

Warming up to WMA:

Applications by Northern States



Informational Webinar:
June 1st, 2011

Brief Project Introduction

Dr. George Dewey, PhD

gdewey@mtu.edu

Associate Professor, Transportation Enterprise
Advisor

Department of Civil and Environmental Engineering
Michigan Technological University

Disclaimer

The contents of this presentation reflect the views of the authors, who are responsible for the facts and accuracy of the information presented herein. This presentation is disseminated under the sponsorship of the Minnesota Department of Transportation in the interest of information exchange. The contents do not necessarily reflect the official views or policies of the Minnesota Department of Transportation or the Federal Highway Administration. This presentation does not constitute a standard, specification, or regulation. The U.S. Government assumes no liability for the contents or use thereof.

Acknowledgements

- Minnesota Department of Transportation
www.dot.state.mn.us
- Transportation Engineering Road Research Alliance (TERRA)
www.terraroadalliance.org
- University Transportation Center for Materials in Sustainable Transportation Infrastructure at Michigan Tech (UTC-MiSTI) www.misti.mtu.edu
- Technical Advisory Volunteers



Transportation Enterprise

- Michigan Tech's Enterprise Program
 - Undergraduate, hands-on, team-based learning
 - Real challenges and problems facing the industry
 - Transportation Enterprise projects (2010-11)
 - Sustainability Model for a Concrete Rail Tie Producer
 - Electric Vehicle Charging Infrastructure Study
 - Predictive Model for Carbonate Aggregate Polishing
 - WMA Synthesis of Northern States

WMA Synthesis Project

- Team
 - Ben Kohler, Tim Nygard, Paul Kopanna, Wes Hinline, and Luke Arnold
- Two semesters – 1 to 2 credits per semester
 - Understand the problem/challenge, learn the technology and begin discovery calls with industry professionals (Fall)
 - Finalize discovery, attend Industry meeting, develop draft report, identify possible speakers for the webinar (Spring)

Luke Arnold's

An Introduction to Warm Mix Asphalt

Outline

- What Is WMA
- Potential Benefits of WMA
- Types of WMA
- Differences between these technologies
- Concerns with WMA pavements
- How these concerns are being addressed

What is WMA?

- Essentially, WMA is HMA produced at a lower temperatures
- WMA leads to
 - Lower viscosity of asphalt mix
 - Decreased binder aging

Potential Benefits

- Improved flow, even at lower temperatures
 - Compaction attainable at lower temperatures
 - Stiffer mixes may be easier to compact

Potential Benefits

- Lower production temperature leads to
 - Slower rate of cooling
 - Energy savings
 - Fewer emissions

Potential Benefits

- Other Possibilities
 - Increased RAP/RAS usage
 - Better cold weather performance
 - Longer paving season

Types of WMA

- Foaming
- Additives

Foaming Technologies

- Addition of water causes volume expansion
 - Earlier aggregate coating
 - Increased workability
- Different types of Foaming Processes
 - Water Injection
 - Zeolites
 - Moist aggregate
- Temperature reductions of $\sim 30^{\circ}\text{F}$

Additives

- Chemical Additives
 - Reduced viscosity of mix
 - Temperature reductions of 75°F
- Organic Additives (wax)
 - Wax dissolves into liquid asphalt
 - Reduces viscosity of mix

Not All WMA is Equal

- Each technology has its own inherent limitations

Foaming Processes

□ Water Injection Systems

- Largest initial investment (\$50,000-\$120,000)
- Fairly fast payback period
- At 30°F ~ 10% reduction in fuel consumption
- ~70c saved per ton of mix
- May be difficult to control volumetrics
- Typically not used during freezing temperatures

Foaming Processes

- Zeolites
 - Plant modification necessary (\$35,000-\$60,000)
 - Cost of additives (around \$1-2 per ton)
 - No problem's controlling volumetrics

Chemical Additives

- Chemical Additives
 - Largest temperature reductions (up to 75°F)
 - More environmental benefits?
 - Less binder aging
 - Typically little to no initial investment
 - Must pay for additives with each use (\$2-\$5 per ton)

