U.S. Department of Transportation
Federal Highway Administration

Office of Pavement Technology
Asphalt Pavement Program

Long-Life Asphalt Pavements for the 21st Century

What's New with WMA?

(at least since this meeting last year)

North Central Asphalt User/Producer Group
NCAUPG

Hot Mix Asphalt Technical Conference
February 4, 2010
Overland Park, KS

warmmixasphalt.com

U.S. Department of Transportation
Federal Highway Administration

WMA in the USA!

WMA Investigation and Implementation Premise

- Although there are many factors driving the development and implementation of WMA technologies globally, in order for WMA to succeed in the U.S., WMA pavements must have equal or better performance when compared to traditional HMA pavements

What is WMA?

- Allows a reduction in the temperatures at which asphalt mixes are produced and placed
  - ~~Reduced viscosity~~ at lower temps

Why WMA?

- Potential Advantages**
  - Energy Savings
  - Decreased Emissions
    - Visible and Non-Visible
  - Decreased Fumes
  - Decreased Binder Ageing
  - Extended Paving Season
  - Compaction Aid
  - Increased RAP usage

**Advantages will only be realized by optimizing production operations and utilizing best practices

Why WMA?

- Potential Advantages**
  - Energy Savings??
  - Decreased Emissions
    - Visible and Non-Visible
  - Decreased Fumes
  - Decreased Binder Ageing??
  - Extended Paving Season
  - Compaction Aid
  - Increased RAP usage??

**Advantages will only be realized by optimizing production operations and utilizing best practices

How Many WMA Technologies are Available in the U.S.?

Hint: This time last year there were fourteen (14) named technologies.

How Many WMA Technologies are Available in the U.S.?

Currently Twenty (20) Technologies Marketed and Available in the U.S.

Technology Overview**

- WAM-Foam
- Low Emission Asphalt
- Aspha-Min
- Advera
- Sasobit
- REVIX
- Evotherm
- Cecabase RT
- Thiopave
- Rediset WMX
- AquaFoam
- Ultrafoam GX
- Terex
- Accu•Shear
- Aquablack
- Double Barrel Green

Mathy Tech. & Eng. Services and Paragon Technical Services, Inc

**FHWA does not endorse any particular proprietary product or technology.

Technology Overview**

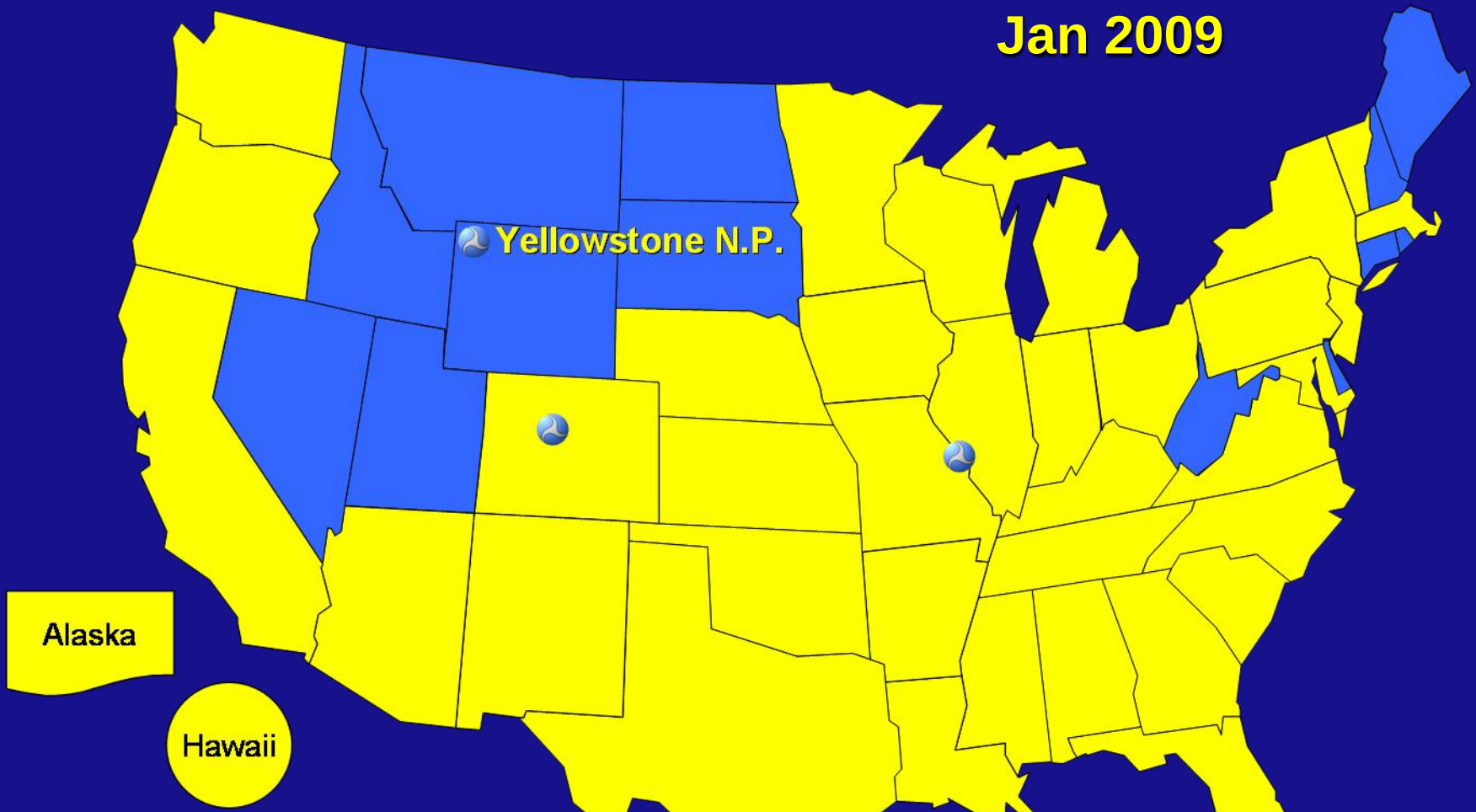
- TLA-X — Lake Asphalt of Trinidad and Tobago
- Iterlow-T & HyperTherm — ITERCHIMICA, CHIMICA INNOVATIVA PER LE PAVIMENTAZIONI STRADALI
- Static Inline Vortex Asphalt Blender — AESCO SINCE 1980 / AESCO MADSEN / MADSEN SINCE 1918
- Ad-RAP (ECOBIT) — sonneborn REFINED PRODUCTS

