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MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation

Federal Highway Administration

37th Annual North Central Local Roads Conference

Rapid City, SD

October 18-20, 2022

Leslie Myers, FHWA HQ

FHWA Mobile Asphalt Technology Center: Technologies to Watch For

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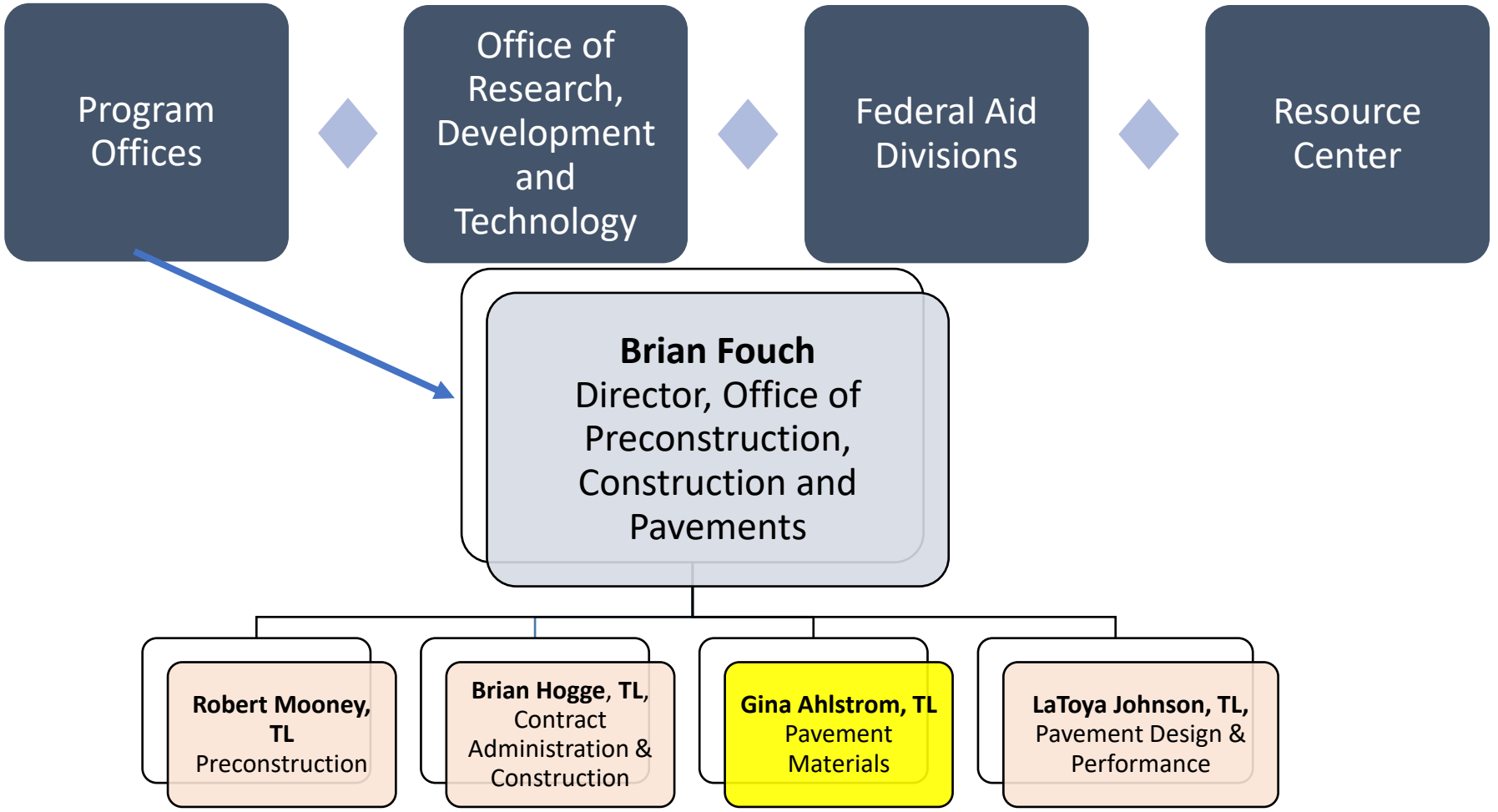
Acronyms

- AASHTO: American Association of State Highway and Transportation Officials
- ABML-ID: Asphalt Binder and Mixture Laboratory – Implementation Division
- ABT: Asphalt Binder Tester
- AIMS: Aggregate Imaging Measurement System
- AMPT: Asphalt Mixture Performance Tester
- ASTM: American Society for Testing and Materials
- BMD: Balanced Mix Design
- DO: FHWA Division Office
- DPS: Density Profiling System
- FTIR: Fourier Transform Infrared Spectroscopy
- HICP: FHWA Office of Preconstruction, Construction, and Pavements
- ICT: IDEAL Cracking Test
- I-FiT: Illinois Fatigue Test
- MATC: Mobile Asphalt Technology Center
- MTV: Material Transfer Vehicle
- NCHRP: National Cooperative Highway Research Program
- NDE: Nondestructive Evaluation
- PEM: Performance Engineered Mixtures
- PEP: Performance Engineered Pavements
- PMS: Pavement Management System
- PRS: Performance-Related Specifications
- QA: Quality Assurance
- R&D: Research & Development
- RC: FHWA Resource Center
- Sapp: Apparent Damage Capacity
- SCB: Semi-circular Bend
- SSR: Stress Sweep Rutting
- TFHRC: Turner-Fairbank Highway Research Center
- TxOT: Texas Overlay Text
- XRF: X-Ray Florescence

FHWA Infrastructure Programs



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Pavement and Materials: What We Do

- All things Asphalt Materials
- All things Concrete Materials
- Technologies for pavements and materials
- Movement toward Performance Engineered Pavements
- Pavement Sustainability and Resilience

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Subject Matter Expert
Materials and Construction Specifications

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Program Goal & Focus Areas

Innovative technologies and practices are implemented by agencies and industry to provide durable, safe, and sustainable asphalt pavements on our nation's highways.

- On-site field evaluations & training + 2-day QA workshop
- Asphalt materials & field testing
- Innovation implementation
- Equipment loans
- Hands-on and virtual demos
- Specification review

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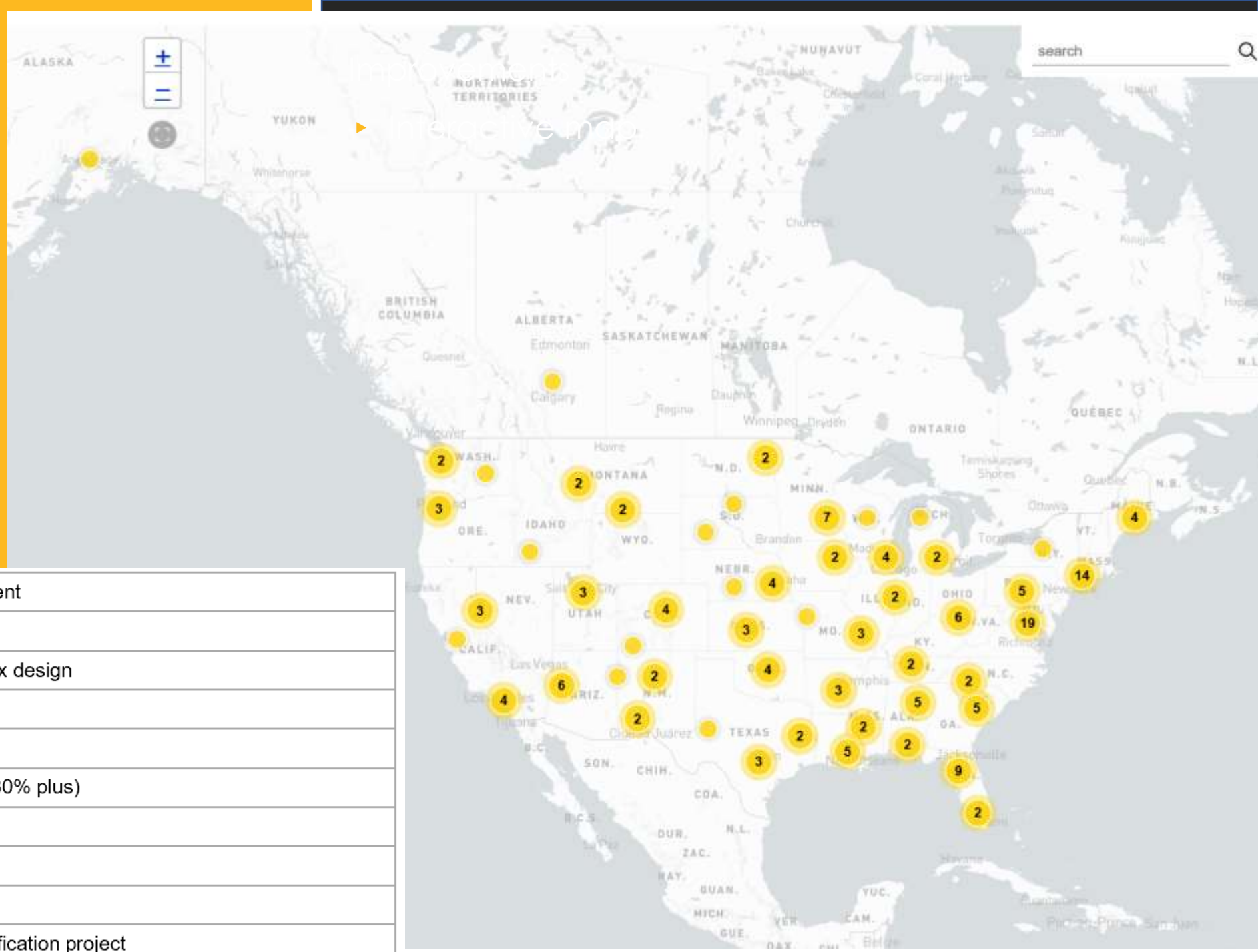
Site Visits