Organic Additives

- Organic Additives
 - ~50°F temperature reduction
 - Some technologies can be blended at the asphalt terminal
 - Plant modification needed for plant blending
 - Cost of additive \$2-\$4 per ton of mix
 - Paraffin waxes (Sasobit) may modify PG Binder grade

Further Research Needs

- Rutting
- Long term performance
- Need for evaluating technologies
- Developing specifications for the use of WMA
- Mix Design
- Economic Feasibility

Final Thoughts

- Many of the research needs are currently being addressed
 - Several large NCHRP projects to evaluate long term performance, mix design, environmental impact and costs
 - Rutgers University – Effect of RAP of WMA
 - Oklahoma University – QC/QA testing differences

<http://www.trb.org/Main/Home.aspx>

WMA Technologies

■ Foaming Processes

- Aquablack
- AquaFoam
- Double Barrel Green (DBG)
- Terex
- Advera (Zeolite)
- Aspha-Min (Zeolite)
- Low Emission Asphalt (LEA)
- Meeker Warm Mix
- Accu-Shear
- Tri-Warm Mix Injection System

□ Chemical Additives

- Cecabase RT
- Evotherm
- Hypertherm
- Rediset WMX

WMA Technologies

- Organic Additives
 - Astech PER
 - Sasobit
 - Sonnewarmix
 - Thiopave
 - TLA-X

Federal Highway Administration
Every Day Counts
Innovation Initiative



WARM MIX ASPHALT





Why?

“We are continuously looking for new ideas, working with stakeholders to bring new products and innovative processes to market.” – V. Mendez

- Challenge... to make
Every Day Count!



Victor Mendez
FHWA Administrator



Greg Nadeau
Deputy Administrator



What are the innovations?

- Warm Mix Asphalt
- Precast Bridge Elements
- Geosynthetic Reinforced Soil
- Safety Edge
- Adaptive Traffic Control Technology





How Were They Selected?

- Stakeholder Rating Panel

January 26th 2010

- NACE
- AASHTO
- South Dakota DOT
- ARTBA
- AGC
- FHWA Divisions & HQ





3 Keys of the EDC Business Model



Key Partners

State DOT
Local Public Agencies
Contractors
Consultants
Industry Suppliers

Key Resources

WMA Core Team
FHWA Division Staff
LTAP Staff
AASHTO
Other Associations

Key Perspective

1. **Focus on advocating and recommending technologies that meet the States' needs;**
2. Develop an internal network of individuals trained to deploy new, national, initiatives at the state and local level;
3. Focus on EDC priority initiatives; and
4. Ensuring all staff incorporates new business model perspective into day to day activities.



Warm Mix Asphalt 101



Just the BASICS
please...



Warm Mix Asphalt 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 US, ***WMA pavements must have equal or better performance when compared to traditional HMA pavements.***





Warm Mix Asphalt

Various technologies are used, which allows the asphalt mixture to be produced, transported, placed, and compacted at lower temperatures ...

Typical production temperature reduction **30 to 75°F**

WMA Technology Categories:

- Materials Processing
- Organic Additives
- Chemical Additives
- Foaming Processes
- Hybrid Systems (combination of technologies)





Brief History...

- 1995 Preliminary Lab Experiments
- 1997 German Bitumen Forum
- 2000 Euroasphalt & Eurobitume Congress
- NAPA 2002 European Scan Tour
 - Germany and Norway
- NAPA 2003 Annual Convention
 - San Diego
- 2004 First public demonstration in US
- 2005 WMA Technical Working Group
- 2007 AASHTO FHWA International Scan Tour
- 2008 First US International Conference on WMA





Factors Driving Development of WMA

- Improvement in field compaction... less variable ... better performance!!!
- Worker comfort ... reduced fatigue
- Environmental and sustainable development concerns, “*Green Highway Construction*”
 - Reduction in energy consumption (fossil fuels)
 - Reduction in CO₂ and other emissions
- Extension of paving season and potential for longer haul distances