More to come …

Many other technologies are also used Internationally.

**FHWA does not endorse any particular proprietary product or technology.

WMA Trials and Demonstrations



Mobile Asphalt Mixture Testing Laboratory (MAMTL)

WMA Trials and Demonstrations

Jan 2010

Yellowstone N.P.

Over 140 documented WMA projects constructed to date.

Alaska

Hawaii

U.S. Department of Transportation
Federal Highway Administration

Well Documented WMA Projects

Climatic Region	State (Number of WMA Projects*)	Reported Performance Problems
Dry, No Freeze	CA(2), TX(4)	No performance problems reported
Dry, Freeze	CO(3), NV(2), WA(1), WY(2)	No performance problems reported
Wet, No Freeze	AL (3), AR(1), CA(8), FL(3), GA(1), MS(2), NC(2), SC(3), TN(1), TX(10), VA(2), WA(6)	Nashville, TN HMA and at least one WMA may be showing signs of moisture damage.
Wet, Freeze	AK (3), IL(1), IN(1), MD(3), MA(1), MI(1), MN(1), MO(5), NE(1), NY(46), OH(4), PA(3), TN(8), VT(1), VA(1), WI(6)	Kimbolton, OH sections are raveling, which may be a sign of moisture damage. No other problems reported

 Courtesy of National Center for Asphalt Technology

MAMTL Trailer WMA Projects

Warm Mix Asphalt Projects				
Location	**Mix Design**	**Lab Compaction Level, Gyrations**	**Base Binder Grade**	**Technologies**
Hall St., St. Louis, MO	12.5 mm Superpave	100	PG 70-22	Aspha-min, Evotherm, Sasobit
I-70, Dillon, CO, West of Eisenhower Tunnel	9.5 mm Superpave	75	PG 58-28	Advera,Evotherm Sasobit
East Entrance Road, Yellowstone National Park, WY	19 mm Hveem	75	PG 58-34	Advera Sasobit
US 190, Jasper, TX	19 mm Superpave	55	PG 70-22	Rediset WMX
SR2006 Centre Hall & SR 2012 Spring Mills, PA	9.5 mm Superpave	75	PG 64-22	Aspha-min, Sasobit, LEA UltraFoam GX
I-55, Sikeston, MO	19 mm Superpave	125	PG 76-22	Aquablack

Mobile Asphalt Testing Laboratory (MATL)

U.S. Department of Transportation
Federal Highway Administration

Asphalt Mixture Performance Tester

Dynamic Modulus (E*)

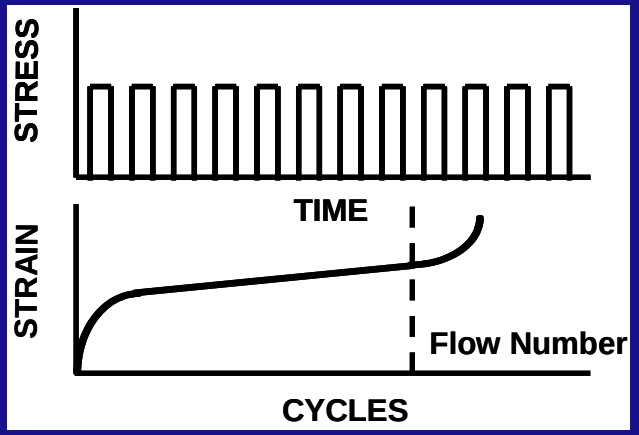
- Test Temperatures
  - **4.4º C** (40º F)
  - **21.1º C** (70º F)
  - **37.8º C** (100º F)
  - **54.4º C** (130º F)
- Frequencies
  - **0.1, 0.5, 1, 5, 10, 25 Hz**