Since 1988

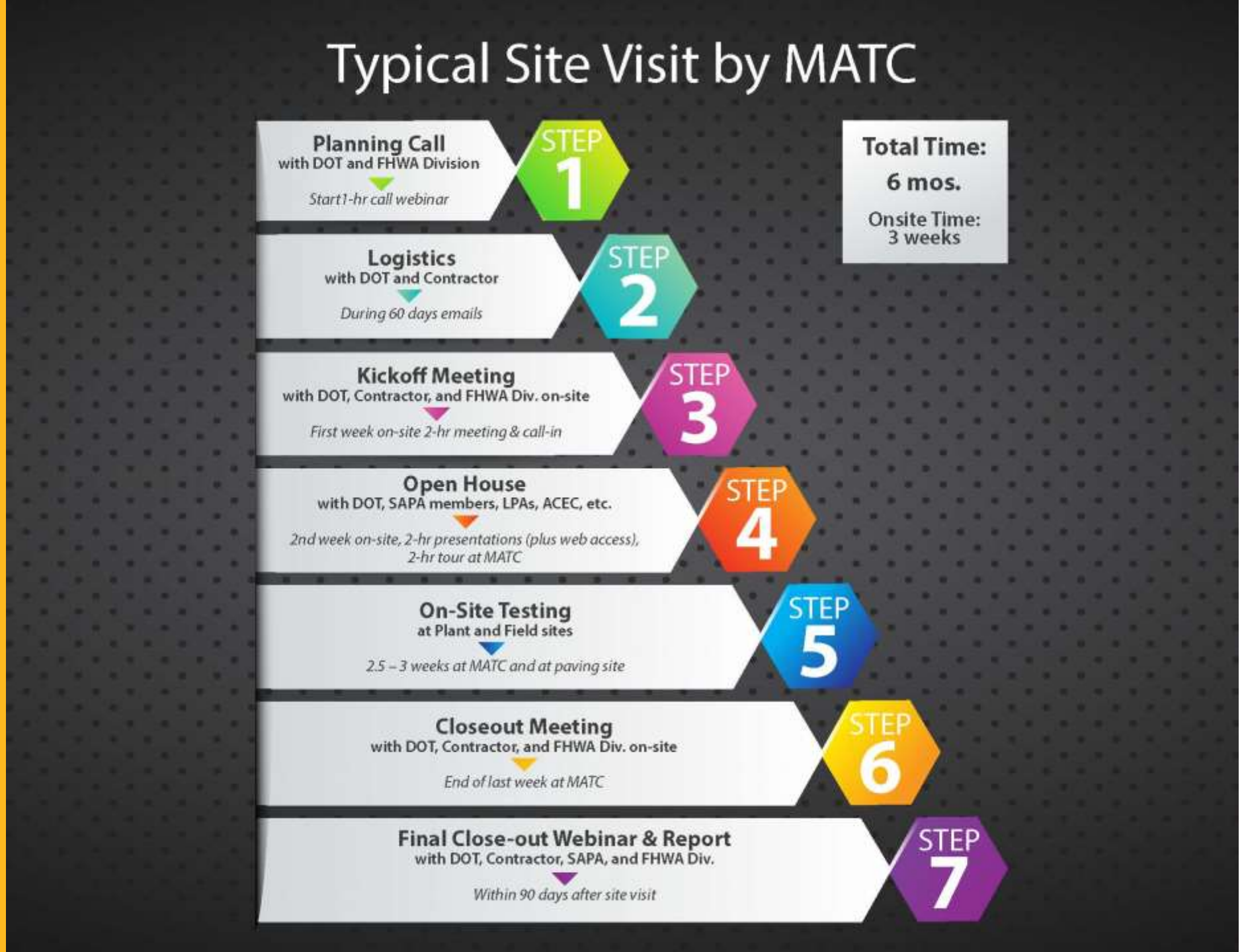
- Interactive Map
- Searchable:

RAP	Reclaimed asphalt pavement
RAS	Recycled asphalt shingles
SMA	Stone matrix aggregate mix design
FC	Friction course
WMA	Warm mix asphalt
Hi-RAP	High percentage of RAP (30% plus)
PMA	Polymer modified asphalt
AR	Asphalt rubber
ARB	Asphalt rubber base
PRS	Performance related specification project



MATC On-site Project Visit

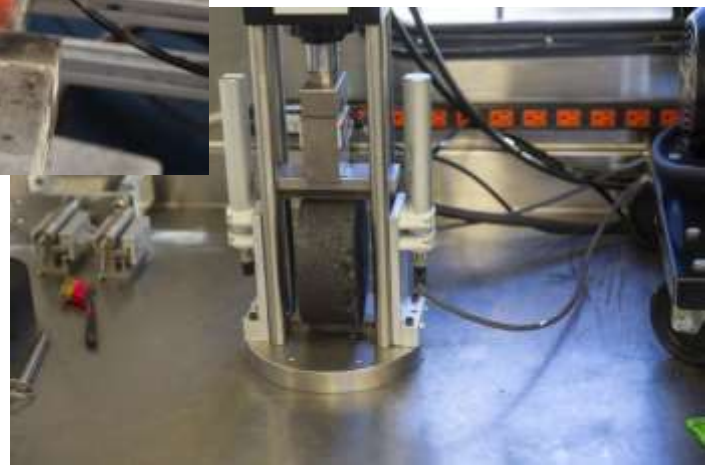
Logistics



While On Site…

Sampling

Preparing specimens



Laboratory testing

Demonstrations

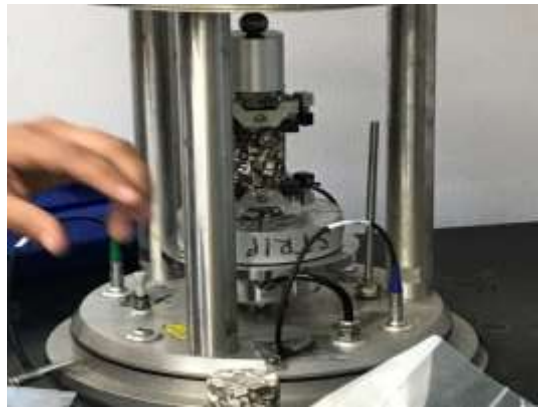
Field testing

MATC – Field Visit (Week 1)

- Kickoff Meeting on-site
- Sampling Testing: 3 samples per day (2 volumetric, 1 performance)
- Testing: mix design tests, volumetric properties, mix performance

Kick-Off Meeting

Volumetrics



Testing

Week 1

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MATC – Field Visit (Weeks 2-3)

- Binder & Aggregate Samples
  - One gallon for each binder
- Mixture Testing
  - Quantities depend on which & how many types of tests
- Material Tests
  - Handheld XRF spectrometer
  - Asphalt Binder QC Tester (ABT)
- Field Tests
  - Density Profiling System (DPS)
  - Circular Track Meter (CTM)
  - Laser texture scanner (LTS)
  - Paver-mounted thermal profiler
  - Pulse induction in situ thickness testing

MATC – Field Visit (Week 4)

- Complete Testing from Weeks1- 3
- Synthesize and Compile Data
- Observations at the Plant and Paving Operation
- Close Out Presentation
- Depart Project

Testing

Plant Operation

On-site closeout presentation

Week 4

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Quality in the Asphalt Paving Process 2-day Workshop

- Two-day workshop on asphalt materials and construction
- Builds off observations from field visit, specification review, and test results for each State
- Scheduled within year after conclusion of MATC site visit
- Agency and industry participation (50/50)
- Goal: Action plan

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Technologies Offered by FHWA MATC

Mixture

- AMPT suite of tests (cyclic fatigue, stress sweep rut, E*)
- Overlay test for reflective cracking
- Flexibility index test (I-FIT) for fracture resistance
- ITC (IDEAL-CT) for crack resistance
- IDEAL-RT for rutting resistance
- Hamburg wheel track test

Materials

- X-Ray Fluorescence (XRF) Spectrometer for binder components
- ABT (true grade binder)
- FTIR for binder molecular analysis

Field

- Paver-mounted thermal profiler (PMTP) for mat temperature
- Pulse induction technology for in-place pavement thickness
- Pavement macrotexture measurements (3 methods)
- Dielectric profiling systems (DPS) for mat density

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MATC – Technology Transfer

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Spotlight on Pavement Density

Use of Dielectric Profiling Systems for Asphalt Density

FHWA-HIF-21-XXXX

For more information on DPS and related technology, contact Monica Jurado, Pavements & Materials Engineer, FHWA Resource Center, monica.jurado@dot.gov

This equipment and more are available on loan at the MATC. www.fhwa.dot.gov/pavement/asphalt/trailer/equipment_loan_program.pdf

The dielectric profiling system series shares information on pavement testing programs.

To access the full series, visit www.fhwa.dot.gov/pavement/asphalt/trailer/initiatives.cfm

Background

Highway agencies seeking a more viable way to check the quality of asphalt construction than through sample cores are considering dielectric profiling systems (DPS) as a solution.

DPS use a ground-penetrating radar (GPR) to collect dielectric values from the underlying surface that help measure air voids or nonuniformity of newly laid hot-mix asphalt. In this way, a DPS unit rolled along a road segment can collect continuous data on asphalt density. Asphalt density is a key indicator for long-term performance of new pavement or resurfacing construction jobs. Improving pavement performance can extend maintenance cycles and save millions of dollars in transportation budgets.

State Departments of Transportation (DOTs) have been field-testing DPS units in their pavement testing programs through the second Strategic Highway Research Program (SHRP2) Initiative (R06C), which advanced the DPS technology as a nondestructive method for checking asphalt density.

DOTs describe initial difficulties in interpreting the intricate data and managing the enormous data output. However, DOTs observe that the data produces a more uniform and immediate picture of a new pavement layer than the process of obtaining sample cores at random spots along a new section.

A DPS unit side view (above) and in use (below). Photo sources: GSSI, ODOT

How DPS Work

DPS units come in various models from multiple commercial vendors, costing about $70,000 per unit. Also known as density profiling systems, they often are in the form of lightweight carts that one person easily pushes along a test path. A three-channel GPR mounted near the wheels continuously collects data that transmits to the unit's computer system.

The unit determines the dielectric readings of the materials that make up the asphalt layer by measuring the velocity of reflected waves to about 2.5 inches. All material has a dielectric constant, ranging from 1 for air to 81 for water. HMA dielectric constants typically range from 3 to 6, depending on the aggregate type, asphalt content, and percentage of air voids.

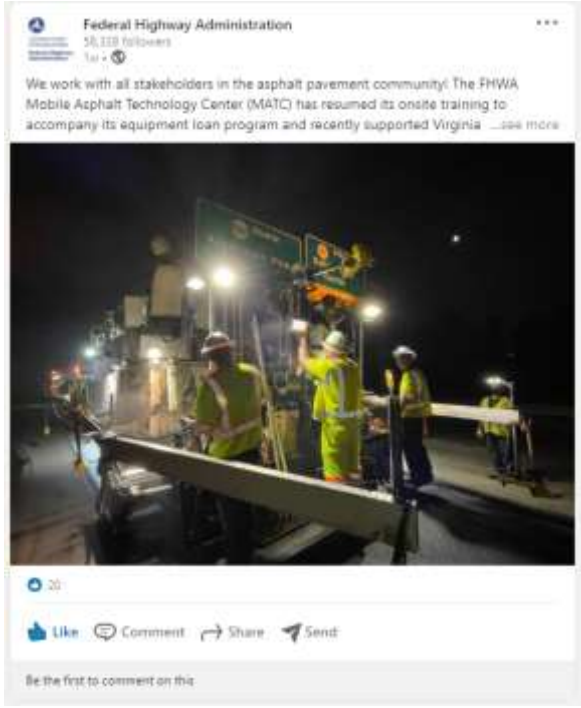
The paving crew can view the data immediately on the unit's trackpad and then export the data to other software for further analysis. The dielectric constants along the test path display as statistical data, histograms, box plots with outliers identified, or heat maps of the production lot.

Considering DPS? Technical assistance is available from the Federal Highway Administration (FHWA) through the Mobile Asphalt Technology Center (MATC) or FHWA division offices. There is also a national pooled fund study on DPS use.

