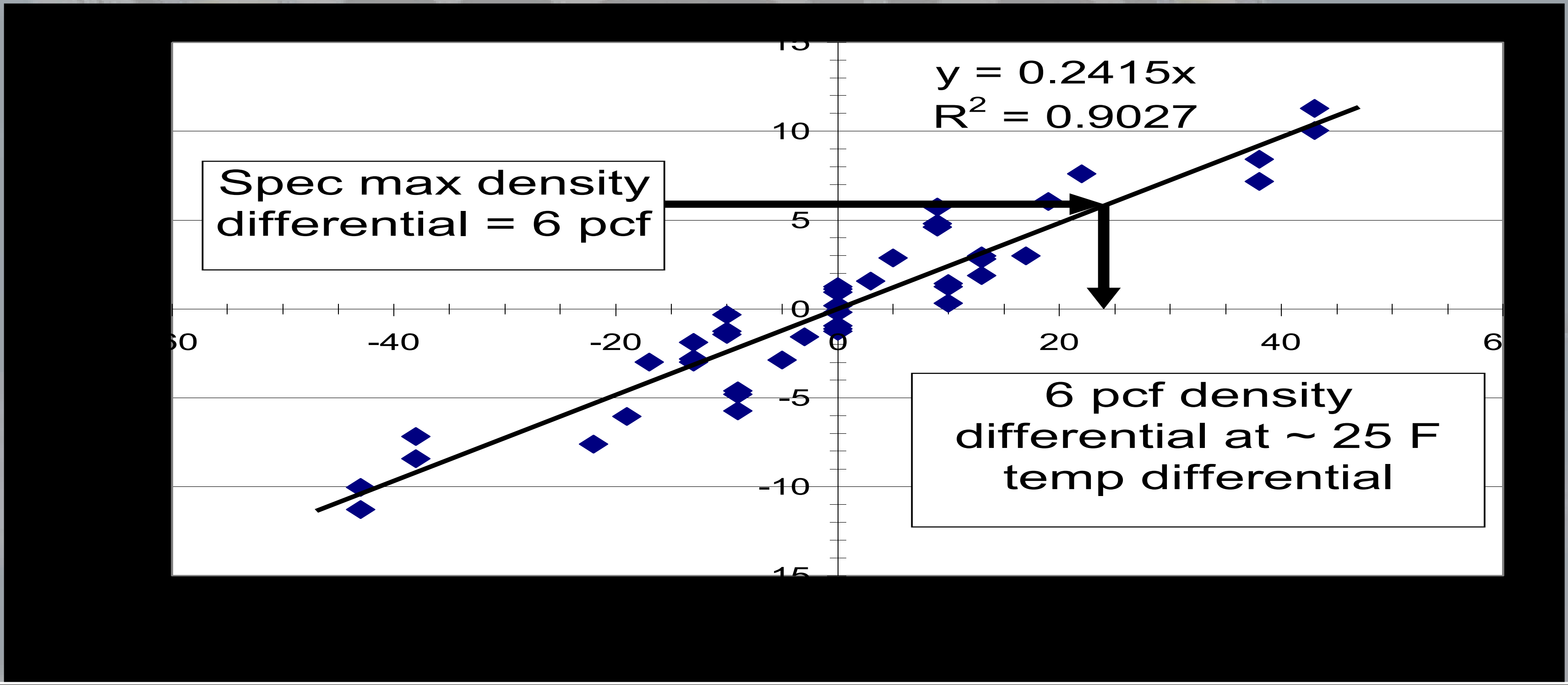
2001-2006

- A number of State DOTs have developed and implemented specifications to address this issue.
- WSDOT's current specification
  - Cyclic density areas are defined as less than 89.0 percent of maximum density.
  - If four or more low cyclic density areas are identified in a lot, a price adjustment will be assessed for that lot (a lot is 400 tons).
  - The price adjustment will be calculated as 15% of the unit bid price of HMA represented by that lot.
  - This assessment starts with examining the mat for temperature differences of 25°F or greater. If these do not exist, then no further special density testing is performed.

Bottom Line Results 2010

- 50% Increase in HMA Pavement Life

- NCAT (2000) and TTI (2002) similarly found thermal uniformity suitable for detecting segregation
  - NCAT – low severity segregation/density when Δt > 18 °F
  - TTI – when Δt > 25 °F, TxDOT density uniformity requirements not met



HISTORY OF PAVE-IR

TxDOT funded research conducted by Texas Transportation Institute (TTI) to study the relationship between thermal segregation and density, in addition to developing a method for practical data collection.

Initial research included the use of a thermal camera operated by a researcher in the back of a pickup truck. In addition to obvious safety considerations, this initial method was found not to be practical. A series of infrared images had to be manually combined to produce a complete profile. Distance and position data were also difficult to incorporate.

First generation Pave-IR system was first used in October 2003.

- Propelled manually
- Long setup time
- Loose connection wires
- Unstable wheel design
- Battery powered
- Required two operators

Third generation Pave-IR system was first used in January 2005.

IMPROVEMENTS

- Paver mounted
- Rapid setup time
- Central master control
- No dedicated operator

CHALLENGES

- Battery powered
- Distance measuring wheel
- Components not suitable for everyday use on heavy equipment.

HISTORY OF PAVE-IR

- In 2005 TTI published research reports outlining the relationship between thermal segregation and density. These reports also outline the methods used for thermal data collection supporting Pave-IR as the preferred tool for thermal data collection.

Reports available online at:

http://tti.tamu.edu/documents/0-4577-2.pdf

http://tti.tamu.edu/documents/5-4577-01-1.pdf

- Following the completion of this research, TTI & TxDOT were interested in finding a commercial partner for development and production of Pave-IR systems for future implementation into TxDOT specifications.

MOBA PAVE-IR SYSTEM COMPONENTS

- 12 – Infrared sensors (standard)
- Absolute encoder used for distance measurement
- MOBA OPERAND™ computer
- GPS antenna
- Includes PAVE PROJECT MANAGER™ software for post analysis and reports
- Kit includes system cabling and all necessary screed mounting hardware.

The MOBA Operand™ computer attaches to sensor beam.

GPS antenna mounts above the Operand™ computer.

Memory drive connects directly to Operand™ computer

System is powered by machine voltage (10-28 VDC).

Sensor beam is hinged in center for easy setup and storage.

PAVE-IR INSTALLATION

The PAVE-IR™ system mounts to the screed walkway by bolting or welding.