IPC Global
AMPT Device

Asphalt Mixture Performance Tester

Flow Number, Fn

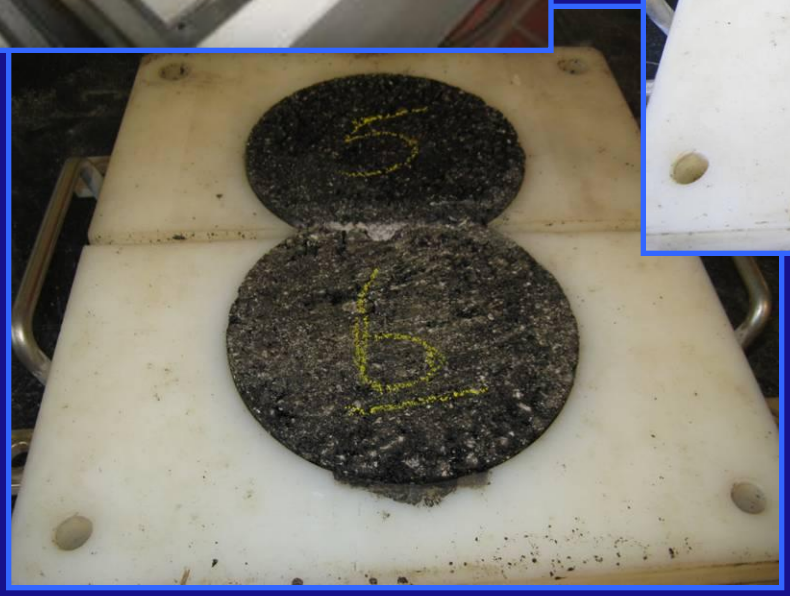
- Loading
  - Axial load applied for 0.1 second with 0.9 second rest period
- Test Temperatures
  - LTTPBind, Version 3.1 Software
  - Site pavement temperature at 50% Reliability
    - Pavement Temperature
    - Pavement Temperature + 6° C
    - Pavement Temperature - 6° C



IPC Global AMPT Device

Hamburg Wheel Track Test

AASHTO T 324



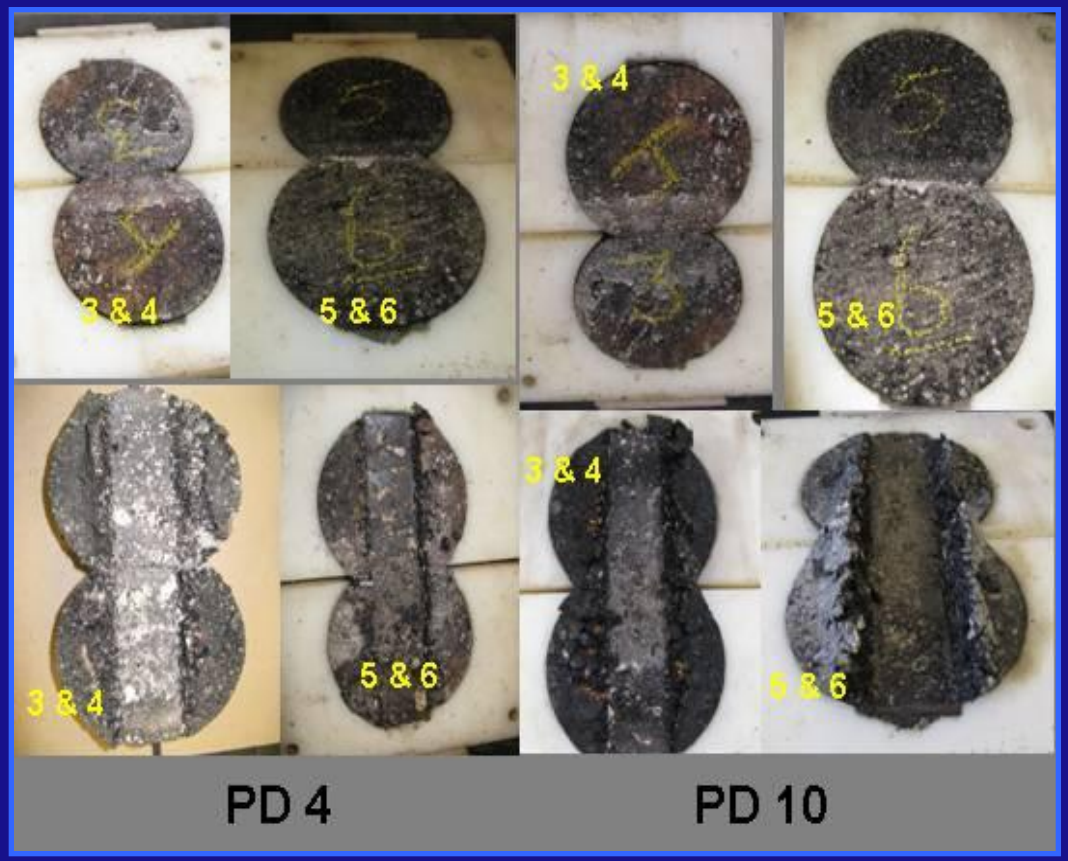
7.0 ± 0.5% voids tested wet @ 50°C to maximum of 20,000 passes

