NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Real-Time Quality Control with DPS and PMTP

May 11, 2023

2:00 – 3:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will address how DPS and PMTP can advance pavement quality measurement from limited random post-construction measurements to near-continuous measurements shortly after construction.

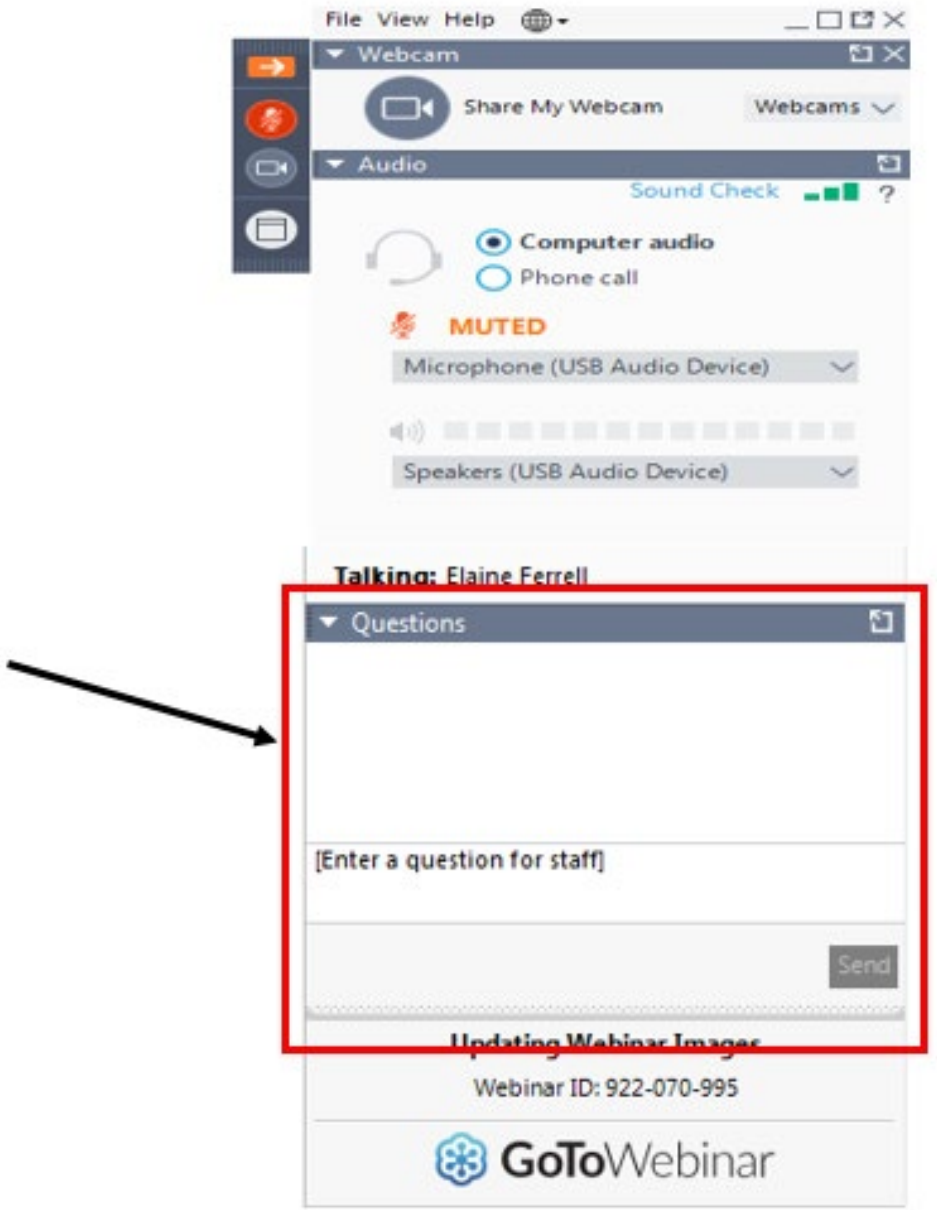
Learning Objectives

At the end of this webinar, you will be able to:

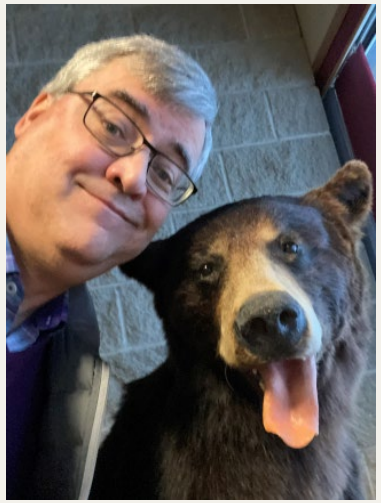
1. Improve workmanship in real-time, leading to improved asphalt pavement sustainability
2. Communicate the use of DPS and PMTP for process control
3. Improve their paving operations and increase profits with DPS and PMTP

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters



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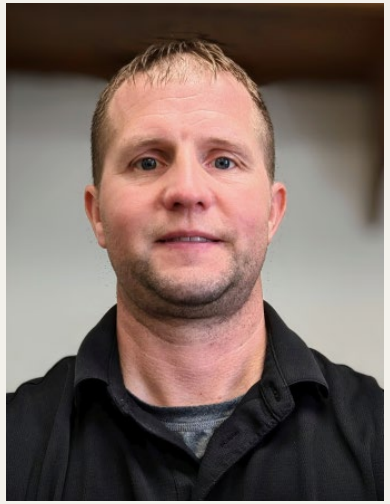

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TRB WEBINAR: REAL-TIME QC WITH DPS & PMTP

MAY 11, 2023













DPS & PAVEMENT PERFORMANCE

Craig E. Landefeld, P.E.
ODOT Office of Pavement Engineering

WHAT IS A DENSITY PROFILING SYSTEM (DPS)??????

- Non-destructive Density Measurement Tool
- Advanced GPR Technology / Non-nuclear
- Measures Dielectric Constant
- Calibrated to Density/Voids
- Continuous Measurement

WHY ??? - PAVEMENT DEFECTS

Distress from Built-in Defects?

- Potholes (Delamination)
- Raveling
- Joint Deterioration
- Long. Cracking
- Bumps

WHY ??? - PAVEMENT DEFECTS

WHY ??? - PAVEMENT DEFECTS

WHY ??? - PAVEMENT DEFECTS

WHY ??? - PAVEMENT DEFECTS

WHY ??? – THE COST OF DEFECTS

Repair Costs:

Repairs @ 5% Mid Cycle:

5% x $35.37/SY x 5280ft x 12ft = $ 12,450 / Lane-Mi.

CY2021 AC Resurfacing ~ 2400 Lane-Mi.

Repair Cost (CY2021): ~ $30M

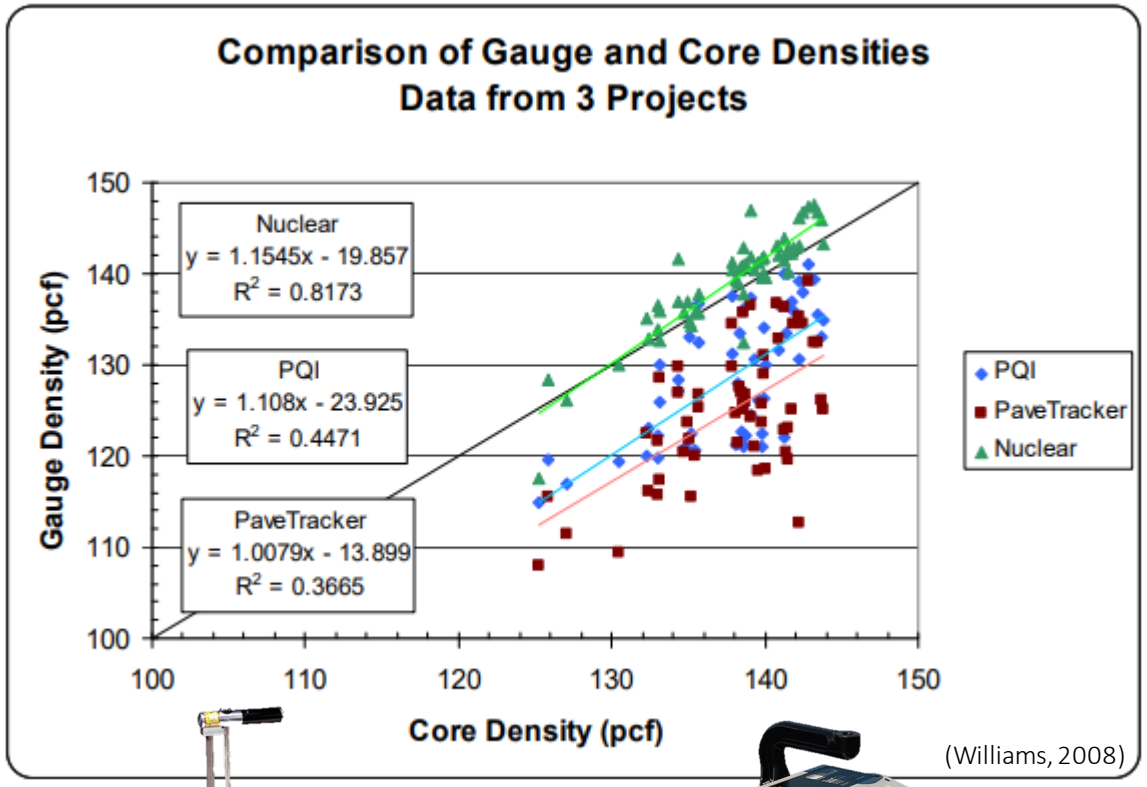
Loss of Service Life Costs:

Pavement Preservation: $650M/Yr

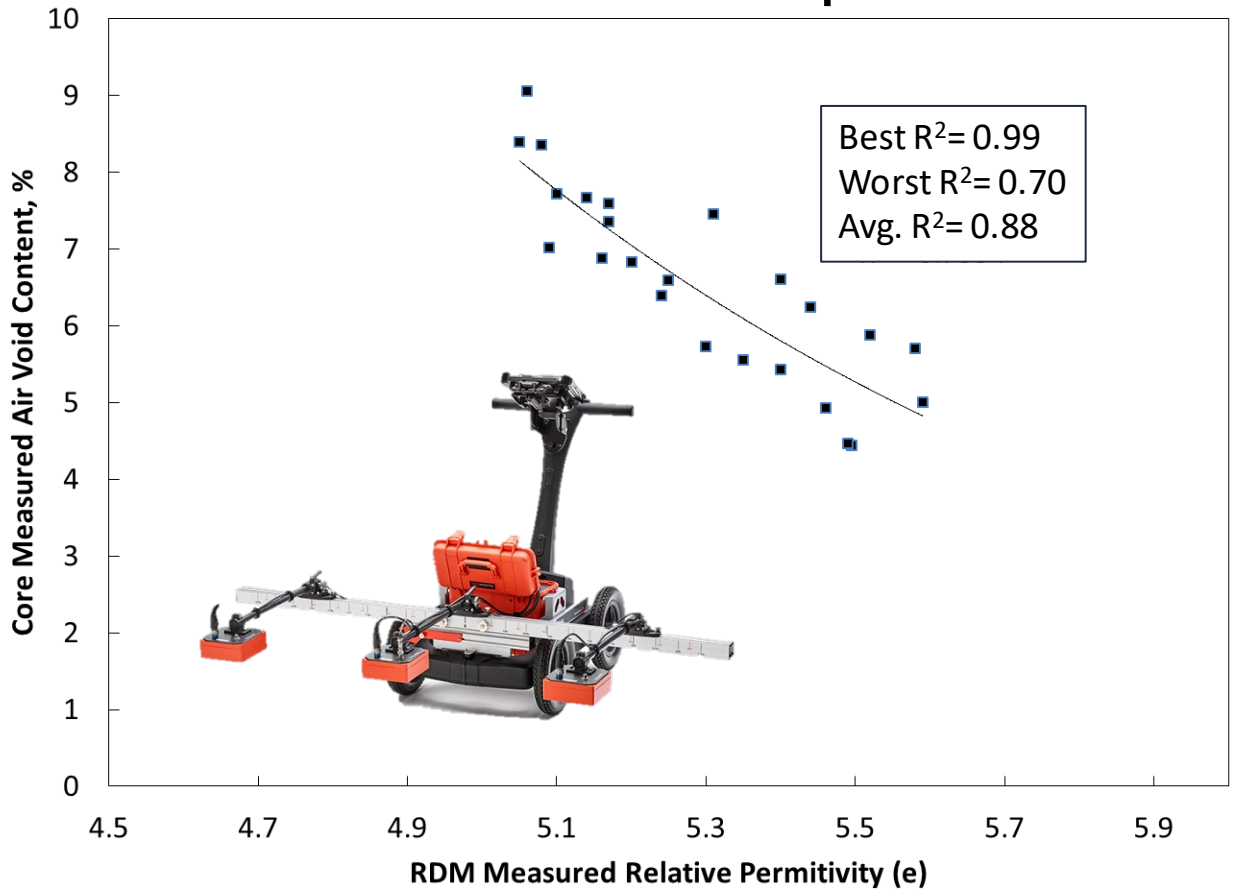
Average Life = 10 to 12yrs

$55M to $65M per year

CORE CORRELATION RESULTS



(Williams, 2008)