Memorable Message

- **I.C. = I.P.**

Improved Compaction = Improved Performance

- **F.E.W. key benefits...**

- Fuel
- Emissions
- Worker Comfort





~~Implementation~~

Deployment Status

- Definition (NCHRP Synthesis 355)
- ***Deployment: The systematic process of distributing an innovation for use.*** *This term implies a relatively broad use, rather than pilot, demonstration, or incidental use of the innovation. A technology can be considered deployed when it is used multiple times within an organizational or group context, such as use resulting from a newly written specification.*



Warm Mix Asphalt Implementation Status

Potential Barriers

and Performance Metrics of EDC...





Deployment Status

- ▶ WMA projects have been completed in over 40 States
- ▶ At least 12+ States have adopted permissive specifications

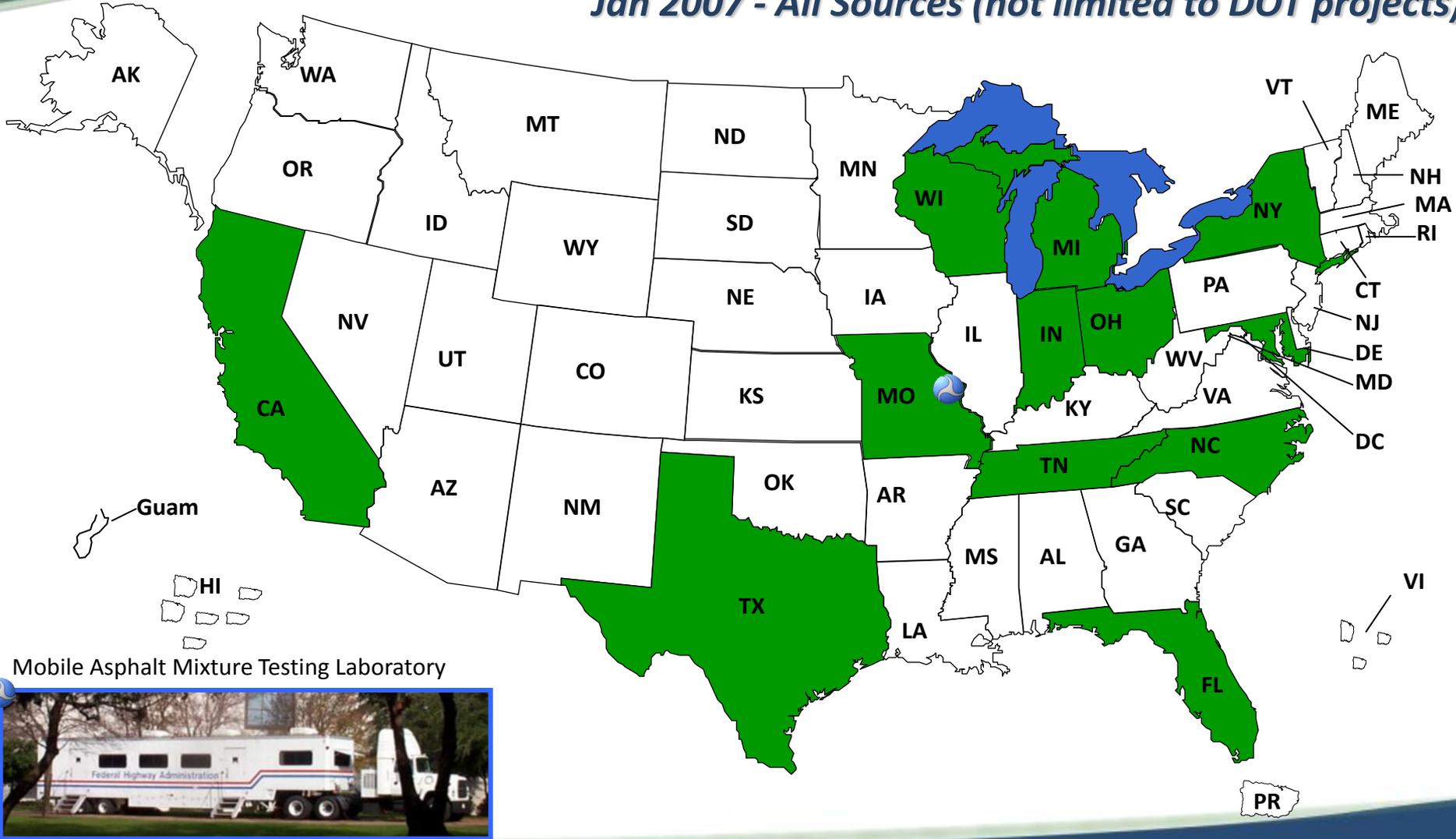
Photo: Maine DOT WMA Demo...





