

*Long-Life Asphalt Pavements for the 21<sup>st</sup> Century*

# *Warm Mix Asphalt Projects & Specifications*

North Central Asphalt User/Producer Group

**NCAUPG**

2009 NCAUPG Conference

February 5, 2009

Madison, WI

[warmmixasphalt.com](http://warmmixasphalt.com)



# *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



# Brief U.S. History

- ❁ NAPA European Scan 2002
  - ❁ Germany and Norway
- ❁ NAPA Annual Meeting 2003
  - ❁ San Diego
- ❁ World of Asphalt 2004
  - ❁ Nashville
- ❁ WMA TWG 2005
- ❁ FHWA International Scan 2007
- ❁ International WMA Conference 2008



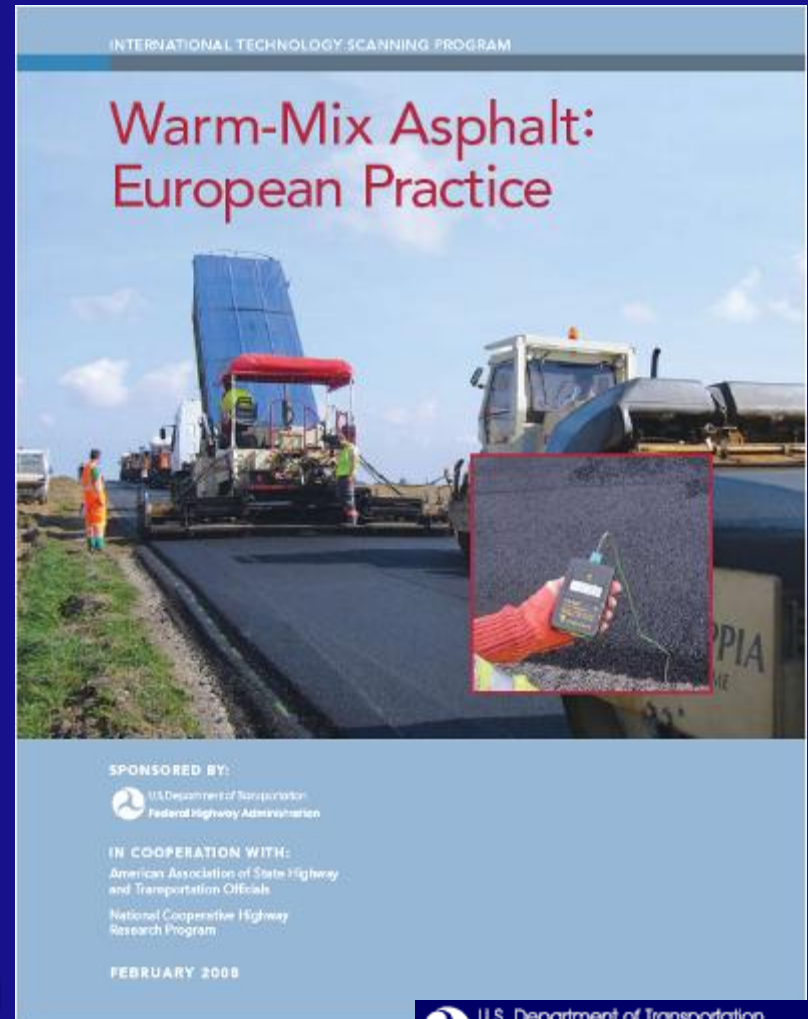


# WMA European Scan Tour

- ❖ Joint Program w/ FHWA, AASHTO, NCHRP and Industry
- ❖ Publication FHWA-PL-08-007
- ❖ Scan Final Report

❏ .pdf available at

<http://international.fhwa.dot.gov/pubs/pl08007/index.cfm>





# *International WMA Conference*

- ✚ NAPA, FHWA & AASHTO sponsored
- ✚ November 11-13, 2008 in Nashville, TN

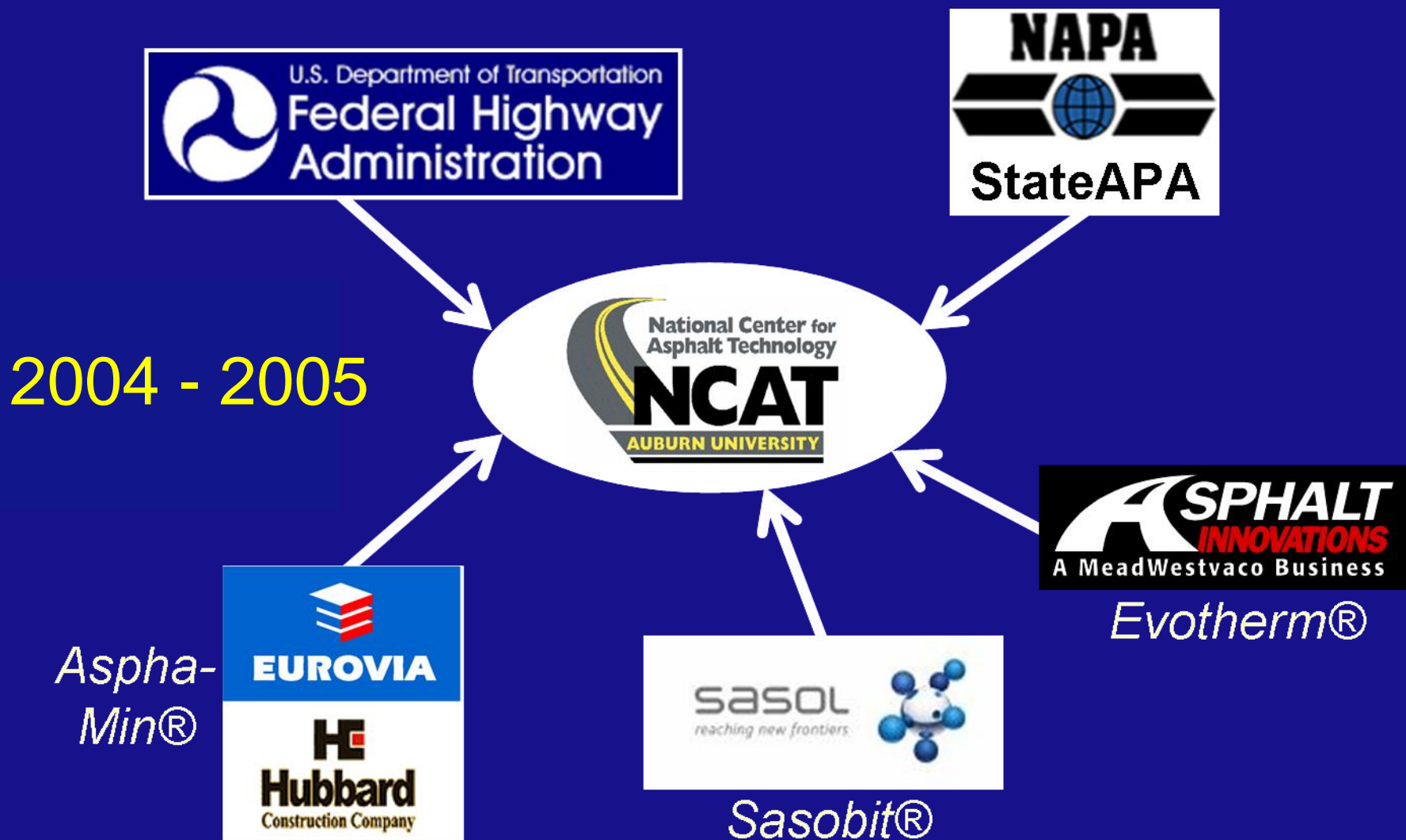
## ✚ Features:

[warmmixasphalt.com](http://warmmixasphalt.com)

- ✚ Processes
- ✚ Mix Production & Placement
- ✚ Energy consumption
- ✚ Mix Design
- ✚ Material Properties
- ✚ Environmental Performance
- ✚ Engineering
- ✚ State of the Practice
- ✚ Future Direction



# Initial U.S. Research Partners





# Technology Overview\*\*

WAM-Foam



Rediset WMX



Low Emission Asphalt



Aspha-Min



Ultrafoam GX



Advera



Terex



Sasobit



Stansteel



REVIX



Aquablack



Evotherm



Double Barrel



Cecabase RT

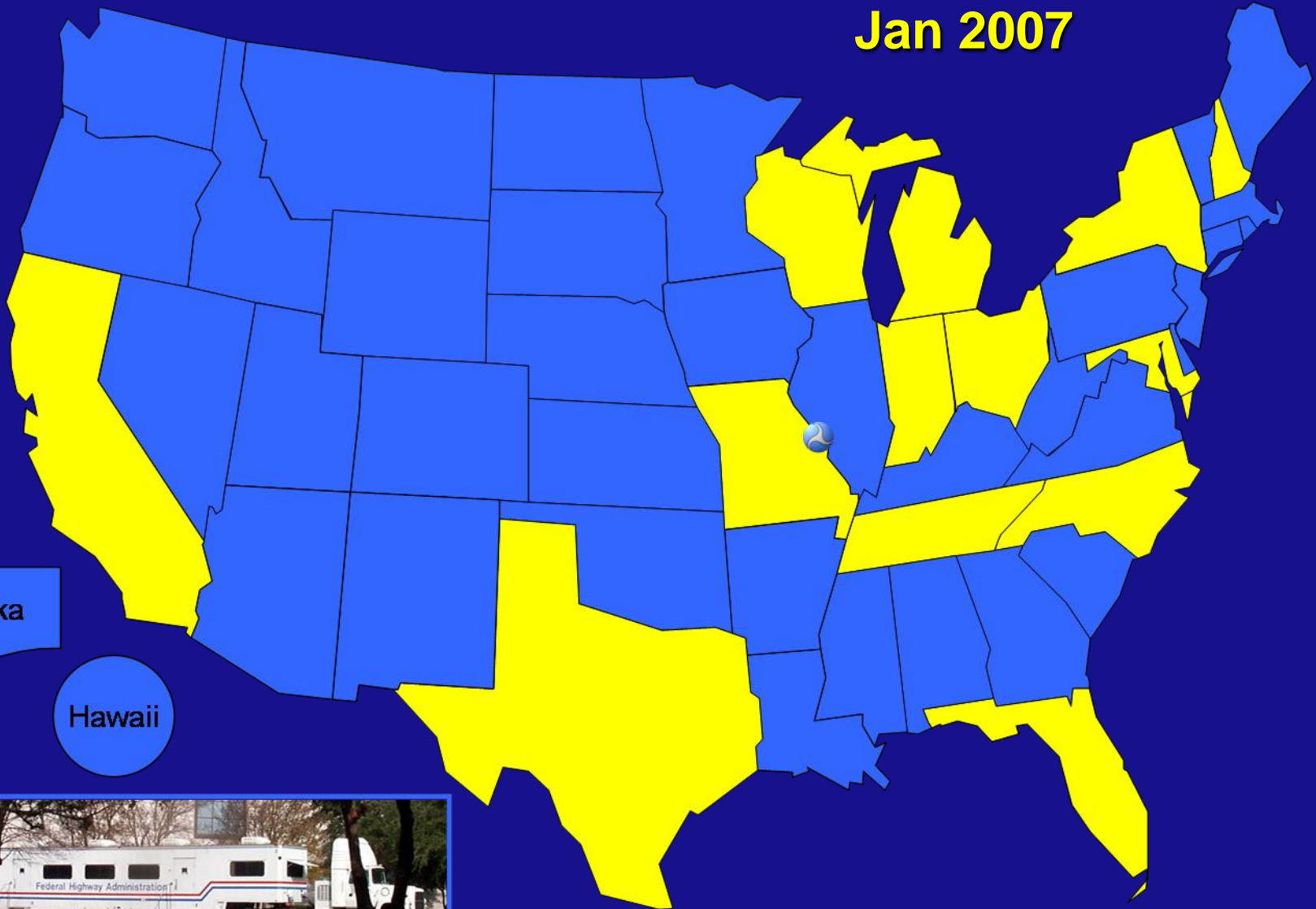


Green



# WMA Trials and Demonstrations

Jan 2007



Alaska

Hawaii

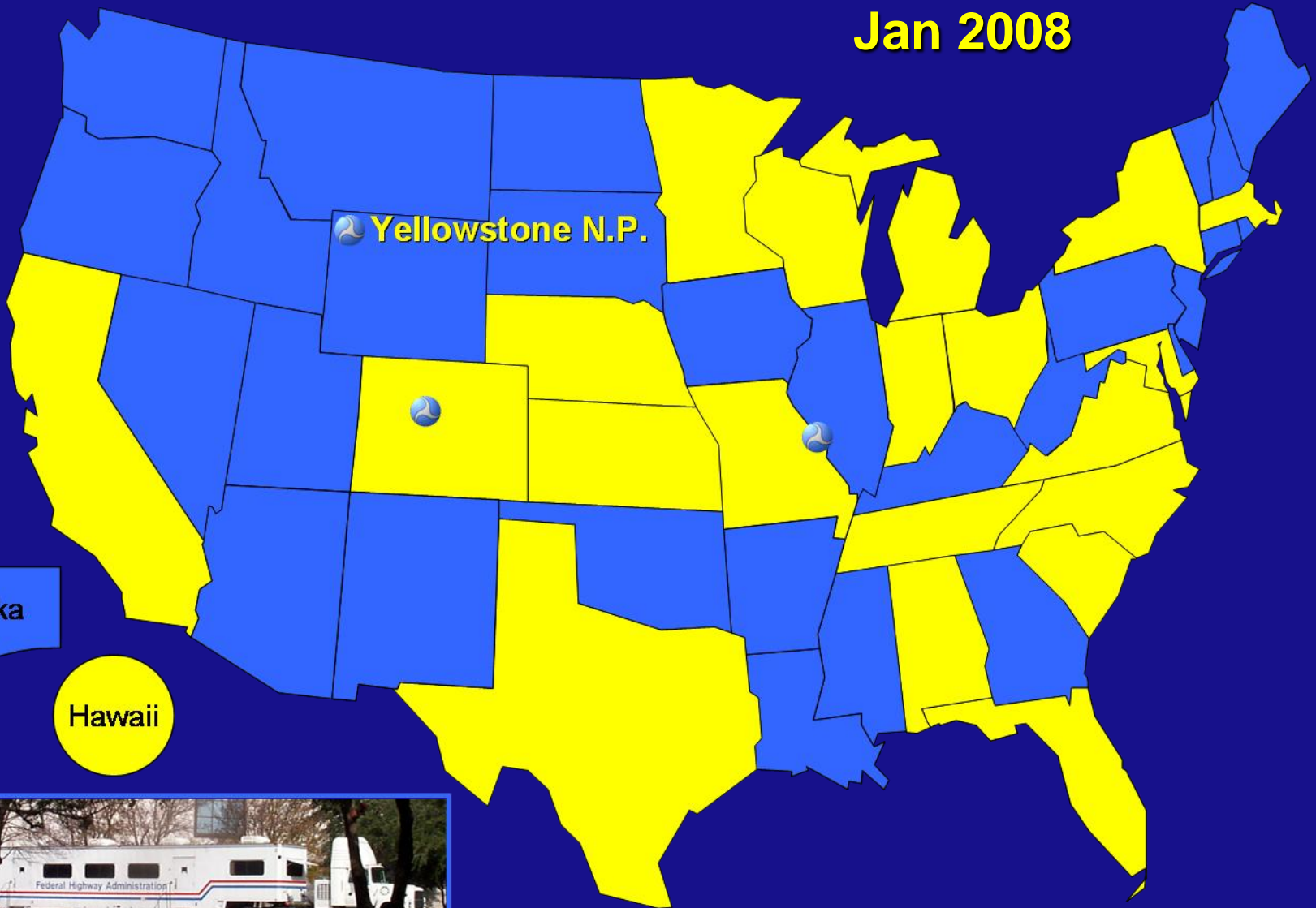






# WMA Trials and Demonstrations

Jan 2008



Alaska

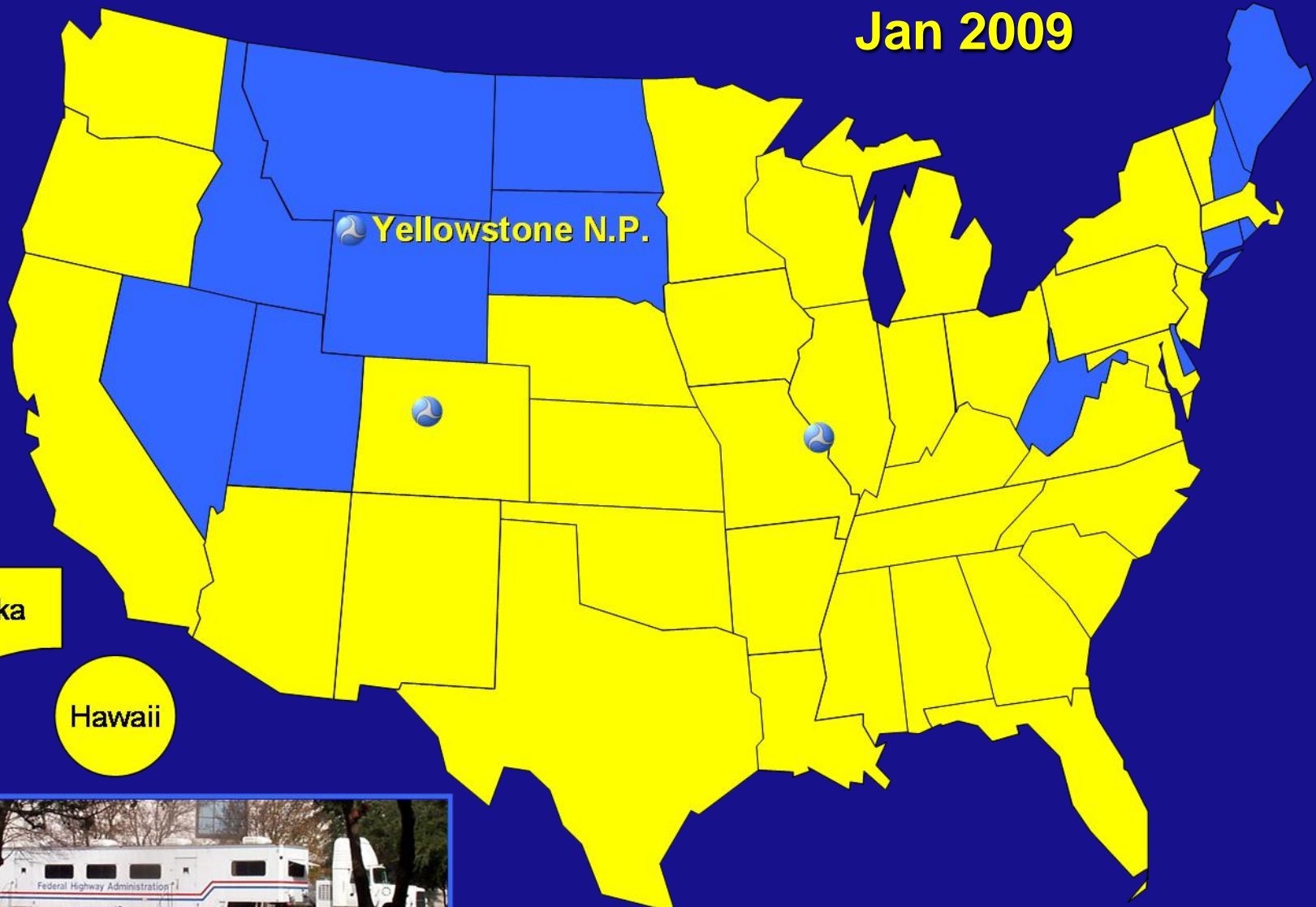
Hawaii





# WMA Trials and Demonstrations

Jan 2009



Alaska

Hawaii



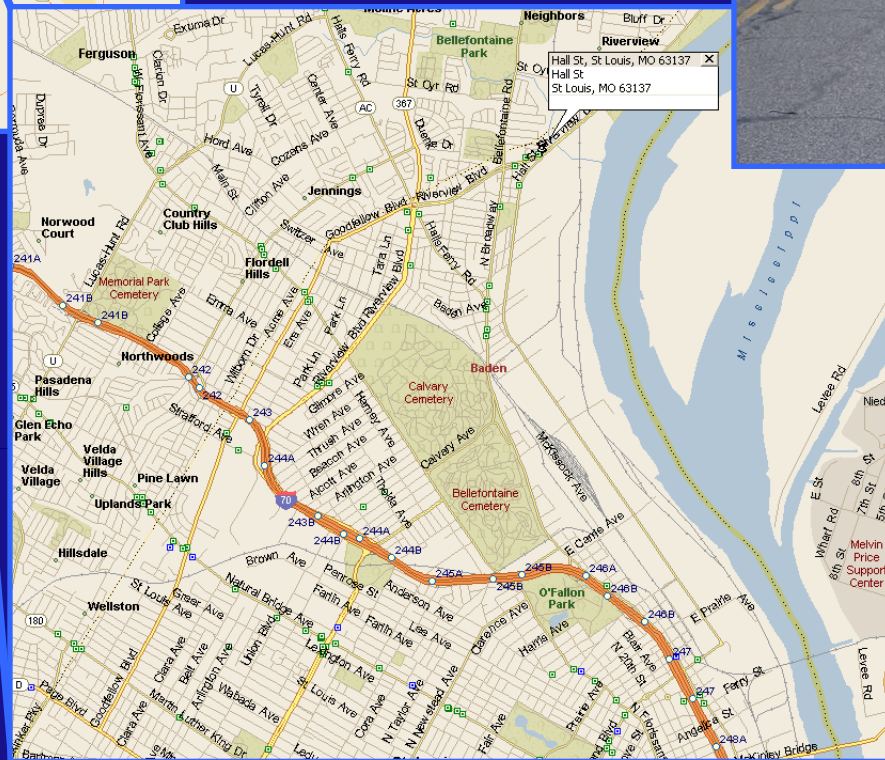
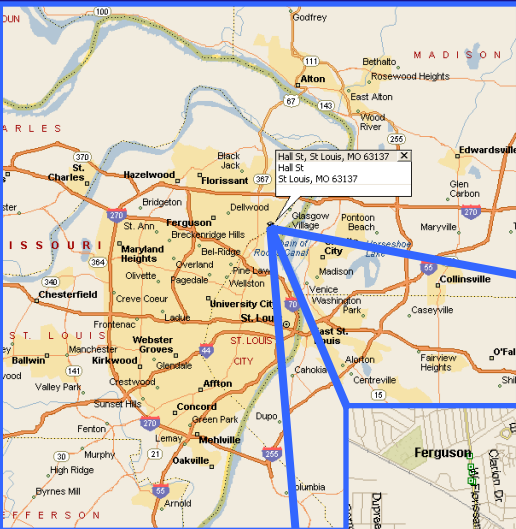