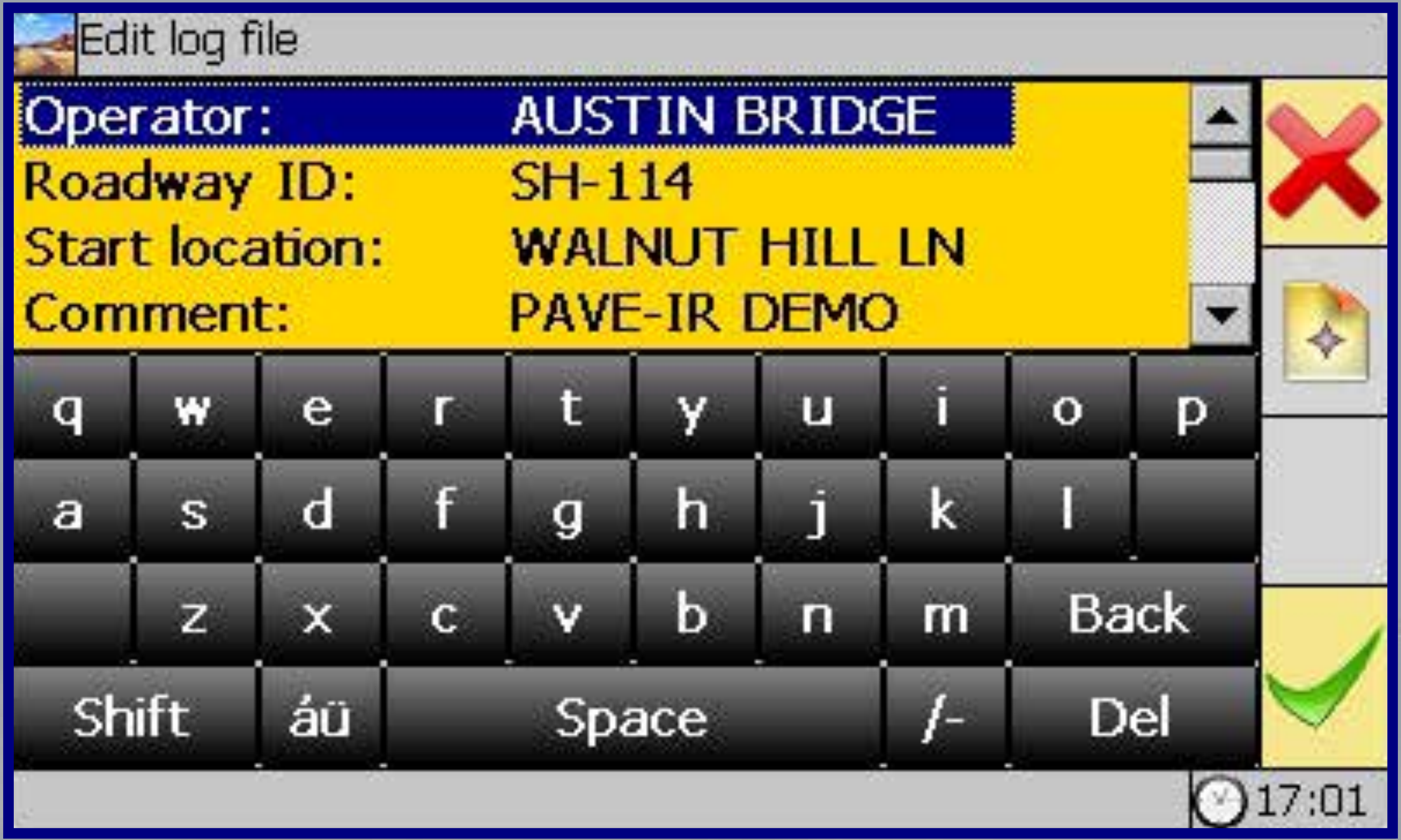
The distance encoder mounts to the wheel or torque hub using a magnet.

- Provides full coverage of entire paved surface.
- Ensures compliance with most existing DOT temperature specification requirements.
- Data is logged automatically and can be stored permanently.
- More cost effective versus infrared cameras.
- System also records paving speed and paver stops.
- System can be moved from one machine to another.
- System is scaleable from 2-8 meters depending on paving width