U.S. Department of Transportation
Federal Highway Administration

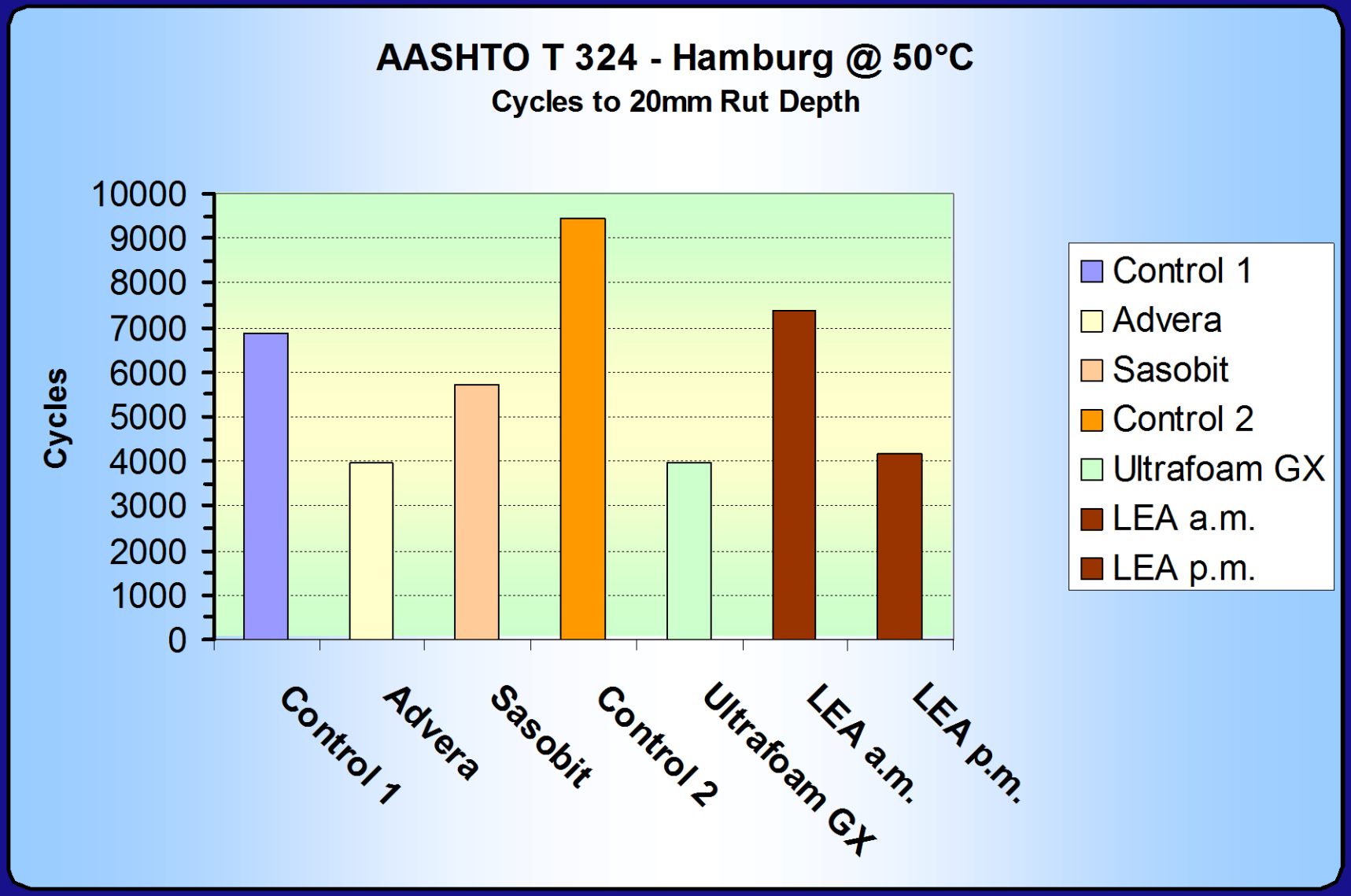
Jasper, TX Hamburg

Rediset WMX plant produced mixture

- PD 4 - 13.18 mm
- PD 10 - 18.80 mm



Centre Hall, PA Hamburg



Plant Produced Mixtures

I-55 Sikeston, MO Hamburg

Aquablack by Maxam

- Testing currently being finalized

General Trend:

FHWA/NCAT Co-Op Agreement

- FHWA funded evaluations
  - Nashville, TN
  - Graham, TX
  - Bridgeport, TX
  - Royal, NE
  - Iron Mountain, MI
  - Brownsburg, IN
  - Kimbolton, OH
  - San Antonio, TX
  - St. Louis, MO
  - Milwaukee, WI

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

U.S. Department of Transportation Federal Highway Administration

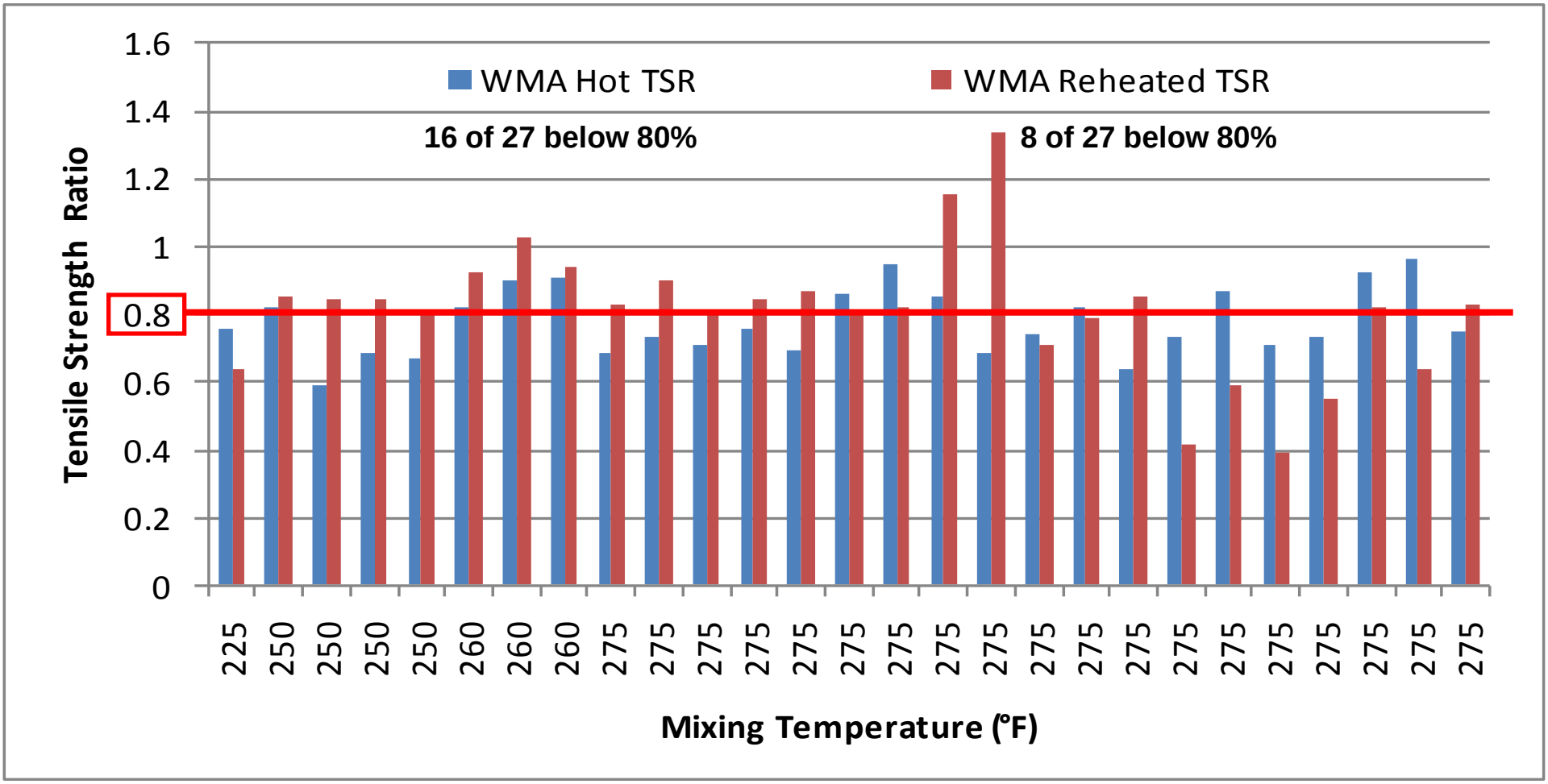
FHWA/NCAT Co-Op Agreement

- Test Results from Field Produced WMA:
  - Tensile strengths and TSRs are typically lower for WMA compared to HMA. Sasobit mixes are the exception.
  - Hamburg results generally show the same trend
- Field cores of WMA after construction often have lower tensile strengths than HMA, but after two years WMA ITS increase to about the same as HMA