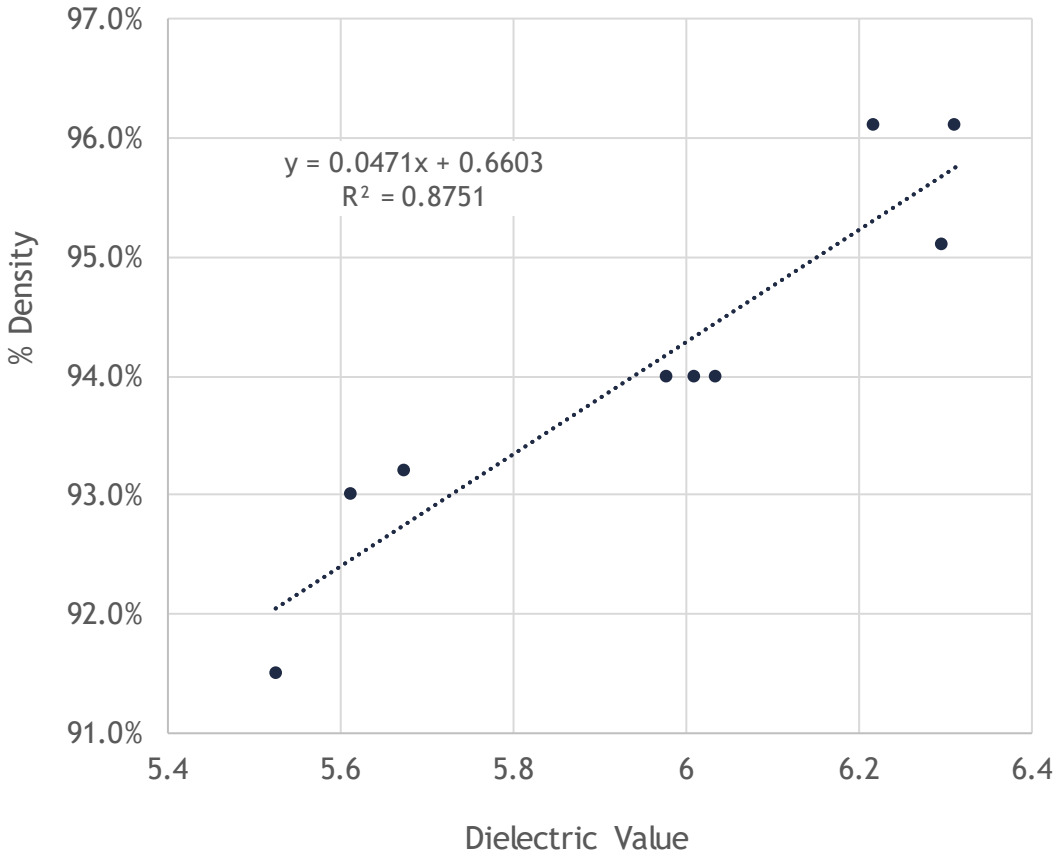
WHY DPS???

Current Sampling Rate:
Coring: ~ 10 cores / 2000T
DPS Scan: ~ 54,000 samples / 2000T

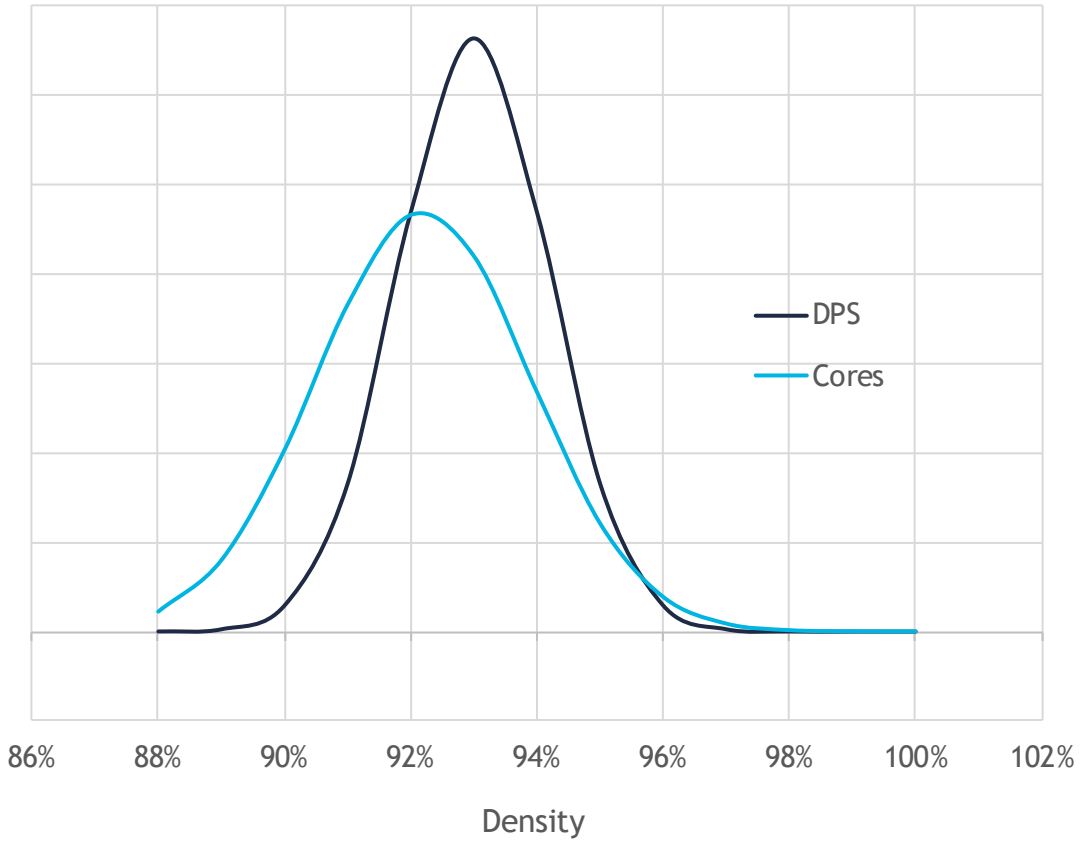
10  =

FRA 71 (17-0393)