Benefits

- Ability to detect and identify areas of concern. Contracting crews can adjust or remediate while the work zone is intact and before a job's acceptance.
- More uniform results than with sample cores, which may miss variations in the new mat.
- Significant reduction of cores per project. This avoids risks of new defects from removal and return of cores. It also can save on contract costs.
- Data applies to other uses, such as simulating changes to construction specifications, mapping locations and data, and other quick visualizations.
- More efficient and safer than coring. A DPS unit can be walked behind the paving equipment without additional road closures against fast-moving traffic.

- Use MATC as a communication vehicle to stakeholders
- Use short communication bursts (1-pagers, social media, etc.) to raise awareness on FHWA efforts



MATC – Equipment Loan Program

Request form submitted via FHWA P&M Engineer in Division Office

- Dielectric profiling system (DPS)
- Paver-mounted thermal profiler (PMTP)
- Circular track meter
- Laser-based texture scanner
- AIMS device for aggregate scans
- Handheld XRF binder device
  - Limestone, titanium dioxide, REOB

Equipment loan includes on-site training by MATC or consultant, final Lessons Learned document, and post-loan briefing presentation

EQUIPMENT LOAN PROGRAM:

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In order to increase the likelihood of adoption of new technologies, the FHWA's Mobile Asphalt Technology Center (MATC) provides loan of several pieces of equipment to agencies and contractors.

The idea is for the agency and contractor personnel to borrow equipment for various lengths of time to evaluate and determine if it meets their needs. Based on the MATC's past experience, this significantly increases the likelihood of adoption, because the agency or contractor doesn't have to buy an expensive piece of equipment only to find that it may not meet their needs. The equipment loan can last from a duration of few weeks to several months.

THE LIST OF EQUIPMENT AVAILABLE FOR LOAN INCLUDES THE FOLLOWING:

- Paver-mounted infrared (Pave-IR) device
- Circular Track Meter (CTM)
- NDT Pavement Thickness (MIT Scan T3)
- Dielectric Profiling System (DPS) for mat and joint density
- Aggregate Imaging System (AIMS) for aggregate properties
- X-Ray Flourescence (XRF) device for binder composition
- Jig set for fatigue testing (I-Fit, TxOT) in AMPT device
- CoreLok for bulk specific gravity of cores
- Warm mix asphalt (WMA) foaming device

MATC – Specification Reviews

Example:

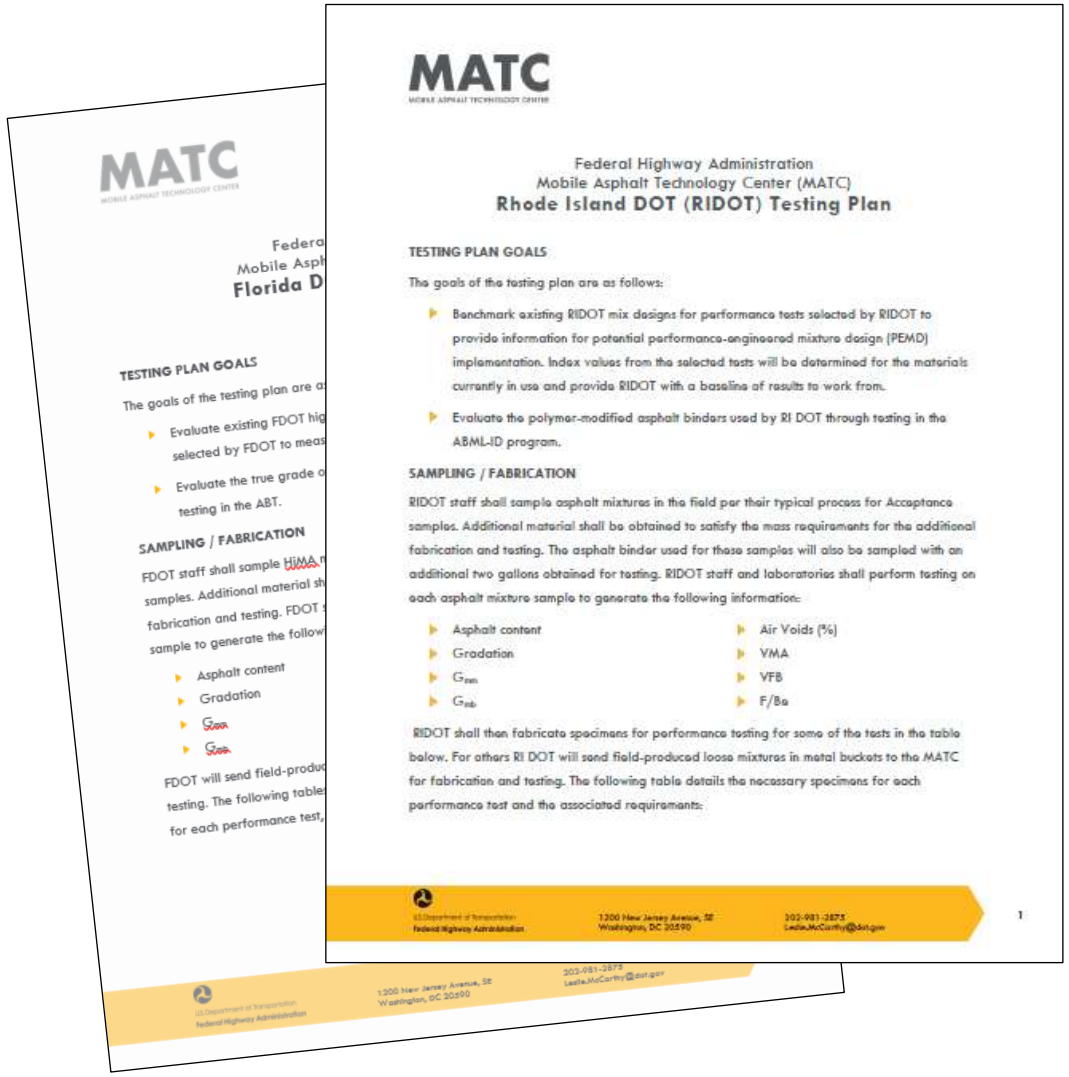
- SCDOT specification review as follow-up to visit in Winter 2020
  - OGFC
  - SMA
  - Comparison to gold medal density states
  - General specification
  - Identified some potential QA issues
- Also reviewed specs for: FL, RI, VT, AZ, OH, ND, PR, USVI, and more…
  - Density is a popular topic
  - New types of mixtures or additives (e.g,. recycled content, fibers, etc.)

Comparison of SCDOT Density Specification to "Gold Medal States"

Meets?	Gold Medal State Best Practice	SCDOT Practice
	Use only Agency testing in Acceptance decision.	SCDOT uses verified Contractor results.
	Use percent within limits or average lot value with a minimum individual sublot value.	SCDOT uses the average density per lot (lot = one day's production) for determination of payfactor.
✓	Lower limit at or slightly above 92.0% of G_{mm}.	SCDOT applies a 1.0 payfactor for average lot in-place density between 93.0 – 93.9% of G_{mm}.
✓	Upper limit at or above 97.0% of G_{mm}.	SCDOT does not define an upper limit for in-place density.
✓	Use of incentive and maximum incentive at or above 94.0% of G_{mm}.	SCDOT applies a 1.05 payfactor for an average lot in-place density of 94.0% of G_{mm} or higher.
	At least four or more sublots within a Lot.	SCDOT defines a lot as a day's production and requires in-place density testing for every 1500 feet of linear paving.
✓	Sublot size and frequency between 200 and 750 tons.	SCDOT defines the sublot by the linear distance paved (1500 feet) and not the tonnage produced. Assuming paving 12 feet wide, a 1" compacted mat results in 250 tons over roughly 800 linear feet so the sublot size is comparable.
✓	Assess in-place density by measuring G_{mb} of roadway core at least once per sublot.	SCDOT requires that one 6-inch core for G_{mb} testing be taken randomly within every 1500 foot sublot.

MATC 2020-2022 Projects

- **Rhode Island DOT:** Intro to BMD approach (full suite)
- **Florida DOT:** Intro to BMD and AMPT suite of tests
  - HiMA & fiber performance testing (8 mixes)
  - Macrotexture evaluation (1 DGA ≥ 45 mph road) with AMES device
- **Maine DOT:** IDEAL-RT split sample testing
- **California DOT:** I-FIT testing as part of I-5 PPP Round Robin
- **Vermont AOT:** SMA project in full suite BMD
- **Ohio DOT:** Hi-RAP project in full suite BMD & AMPT
- **North Dakota DOT:** Intro to BMD approach (full suite)
- **Arizona DOT:** Intro to BMD approach (full suite)
- **Washington DOT:** Intro to BMD approach (full suite)
- **Mississippi DOT:** Intro to BMD approach (full suite)

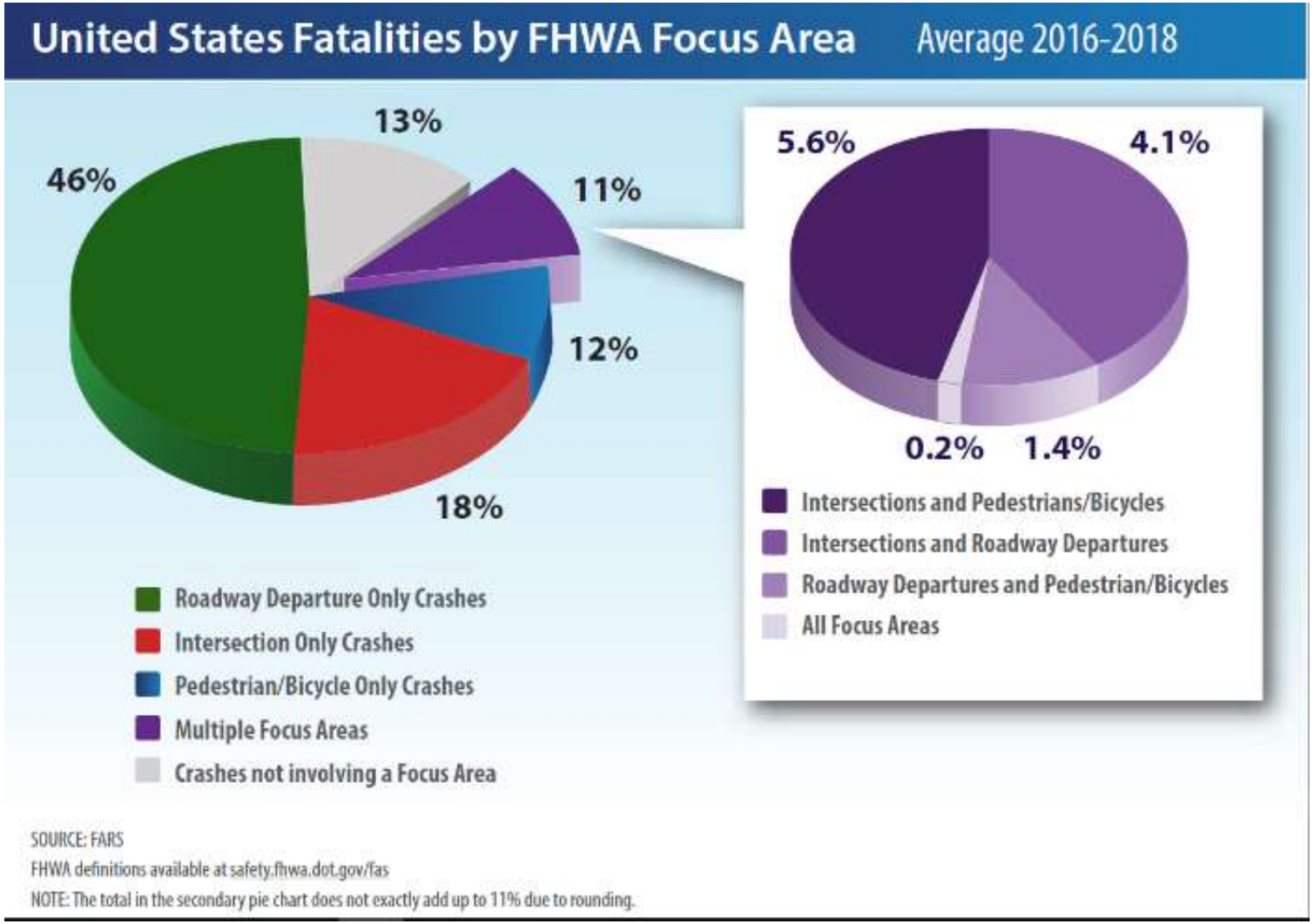


Macrotexture Initiative

The Motivation…

Surface Texture for Asphalt and Concrete Pavements T-5040.36 Issued June 17, 2005