WMA Trials & Demonstration Projects

Jan 2007 - All Sources (not limited to DOT projects)



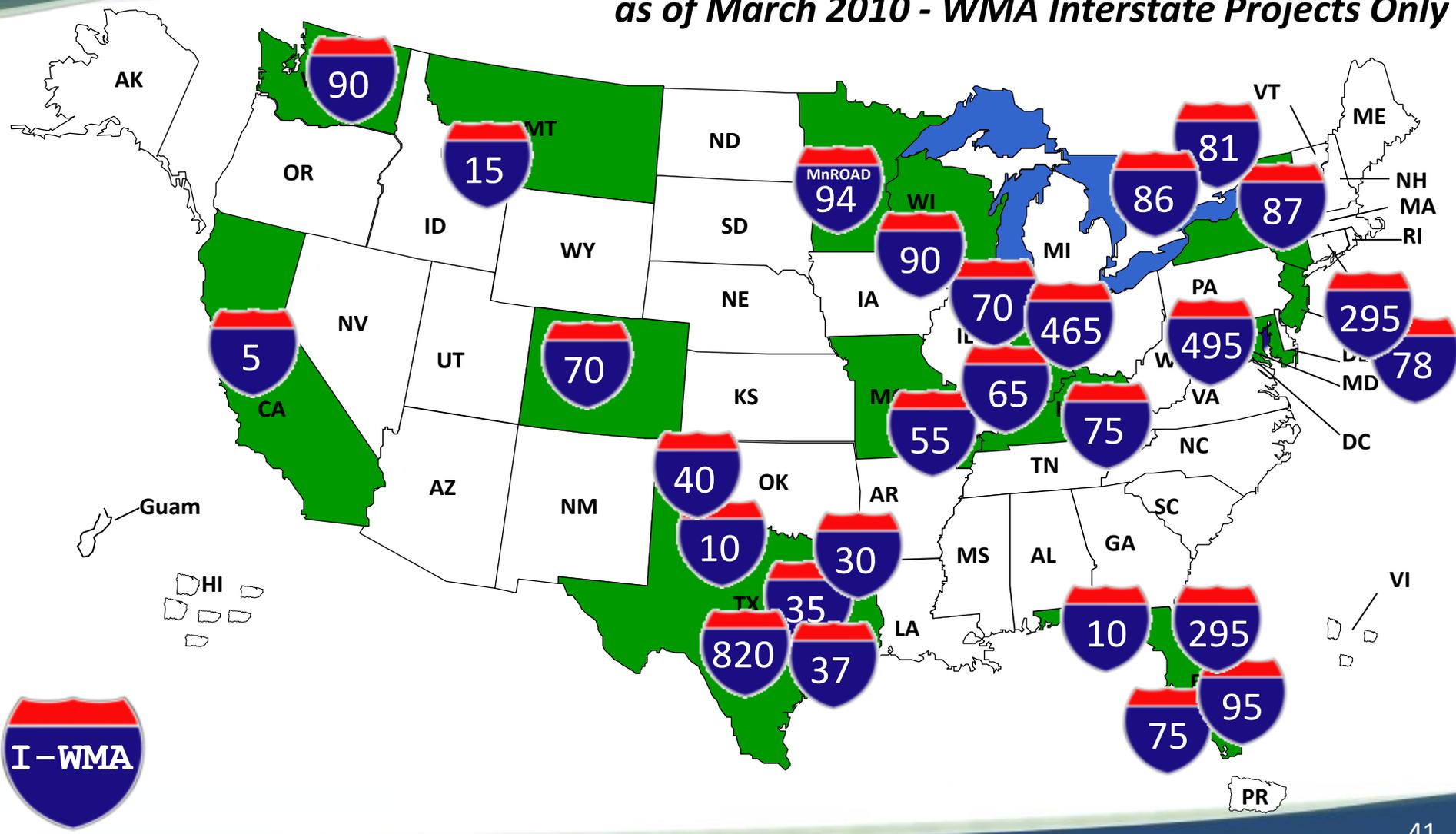
Mobile Asphalt Mixture Testing Laboratory