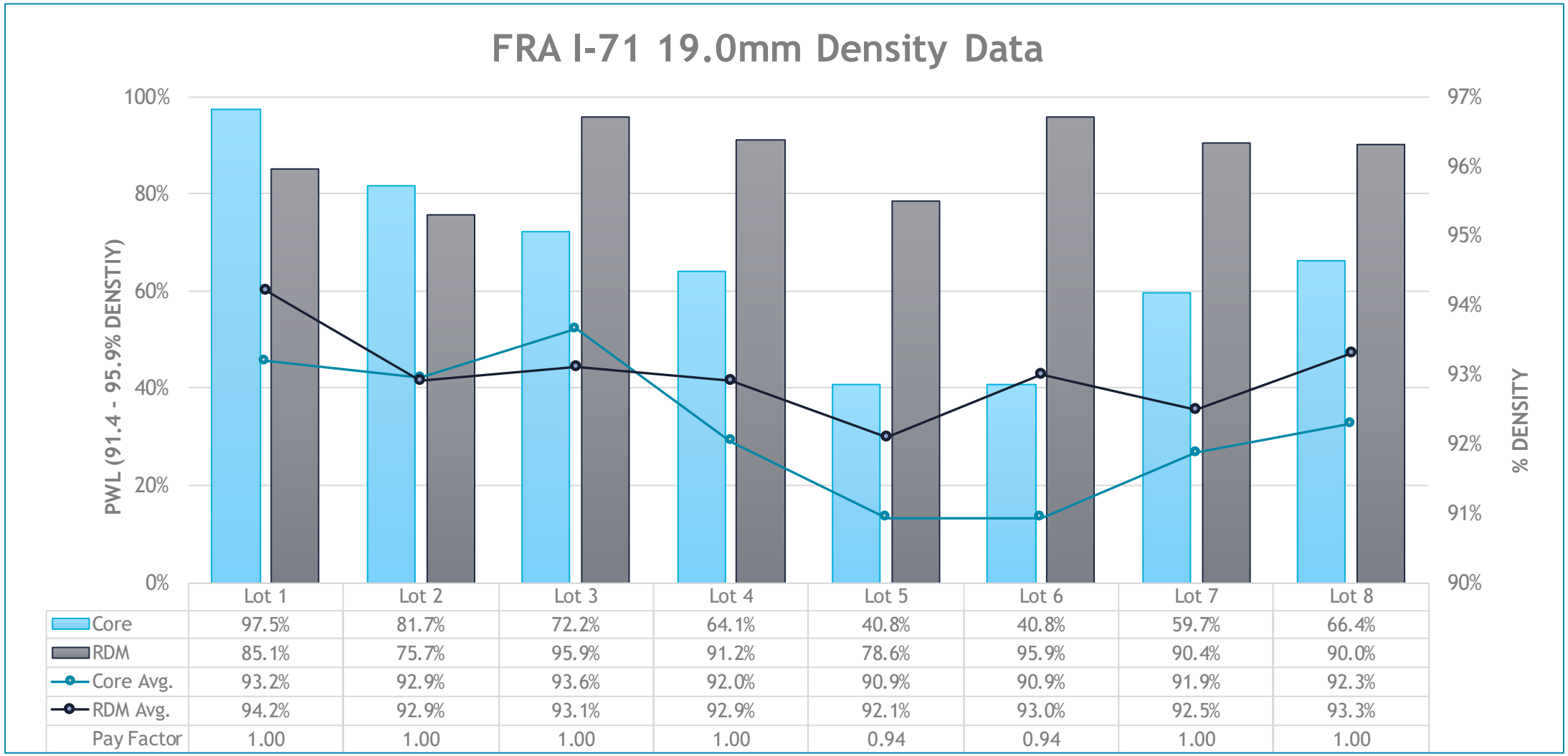
Core Collection Mode Calibration



19.0mm Density Distribution

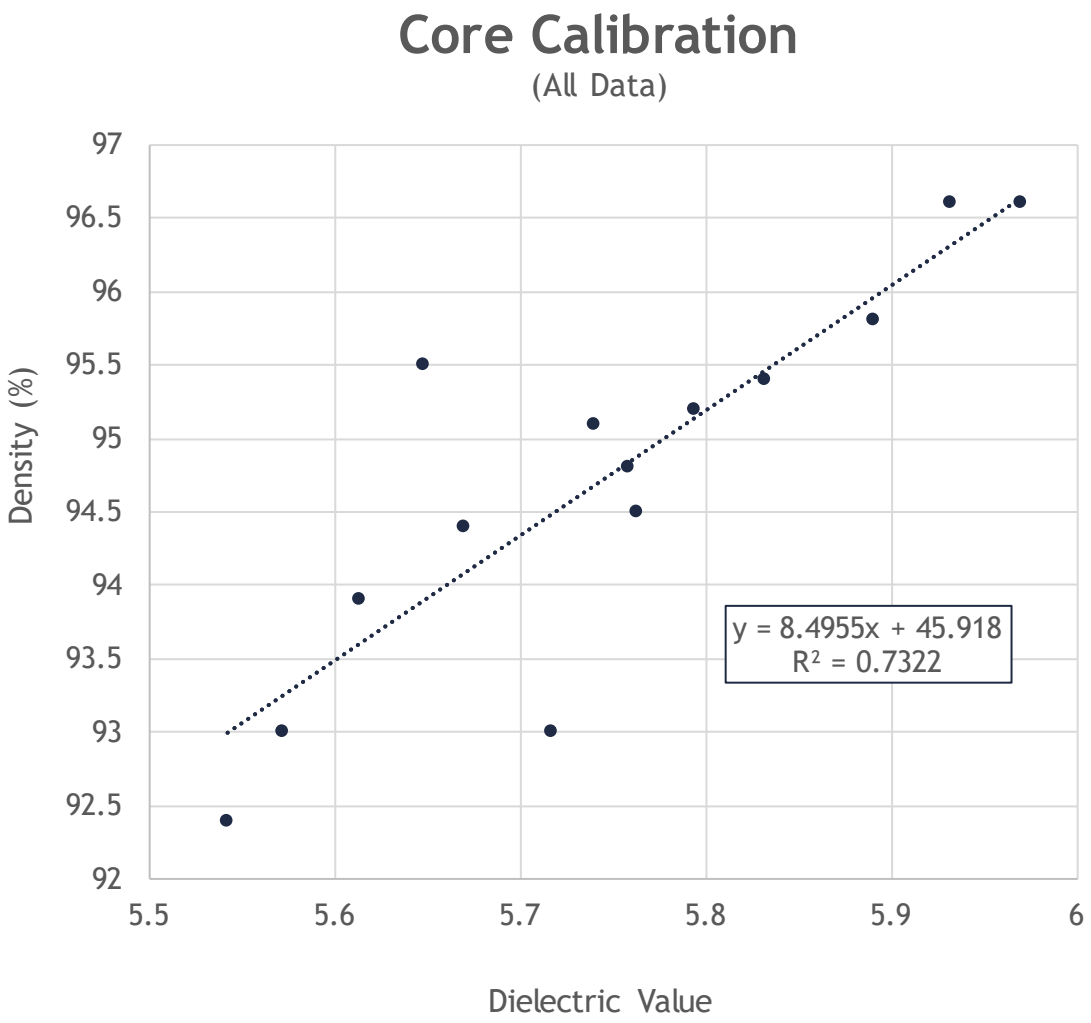


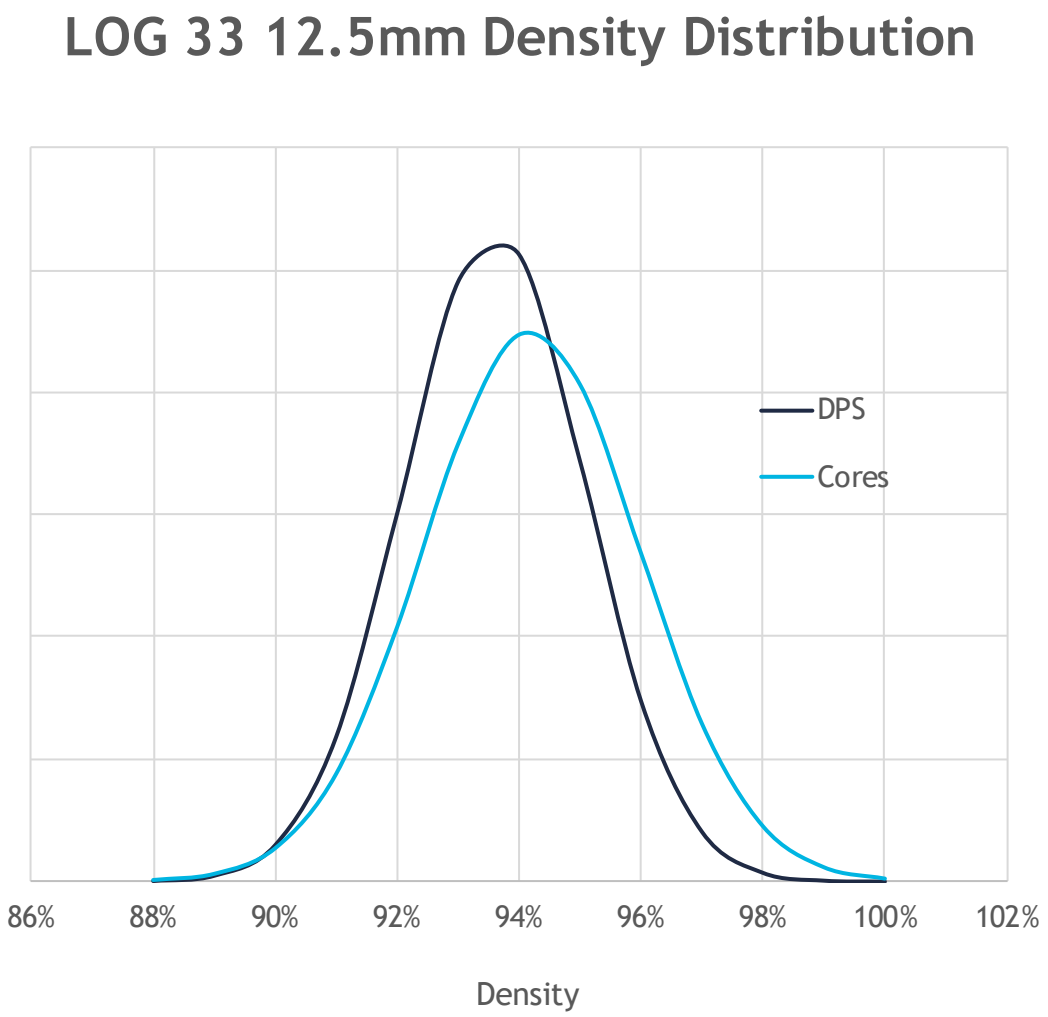
FRA 71 (17-0393)



	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
Core	97.5%	81.7%	72.2%	64.1%	40.8%	40.8%	59.7%	66.4%
RDM	85.1%	75.7%	95.9%	91.2%	78.6%	95.9%	90.4%	90.0%
Core Avg.	93.2%	92.9%	93.6%	92.0%	90.9%	90.9%	91.9%	92.3%
RDM Avg.	94.2%	92.9%	93.1%	92.9%	92.1%	93.0%	92.5%	93.3%
Pay Factor	1.00	1.00	1.00	1.00	0.94	0.94	1.00	1.00

LOG 33 (22-0399)





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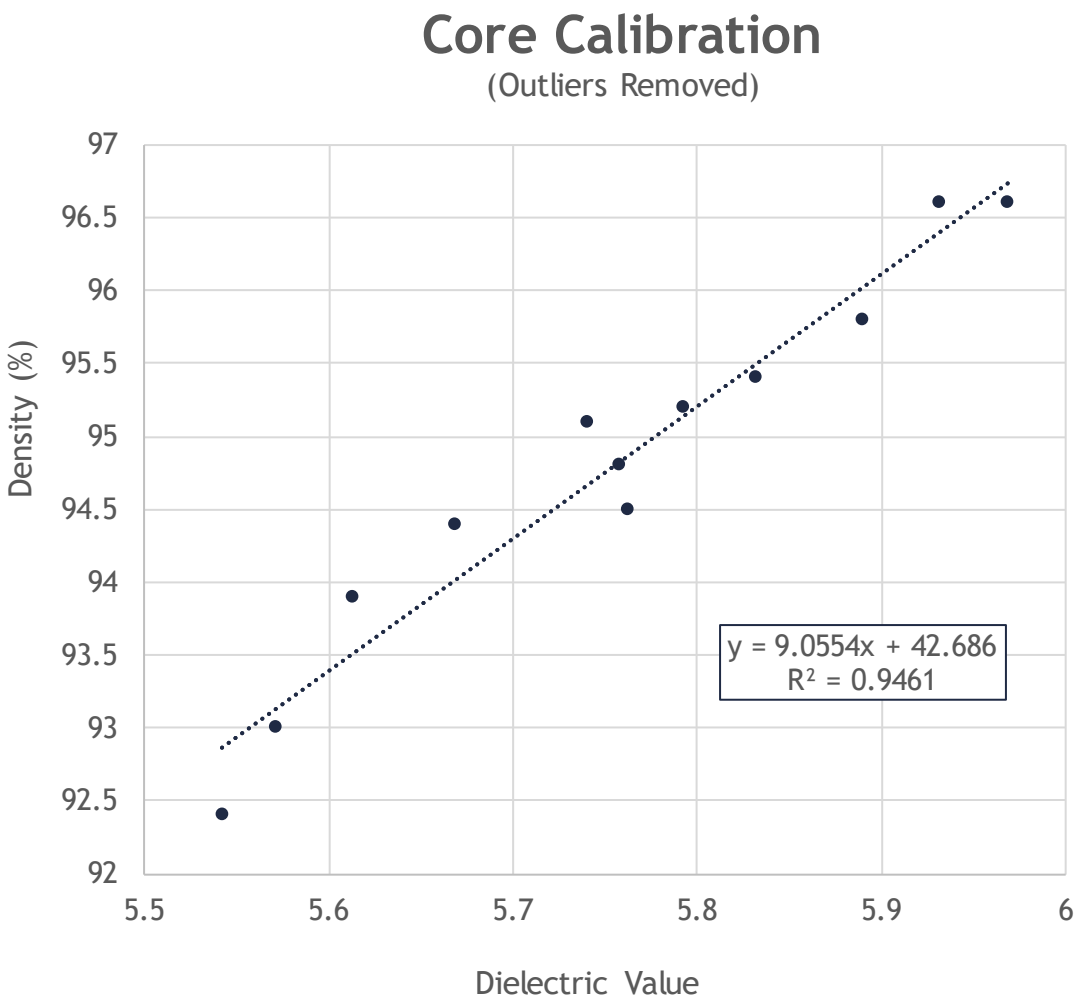
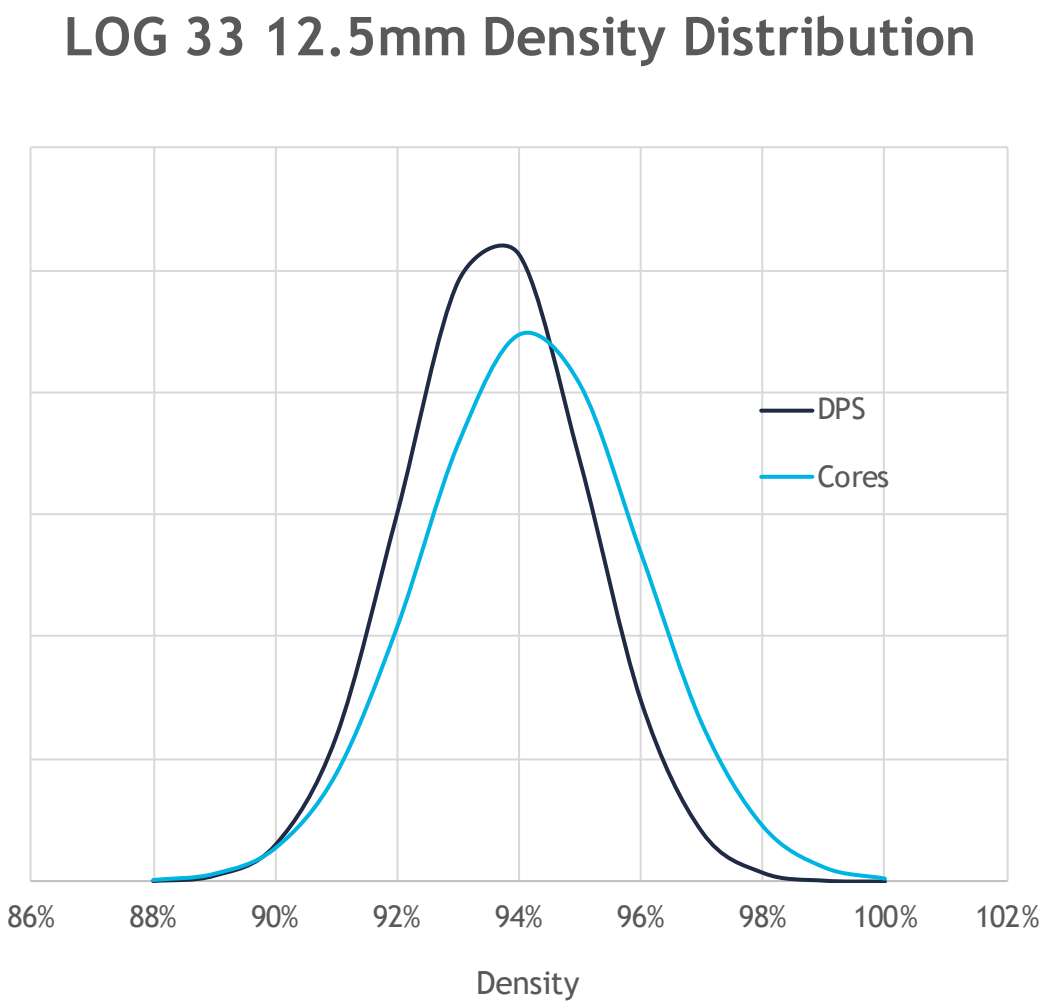
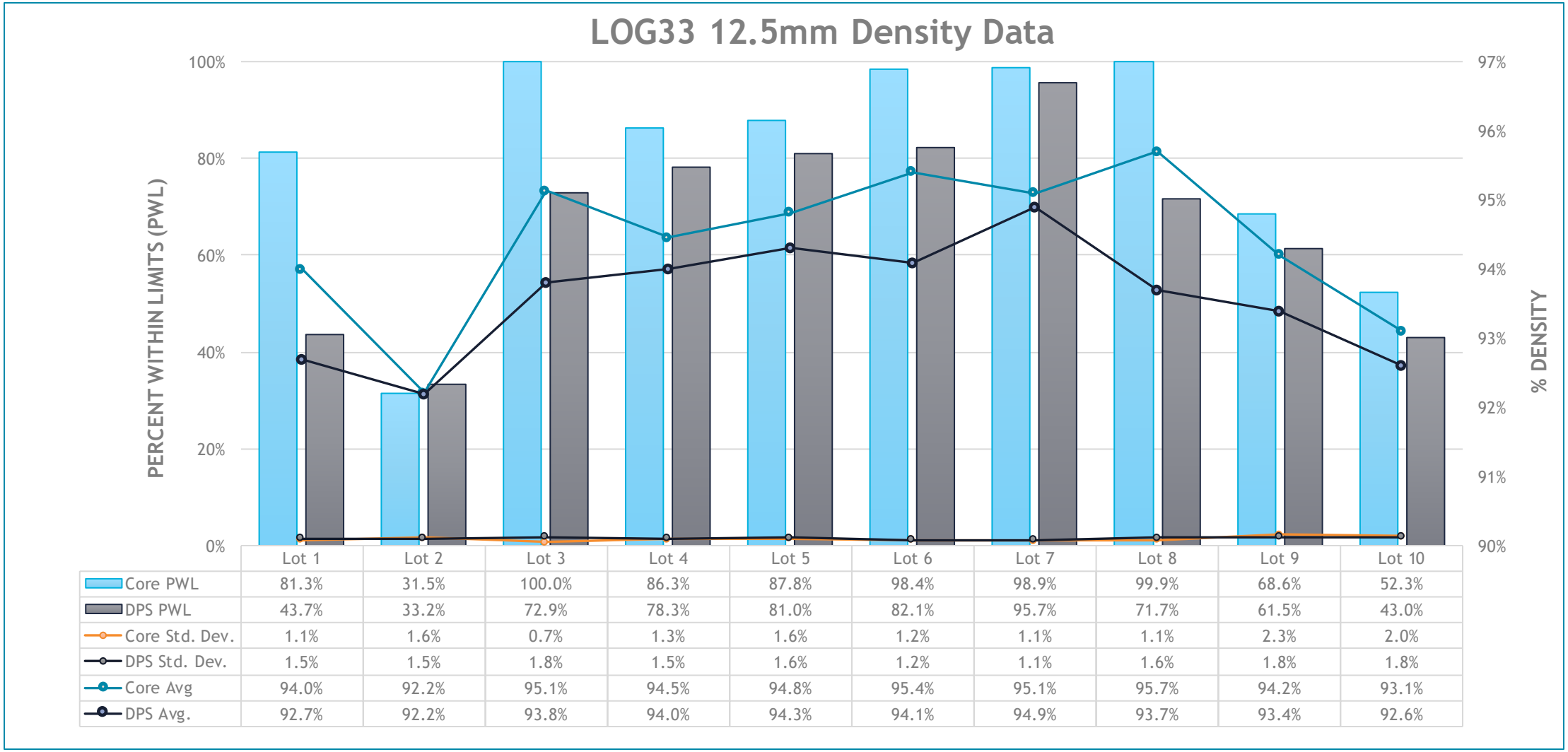