http://www.fhwa.dot.gov/pavement/t504036.cfm?prnt=yes



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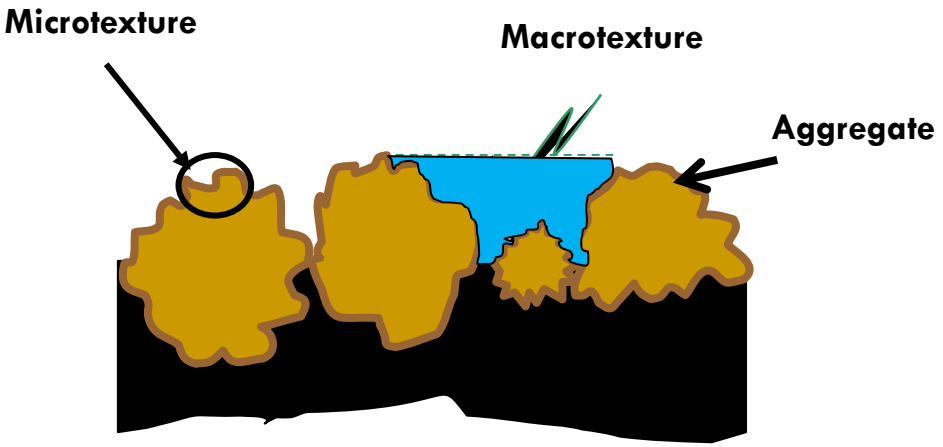
Asphalt Pavement Macrotexture

- **Significant focus on adding life (durability) to dense-graded mixes over the past several years**
  - Concern that macrotexture may be compromised
- **Macrotexture – mix surface voids, aggregate gradation driven**
  - Provides voids/channel to evacuate water – more critical at higher speeds
  - Provides friction from hysteresis – hysteresis increases with speed – more critical at higher speeds
  - FHWA is investigating macrotexture testing procedures that could be used in mix design, mix verification, and field verification

What is texture?

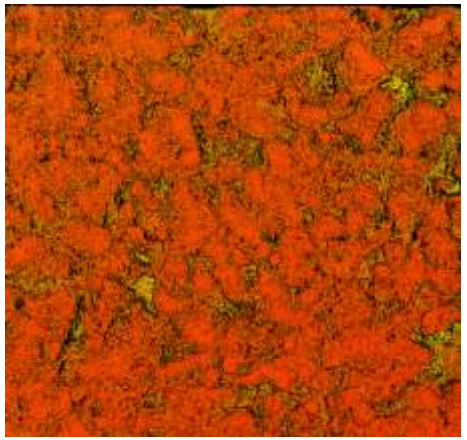


Pavement Cross Section

Sand Patch Test for Macrotexture

Laser Texture Scanner in Lab or Field

- Lightweight, portable, rapid, 3D scanner
- Utilizes a 100-mm laser line and travels 100 mm to collect a square area
- Measures macrotexture on freshly compacted mats in field and on cores or gyratory specimens in lab



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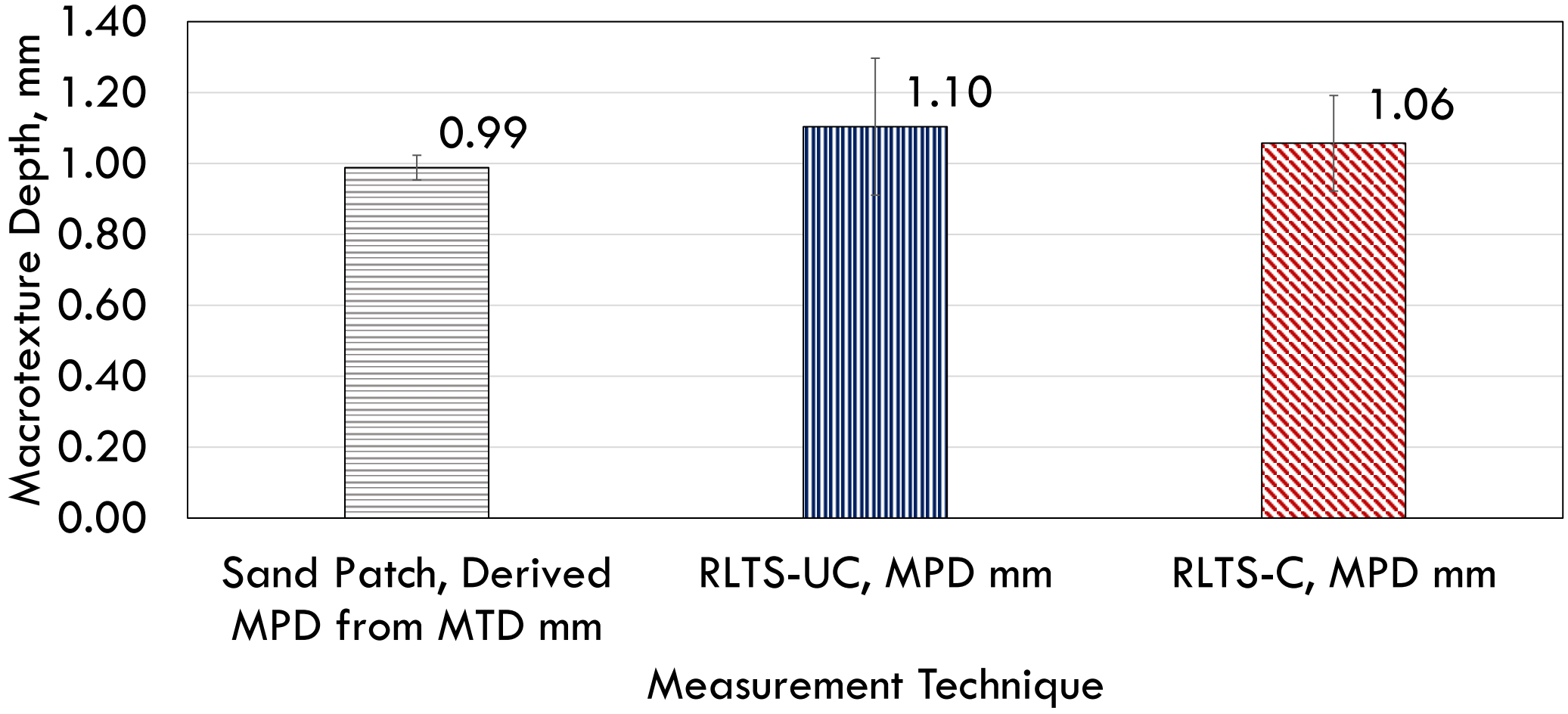
Mean Profile Depth (MPD) – Vermont AOT



Stone Matrix Asphalt (SMA) – MPD Typically exceeds 1.0 mm (0.04 in) according to 2008 AASHTO Guide for Pavement Friction

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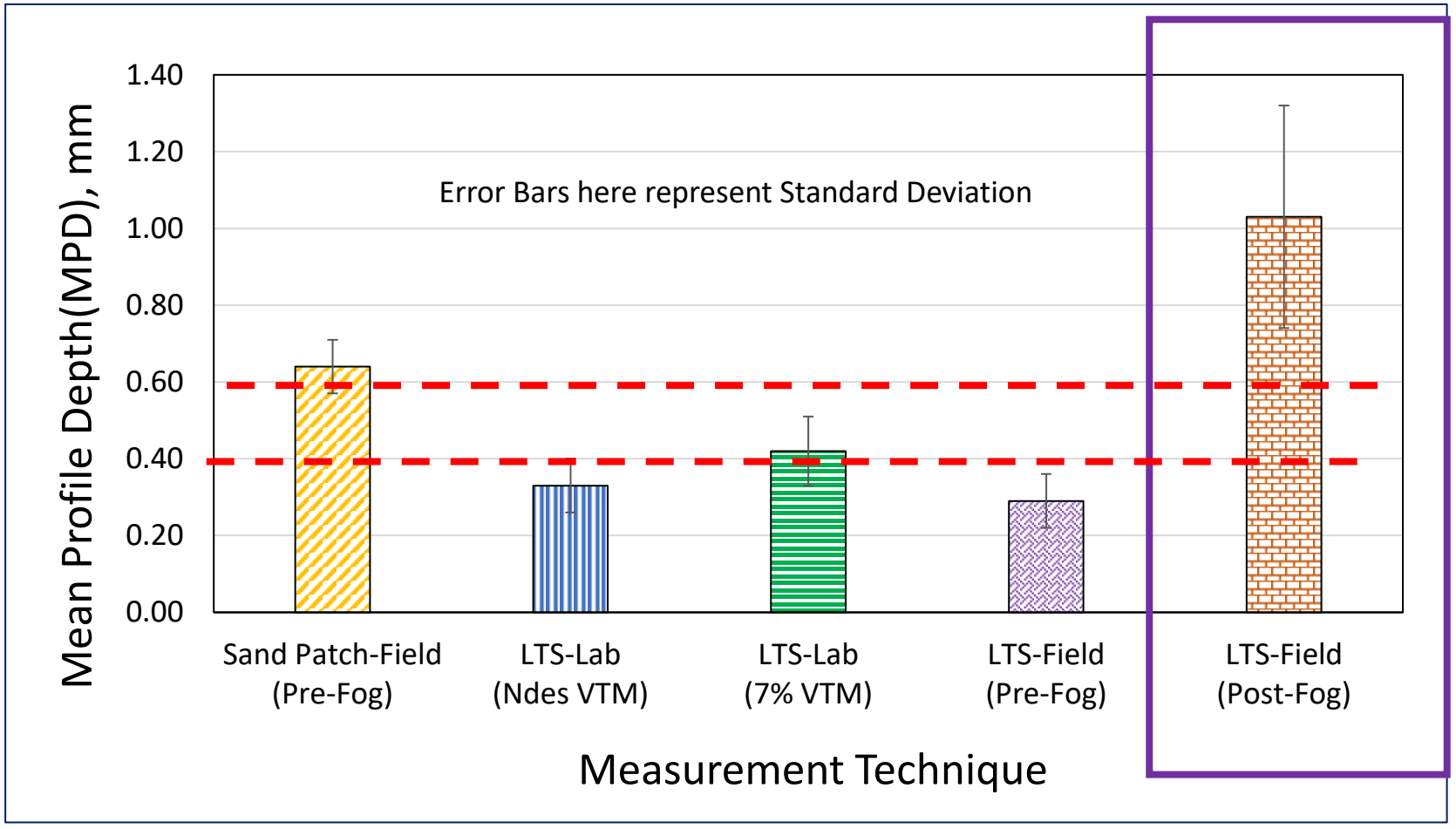
Mean Profile Depth (MPD) – Field