Interstate Highway WMA Usage

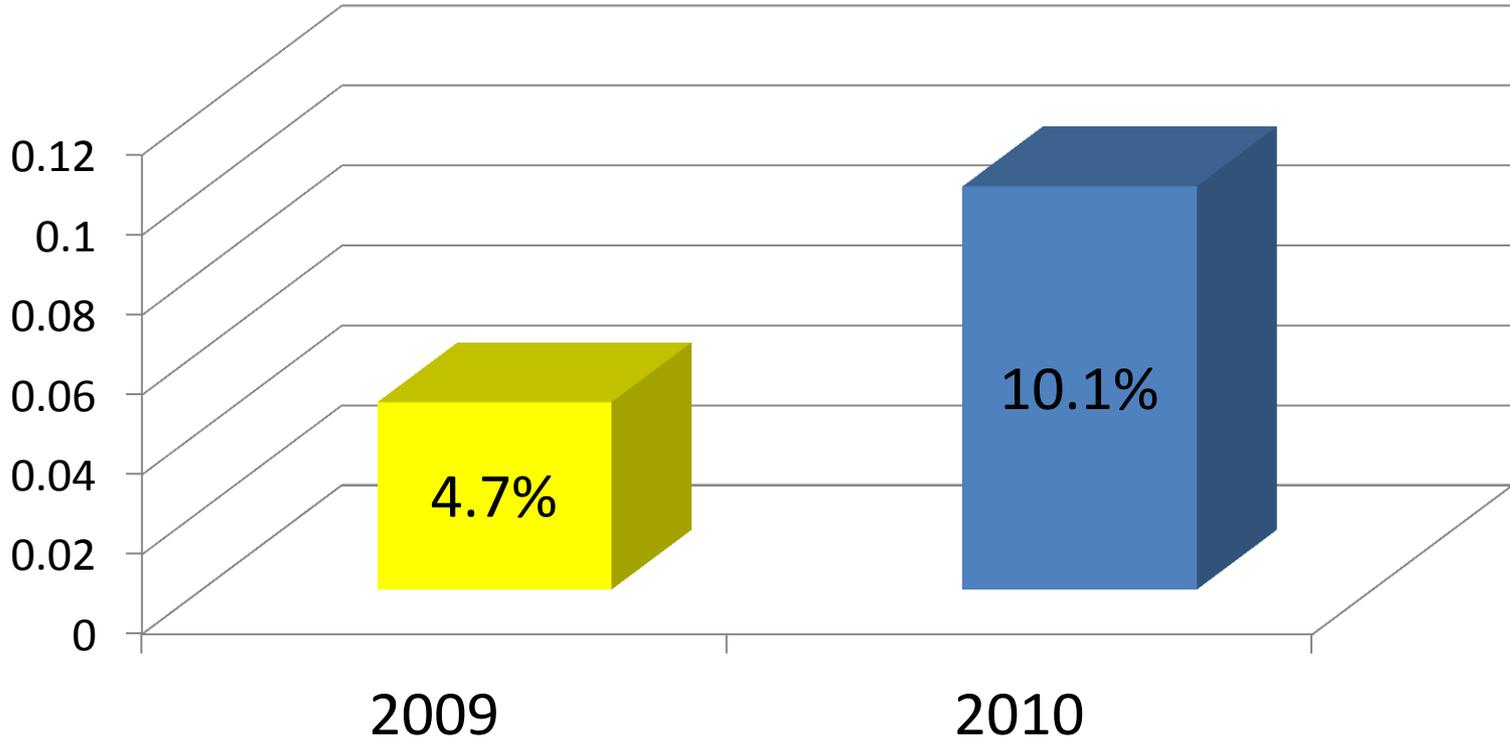
as of March 2010 - WMA Interstate Projects Only