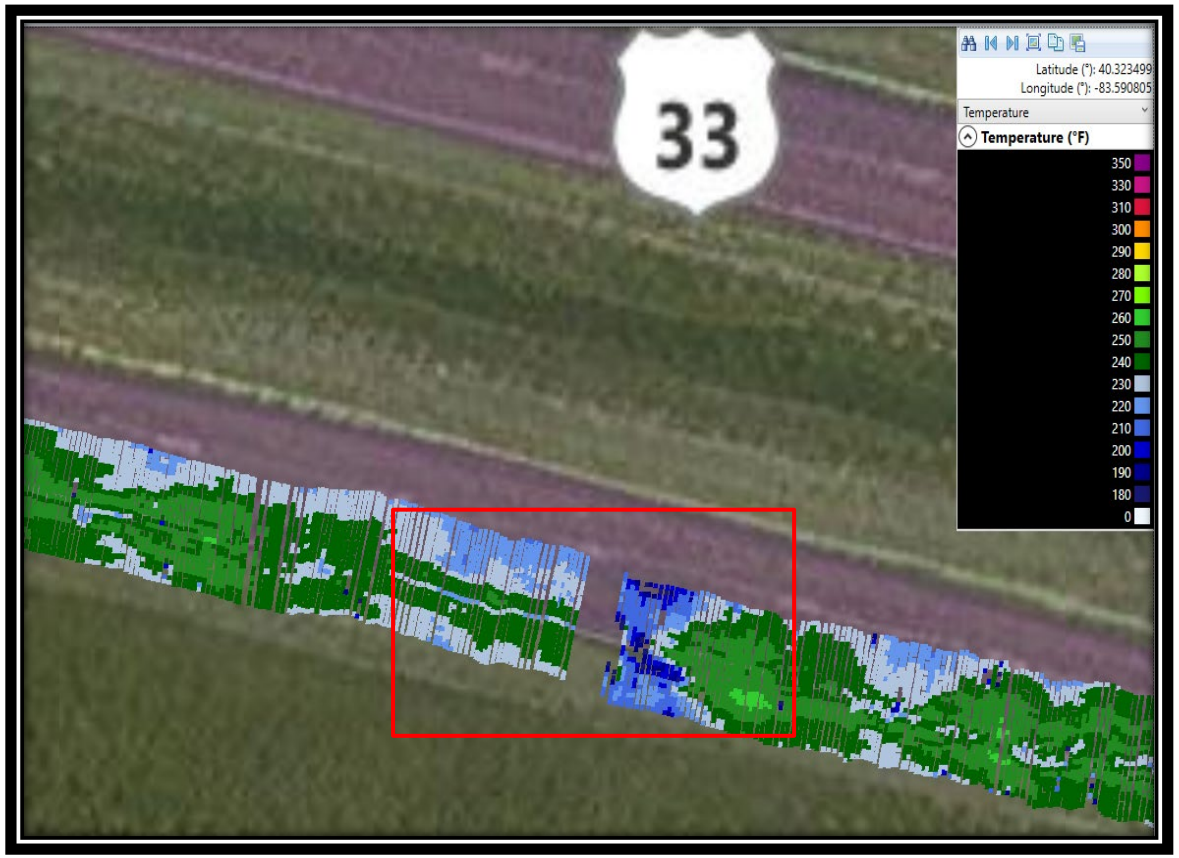
LOG 33 (22-0399)



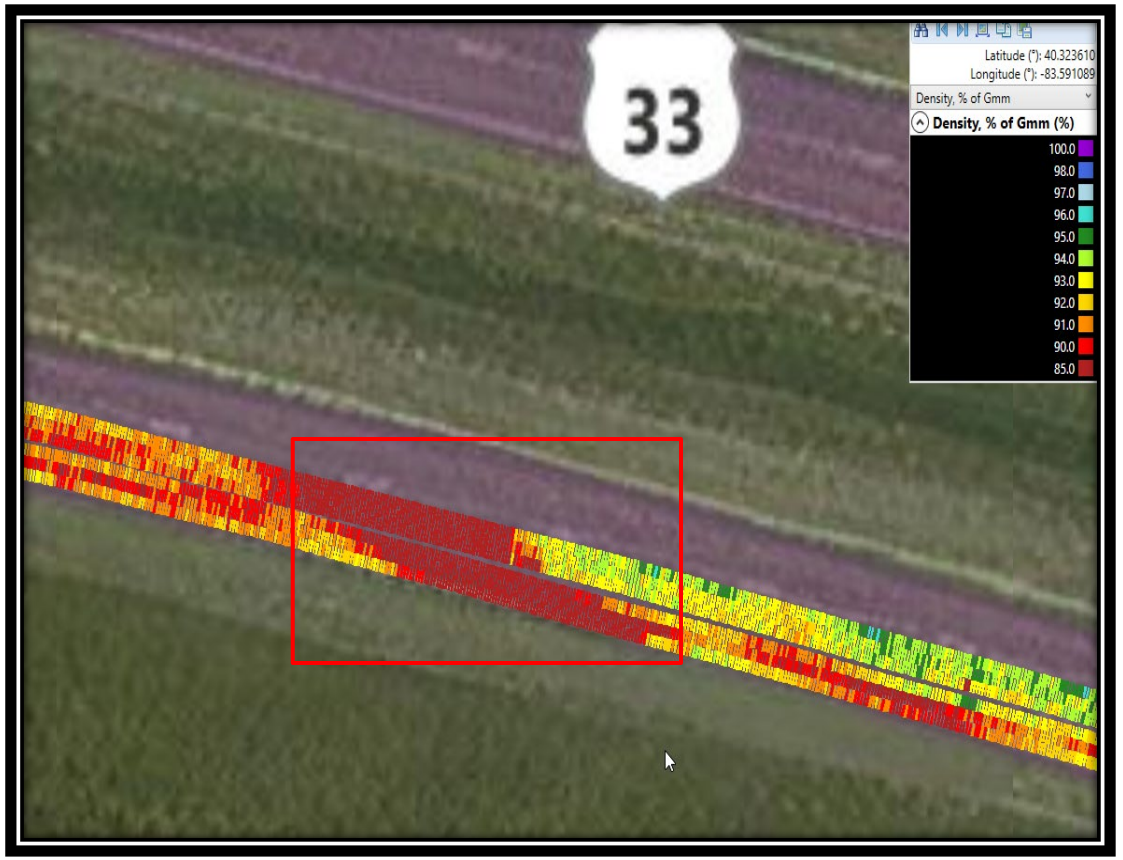
	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10
Core PWL	81.3%	31.5%	100.0%	86.3%	87.8%	98.4%	98.9%	99.9%	68.6%	52.3%
DPS PWL	43.7%	33.2%	72.9%	78.3%	81.0%	82.1%	95.7%	71.7%	61.5%	43.0%
Core Std. Dev.	1.1%	1.6%	0.7%	1.3%	1.6%	1.2%	1.1%	1.1%	2.3%	2.0%
DPS Std. Dev.	1.5%	1.5%	1.8%	1.5%	1.6%	1.2%	1.1%	1.6%	1.8%	1.8%
Core Avg	94.0%	92.2%	95.1%	94.5%	94.8%	95.4%	95.1%	95.7%	94.2%	93.1%
DPS Avg.	92.7%	92.2%	93.8%	94.0%	94.3%	94.1%	94.9%	93.7%	93.4%	92.6%

LOG33 PMTP / DPS DATA VETA

PMTP Temperature Data

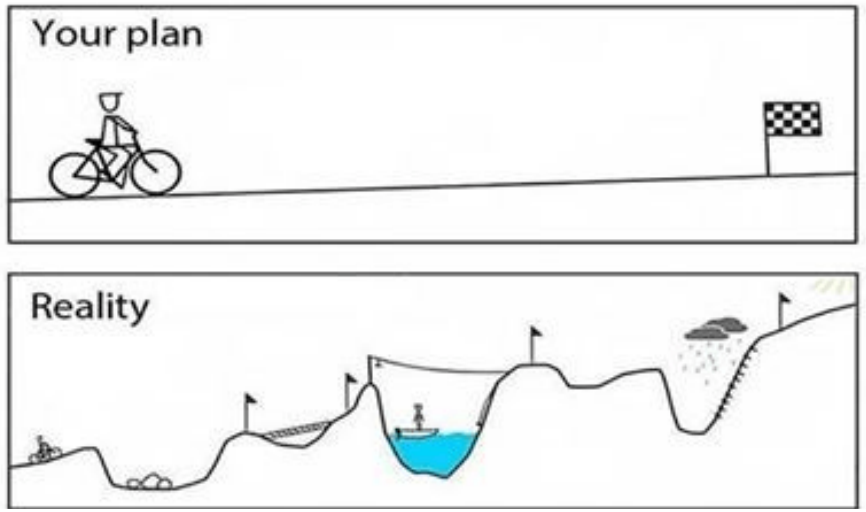


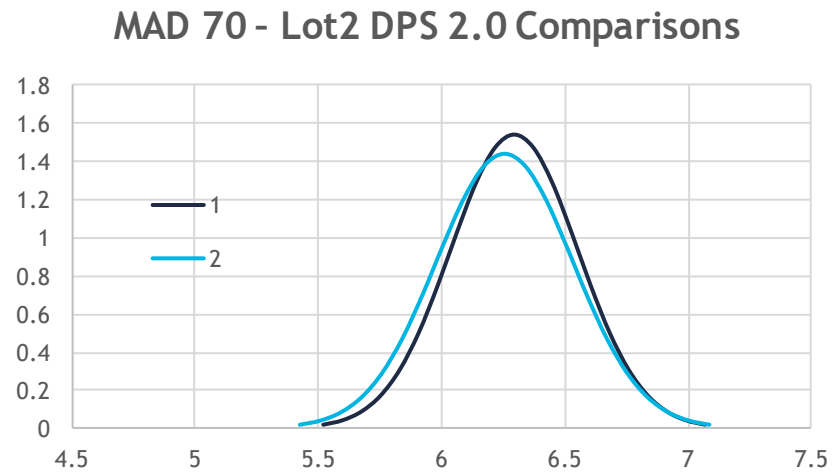
DPS Density Data

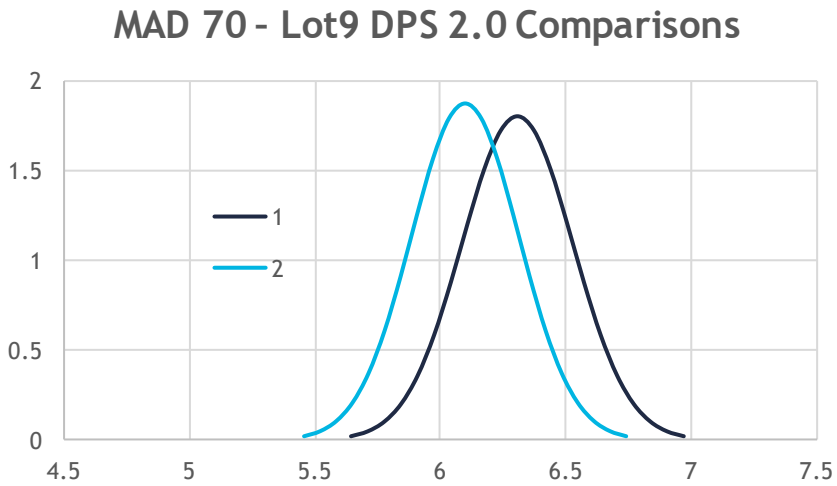


DPS CHALLENGES

- Cold Weather Issues
- Sensor Sensitivity to Height
- Ruggedness of Units
- Gyratory/Core Calibration Comparison







WHY DPS ?????????????

"If you can't measure it, you can't improve it." – *Peter Drucker*

- Cost Savings
  - Better QC = Less Defects
  - Less Defects = Improved Performance
- Improved Personnel Safety
  - Less exposure time
  - Vehicle mounting?

"To Be a Great Leader, You Must Inspect What You Expect" – *Doug Thorpe*

QUESTIONS

Last updated 5/5/2023

Paver Mounted Thermal Profiling and Dielectric Profiling System

And you may ask yourself, how did we get here?