GPS - 48°45'47.16"N , 101°16'42.959"W
Location - US 83 N, Maxbass, ND

Note:
Dulling spray type used wasn't able to sufficiently reduce reflectance

Fine Dense-graded Asphalt – MPD typically ranges from 0.015 to 0.025 in. (0.4 to 0.6 mm) according to 2008 AASHTO Guide for Pavement Friction

Deployment of Field Technologies to Assist Asphalt Pavement Constructability

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Pulse Induction Technology

- Nondestructive device to measure pavement thickness on either asphalt or concrete pavements
- Eliminates need for taking cores
- Pulse Induction device requires preplacing a thin metal ‘target’ (plate) on the base before paving
- Distance between the plate and surface of the pavement is measured

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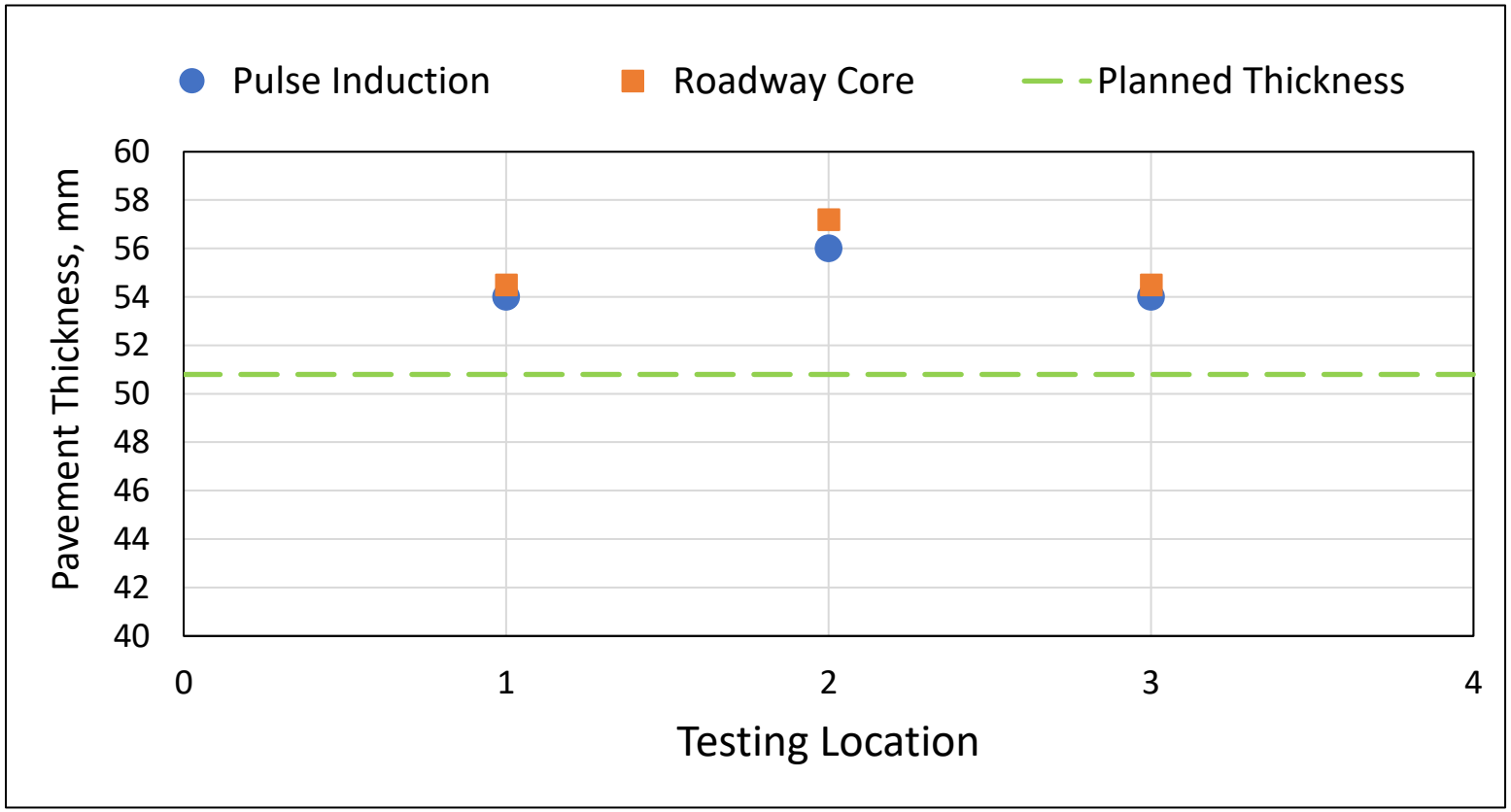
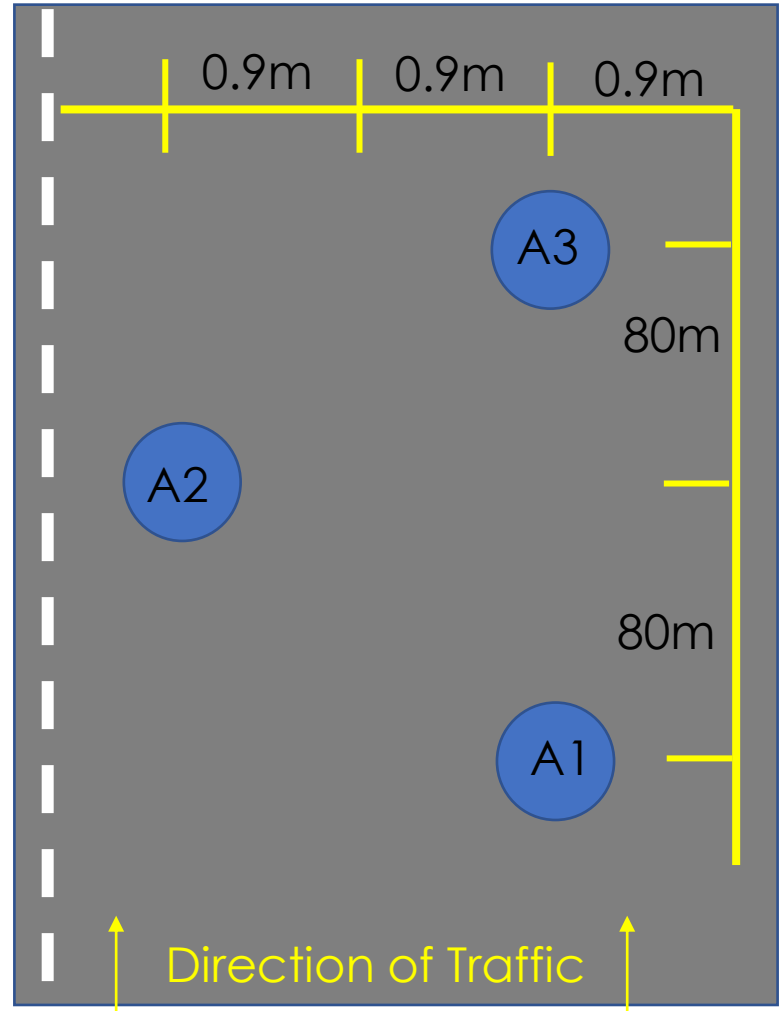
Pulse Induction Technology