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

U.S. Department of Transportation Federal Highway Administration

Tensile Strength Ratios for Field Produced WMA



 Courtesy of National Center for Asphalt Technology

National Research Initiatives

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- NCHRP 9-43 “Mix Design Practices for Warm Mix Asphalt” $500,000
- NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance” $900,000
- NCHRP 9-49 “Long Term Field Performance of Warm Mix Asphalt Technologies”
  - Phase I, Moisture Susceptibility
  - Phase II, Long-Term Performance

U.S. Department of Transportation
Federal Highway Administration

NCHRP 9-43 *(preliminary findings)*

- Mixture Design
  - Similar to AASHTO R35 “Standard Practice for Superpave Volumetric Design for (HMA)”
  - Criteria for HMA from AASHTO M323
  - Mandatory Test for Rutting Resistance utilizing the AMPT Flow Number (Fn) test
- Mixture Analysis
  - Optional Performance Tests
    - Modulus
    - Fatigue Cracking
    - Thermal Cracking

NCHRP 9-43 *(preliminary findings)*

Summary of Differences from M323

- Process Specific Specimen Fabrication Procedures (Modified Wirtgen lab foaming device used)
- Recommended Binder Grade Changes Based on Production Temperature (Binder ageing index)
- Recommended Max. RAP Stiffness Based on Compaction Temp (RAP Binder G*/sin δ =1.0 kPa)
- Coating Evaluated at Production Temperature
- Rutting Resistance Evaluated for 3 Million ESAL or Greater mixtures

NCHRP 9-43 *(preliminary findings)*

Binder Ageing Index = $\dfrac{G^*/\sin\delta_{RTFOT}}{G^*/\sin\delta_{Tank}}$

PG High Temperature Grade	Aging Index (AI)[1]											
	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6
	Minimum WMA Mixing Temperature Not Requiring PG Grade Increase, °F											
52	170	190	200	205	210	215	220	220	225	225	230	230
58	185	205	215	220	225	230	235	235	240	240	245	245
64	190	210	220	230	235	235	240	245	245	250	250	250
67	200	220	230	235	240	245	250	255	255	255	260	260
70	200	220	230	240	245	245	250	255	255	260	260	260
76	210	225	235	245	250	255	260	260	265	265	265	270
82	215	235	245	250	255	260	265	265	270	270	275	275

NCHRP 9-43 *(preliminary findings)*

Phase II work near completion

- Expanded RAP Mixing Experiment (ongoing)
- Low Temperature Binder Grade Experiment (ongoing)
- Mixture Design Experiment (completed)
- Fatigue Experiment (ongoing)
- Field Validation (completed)

NCHRP 9-43 *(preliminary findings)*

- Expanded RAP mixing study utilizing dynamic modulus E* evaluation criteria developed by Advanced Asphalt Technologies: Bonaquist & Christensen
- E* from specified mixing and compaction temperatures compared to fully blended condition E* determined through the Hirsch model (assuming 100% blending of RAP and virgin binders)

U.S. Department of Transportation
Federal Highway Administration

NCHRP 9-43 *(preliminary findings)*

- Expanded RAP mixing study

Process	Temperature	Conditioning Time, hrs		
		0.5	1.0	2.0
Control	280/255	X	X	X
	248/230	X	X	X
Organic	248/230	X	X	X
	230/212	X	X	X
Foaming	248/230	X	X	X
	230/212	X	X	X
Chemical	248/230	X	X	X
	230/212	X	X	X

Mixture E* results only approach Hirsch Fully Blended E*

NCHRP 9-43

- Scheduled Completion March 2010
- Final Report Will be Submitted in March
- Three Month Time Extension Requested for Review/Revision of Deliverables

NCHRP 9-47A

- NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance” $900,000
- National Center for Asphalt Technology at Auburn University, Alabama
- State of the Practice Report and Research Plan have been submitted to the NCHRP panel for review and approval
- Additional work will begin after panel approval of the Research Plan

NCHRP 9-49 Moisture …

- Phase 1, Moisture Susceptibility
- Request for Proposal (RFP) submissions closing date was January 14, 2010
- Research Principle selection and contract award to occur Spring 2010
- 30 month duration
- $450,000 funds available for Phase 1

Additional Research

Binder ETG Research Projects

- Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder
- Evaluated the effect of nine (9) non-paraffin wax additives
- Testing Completed and Final Report is near completion