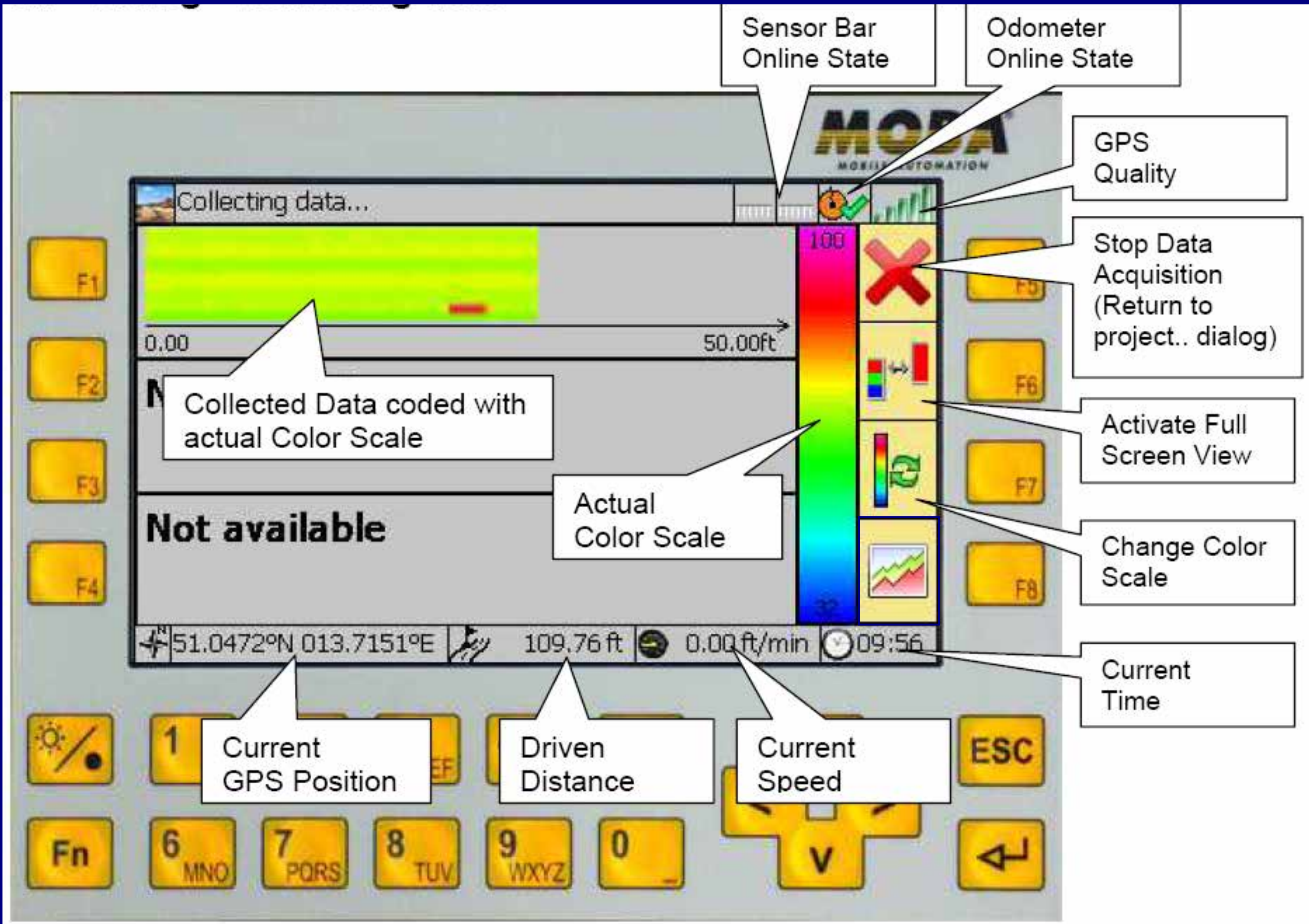
ONGOING DEVELOPMENT

- **Next Generation PAVE-IR(I)**
  - **Real-time (pre-compacted) IRI smoothness measurement.**
  - **Network (wireless) to onboard compaction systems.**
  - **Wireless transmission of job data to QC office or plant.**
  - **Grade and slope control monitoring.**
  - **Material control (auger/conveyor) system monitoring.**
  - **Infrared scanner mounted above paver deck.**

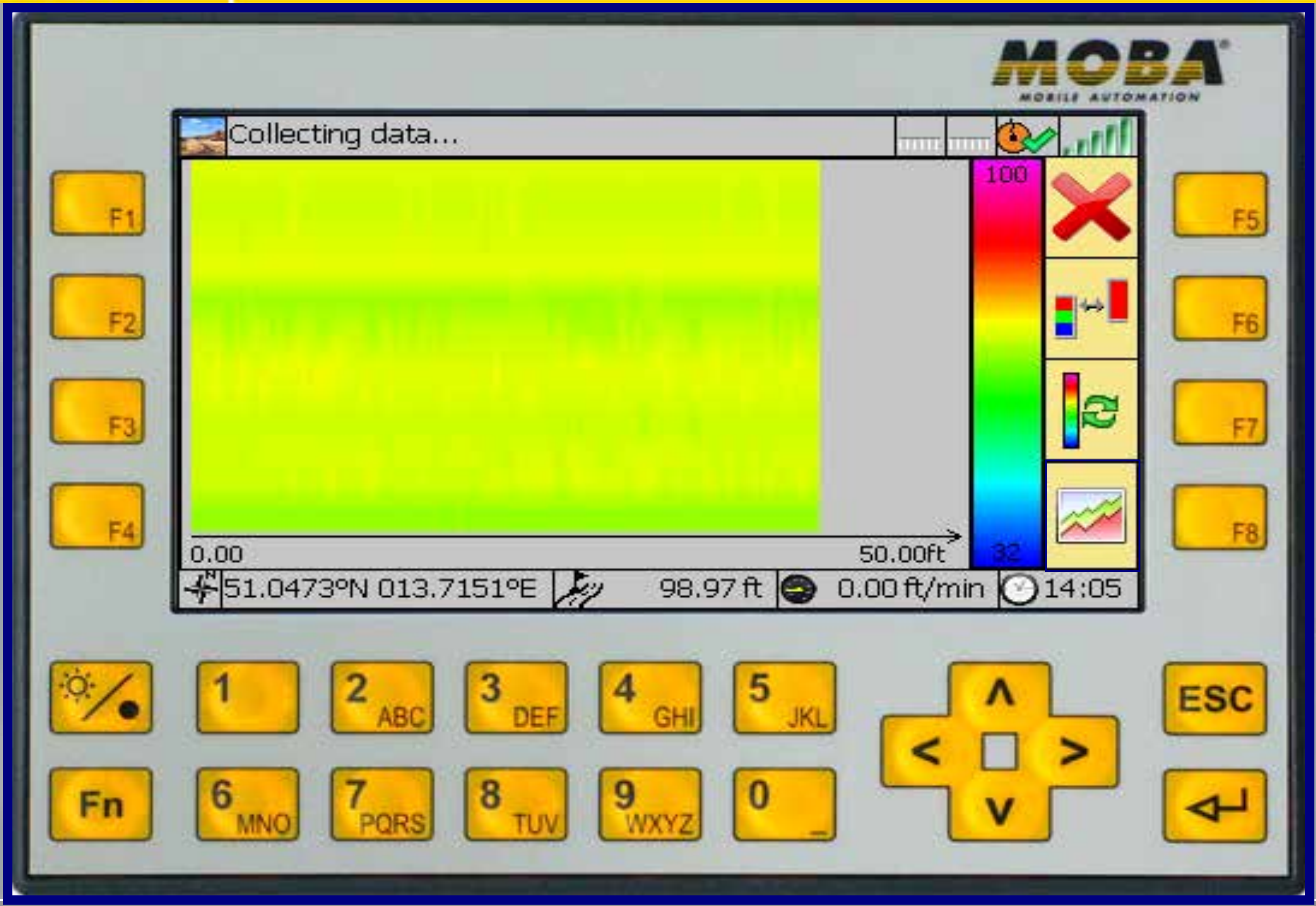
Prototype Scanner


Edit log file
Operator: AUSTIN BRIDGE
Roadway ID: SH-114
Start location: WALNUT HILL LN
Comment: PAVE-IR DEMO
q w e r t y u i o p
a s d f g h j k l
z x c v b n m Back
Shift áü Space /- Del
17:01