May 11, 2023

Curt Turgeon

State Pavement Engineer

Minnesota Department of Transportation

Brief History of:

Paver Mounted Thermal Profiling

AASHTO R110-22

Intelligent Compaction for Asphalt Pavements

AASHTO R111-22

Dielectric Profiling System

AASHTO PP98-20 and a player to be named later

State Pavement Technical Consortium

- Washington
- Texas
- California
- Minnesota

CONSTRUCTION-RELATED ASPHALT CONCRETE PAVEMENT TEMPERATURE DIFFERENTIALS AND THE CORRESPONDING DENSITY DIFFERENTIALS

by

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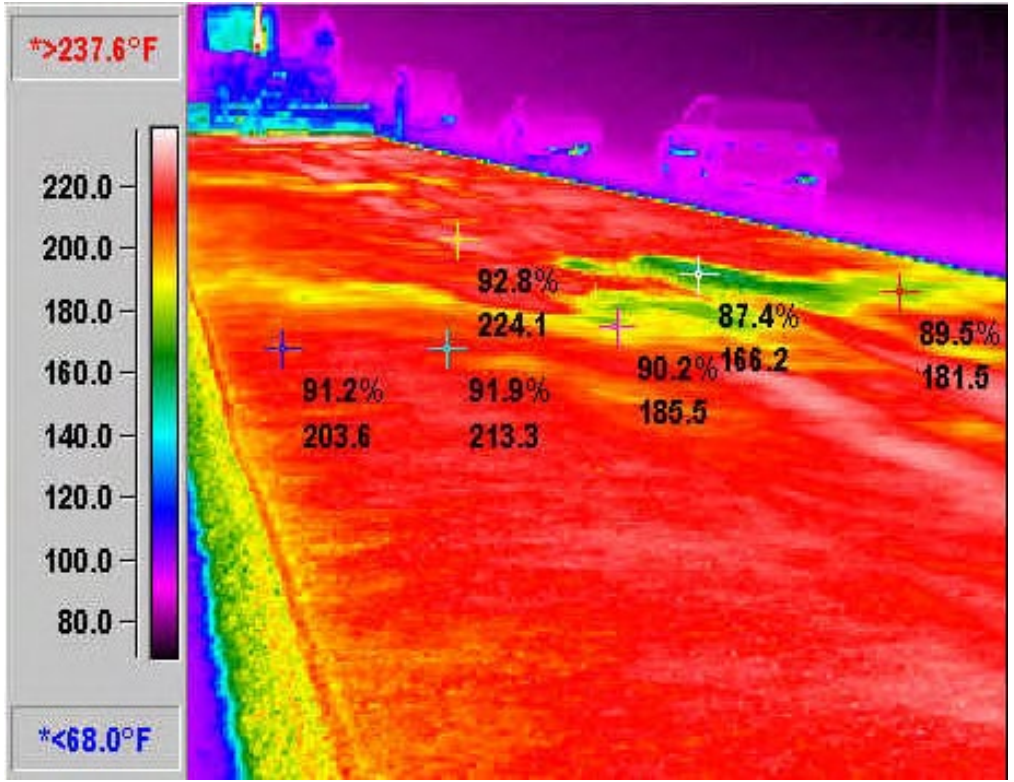
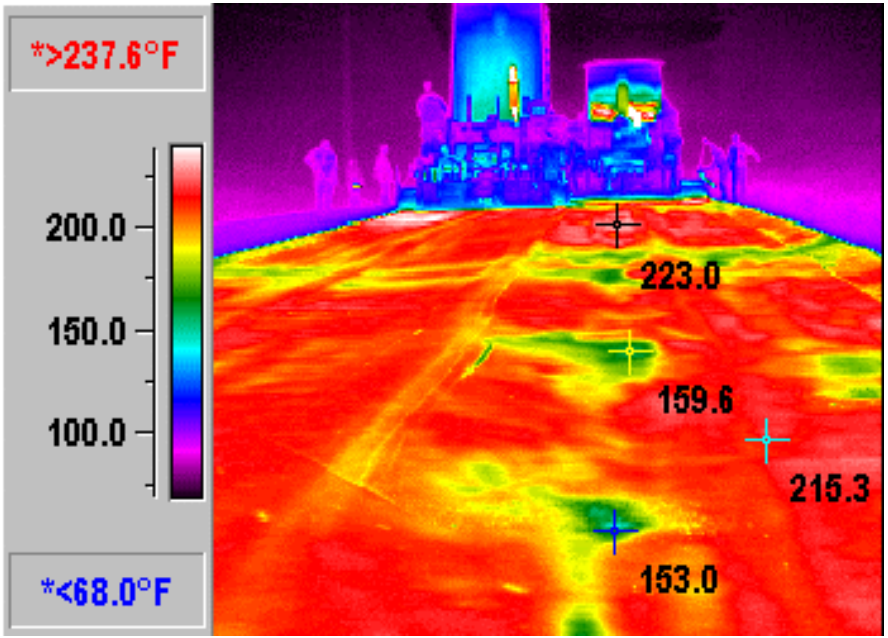
Prepared for

Washington State Transportation Commission
Department of Transportation and in cooperation with
U.S. Department of Transportation
Federal Highway Administration
July 2001

Infrared Image with Corresponding Densities and Temperatures.



Willoughby etal, 2001



Thermal Profile

One Year Later

Willoughby etal, 2001

APPENDIX D

TxDOT Method TEX-244-F for Thermal Profile of Hot-Mix Asphalt

Test Procedure for

Thermal Profile of Hot-Mix Asphalt

TxDOT Designation: Tex-244-F

Effective Date: May 2011

1. SCOPE

1.1 Use this test method to obtain a thermal profile that identifies the presence of thermal segregation of an uncompacted mat of hot-mix asphalt. The thermal profile may be determined by using a handheld noncontact infrared thermometer, a thermal camera immediately behind the paver during uninterrupted paving operations, or a paver-mounted infrared bar (Pave-IR system).

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

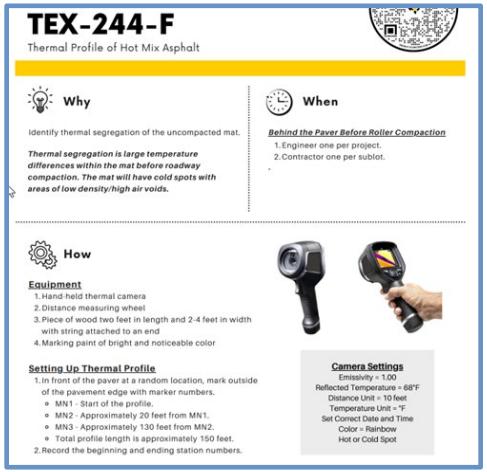
2. APPARATUS

2.1 *Handheld Noncontact Infrared Thermometer, Thermal Imaging Camera, or Paver-Mounted Infrared Bar (Pave-IR System).*

2.1.1 Handheld noncontact infrared thermometer must be capable of

- Measuring from 40°F to 475°F with an accuracy of ±2°F or ±1% of reading, whichever is greater;
- Storing and recalling the maximum (and minimum temperature if available) from the most recent scan using a liquid-crystal display (LCD) viewing screen;
- Measuring with a minimum 6:1 distance-to-spot ratio; and
- Adjusting emissivity in increments of 0.01 or a fixed emissivity equal to or greater than 0.95.

Initial Texas Approach



TEX-244-F

Thermal Profile of Hot Mix Asphalt

Why

Identify thermal segregation of the uncompacted mat.

Thermal segregation is large temperature differences within the mat before roadway compaction. The mat will have cold spots with areas of low density/high air voids.

When

Behind the Paver Before Roller Compaction

1. Engineer one per project.
2. Contractor one per sublot.

How

Equipment

1. Hand-held thermal camera
2. Distance measuring wheel
3. Piece of wood two feet in length and 2-4 feet in width with string attached to an end
4. Marking paint of bright and noticeable color

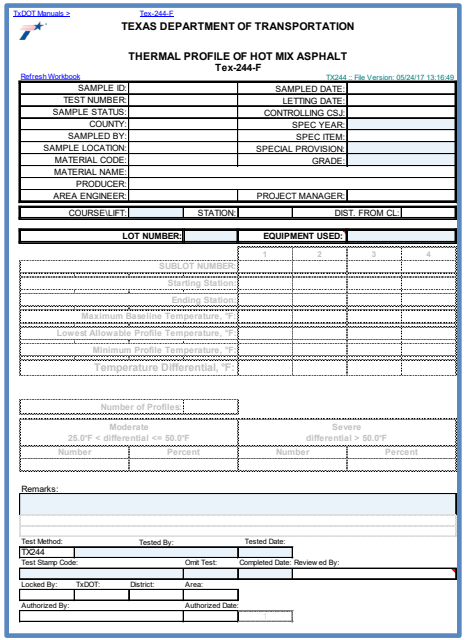
Setting Up Thermal Profile

1. In front of the paver at a random location, mark outside of the pavement edge with marker numbers.
   - MN1 - Start of the profile.
   - MN2 - Approximately 20 feet from MN1.
   - MN3 - Approximately 130 feet from MN2.
   - Total profile length is approximately 150 feet.
2. Record the beginning and ending station numbers.

Camera Settings

Emissivity = 1.00
Reflected Temperature = 68°F
Distance Unit = 10 feet
Temperature Unit = °F
Set Correct Date and Time
Color = Rainbow
Hot or Cold Spot

Figure 25. Infrared Imaging in Progress.



TxDOT Manuals > Tex-244-F

TEXAS DEPARTMENT OF TRANSPORTATION

THERMAL PROFILE OF HOT MIX ASPHALT
Tex-244-F

Refresh Workbook — TX244 :: File Version: 05/24/17 13:16:49

SAMPLE ID:		SAMPLED DATE:	
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	
COUNTY:		SPEC YEAR:	
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:		SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	
MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	
COURSE\LIFT:	STATION:	DIST. FROM CL:	

LOT NUMBER:		EQUIPMENT USED:		
		1	2	3	4
Starting Station:					
Ending Station:					
Maximum Baseline Temperature, °F:					
Lowest Allowable Profile Temperature, °F:					
Minimum Profile Temperature, °F:					
Temperature Differential, °F:					

Number of Peaks:			
Moderate 25 °F < differential <= 50 °F		Severe differential > 50 °F	
Number	Percent	Number	Percent

Remarks:

Test Method:	Tested By:	Tested Date:	
TX244			
Test Stamp Code:		Omit Test:	Completed Date: Reviewed By:
Locked By: TxDOT:	District:	Area:	
Authorized By:		Authorized Date:	

Get a Thermal Camera

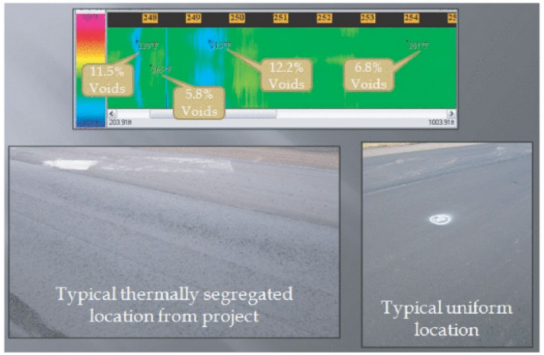
Take a Photo

Fill out Form

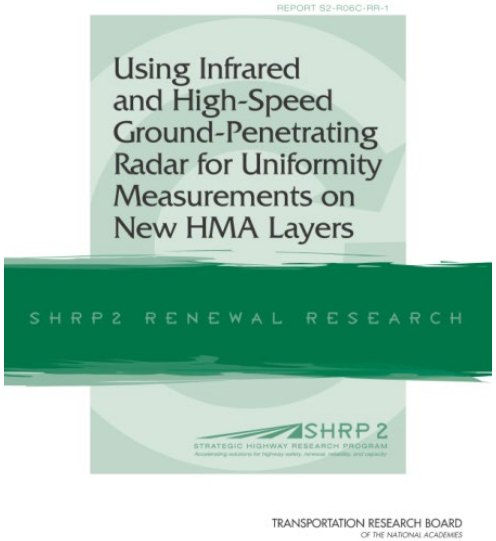
The First Pave IR

Sebesta etal 2004

Concept



Region 3
Minnesota



PMTP Implementation in Minnesota

- Change Orders to Pay for Data
  - Understand Value
  - Ruggedness
  - No Surprises and Limit Risk
  - Vendor Support
- Developed Software VETA
- Developed Incentive/Disincentive Specification
- Commitment to Work Through Kinks, Keep Paver Moving
- Set a Road Map for full implementation
  - Yes we are serious
  - Provides Time to Adapt &Train
    - Contractors
    - Vendors
    - Agency
- **ALL PROJECTS SINCE 2018 REQUIRE THERMAL IMAGING**

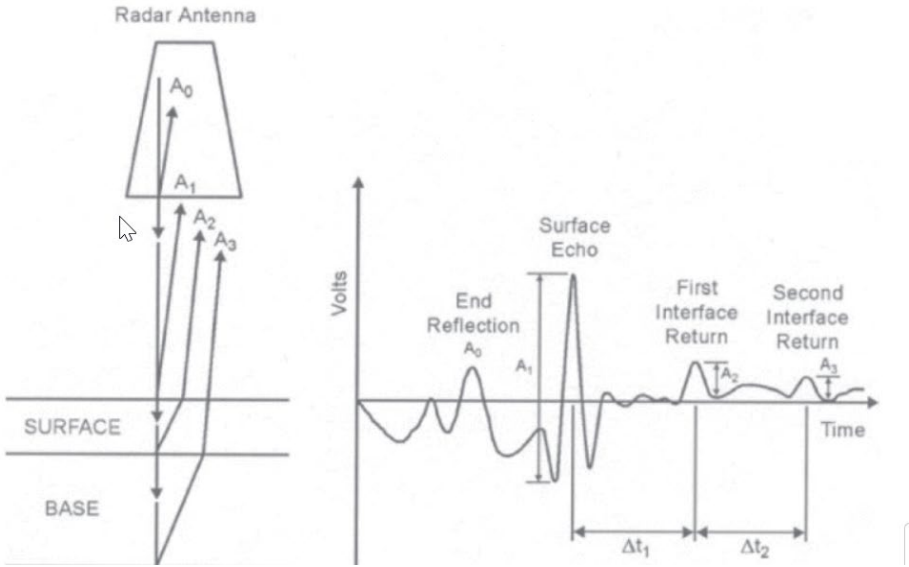
Intelligent Compaction Implementation in Minnesota

- Started with Unbound Materials
  - Very complicated: Moisture, gradation, speed, direction, rollers are not test equip
- BIG MIKE PROJECT
- Change Orders to Pay for Data
  - Understand Value
  - Ruggedness
  - No Surprises and Limit Risk
  - Vendor Support
- Developed Software VETA
- Commitment to Work Through Kinks, Keep Paver Moving
- Developed Coverage Spec.
- Commitment to Work Through Kinks, Keep Paver Moving
- Set a Road Map for full implementation
  - Yes we are serious
  - Provides Time to Adapt & Train
    - Contractors
    - Vendors
    - Agency
- **ALL PROJECTS SINCE 2018 REQUIRE PAVER MOUNTED THERMAL IMAGING**