# Mobile Asphalt Testing Laboratory (MATL)





# Hall Street, St. Louis, MO



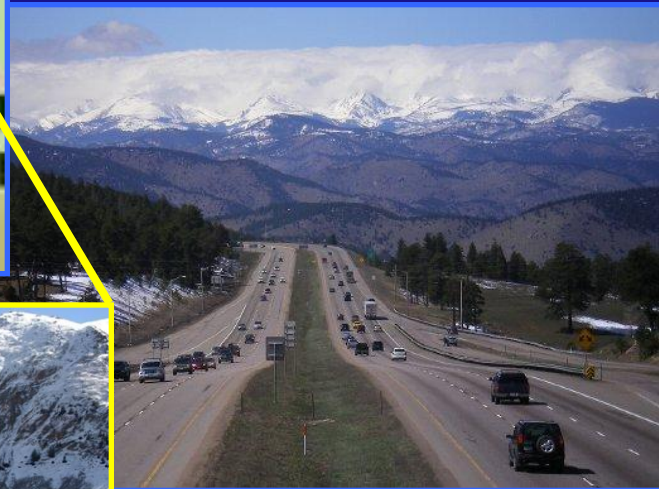
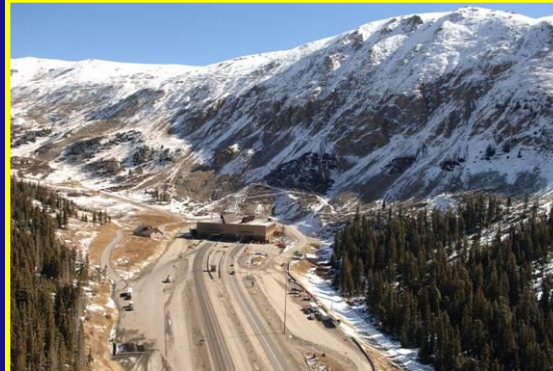


# Interstate 70, Dillon, CO



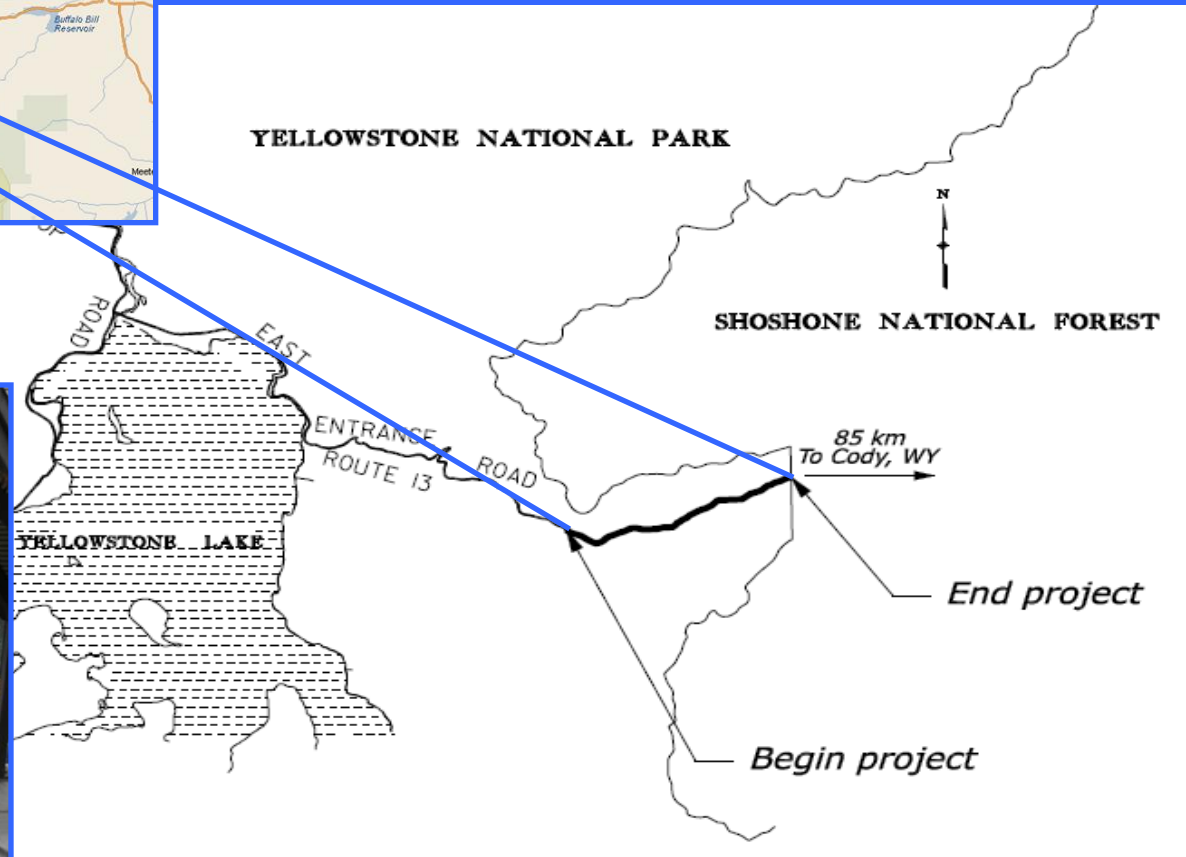
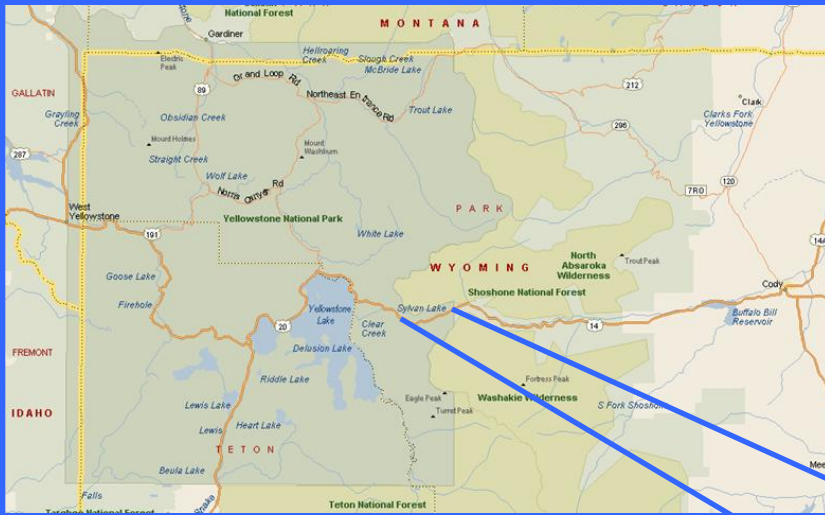
70 miles West of Denver, CO