WMA Usage

Percentage of Total Asphalt Production in US





Potential Barriers



- There are several approaches being employed to allow WMA by SHAs...
 - Florida/Texas – Approved/Qualified Products List
 - Texas/Illinois – Performance Approach
 - WMA with Hamburg LWT for rutting & moisture damage
 - Illinois/New York – Experimental Features Program
 - www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm
- Challenging: Working with each Agency to find the best approach for them!



Potential Barriers



- WMA technologies can not be simply “dropped in” to an existing HMA mix design or HMA production facility
- Challenge: WMA technologies require mix design changes, production operational changes, and greater QC and best practices for the contractor to achieve all WMA benefits, including fuel savings and lower emissions





Performance Metrics

1. By December 2011, 40 State DOTs and all Federal Lands Divisions will have a specification &/or contractual language that allows WMA on Federal-aid or Federal Lands projects.
2. By December 2012, at least 30 State DOTs will have achieved set targets for WMA usage.





Ex. Performance Measures

- Target % of asphalt production
 - Ex. 15% or more uses WMA technologies
- Target % of asphalt projects specify WMA
 - Ex. 20% or more
- Target % of asphalt projects allow WMA (permissive spec)
 - Ex. 50% or more allow...
- Target number of demonstration/trial projects using WMA are placed AND standard WMA specification/contract language is developed.





Warm Mix Asphalt

General Technology Categories:

- Materials Processing
- Organic Additives
 - wax, zeolites, other
- Chemical Additives
- Foaming Processes
 - water injection, zeolites
- Hybrid Systems
(combination of technologies)



HMA @ 320°F

WMA @ 250°F



How Many WMA Technologies are Available in the US?

Currently over 30 Technologies are Marketed and Available in the US.



More to come ...

Many other technologies are also used Internationally.



National Research Initiatives

- 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





National Research Initiatives

- NCHRP 9-43 “*Mix Design Practices for Warm Mix Asphalt*” \$500,000
- The full report and appendices are available at the following link:

[http://www.trb.org/Main/Blurbs/Mix Design Practices for WarmMix Asphalt 165013.aspx?utm_medium=email&utm_source=Transportation%20Research%20Board&utm_campaign=TRB+E-Newsletter+-+05-24-2011&utm_content=Customer&utm_term=](http://www.trb.org/Main/Blurbs/Mix_Design_Practices_for_WarmMix_Aspphalt_165013.aspx?utm_medium=email&utm_source=Transportation%20Research%20Board&utm_campaign=TRB+E-Newsletter+-+05-24-2011&utm_content=Customer&utm_term=)





- 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 09-43

- Address the increasingly wide range of WMA technologies and processes
- Design Mixtures Based on AASHTO M323
 - Materials Selection
 - Volumetric Design
 - Moisture Damage and Rutting
 - Coating and “Compactability”
- Develop AASHTO Standard Practice
 - Modified AASHTO R35 for WMA
 - Short Term Conditioning
 - 2 hours at compaction temperature





(Final Report) NCHRP 09-43

- NCHRP 09-43 is complete.
- A Draft Appendix to AASHTO R35 outlining recommended design adjustments for WMA is currently available.
- An NHI web based training on the draft Appendix is currently under development and may be available this fall.