35

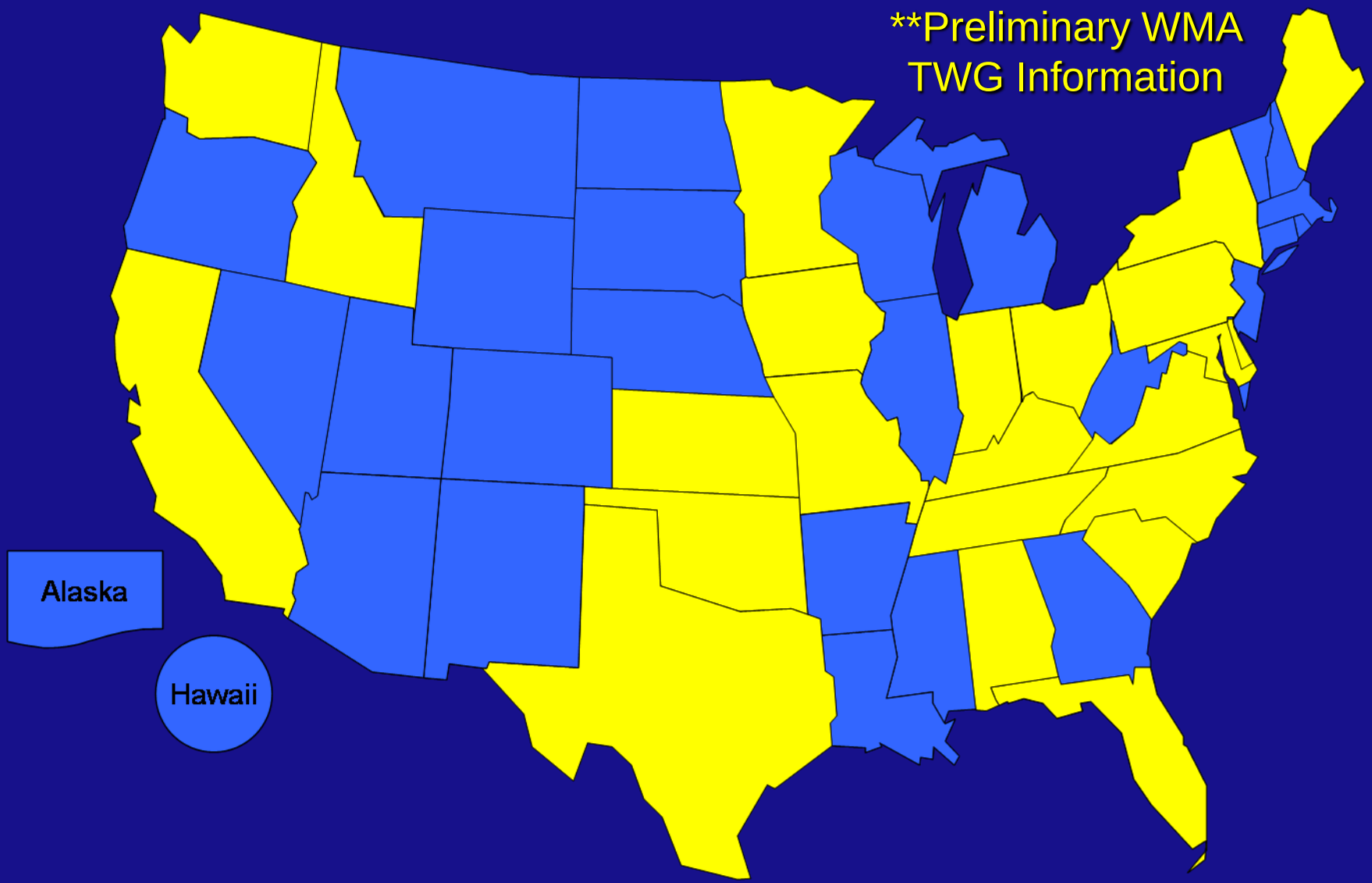
WMA Technical Working Group (TWG)

- FHWA / NAPA sponsored
- Co-Chairs
  - Matthew Corrigan, FHWA
  - Ron White, Industry
- Represented
  - State DOT
  - State APA
  - NCAT
  - AASHTO
  - Labor
  - NIOSH
  - Hot Mix Asphalt Industry

WMA TWG Task Forces

- Task Force 08-01 “Ageing/Conditioning Criteria for Mechanical Testing of WMA Technologies”
- Task Force 08-02 “National Approval/Certification Program for WMA Technologies”
  - To utilize AASHTO National Transportation Product Evaluation Program (NTPEP)
  - NCAT developed their own alternate evaluation program proposal
- Task Force 09-01 “State Agency WMA Specifications and Project Synthesis”

WMA Specification Language



WMA TWG future initiatives?

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- WMA plus RAP/Shingles/Crumb Rubber
- Laboratory versus in service field ageing of WMA mixtures
- Conditioning criteria for mechanical testing of WMA
- Laboratory versus production ageing of WMA mixtures
- Synthesis/Collection of information on State DOT usage/implementation of WMA

WMA TWG future initiatives?