Elevation 8,800 – 11,100 Feet



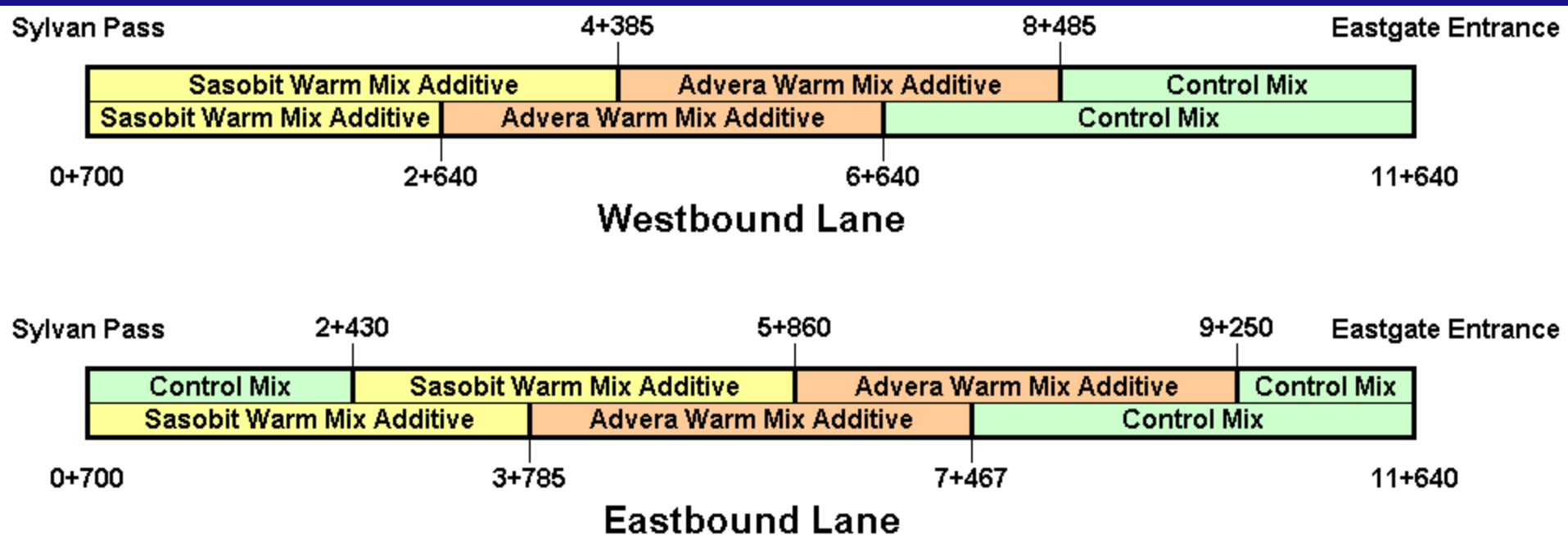


# East Entrance, Yellowstone, WY





# East Entrance, Yellowstone, WY









# MAMTL Trailer WMA Projects

## Warm Mix Asphalt Projects

Location	Mix Design	Lab Compaction Level , Gyration	Base Binder Grade	Technologies
Hall St., St. Louis, MO	12.5mm Superpave	100	PG 70-22	Aspha-Min Evotherm Sasobit
I-70, Dillon, CO, West of Eisenhower Tunnel	9.5mm Superpave	75	PG 58-28	Advera Evotherm Sasobit
East Entrance Road, Yellowstone National Park, WY	19mm Hveem	75	PG 58-34	Advera Sasobit



Mobile Asphalt Mixture Testing Laboratory (MAMTL)



# Asphalt Mixture Performance Tester

## Dynamic Modulus ( $E^*$ )

### Test Temperatures

- ❑ 4.4° C (40° F)
- ❑ 21.1° C (70° F)
- ❑ 37.8° C (100° F)
- ❑ 54.4° C (130° F)