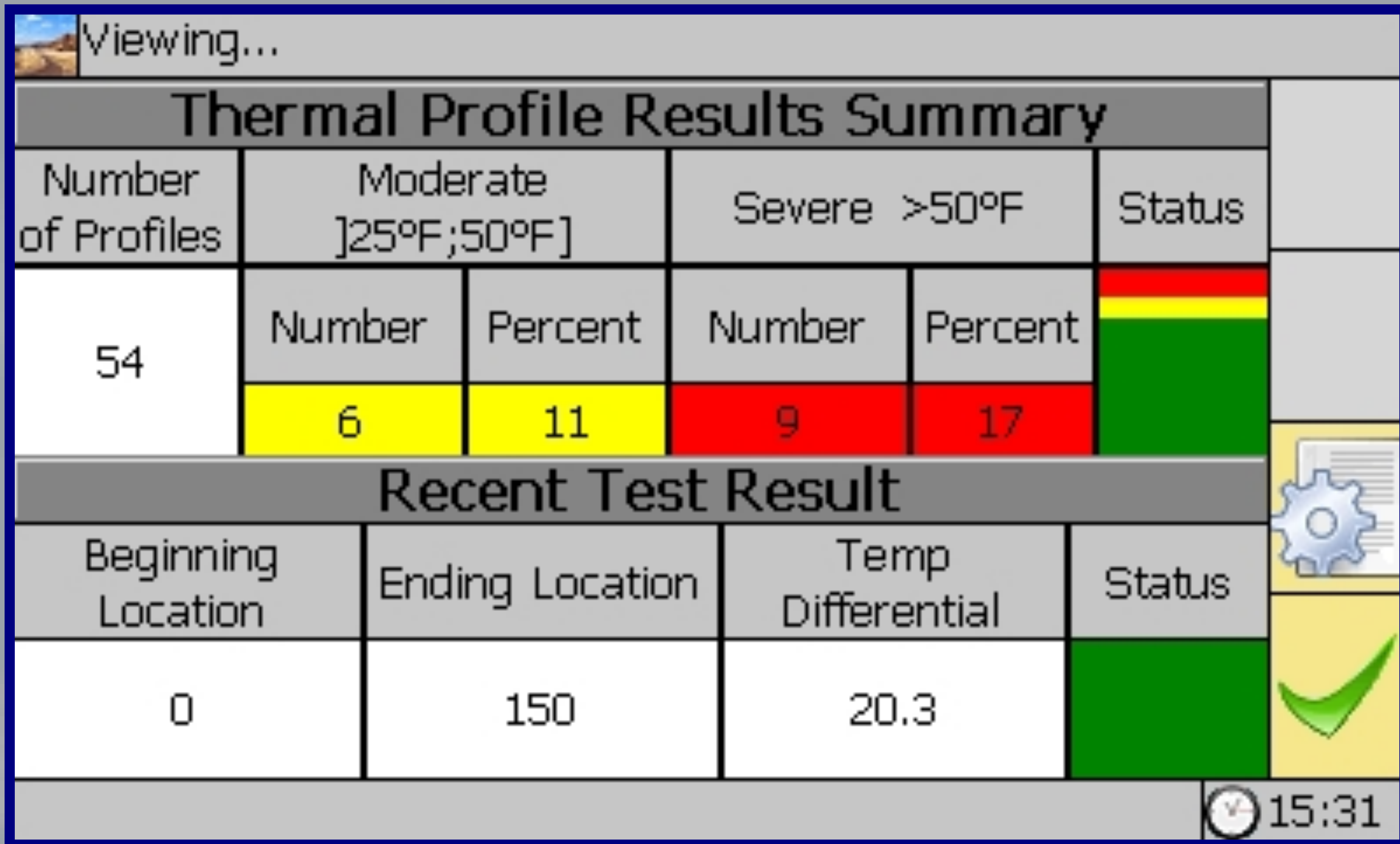
DATA COLLECTION SCREEN



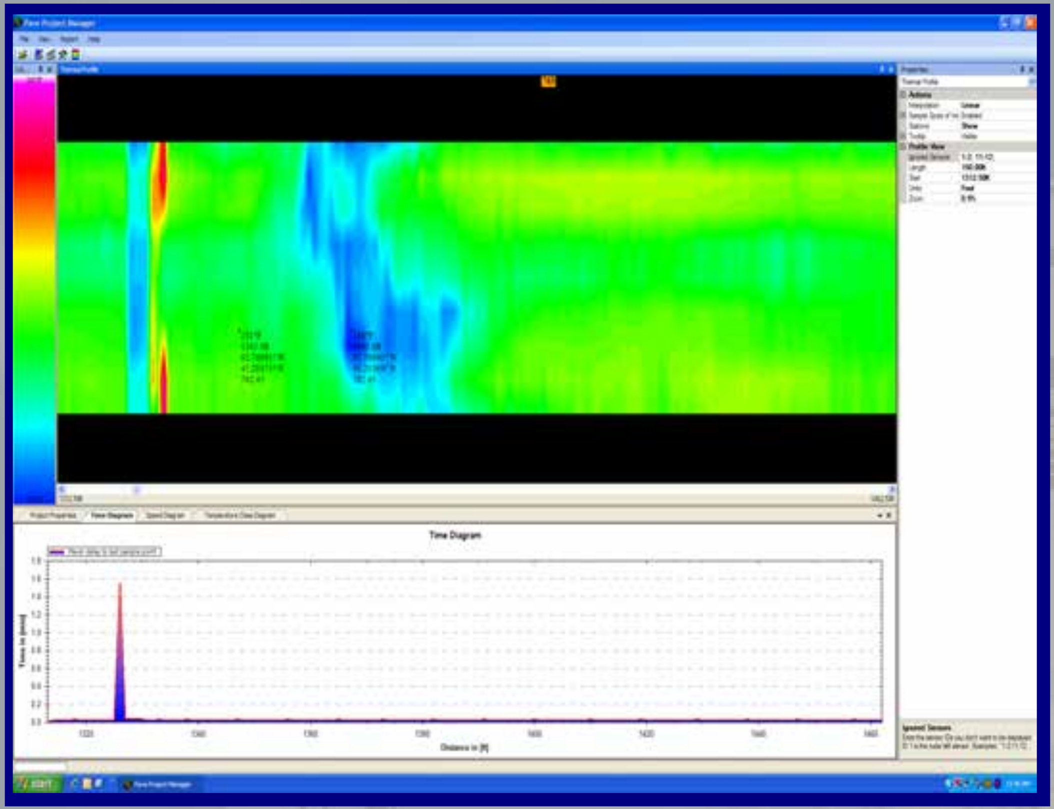
FULL SCREEN MODE



REAL-TIME ANALYSIS SCREEN



PAVE PROJECT MANAGER (PPM)