Source: FHWA

Actual Measured Core thickness and Pulse Induction measurements found to be same

GPS - 48°45'47.16"N , 101°16'42.959"W
Location - US 83 N, Maxbass, ND



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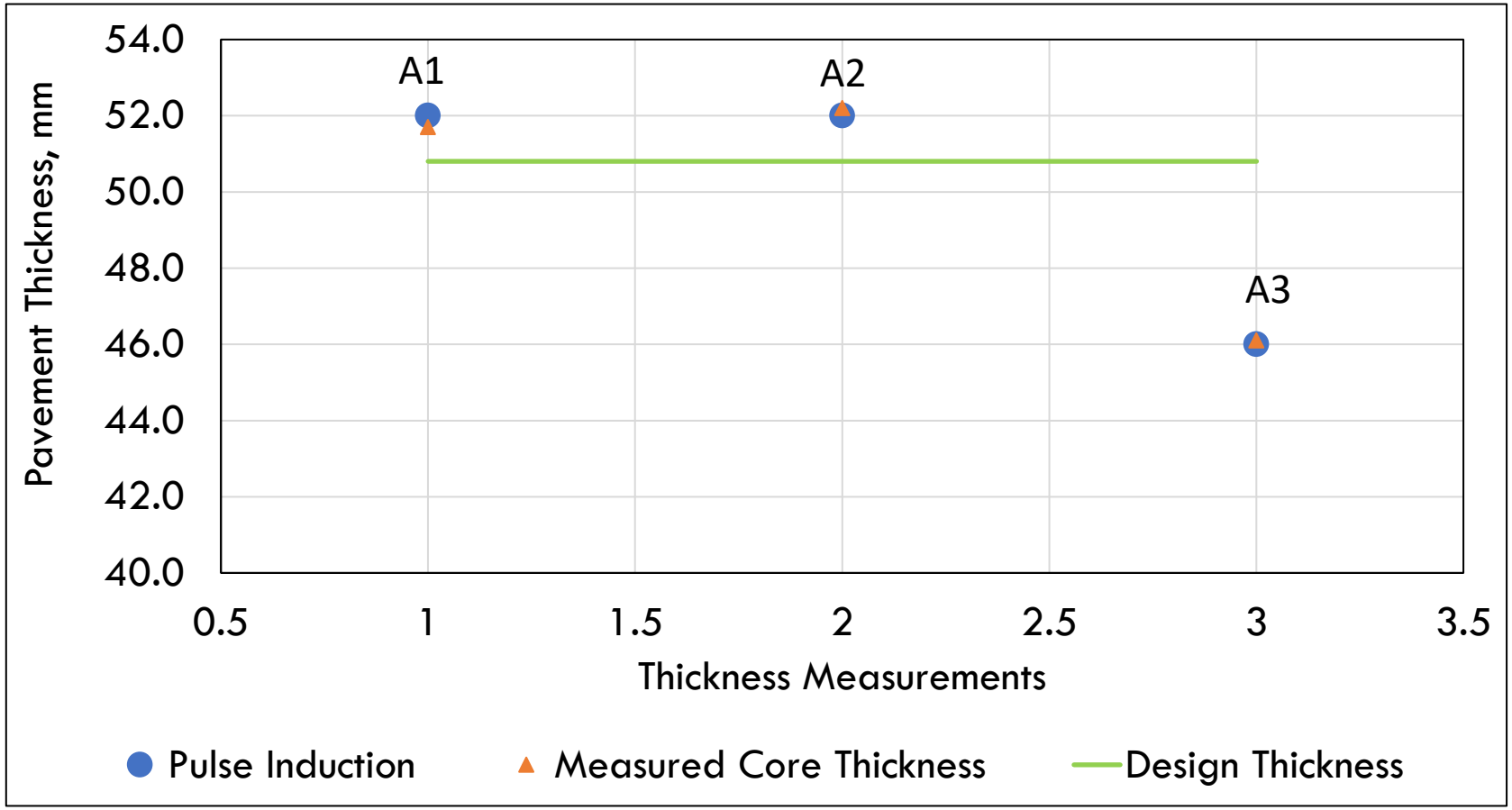
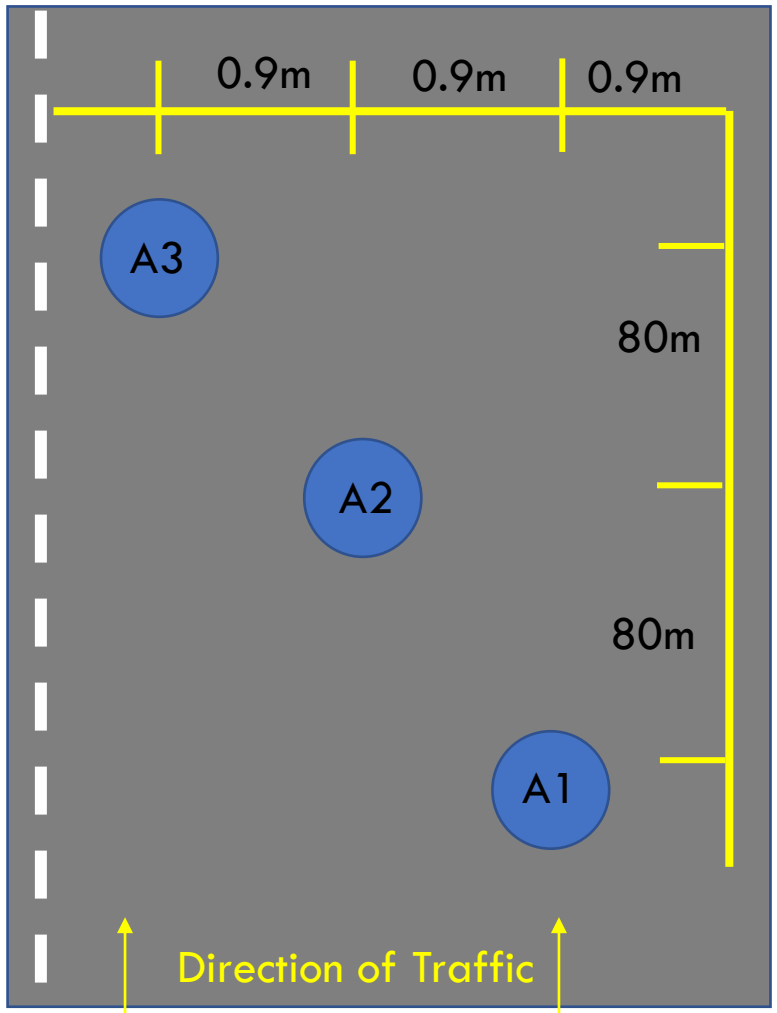
Pulse Induction Technology: Vermont

GPS - 43°51'13.3"N, 72°36'20.7"W
Location - Interstate 89 N, Bethel, VT





Actual Measured Core thickness and Pulse Induction measurements found to be same

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NDE Field Technologies: Paver-Mounted Thermal Profiler

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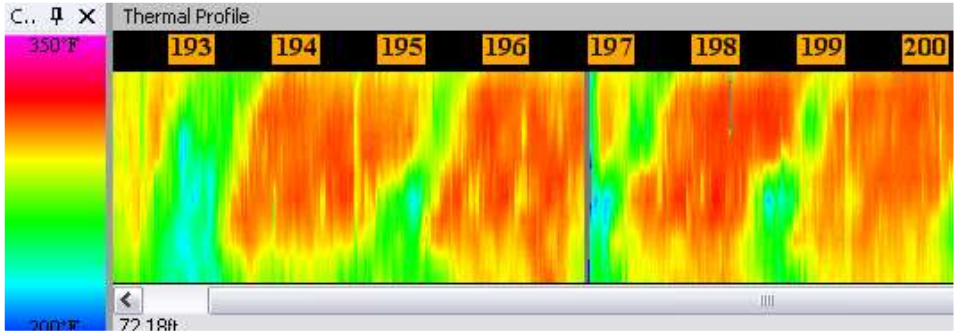
Paver-Mounted Thermal Profiler (PMTP)

- High precision real time thermal profiler to detect pavement mat defects before compaction
- Used for Identifying Segregation and Low-Density Issues
- Infrared Sensors for Measuring Temperature Uniformity of New Asphalt Surfaces
- Thermal Profile Imaging of Mat Surface Done at 2 to 3 meters behind screed



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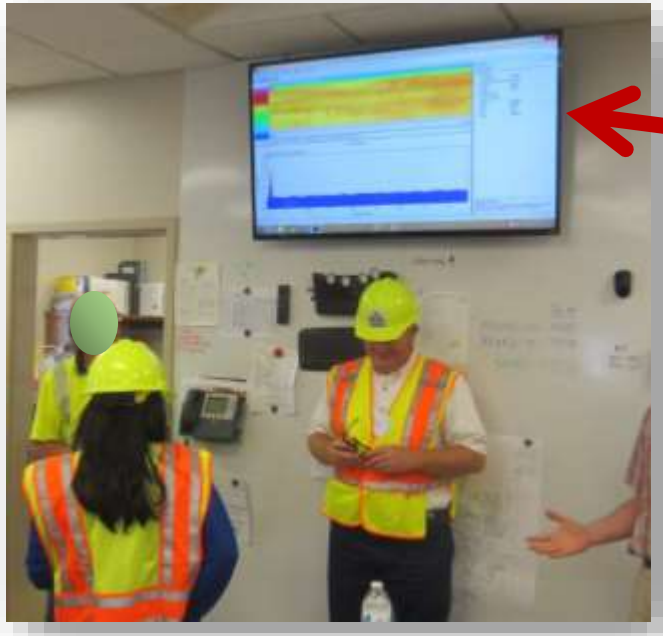
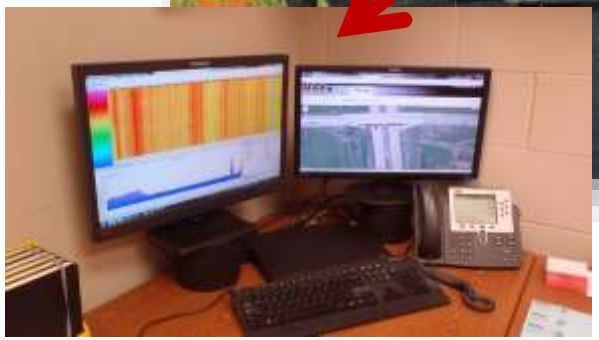
How it works

- Real-time Data Visualization and Communication Between Plant and Paver to Minimize Temperature Differentials While Paving Operation



Contractor monitors from plant



DOT can monitor from the Office

Images: SHRP2 (R06 C)

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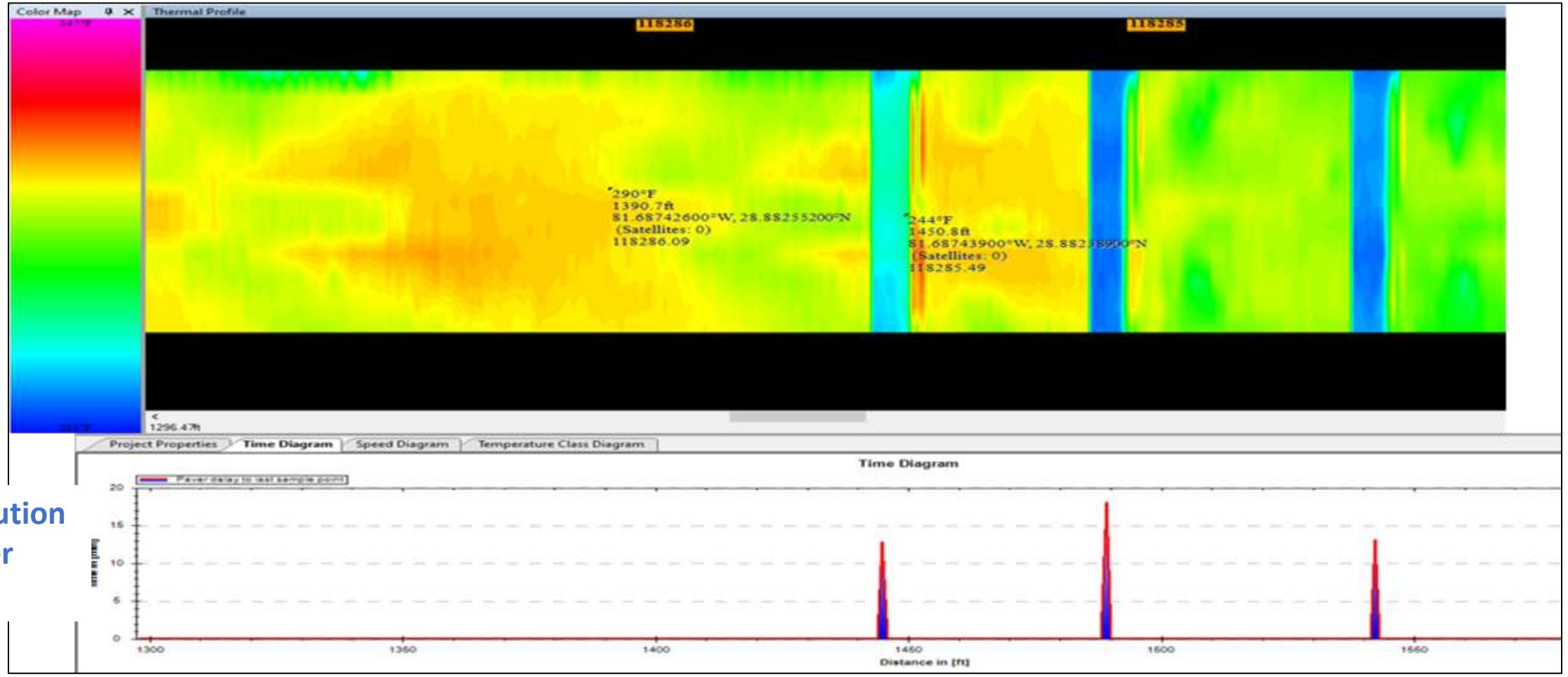
Paver-IR - Heat Maps: Florida