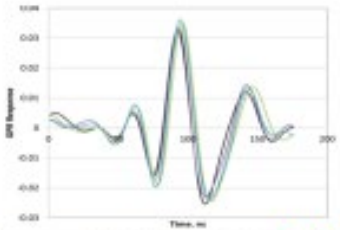
Initial GPR Systems

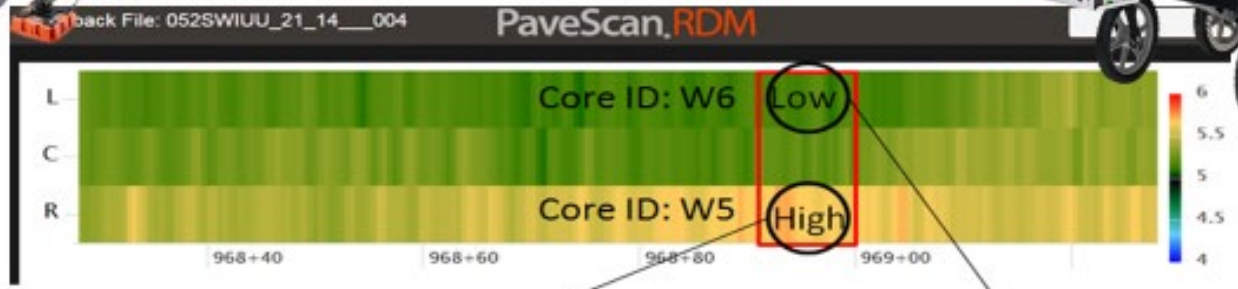
Sebesta etal 2004

The Devil is in the Details



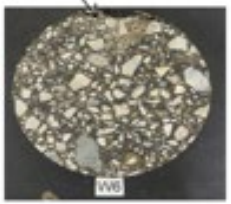
Dielectric Profile System DPS

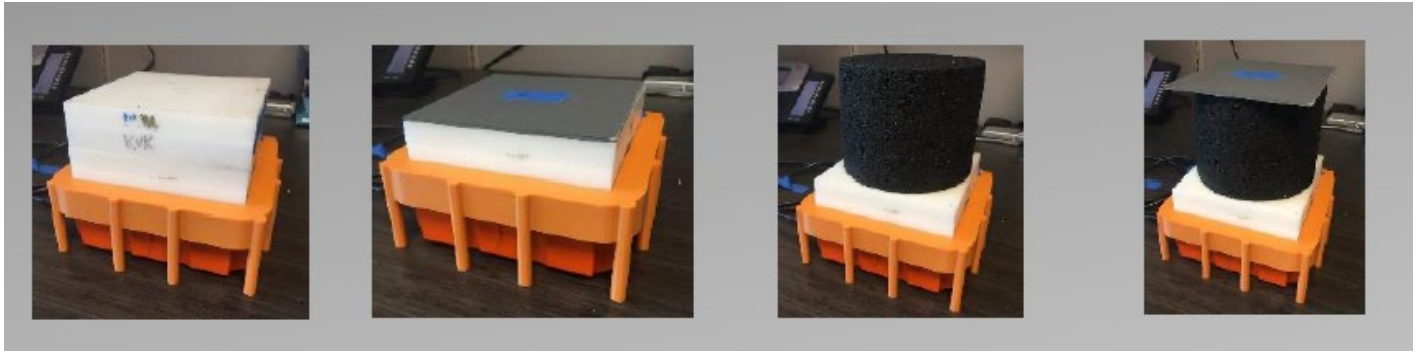




5% Air Voids

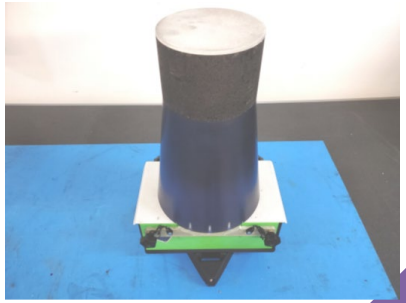
10% Air Voids





Time of Flight Dielectric

"Coming to an AASHTO Standard Near You"



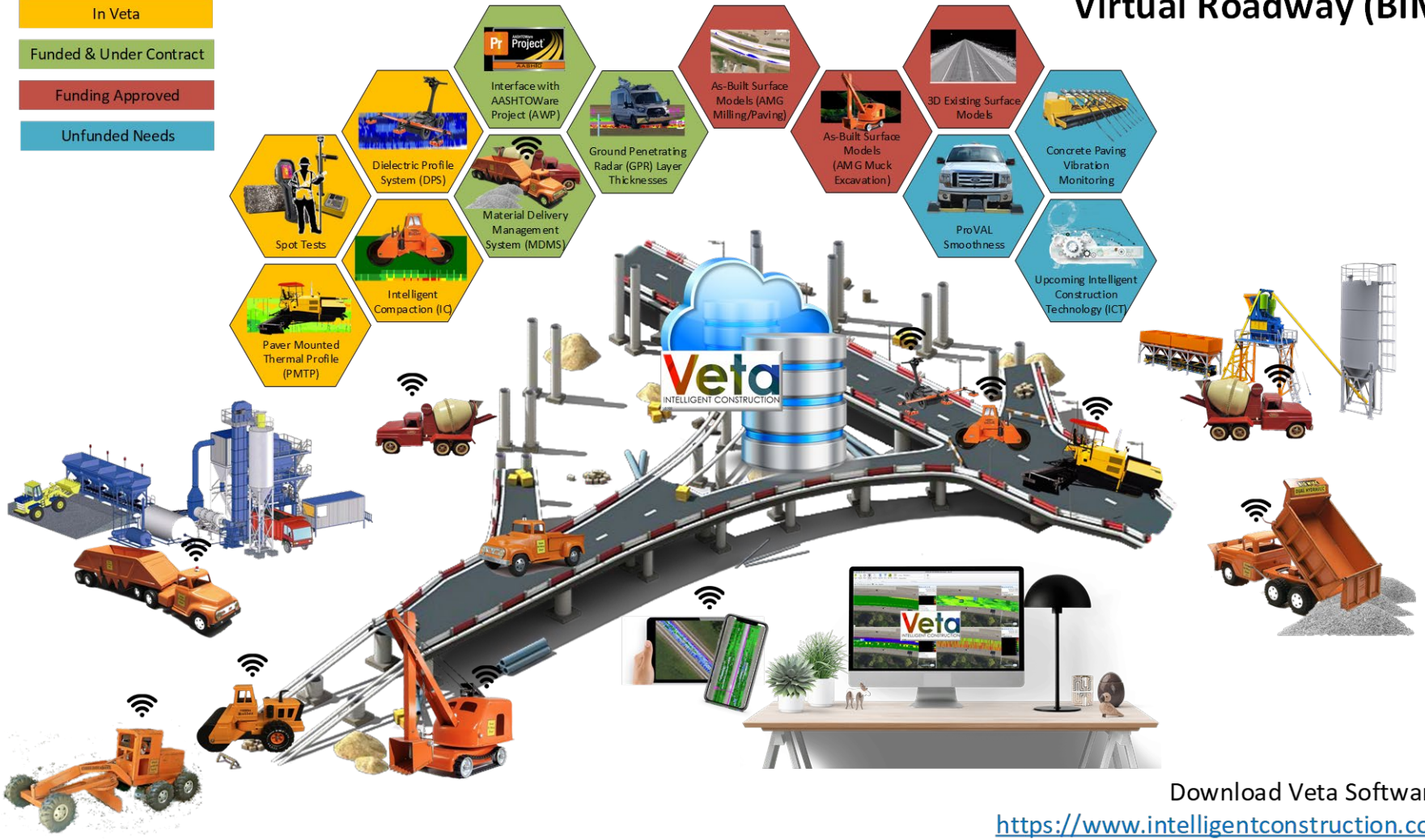

Latitude (°): 46.652492
Longitude (°): -120.496000
Density, % of Gmm
Density, % of Gmm (%)
94.0
93.0
92.0
91.0
90.0
89.0
Forrest Hierholzer
Granite Construction
November, 2022
0.01 mi
Latitude (°): 46.652407
Longitude (°): -120.496029
Pass Count
Pass Count
20
16
12
8
4
3
2
1
Selections
Final Coverage
Individual Passes
Data Filtered: Temperature > 210 F
0.005 mi

Take Aways

- Be Organized before you collect your data
  AAHTO MP 39 – 22
- Use the FREE VETA Software.
  Intelligentconstruction.com
- Limit Risk for all Parties, things will break
- These Concepts are NOT NEW
- THE MOST SUSTAINABLE PAVEMENT IS THE ONE THAT LAST LONGER SIMPLE BECAUSE IT WAS BUILT RIGHT.

Virtual Roadway (BIM)

- In Veta
- Funded & Under Contract
- Funding Approved
- Unfunded Needs



Download Veta Software:
https://www.intelligentconstruction.com

DEPARTMENT OF TRANSPORTATION

Thank You!

2023 TRB
- Implementing DPS & PMTP-

A Contractor Perspective

Derek Frederixon

Mathy Technology & Engineering

DPS & PMTP

Discussion Points

- Project Preparation
- Data Collection & Analysis
- Challenges
- Benefits to Contractor
- Final Thoughts

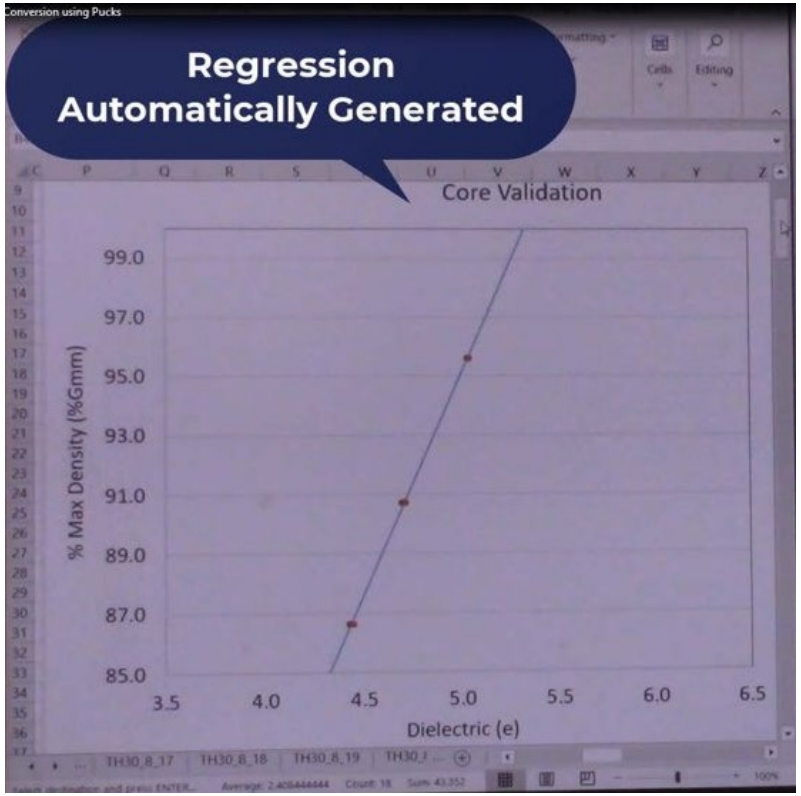
Project Preparation - DPS

Mix Design Correlation

- Establish dielectric constants for mix
- Plant produced mix best, lab batched ok also
- Take dielectric measurements on set of pucks
  - Production puck (~95-98% Gmm depending on state)
  - Second puck less 250 grams compacted to same height (~91-94% Gmm)
  - Third puck less 500 grams compacted to same height (~87-91% Gmm)

  !! Take dielectric measurement before putting under water to get density !!

  - Generate regression for field measurements!