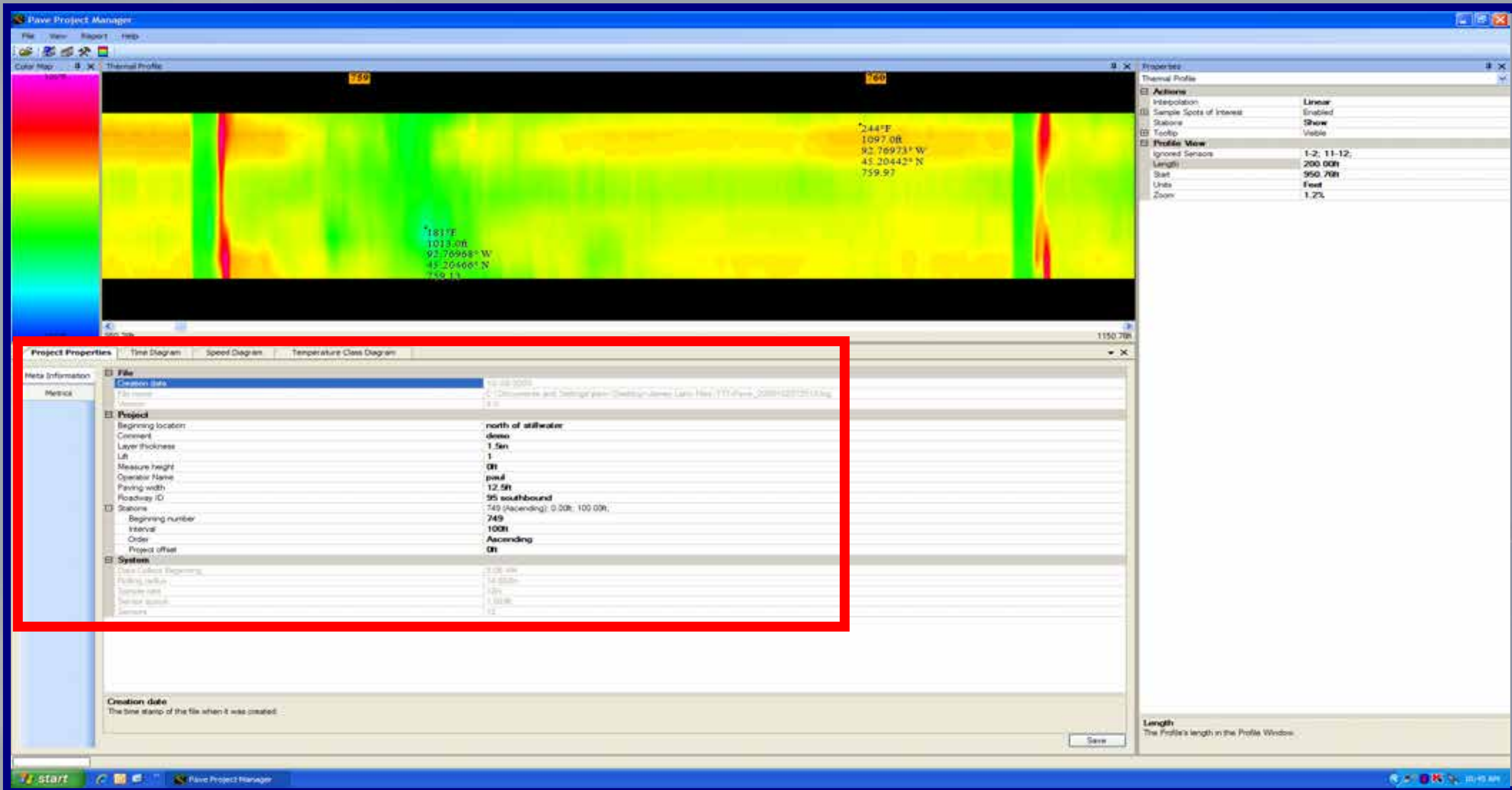
After data collection, the project file is transferred to PC via USB cable.

PPM allows contractor to evaluate the project in detail.

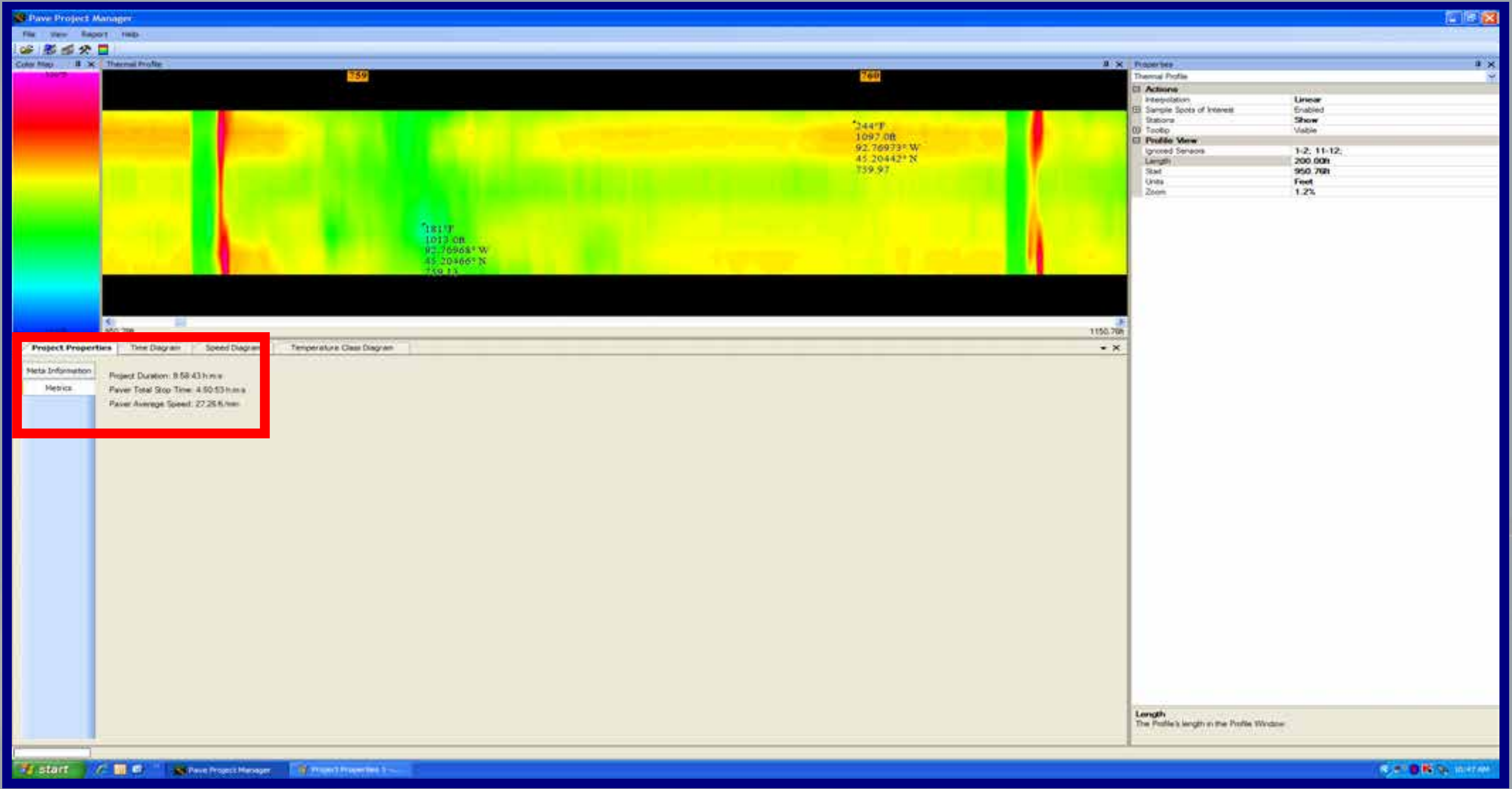
PPM displays thermal data, stations, paving speed, paver stops, and GPS location for any position in the project.