### Frequencies

- ❑ 0.1, 0.5, 1, 5, 10, 25 Hz

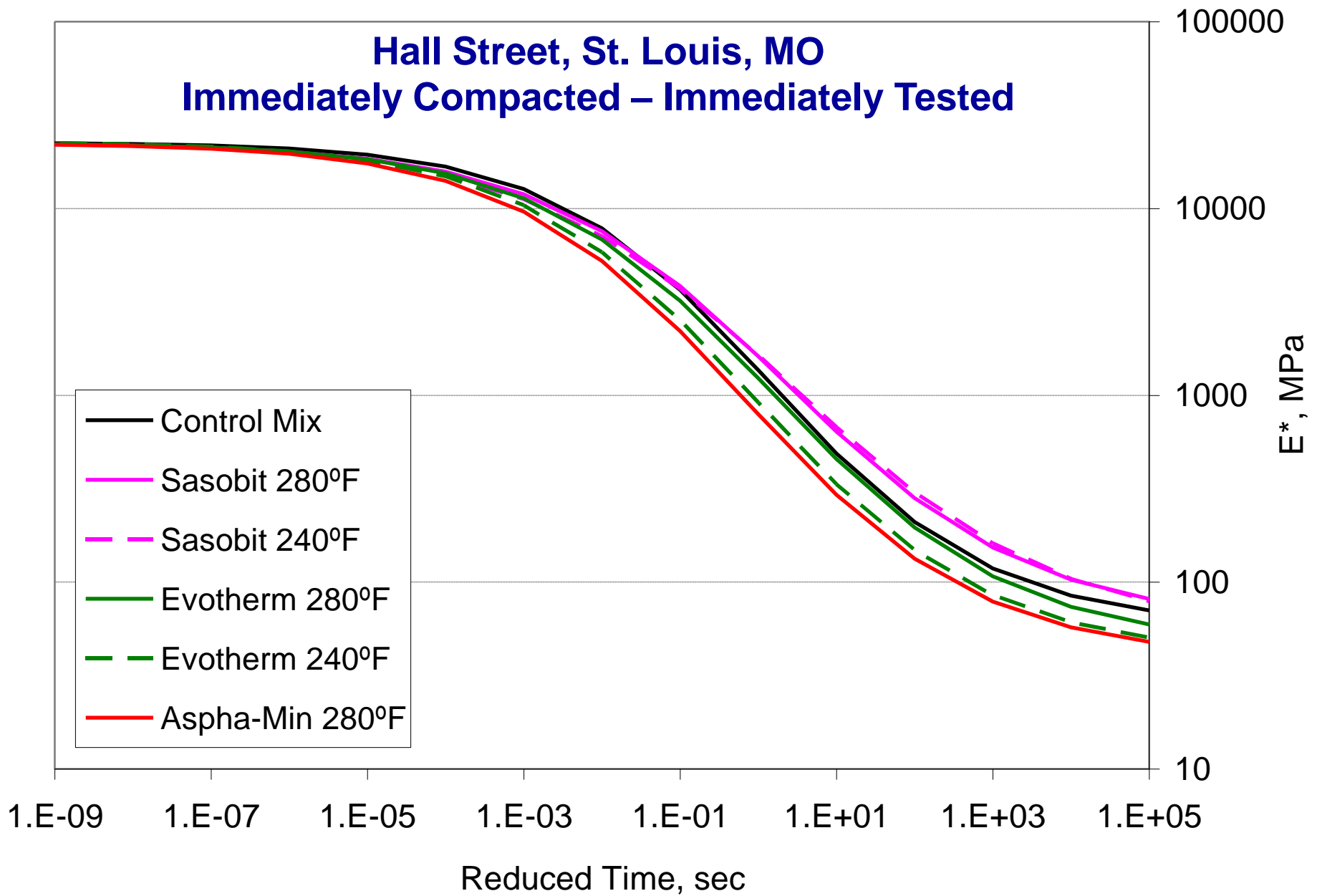


IPC Global  
AMPT Device



# Hall Street, St. Louis, MO

## Immediately Compacted – Immediately Tested





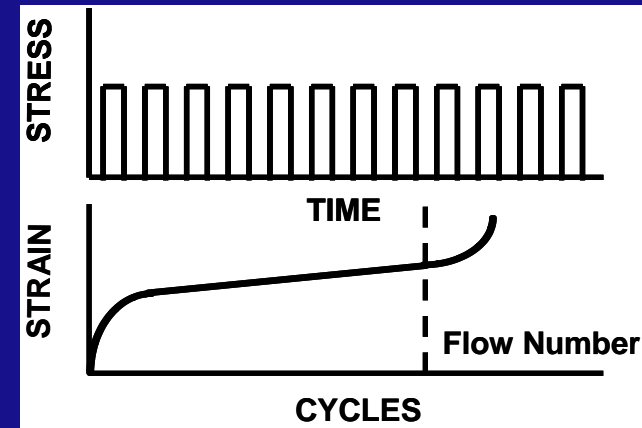
# Flow Number, $F_n$

## ⊕ Loading

- ⊞ Axial load applied for 0.1 second with 0.9 second rest period

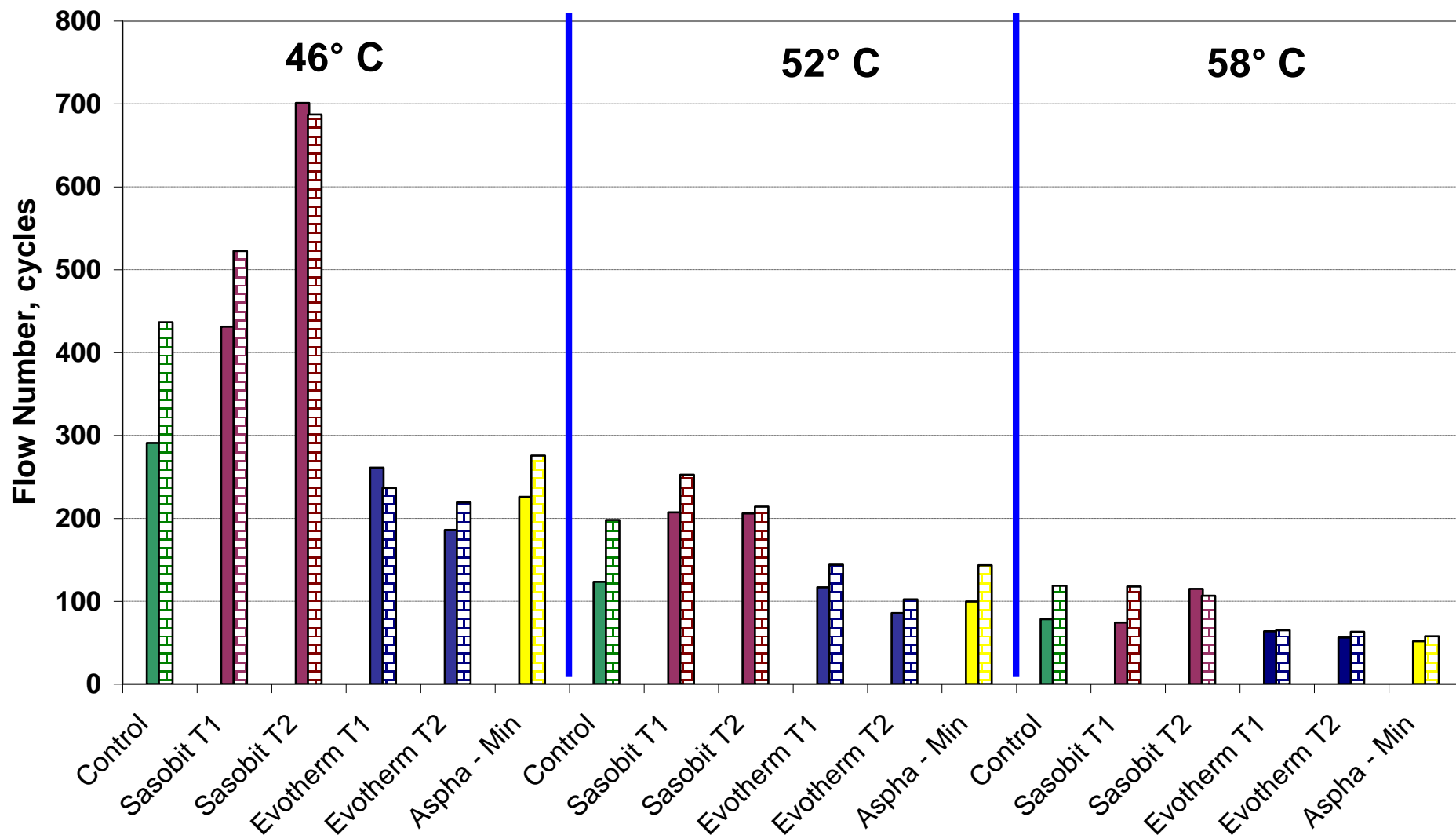
## ⊕ Test Temperatures

- ⊞ 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

# Immediate and Delayed Test Specimens





# *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



# *WMA Technical Working Group (TWG)*

● FHWA / NAPA sponsored

● Co-Chairs

■ Matthew Corrigan, FHWA

■ Ron White, Industry

● Represented

■ State DOT

■ AASHTO

■ State APA

■ Labor

■ NCAT

■ NIOSH

■ Hot Mix Asphalt Industry





# WMA TWG Accomplishments

- ❁ [www.warmmixasphalt.com](http://www.warmmixasphalt.com)
- ❁ Material Testing Framework
- ❁ Emission Testing Framework
- ❁ WMA Best Practices Document
- ❁ Research Needs Identified
  - ❑ Developed three (3) research statements
  - ❑ Submitted through AASHTO to NCHRP
    - All projects highly ranked by SCOR
    - Total \$1.4 million
- ❁ WMA Guide Spec for Highway Construction