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

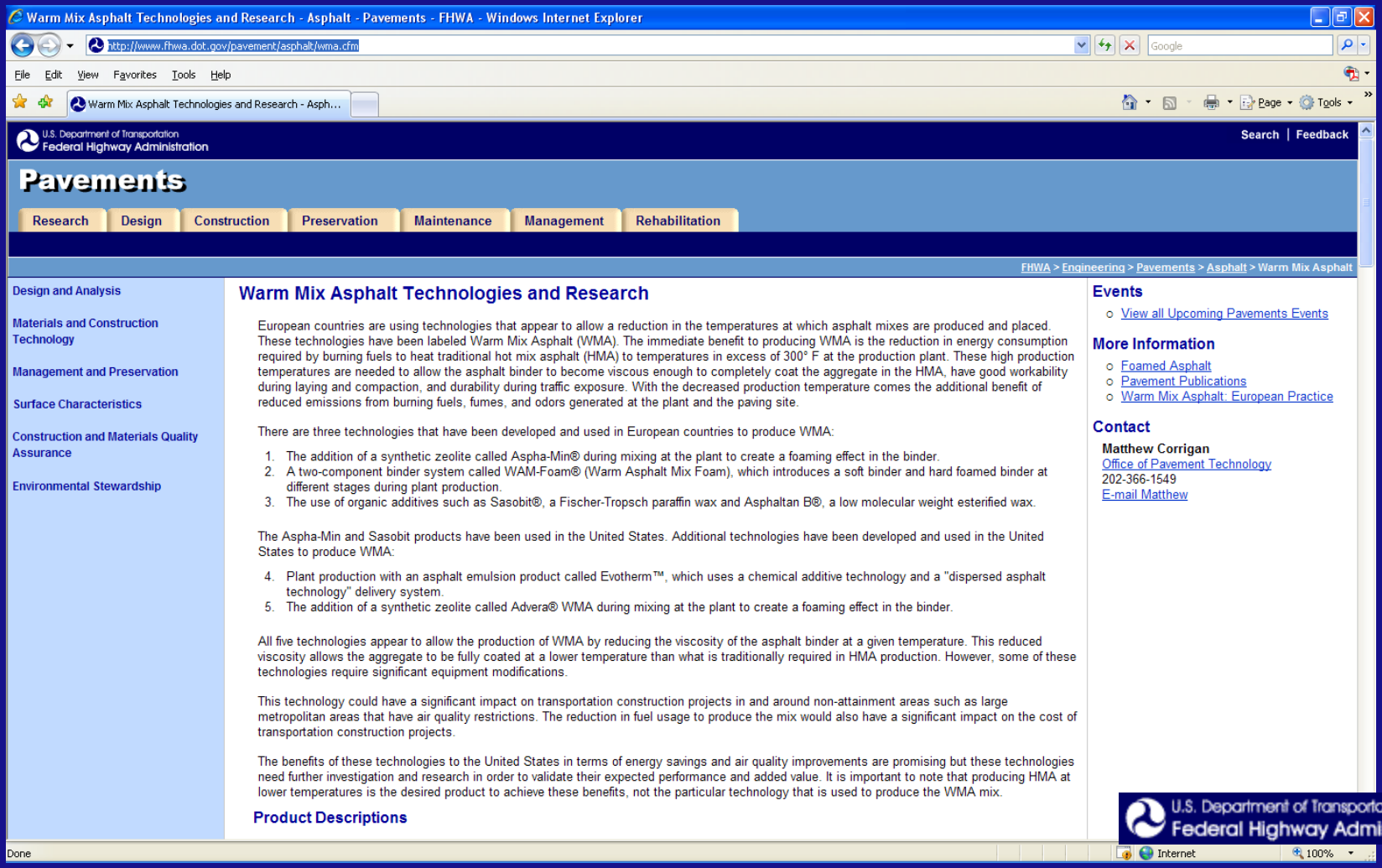
- National Evaluation Program for WMA Technologies
- Understanding the role of additives in WMA production and construction
- Understanding the role of asphalt foam in aggregate coating, workability, compaction, and long term performance
- Quality control and acceptance testing for WMA mixtures
- Open Graded Friction Course (OGFC) plus WMA

Future WMA Specifications

- Emphasis on "Performance"
  - Asphalt Mixture Performance Tester (AMPT)
    - Flow Number (Fn), mixture rutting
    - Dynamic Modulus (E*), mixture stiffness
    - Cyclic Tension – Compression, fatigue cracking
  - IDT Creep and Strength
    - fatigue and thermal cracking
  - loaded wheel rut testing
    - Hamburg or APA
  - Moisture Susceptibility Testing

Written Summary of WMA @

www.fhwa.dot.gov/pavement/asphalt/wma.cfm



U.S. Department of Transportation
Federal Highway Administration

Office of Pavement Technology
Asphalt Pavement Program

Matthew Corrigan, P.E.

Mobile Asphalt Laboratory Program Manager
Warm Mix Asphalt Program Manager

Office of Pavement Technology
HIPT-10, Room E73-465
1200 New Jersey Ave. S.E.
Washington, DC 20590

matthew.corrigan@fhwa.dot.gov
www.fhwa.dot.gov/pavement

PENN STATE

Steelers