QC/QA reports are generated by PPM.

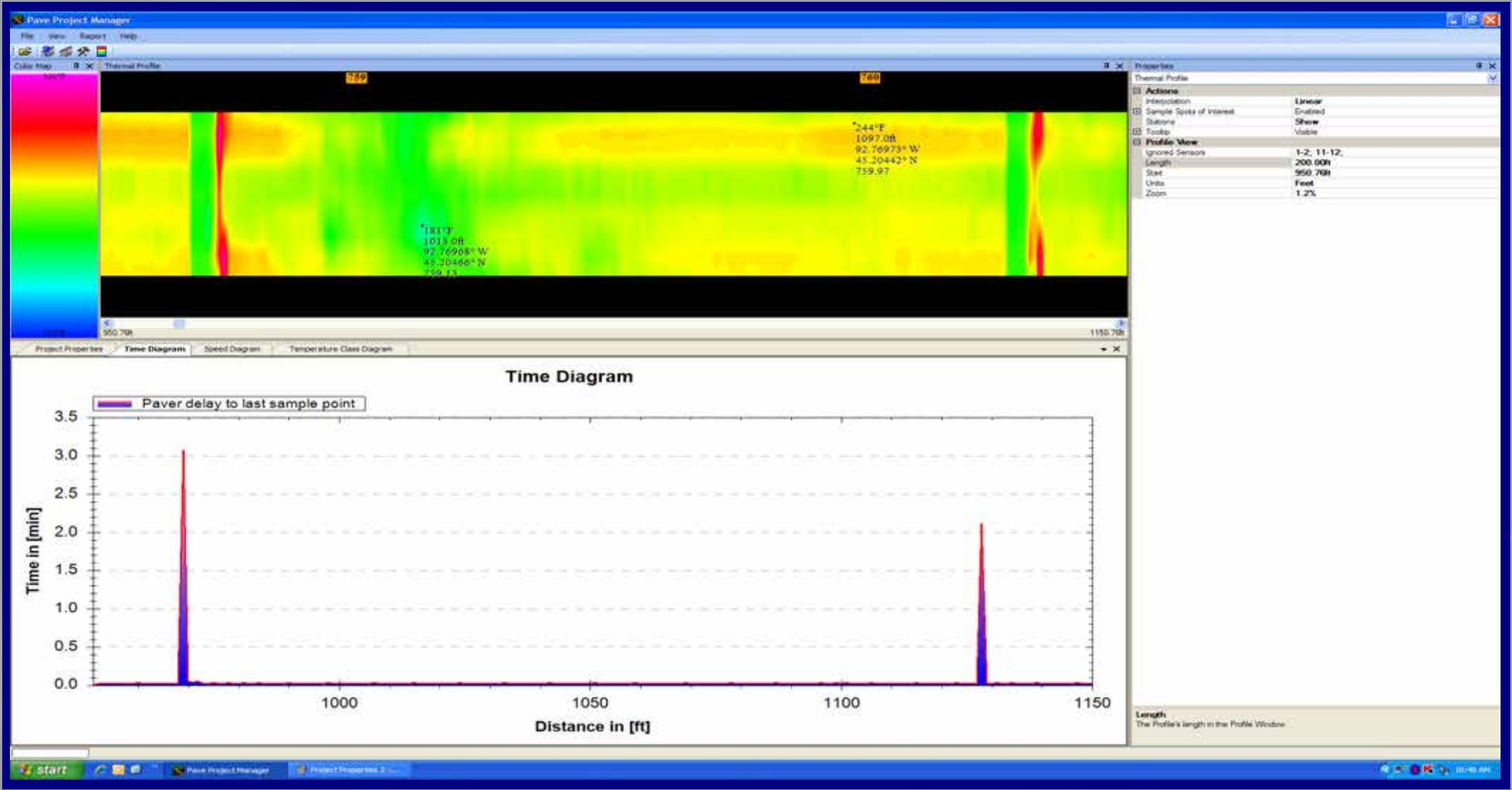
PROJECT PROPERTIES WINDOW (Meta Information)