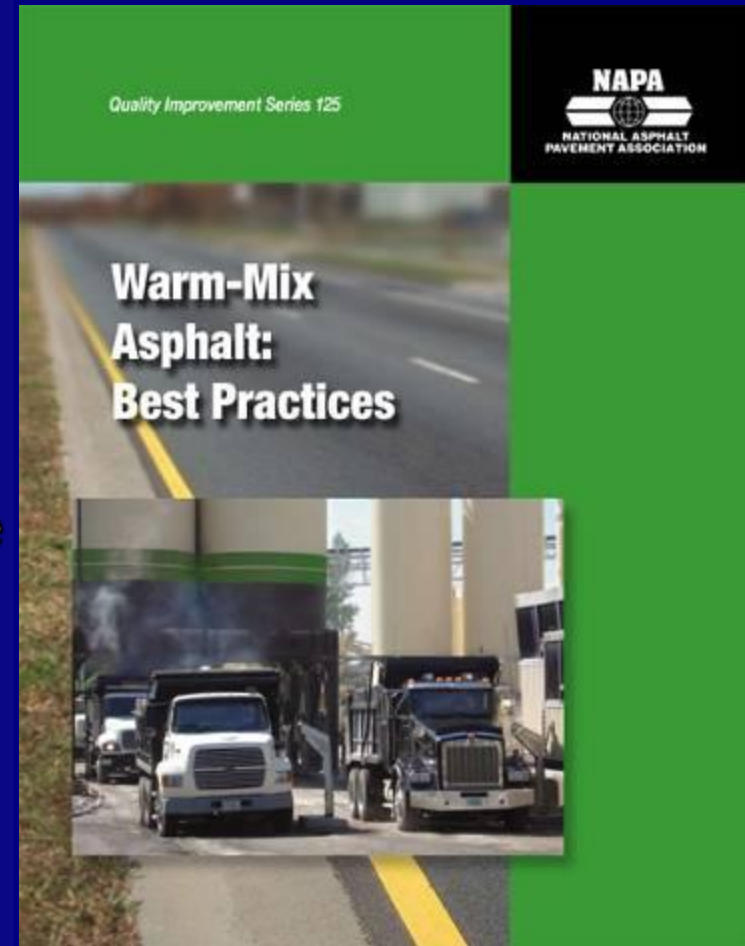




# Warm Mix Asphalt: Best Practices

## Quality Improvement Series (QIP) 125

- ❑ Stockpile Moisture Management
- ❑ Burner Adjustments and Efficiency
- ❑ Aggregate Drying and Baghouse Temperatures
- ❑ Drum Slope and Flighting
- ❑ Combustion Air
- ❑ RAP usage
- ❑ Placement Changes



# AASHTO Guide Specification for Highway Construction 2008

## DIVISION 400 FLEXIBLE PAVEMENTS

### SECTION 401 HOT MIX ASPHALT (HMA) PAVEMENTS

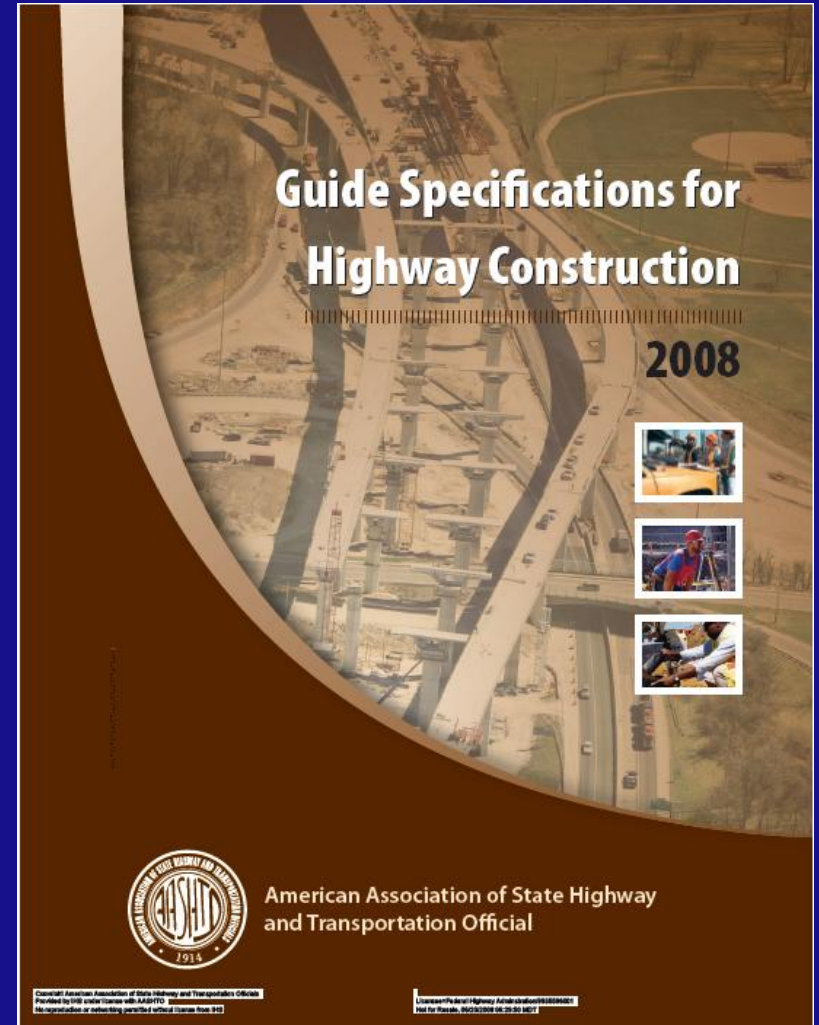
401.01 Description

401.02 Material

401.03 Construction

401.04 Measurement

401.05 Payment



# Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

## DIVISION 400 - Asphalt Pavements and Surface Treatments

### SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENTS

#### 4XX.01 Description

#### 4XX.02 Material

#### 4XX.03 Construction

#### 4XX.04 Measurement

#### 4XX.05 Payment

## Warm Mix Asphalt (WMA) Guide Specification for Highway Construction

### Division 400 - Asphalt Pavements and Surface Treatments

#### SECTION 4XX - WARM MIX ASPHALT (WMA) PAVEMENT

Warm mix asphalt (WMA) is the generic term used to describe the reduction in production, paving, and compaction temperatures achieved through the application of one of several WMA technologies.

Some modifications to HMA plants may be necessary to accommodate the WMA technologies as noted in Section 4XX.03 Construction.

Production and paving temperatures may need to be increased for higher reclaimed asphalt pavement (RAP) contents, increased haul distances, decreased ambient temperatures, or other WMA project specific conditions.

All provisions for the production and placement of conventional HMA mixtures as stipulated in [\[applicable Agency specification\]](#) are in force except as noted below.

#### 4XX.01 Description

Construct one or more courses of plant produced warm mix asphalt (WMA) pavement on a prepared foundation, using virgin aggregate or a combination of virgin and/or reclaimed aggregate material (RAM) and prescribed manufactured WMA additives and/or WMA plant process modifications. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture, and reclaimed asphalt shingles (RAS) are permitted at the current [\[Agency specified\]](#) percentages, provided that the mixture meets all the requirements of these specifications.

#### 4XX.02 Material

WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185°F to 275°F. *(Note: The upper temperature range is appropriate for modified asphalt binders and WMA mixtures which include higher percentages of reclaimed asphalt pavement.)*

Provide materials as specified in:

Aggregate	Subsection XXXX
Liquid Antistriper	Subsection XXXX
Asphalt Binder	Subsection XXXX
HMA Additives	Subsection XXXX
Lime for Asphalt Mixtures	Subsection XXXX
Mineral Filler	Subsection XXXX
Reclaimed Asphalt Pavement	Subsection XXXX
Reclaimed Aggregate Material	Subsection XXXX
Reclaimed Asphalt Shingles	Subsection XXXX



The following **references** detail specifics related to **plant modifications and operational changes** in order to **maximize the benefits of WMA** production:

- Quality Improvement Series 125 (QIP 125), “Warm Mix Asphalt: Best Practices”,
- Quality Improvement Series 126 (QIP 126), “Energy Conservation in Hot Mix Asphalt Production,” and
- Environmental Council 101 (EC-101), “Best Management Practices to Minimize Emissions During HMA Construction”)



# Ongoing National Research



TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES



- ❖ NCHRP 9-43 “Mix Design Practices for Warm Mix Asphalt” \$500,000
- ❖ NCHRP 9-47 “Engineering Properties, Emissions, and Field Performance” \$900,000



# Proposed National Research



TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES



- ❖ D-06 “Long Term Field Performance of Warm Mix Asphalt Technologies”  
\$1,200,000
- ❖ D-08 “Moisture Sensitivity of Warm Mix Asphalt Technologies” \$600,000
- ❖ D-05 “Development of a New Protocol for Determination of Moisture Susceptibility of Asphalt Mixtures” \$300,000



# Future National Research?



TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES



- ❖ Short Term Ageing of WMA Binders During Production
- ❖ Differences between Field Produced WMA and HMA Volumetric Properties
- ❖ More to come ...??