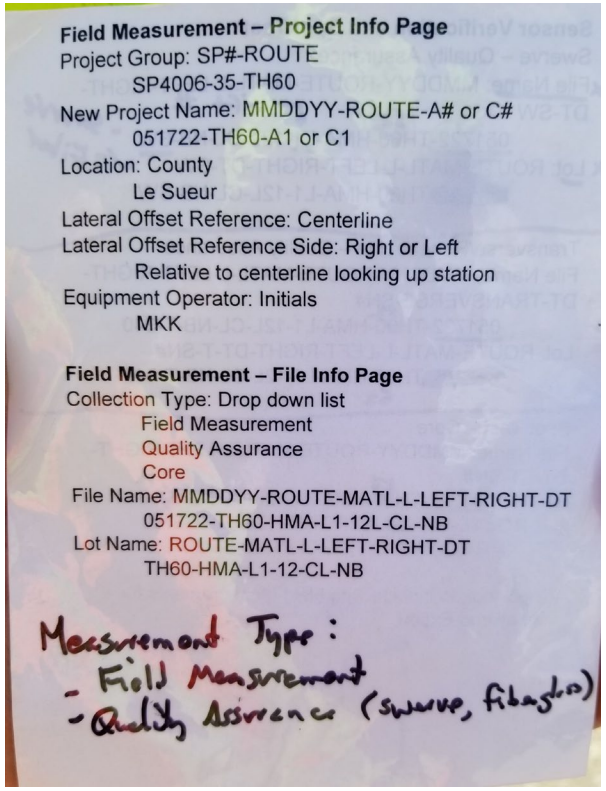
Project Preparation - PMTP

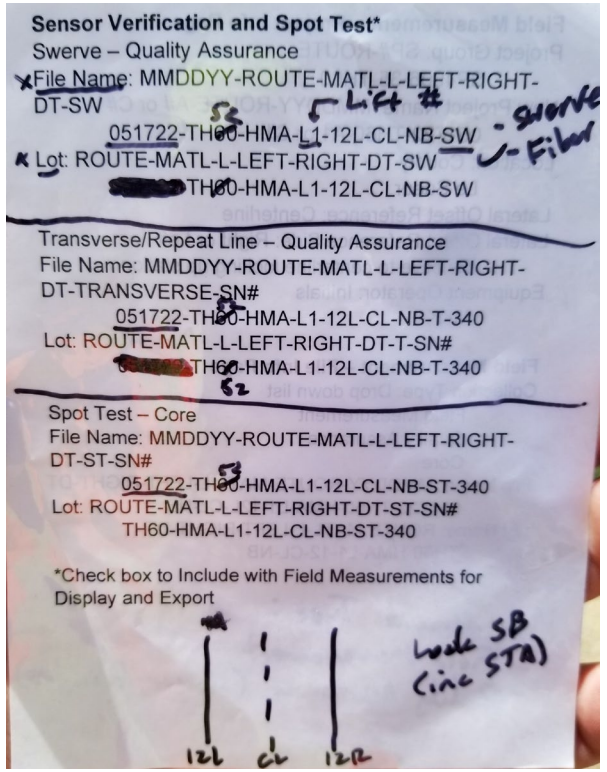
- Equipment Installation

Project Preparation – DPS & PMTP

Data Management

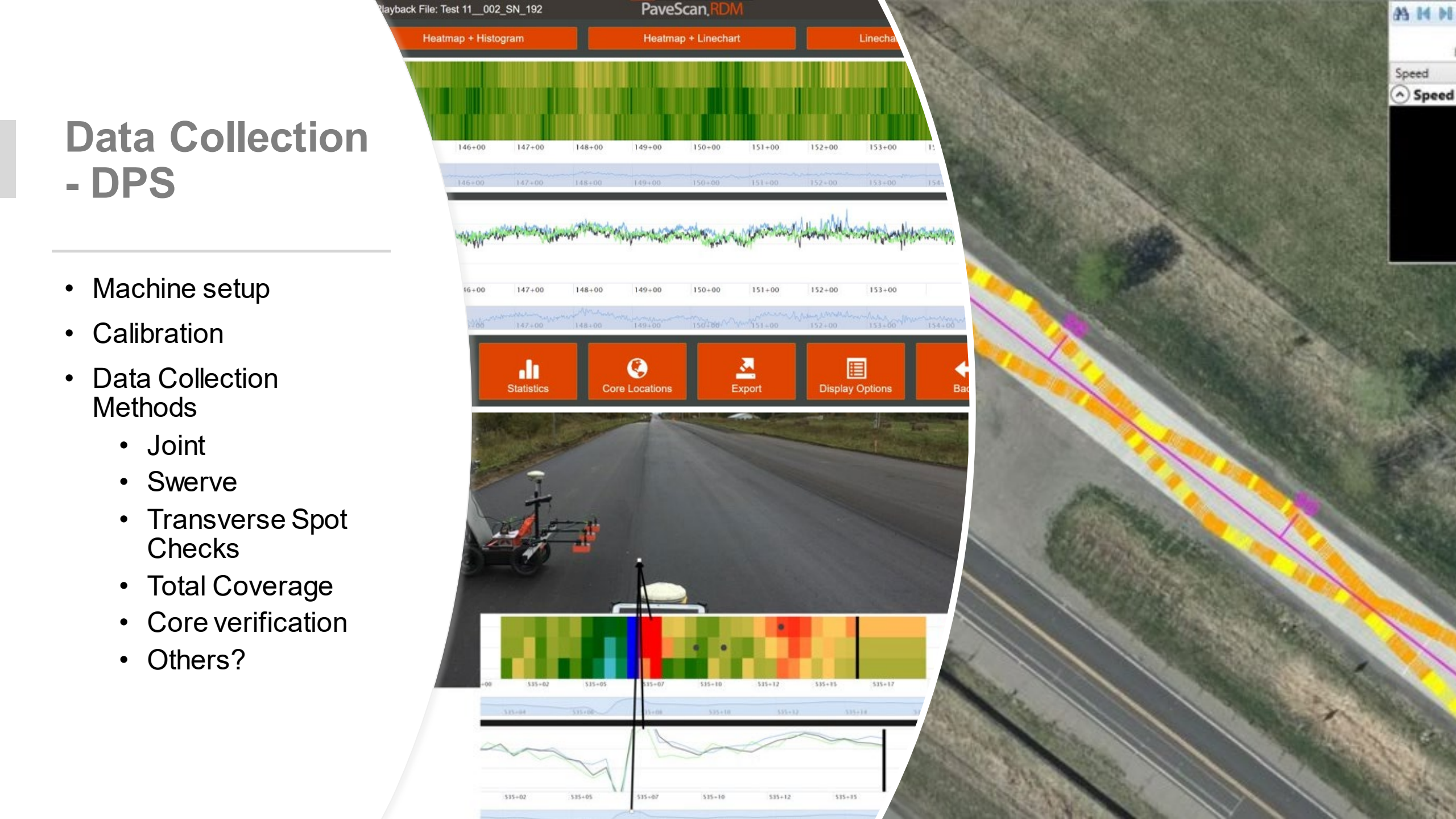
- There is a lot of data!
- Need a plan.
  - File naming conventions?
  - Where is data to be stored/backed up?
  - What collection methods are we using?
  - Are we sharing data with another party or comparing data?
- What other information do we need to collect?
  - Weather information?
  - Paving information?
  - Plant information?
  - Mix design changes?





Data Collection - DPS

- Machine setup
- Calibration
- Data Collection Methods
  - Joint
  - Swerve
  - Transverse Spot Checks
  - Total Coverage
  - Core verification
  - Others?

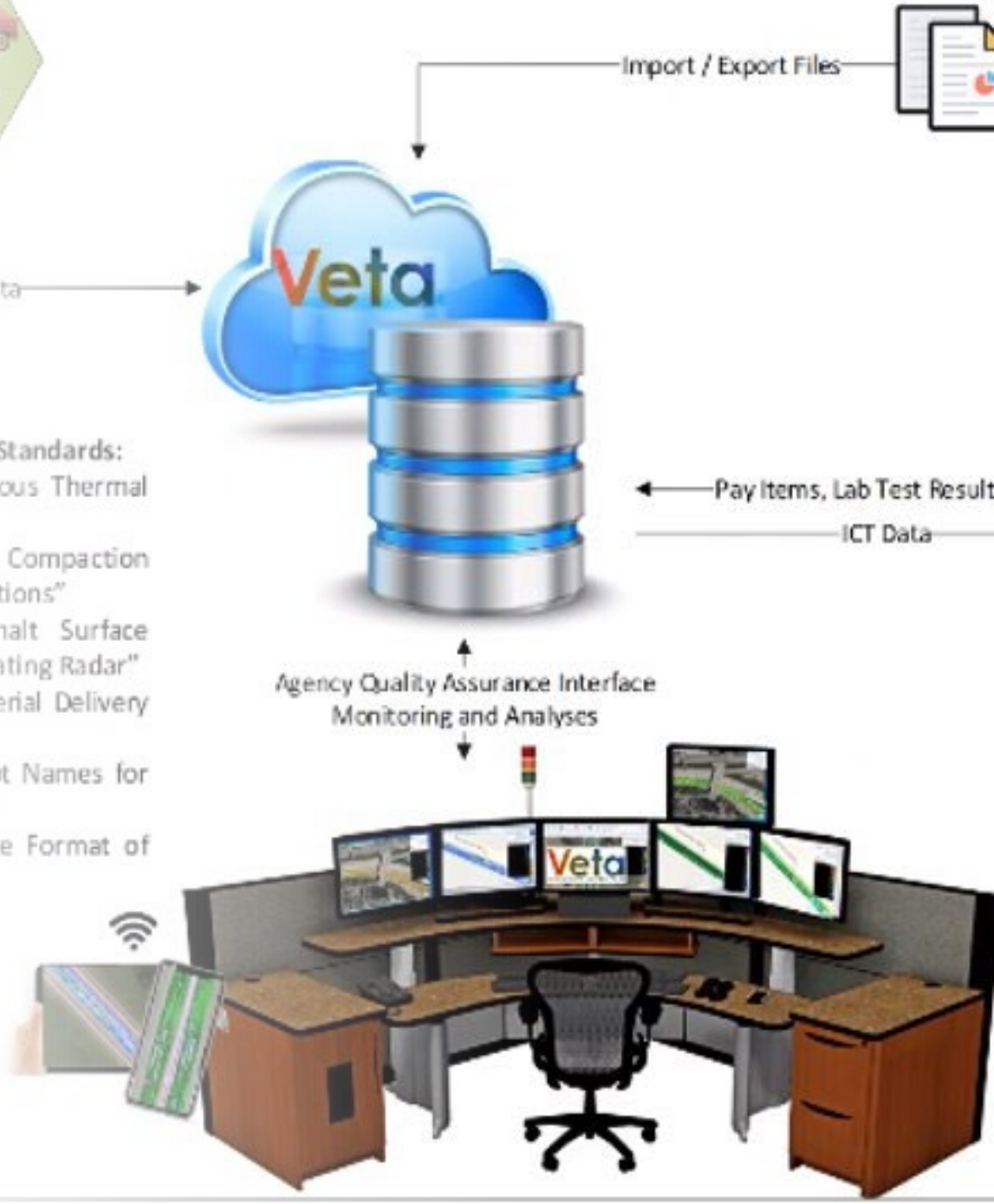


Field Data Collection - PMTP

- Fairly straight forward once equipment is installed
- Need stationing and direction
- Settings adjustments

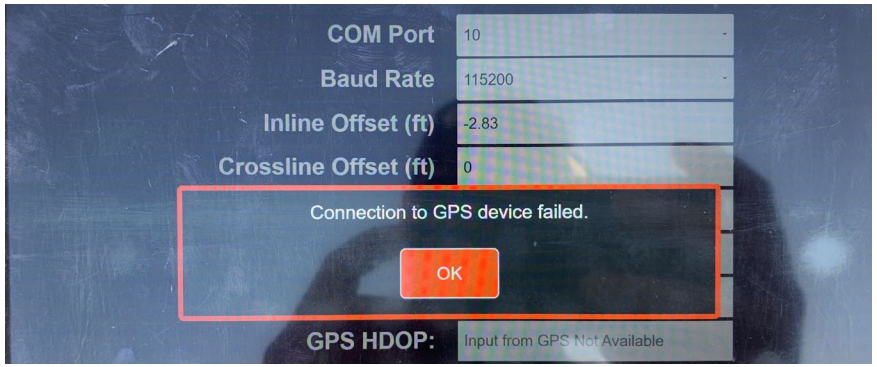
Data Analysis

- Lots and lots of data!
- MnDOT uses VETA
- Other intelligent construction programs?
- Google Earth
- Excel
- **REAL TIME ANALYSIS ON PROJECT**!
- **TRAINING!**



Challenges - DPS

- Traffic & Traffic Control
- Weather
- GPS Connectivity
- Sensor Connectivity
- Other Equipment Nuisances
- Data Management
- Training
- Fatigue



Challenges - PMTP

GPS Connectivity

Data Signal

Equipment Setups

Data Management

Training!

Next Steps

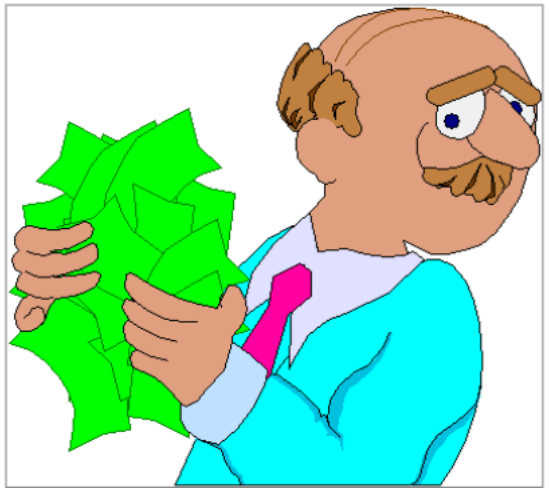
DPS

- Mainline Paving Projects
  - Mixes requiring high compactive effort.
  - Test strips, especially on core projects.
  - Projects with unusual structures.
- Commercial Work
  - Parking Lots!
  - Industrial facilities

PMTP

- Continue implementing on mainline pavers.
- Value for implementing in commercial work?

Benefit/Cost > 1 ?



Contractor Benefits

- Correlated dielectric values PRIOR to project start!
- Much more data than cores, nuke gauge, non-nuke gauge
- Mapping visual aids makes trouble shooting density issues easier
- Forensic investigation
- Improve quality/consistency => more incentives
- Monitor paving operations
- Training tools!