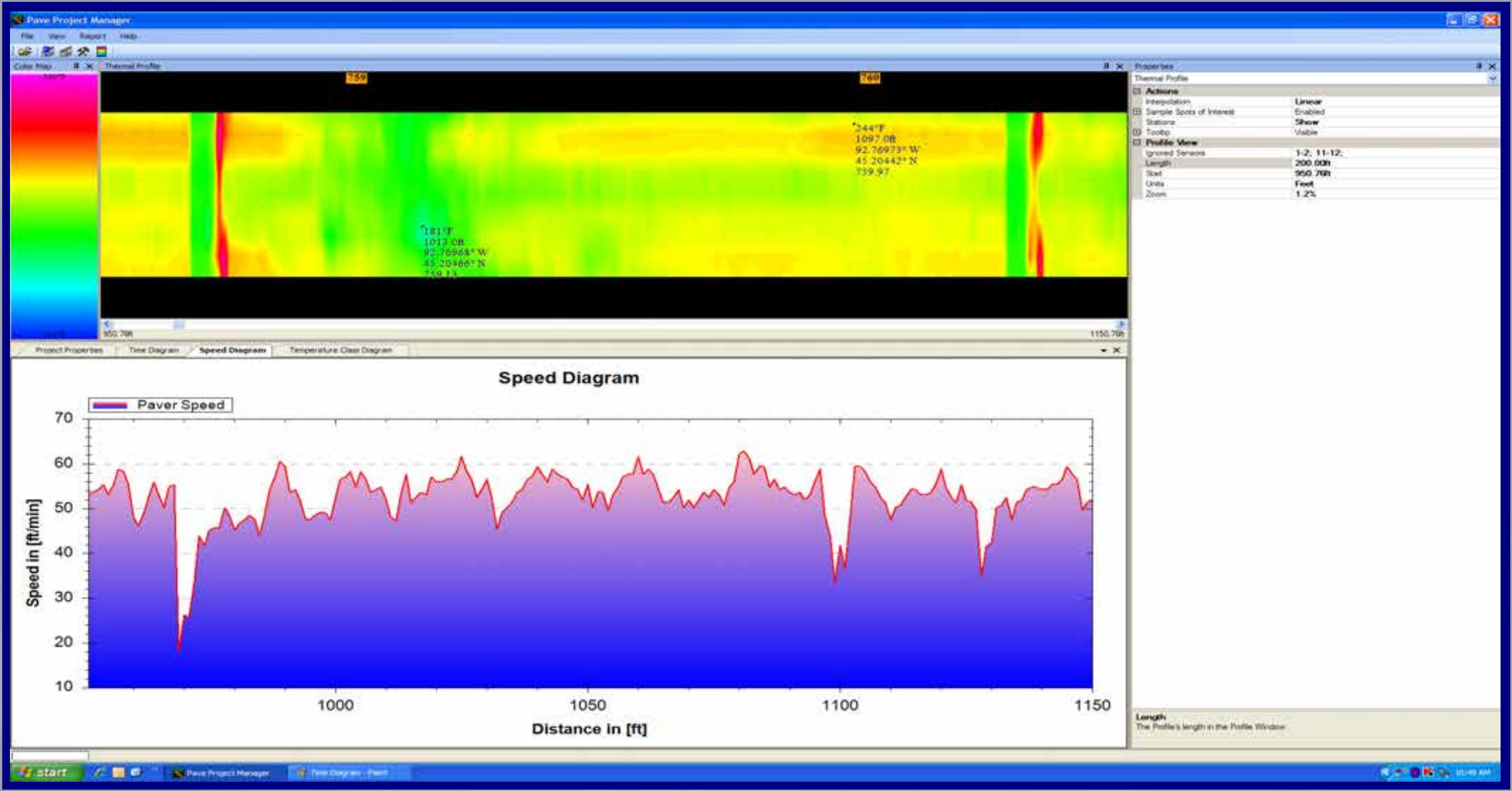
PROJECT PROPERTIES WINDOW (Metrics)



TIME DIAGRAM DISPLAYS PAVER STOPS



SPEED DIAGRAM DISPLAYS PAVING SPEED



PPM QC/QA REPORT GENERATION

Tex-244-F Part II

Thermal Profile Summary Report

Profile ID:	SH-114	Profile Date:	11/16/2009 7:38:53 PM
Profile Number:	1	Letting Date:	10/5/2009
Status:		Controlling CSJ:	
County:	Dallas	Spec Year:	2009
Tested By:	J. Lano (MOBA)	Spec Item:	
Test Location:	WALNUT HILL LN	Special Provision:	341-024
Material Code:	FC12	Mix Type:	
Material Name:			
Producer:	ABR		
Area Engeneer:		Project Manager:	

Course/Lift:	2	Temperature Differential Threshold:	25.0
Segment Length (ft):	150	Sensors Ignored:	-

Thermal Profile Results Summary				
Number of Profiles	Moderate 25.0°F < differential <= 50.0°F		Severe differential > 50.0°F	
	Number	Percent	Number	Percent
55	6	11	10	18

ID: SH-114 Page: 1

Reports specific to various DOT specifications can be generated in PPM.

This report is based on TxDOT thermal specification Tex-244-F

TEX-244-F REPORT

Summary of Locations with Thermal Segregation

Profile Nr	Beginning Location		Ending Location		Max Temp	Min Temp	Temperature Differential
	Distance (ft)	GPS in °	Distance (ft)	GPS in °			
2	150.50	96.95501 W, 32.88593 N	300.00	96.95462 W, 32.88572 N	309.9	283.8	26.1
20	2850.07	96.94865 W, 32.88120 N	2999.58	96.94837 W, 32.88087 N	316.8	257.9	58.9
21	3000.08	96.94837 W, 32.88087 N	3149.58	96.94813 W, 32.88054 N	311.2	248.9	62.3
23	3300.09	96.94787 W, 32.88020 N	3449.56	96.94762 W, 32.87986 N	327.2	297.3	29.9
31	4500.17	96.94655 W, 32.87720 N	4649.61	96.94649 W, 32.87680 N	324.1	296.6	27.5
33	4800.06	96.94645 W, 32.87639 N	4949.50	96.94642 W, 32.87600 N	310.1	284.5	25.6
36	5250.39	96.9464 W, 32.87519 N	5399.84	96.94639 W, 32.87480 N	318.9	291.4	27.5
47	6900.28	96.94559 W, 32.87085 N	7049.73	96.94546 W, 32.87045 N	336.7	307.0	29.7
48	7050.23	96.94546 W, 32.87045 N	7199.67	96.9452 W, 32.87014 N	351.7	294.1	57.6
49	7200.17	96.9452 W, 32.87014 N	7349.62	96.94497 W, 32.86979 N	351.0	284.7	66.2
50	7350.12	96.94497 W, 32.86979 N	7499.56	96.94474 W, 32.86944 N	349.7	264.4	85.3
51	7500.06	96.94474 W, 32.86943 N	7649.50	96.94451 W, 32.86909 N	348.8	268.3	80.5
52	7650.00	96.94451 W, 32.86909 N	7799.95	96.94425 W, 32.86876 N	349.7	257.9	91.8
53	7800.45	96.94425 W, 32.86876 N	7949.89	96.94399 W, 32.86842 N	352.0	247.3	104.8
54	7950.39	96.94399 W, 32.86842 N	8099.84	96.9437 W, 32.86809 N	348.4	262.9	85.5