Distribution of Paver Speed

Paver Stop

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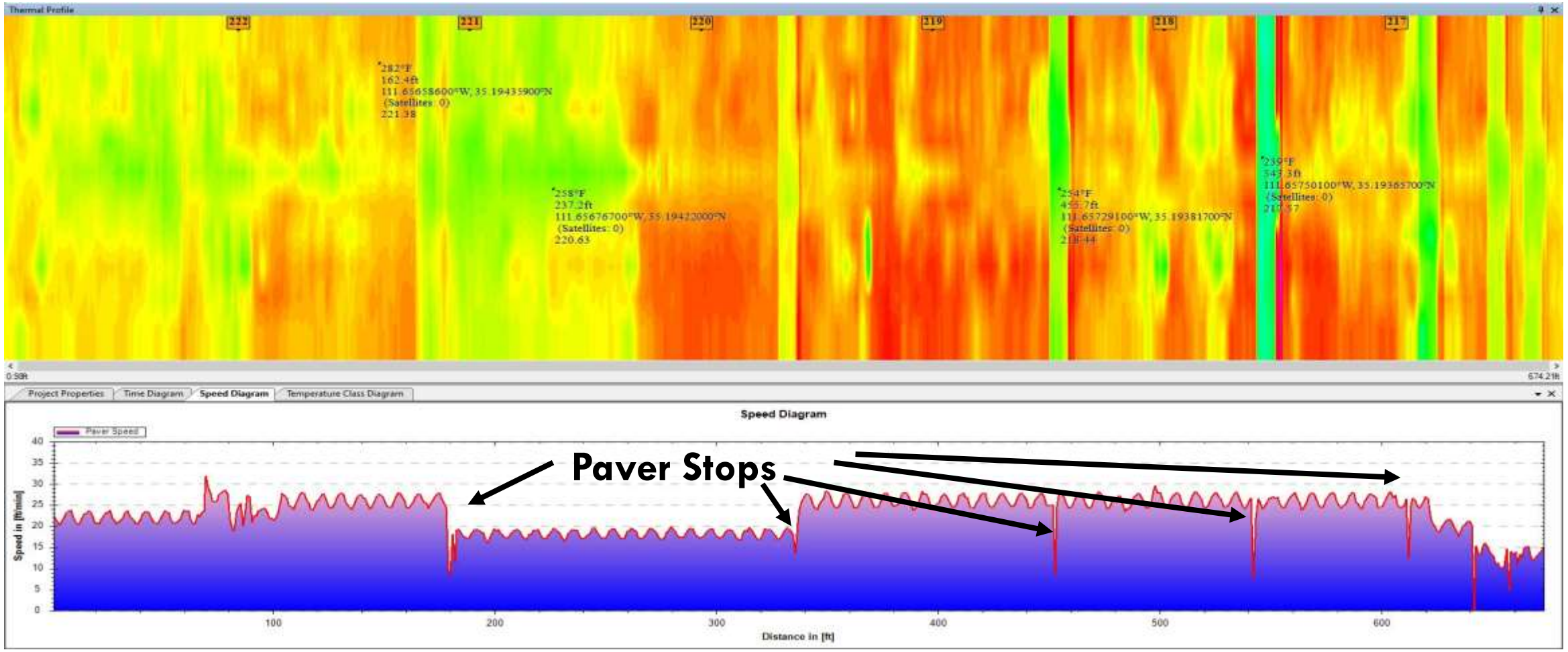
Paver-IR - Heat Maps: Arizona



Paver Speed

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NDE Field Technologies: Dielectric Profiling System

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Dielectric Profiling Systems (DPS)

- Testing equipment that uses high frequency ground penetrating radar (GPR) to nondestructively assess asphalt pavement density
- Reduce turnaround times
- Perform continuous density measurements over larger areas
- Dielectric profiling systems (DPS) address many of the issues with traditional density measurement techniques

Use of DPS Data

Low Dielectric Value → Higher Air Void Content → Lower Density

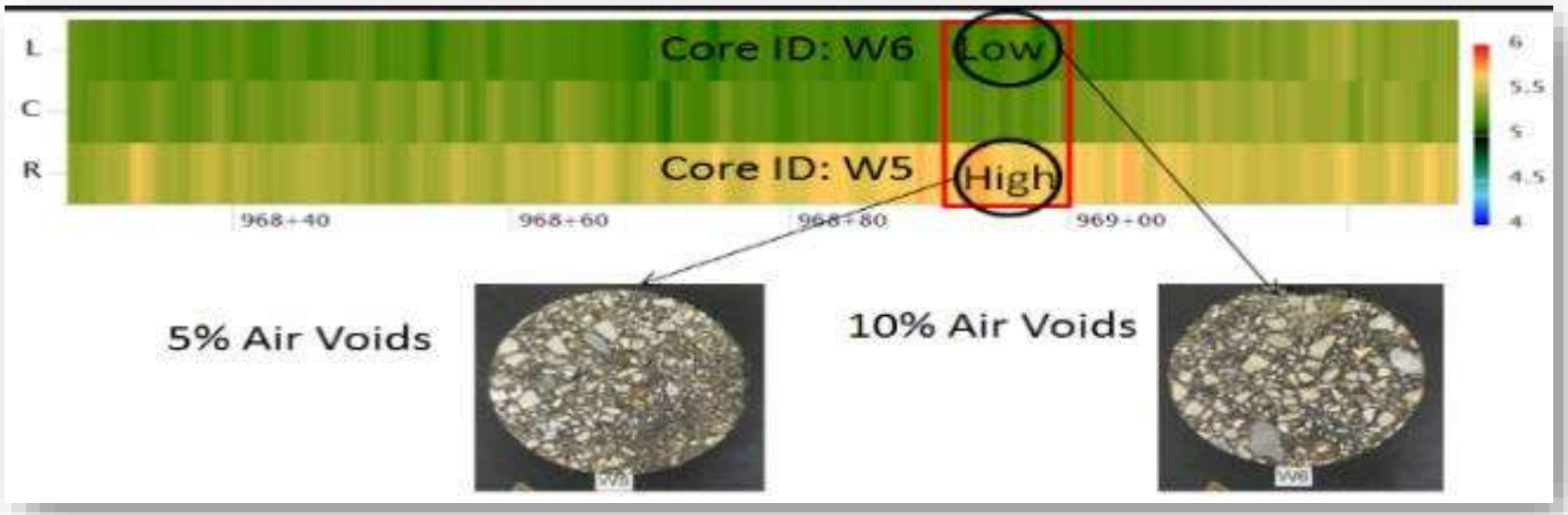

Image Source: GSSI

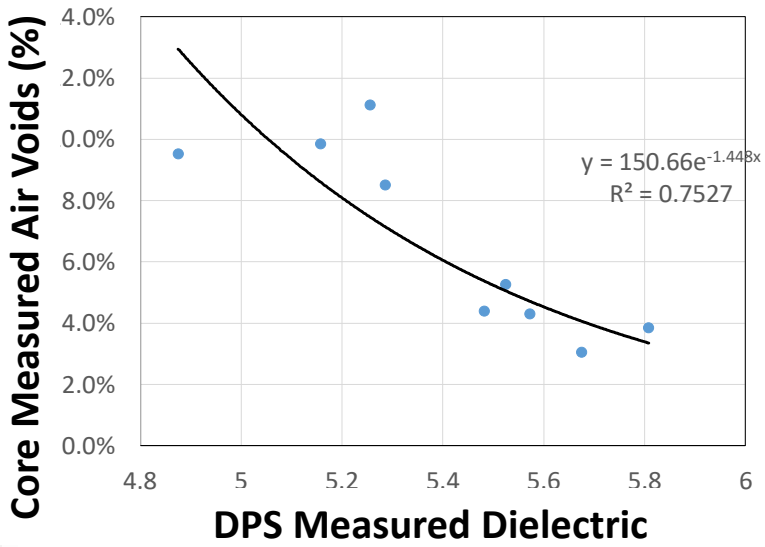

Image Source: FHWA

High Dielectric Value → Lower Air Void Content → Higher Density

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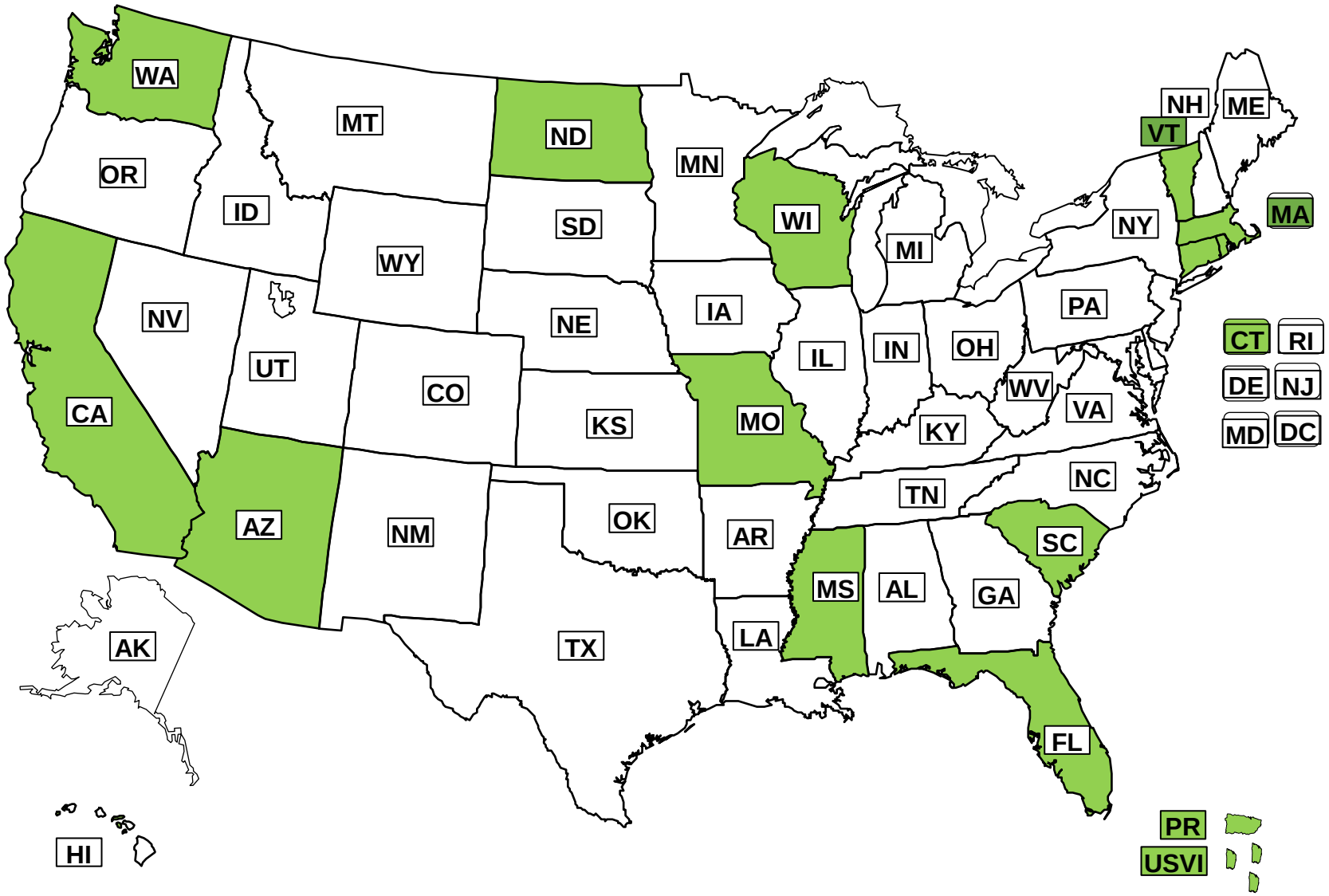
Dielectric Profiling System (DPS) Demos