DPS & PMTP Final Thoughts

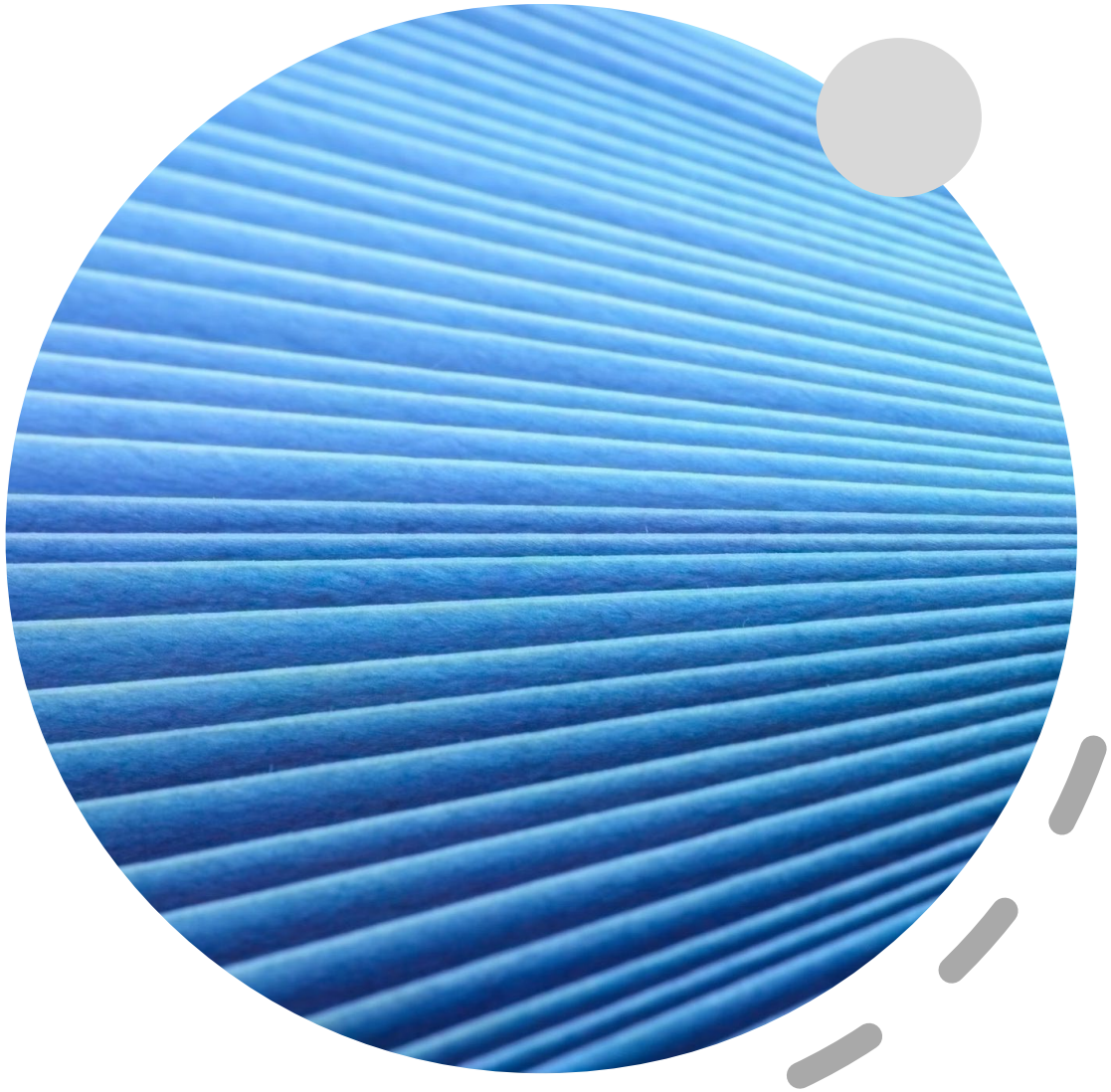
Implementation is not cookie cutter and requires upfront preparation and understanding

Data management is one of the biggest hurdles

Patience is a virtue…

Once implemented and understood, great tool for improving quality

DPS and PMTP are useful technologies worth the investment when implemented correctly



Thank you for your time!

Derek.Frederixon@mathy.com

TRB Webinar

Real-Time Quality Control with DPS and PMTP

Ervin Dukatz, Ph.D, P.E. (AL, TX, WI)
Flyereld Consulting, LLC, Moderator

Curt Turgeon, MnDOT
Overview – What would be the best use of DPS and PMTP technologies?

Craig Landerfeld, ODOT
DPS and PMPT for performance, sustainability, and safety.

Derek Frederixon, Mathy Construction Co.
Implementing DPS and PMTP

Thursday, May 11, 2023

Sponsored by: TRB committees AKC30 AKC60 AKM10 AKT10

Results of Menti-poll during 2023 TRB Workshop 5006

Q1: a. What would be the best use of DPS and PMPT for your agency or company?

Responses (58):

Agency (9): Use as bid items to provide data to support implementation
*Measure **consistency** in real-time*
Keep production team aware of their processes in real-time
Contractors (5): Use as a QC tool for (paving) process improvement
*Use as (standard practice) tools for making **real-time process improvement** changes*
Contractors collect data and agency verifies
Fed (1): Assessment of pavement compaction
*Industry (1): Use for automated QC data collection/acceptance for pavements; **eliminate sampling bias***
Unk (41): QUALITY CONTROL
An accurate tool(s) that outperforms current NDT test methods
Continuous, geolocated pavement data

Results of Menti-poll during 2023 TRB Workshop 5006

Q1: b. How would you measure success?

Responses (58):

*Agency (9): **Improved Measured** Pavement Quality/**Consistency**;*
e.g. improved pavement density, smoothness, slope and no segregation

Contractors (5) & Consultant (1): (more) Bonuses (less disincentives)
***Consistent** densities*
Used for process control

Fed (1): Accuracy and reliability of measurements

Industry (1):

*Unk (41): **CONSISTENCY***
Improved (pavement) uniformity, less cracking and segregation
Implemented as a standard tool(s) for QM and acceptance

Results of Menti-poll during 2023 TRB Workshop 5006

Q2: a. What data and data-collection methods are needed to illustrate pavement performance?

Responses (22):

Agency (3): Condition ***data collected over time*** *compared to DPS and PMTP*

e.g. improved pavement density, smoothness, slope and no segregation

Contractors (2): Longer lasting pavements produced by proactive process control

Consultant (2): Less isolated defects; ***less maintenance***

Fed (1): Less rework;

Unk (13): Automated data entry and analysis

Data to illustrate *(improved) material performance*

(collect) Underlying *surface quality*

Use of crowd source data to obtain continuous pavement performance data

GIS based virtualization tools that overlap construction data with (pavement) performance data

Results of Menti-poll during 2023 TRB Workshop 5006

Q2: b. How could DPS and PMTP help sustainability and safety?

Responses (22):

*Agency (3): Pavements with **longer life cycle** are a huge improvement in sustainability*
Less frequent resurfacing reduces worker exposure

*Contractors (2): Improves safety by **reducing people on road** coring/nuclear density readings*
Improved pavement density, smoothness– longer lasting roads

Consultant (2): Less isolated defects; less maintenance

Fed (1): Extended pavement life; less construction time and better safety

*Unk (13): **Sustainability-better** performance, better service life, reduced carbon footprint*
Safety: less exposure to live traffic

Results of Menti-poll during 2023 TRB Workshop 5006

Q3: a. How would you sell DPS and PMTP to your agency/company?

Responses (34):

Academic (1): Show them a summary of this workshop

*Agency (8): **("Show me the money")** explain monetary benefits and pavement improvement*

Show advantage of continuous measurements vs. random spot tests

Implement by requiring as QC tool

Consultant (1): Lower LCC; fewer work zones

Contractors (4): Improved pavement quality and incentives

Reduced disincentives (preventing one could pay for the equipment

Fed (1): Save money in long term with increased pavement life

Unk (19): Book,file,(e-circular) with project examples and data

Show (positive) ROI

Ability to make real-time/live decisions

Results of Menti-poll during 2023 TRB Workshop 5006

Q3: b. How would you implement the technology (what are probable roadblocks and solutions)?

Responses (34):

Academic (1): Workshops and webinars

*Agency (8): **Need a champion**; Roadblocks are available responses; confidence in measurements*
Implement with Pilot projects; Roadblock is contractor hesitancy

Consultant (1): Fewer disputes; Roadblocks are the technology, personal and initial cost of equipment

Contractors (4): Show how can reduce costs and improve profits
Roadblocks are equipment costs and personal; data collection and analysis

Fed (1): Save money in long term with increased pavement life
***Roadblocks are (management) lack of understanding**; contractor resistance*

Unk (19): Tighter specifications with targets and incentives so contractors need the equipment
Separate pay item for using the equipment
Roadblocks are cost and knowledge-training

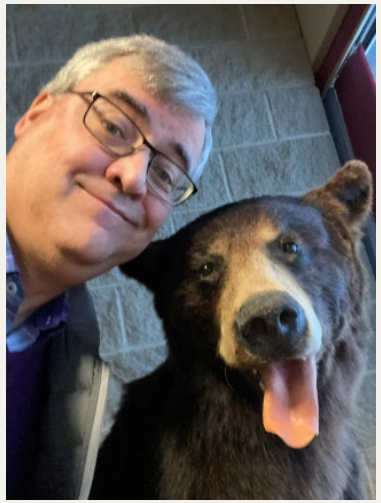
Results of Menti-poll during 2023 TRB Workshop 5006

Q4: What are the biggest challenges and risks in using these technologies for acceptance/ payment? (For owners/agencies? For contractors?)

Responses (18):

Agency (4): FHWA interpretation of CFR for QA
Accuracy and proficiency of equipment users
***SOP for when data can't be collected** due to weather, equipment failure….*
*Consultant (1): Abuse of black box component and **moisture***
Contractors (1): Meeting CFR
*Fed (2): **Accuracy** of data for acceptance*
***Verification** process for data acceptance*
Unk (10): Agency verification and validation of contractor data
Confidence in accuracy, consistency, repeatability, training and qualifications of operators;
Costs
Equipment limitations and unpredicted events

Today's presenters



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Craig Landefeld
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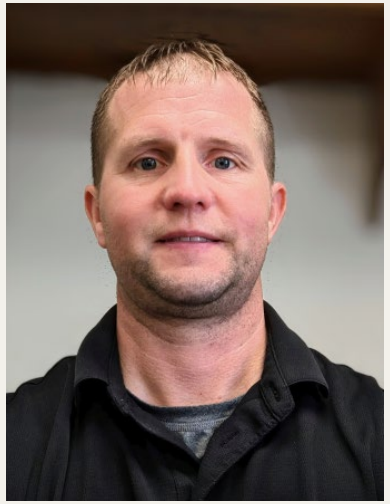

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Ervin Dukatz
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Flyereld Consulting, LLC

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May 15

TRB Webinar: Aggregate Sustainability—Production

July 8-11

TRB's National Conference on Transportation Asset Management

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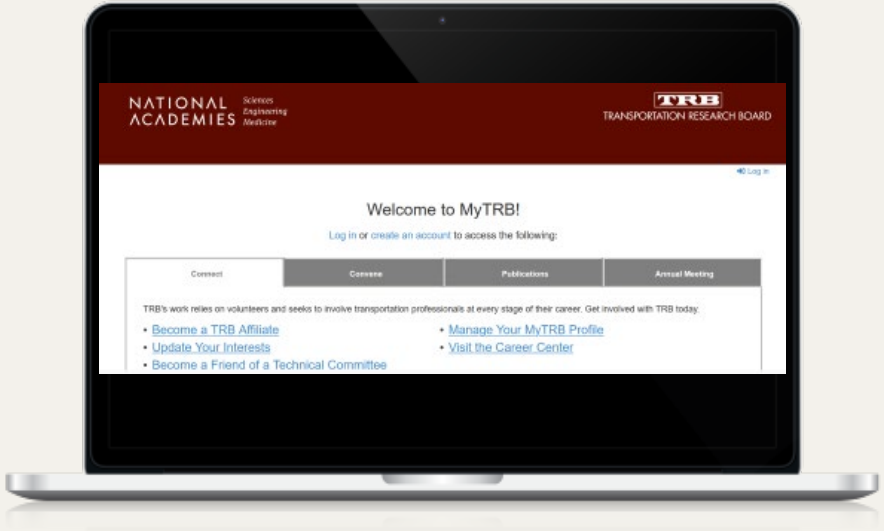

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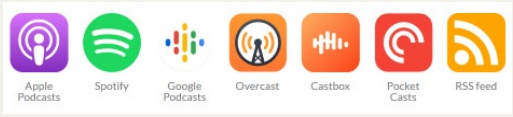

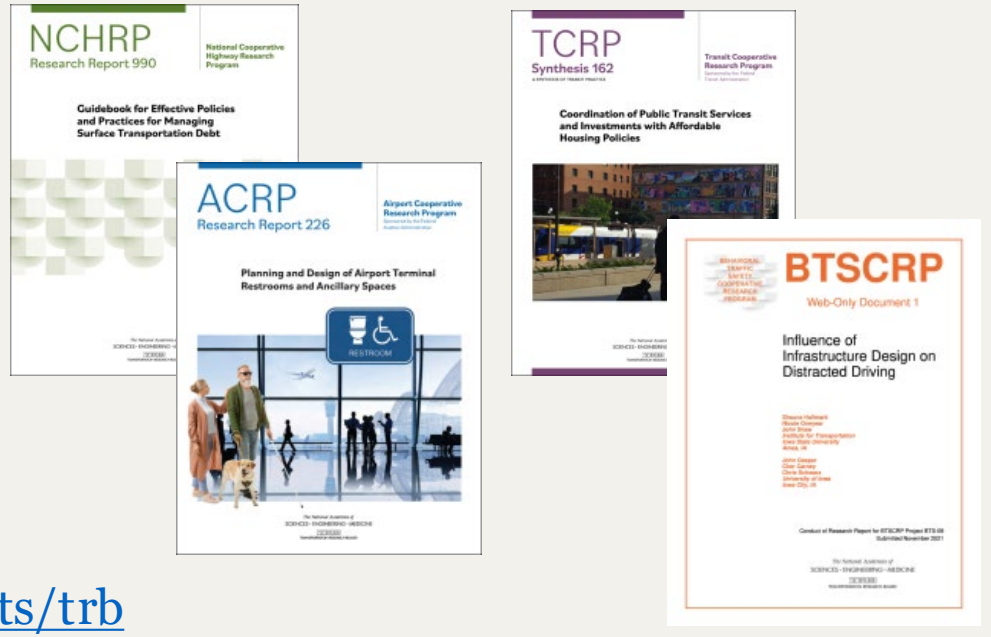

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