ID: SH-114 Page: 2

Summary of Locations with Thermal Segregation

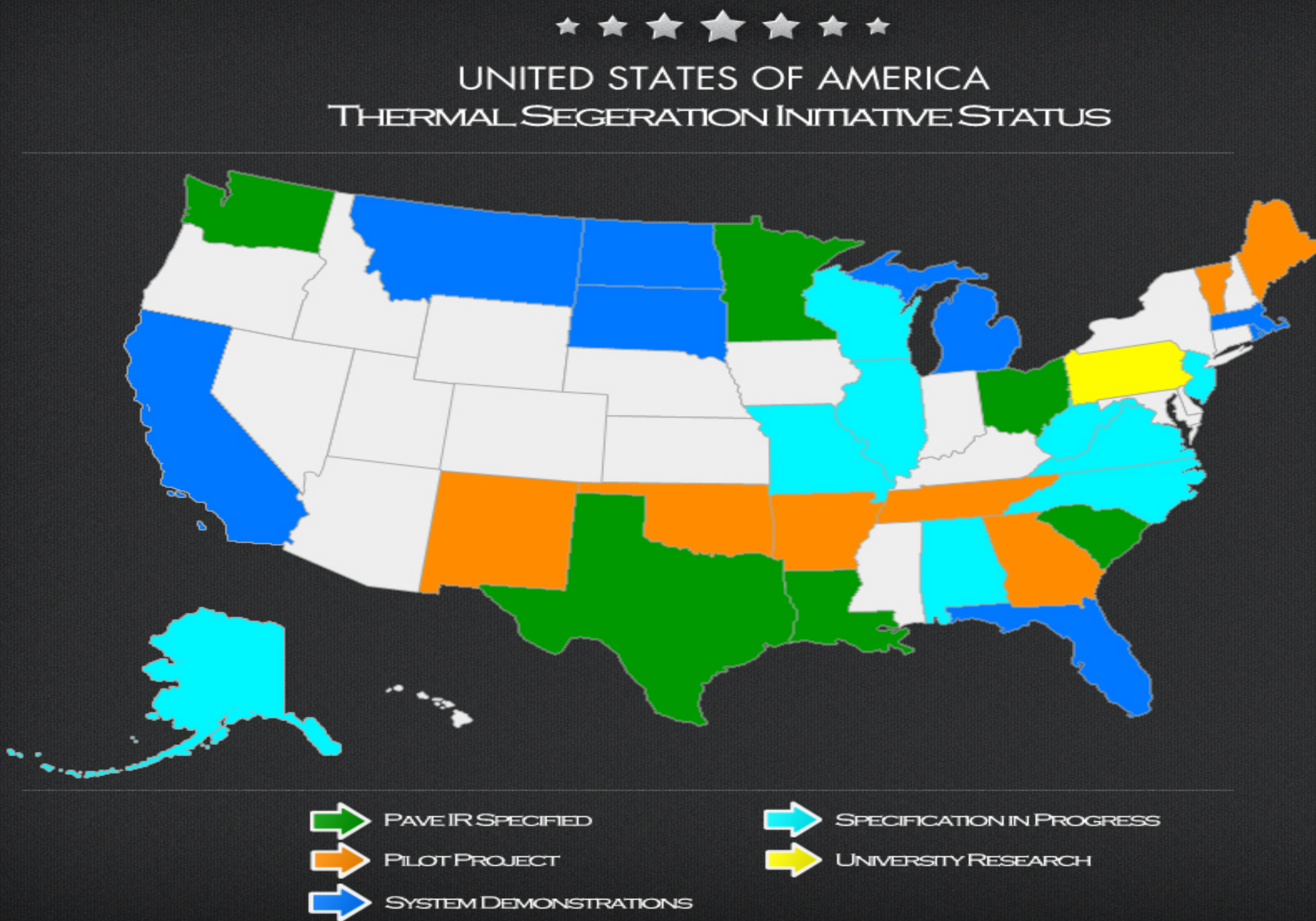
Profile Nr	Beginning Location		Ending Location		Max Temp	Min Temp	Temperature Differential
	Distance (ft)	GPS in °	Distance (ft)	GPS in °			
55	8100.34	96.9437 W, 32.86809 N	8214.80	96.94349 W, 32.86786 N	328.8	243.9	85.0

Summary of Locations Without Thermal Segregation

Profile Nr	Beginning Location		Ending Location		Max Temp	Min Temp	Temperature Differential
	Distance (ft)	GPS in °	Distance (ft)	GPS in °			
1	0.00	96.95544 W, 32.88615 N	150.00	96.95501 W, 32.88593 N	295.9	275.5	20.3
3	300.50	96.95462 W, 32.88572 N	450.00	96.95423 W, 32.88550 N	311.9	288.1	23.8
4	450.50	96.95422 W, 32.88550 N	599.50	96.95384 W, 32.88529 N	318.4	305.1	13.3
5	600.00	96.95383 W, 32.88529 N	749.51	96.95344 W, 32.88507 N	319.6	305.2	14.4
6	750.01	96.95344 W, 32.88507 N	899.51	96.95303 W, 32.88485 N	317.3	303.3	14.0
7	900.01	96.95303 W, 32.88485 N	1049.52	96.95262 W, 32.88462 N	313.0	290.1	22.9
8	1050.02	96.95262 W, 32.88462 N	1199.52	96.95223 W, 32.88441 N	300.9	283.5	17.5
9	1200.02	96.95222 W, 32.88441 N	1349.53	96.95182 W, 32.88418 N	303.1	285.6	17.5
10	1350.03	96.95182 W, 32.88418 N	1499.53	96.95145 W, 32.88394 N	305.1	291.7	13.3
11	1500.03	96.95145 W, 32.88393 N	1649.54	96.95109 W, 32.88368 N	308.3	294.6	13.7

ID: SH-114 Page: 3

US Useage


UNITED STATES OF AMERICA
THERMAL SEGERATION INITIATIVE STATUS
PAVE IR SPECIFIED
SPECIFICATION IN PROGRESS
PILOT PROJECT
UNIVERSITY RESEARCH
SYSTEM DEMONSTRATIONS

- Specified in Texas, Ohio, Louisiana, Minnesota, Washington, South Carolina
- SHRP 2 Study completed(Recommend Implementation)
- SHRP 2 Implementation Assistance Program R06C (10 states picked)
- Every Day Counts/IC
- NCAT Alabama Study
- AASHTO Spec PP-80, Provisional Practice

Thank You!

Questions?

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