# *Future National Research?*



Photo courtesy of Texas A&M University





# *Additional Research*

## *Binder ETG Research Projects*

- ❖ Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder
- ❖ Evaluate the effect of wax additives on physical properties and characteristics of asphalt binders and their subsequent performance in mixtures.



# *Binder ETG Research Projects*

- ❖ Asphalt – One (1)
  - ❖ Lion Oil PG64-22 Eldorado, AR Refinery
- ❖ Wax Additives – Nine (9)
  - ❖ Non-Paraffin Wax Additives
- ❖ Aggregates
  - ❖ Vulcan Barin Quarry Granite, Columbus, GA
- ❖ Mix Design
  - ❖ 12.5mm Dense Graded SuperPave Gyratory
    - ~5.5% Binder
    - ~7.0% Air Voids



# *Binder ETG Research Projects*

- ✚ Fourier Transform Infra-Red Spectroscopy
- ✚ Gel Permeation Chromatography
- ✚ Glass Transition ( $T_g$ )
- ✚ Branching
- ✚ Physical Hardening (32 days saturation at  $-12^\circ\text{C}$ ) Bending Beam Rheometry
  - ✚ Testing at 1,2,4,8,16 and 32 Days
- ✚ Multi-Step Creep Recovery (MSCR)
- ✚ Binder Stress Sweep Fatigue
- ✚ Additional testing ... etc.



# 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

### Hamburg wheel tracking

### Asphalt Pavement Analyzer

### Moisture Susceptibility Testing





# How to get WMA into projects?

## Continued Progress

- ❑ Ongoing national research projects
- ❑ Ongoing questions by industry
- ❑ Short performance history
- ❑ Multiple technologies and more on the way ...



## Must prove WMA quality and performance

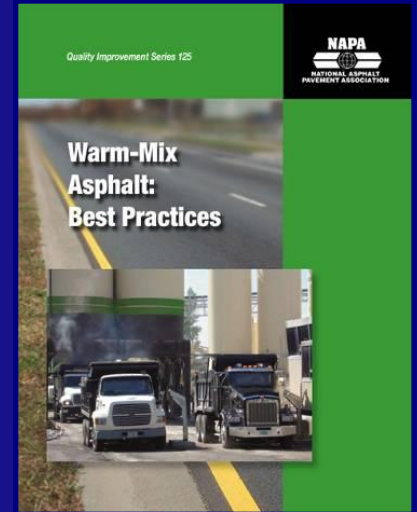
- ❑ Hamburg / Asphalt Pavement Analyzer
- ❑ Tensile strength / TSR





# How to get WMA into projects?

- ❖ Not a cure for poor practice
- ❖ Production optimization
  - ❖ Stockpile moisture management
  - ❖ Burner size and efficiency
  - ❖ Drum slope, dwell time, and flighting
  - ❖ Etc.
- ❖ Cannot request waiver of existing HMA performance requirements
  - ❖ Need to find a way to make technologies pass existing testing requirements





# *Too many activities at one time?*

- ⊕ WMA + high RAP
- ⊕ WMA + shingles
- ⊕ WMA + rubber
- ⊕ WMA + asphalt binder extenders
- ⊕ WMA + asphalt binder alternatives
- ⊕ WMA + other additives (compatibility?)
- ⊕ WMA - one asphalt roller compactor



# *Experimental Features*

- ❖ FHWA policy prohibits the use of a patented or proprietary material, specification, or process ....:
- ❖ ...competitive bidding with equally suitable unpatented items
- ❖ ...used for research or for a special type of construction on relatively short sections of road for experimental purposes
- ❖ <http://www.fhwa.dot.gov/construction/cqit/proprietary.cfm>





# Experimental Features

- ❖ *Experimental Feature - a material, process, method, equipment item, traffic operational device, or other feature that: (1) has not been sufficiently tested under actual service conditions to merit acceptance without reservation in normal highway construction, or (2) has been accepted but needs to be compared with alternative acceptable features for determining their relative merits and cost effectiveness.*



# *Experimental Features*

- ❖ *Construction Projects Incorporating Experimental Features*
- ❖ *Federal-Aid Policy Guide*
  - ❖ *G6042.4 - Construction Projects Incorporating Experimental Features*
- ❖ *Justification, Work Plan, Evaluation Criteria, Control Section, Cost Data*
- ❖ *Annual Reporting Requirements*
- ❖ *<http://www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm>*



# Written Summary of WMA @ <http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm>

Warm Mix Asphalt Technologies and Research - Asphalt - Pavements - FHWA - Windows Internet Explorer

<http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm>

File Edit View Favorites Tools Help

U.S. Department of Transportation  
Federal Highway Administration

**Pavements**

Research Design Construction Preservation Maintenance Management Rehabilitation

FHWA > Engineering > Pavements > Asphalt > Warm Mix Asphalt

**Design and Analysis**

**Materials and Construction Technology**

**Management and Preservation**

**Surface Characteristics**

**Construction and Materials Quality Assurance**

**Environmental Stewardship**

**Warm Mix Asphalt Technologies and Research**

European countries are using technologies that appear to allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies have been labeled Warm Mix Asphalt (WMA). The immediate benefit to producing WMA is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt (HMA) to temperatures in excess of 300° F at the production plant. These high production temperatures are needed to allow the asphalt binder to become viscous enough to completely coat the aggregate in the HMA, have good workability during laying and compaction, and durability during traffic exposure. With the decreased production temperature comes the additional benefit of reduced emissions from burning fuels, fumes, and odors generated at the plant and the paving site.

There are three technologies that have been developed and used in European countries to produce WMA:

1. The addition of a synthetic zeolite called Aspha-Min® during mixing at the plant to create a foaming effect in the binder.
2. A two-component binder system called WAM-Foam® (Warm Asphalt Mix Foam), which introduces a soft binder and hard foamed binder at different stages during plant production.
3. The use of organic additives such as Sasobit®, a Fischer-Tropsch paraffin wax and Asphaltan B®, a low molecular weight esterified wax.

The Aspha-Min and Sasobit products have been used in the United States. Additional technologies have been developed and used in the United States to produce WMA:

4. Plant production with an asphalt emulsion product called Evotherm™, which uses a chemical additive technology and a "dispersed asphalt technology" delivery system.
5. The addition of a synthetic zeolite called Advera® WMA during mixing at the plant to create a foaming effect in the binder.

All five technologies appear to allow the production of WMA by reducing the viscosity of the asphalt binder at a given temperature. This reduced viscosity allows the aggregate to be fully coated at a lower temperature than what is traditionally required in HMA production. However, some of these technologies require significant equipment modifications.

This technology could have a significant impact on transportation construction projects in and around non-attainment areas such as large metropolitan areas that have air quality restrictions. The reduction in fuel usage to produce the mix would also have a significant impact on the cost of transportation construction projects.

The benefits of these technologies to the United States in terms of energy savings and air quality improvements are promising but these technologies need further investigation and research in order to validate their expected performance and added value. It is important to note that producing HMA at lower temperatures is the desired product to achieve these benefits, not the particular technology that is used to produce the WMA mix.

**Product Descriptions**

**Events**

- o [View all Upcoming Pavements Events](#)

**More Information**

- o [Foamed Asphalt](#)
- o [Pavement Publications](#)
- o [Warm Mix Asphalt: European Practice](#)

**Contact**

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U.S. Department of Transportation  
Federal Highway Administration

Done Internet 100%

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