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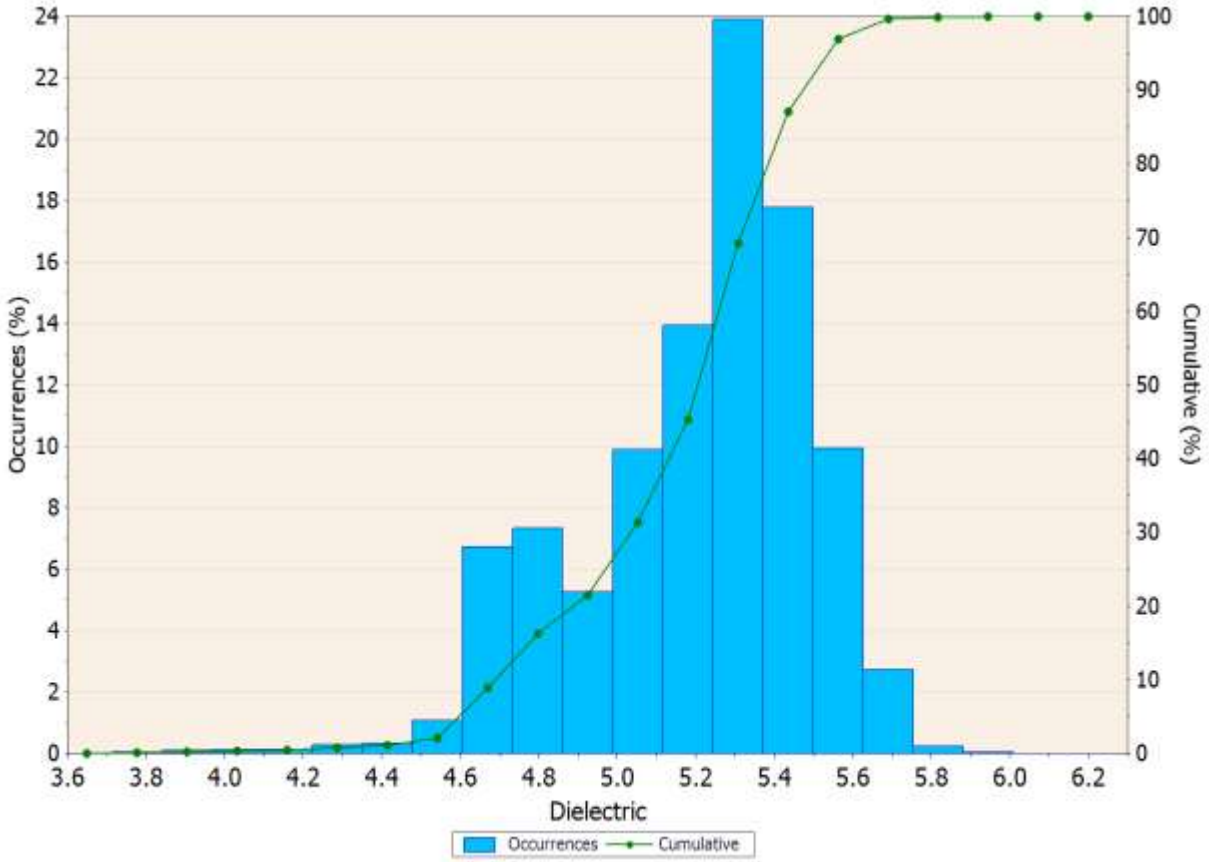
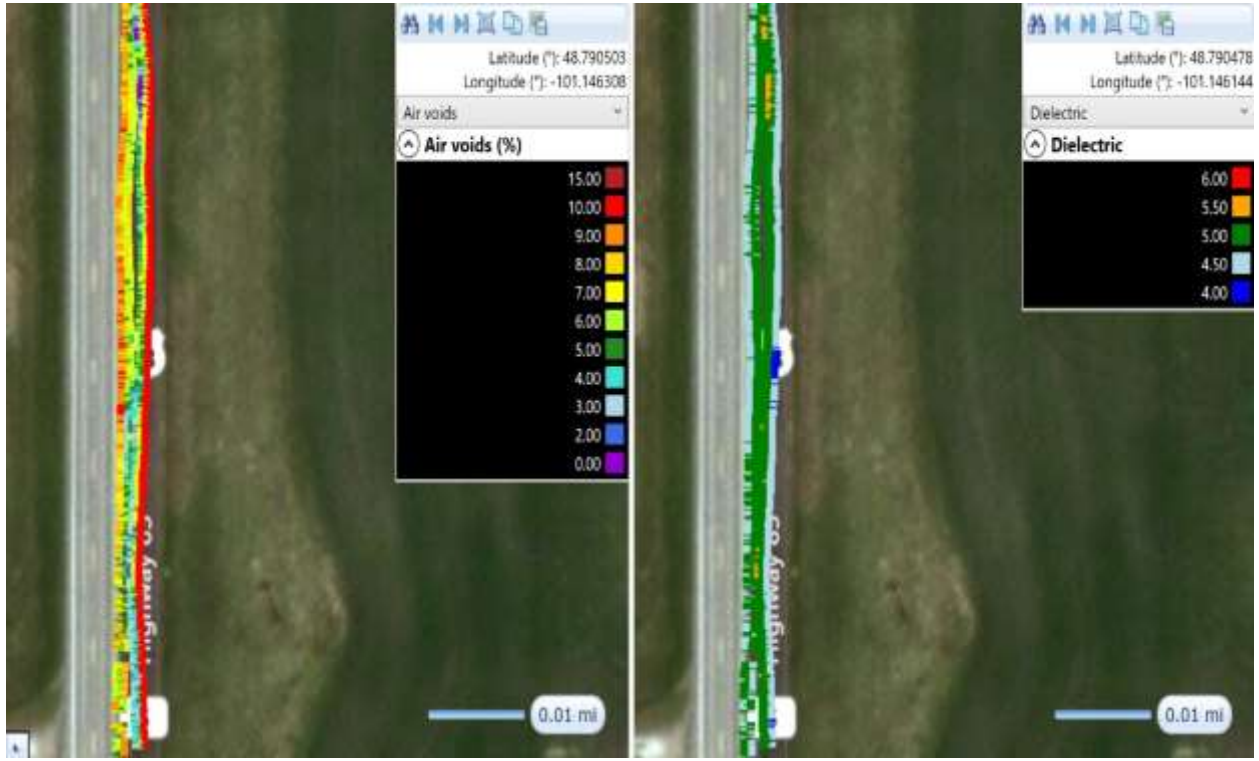
DPS – North Dakota (VETA)





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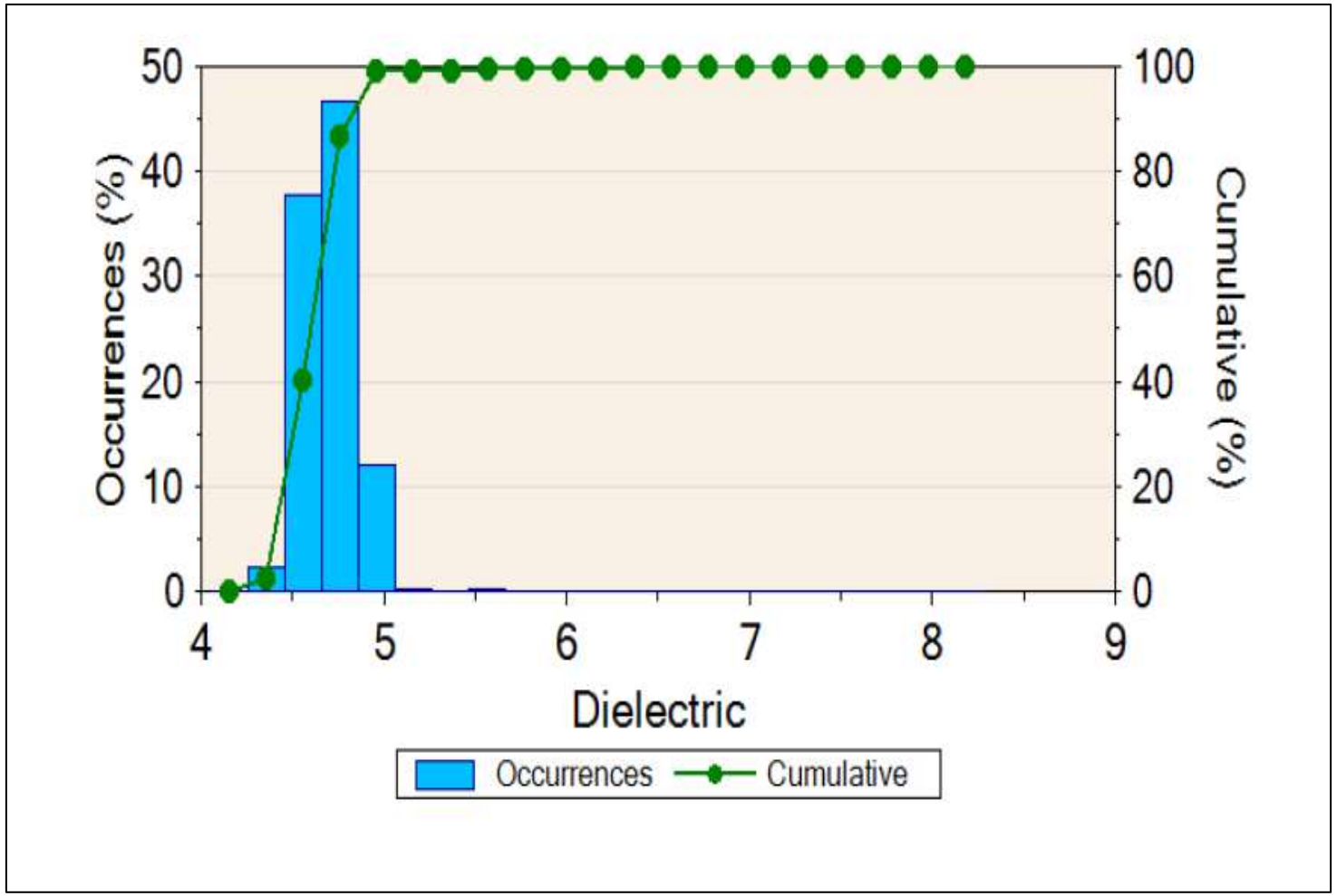
DPS – Florida (VETA)



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Questions

For more information on **Balanced Mix Design** and requesting **Specification Reviews:**

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For more information on **Technology Deployment Site Visit, Equipment Loan, or Workshops:**
https://www.fhwa.dot.gov/pavement/asphalt/MATC/
Dr. Leslie Myers, FHWA HQ
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For more information on **Logistics and Scheduling MATC site visit:**
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