National Research Initiatives

- NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance” \$900,000





NCHRP 09-47A

- 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
 - Emissions & Fuel Savings data collection is complete and the data will be reported later this fall.





National Research Initiatives

- NCHRP 9-49 and 9-49A “Long Term Field Performance of Warm Mix Asphalt Technologies”
 - Project 9-49 is Phase I, “Moisture Susceptibility”
 - Project 9-49A is Phase II, “Long-Term Performance”





NCHRP 09-49

- Phase 1, Moisture Susceptibility
- Texas Transportation Institute at Texas A&M University, College Station, TX
- 30 month duration
- \$450,000 funds available for Phase 1
- Phase 2 (Project 9-49A), Long Term Performance will be initiated late 2011





Anticipated NCHRP Projects

- Project 09-52 *Short-Term Laboratory Conditioning of WMA Mixtures for Mix Design and Performance Testing*
- Project 09-53 *Asphalt Foaming Characteristics for Warm Mix Asphalt Applications*

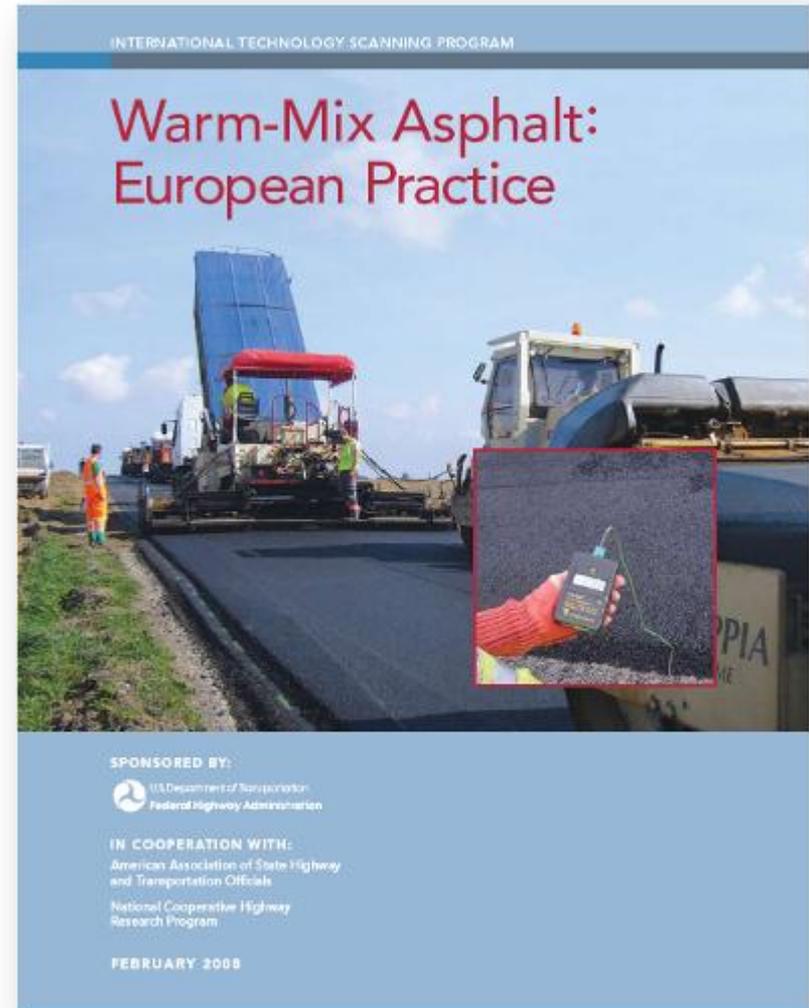
Both are expected to be awarded in 2012





WMA International 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>





AASHTO Guide Specification for Highway Construction 2008

DIVISION 400 FLEXIBLE PAVEMENTS

SECTION 401 HOT MIX ASPHALT (HMA) PAVEMENTS

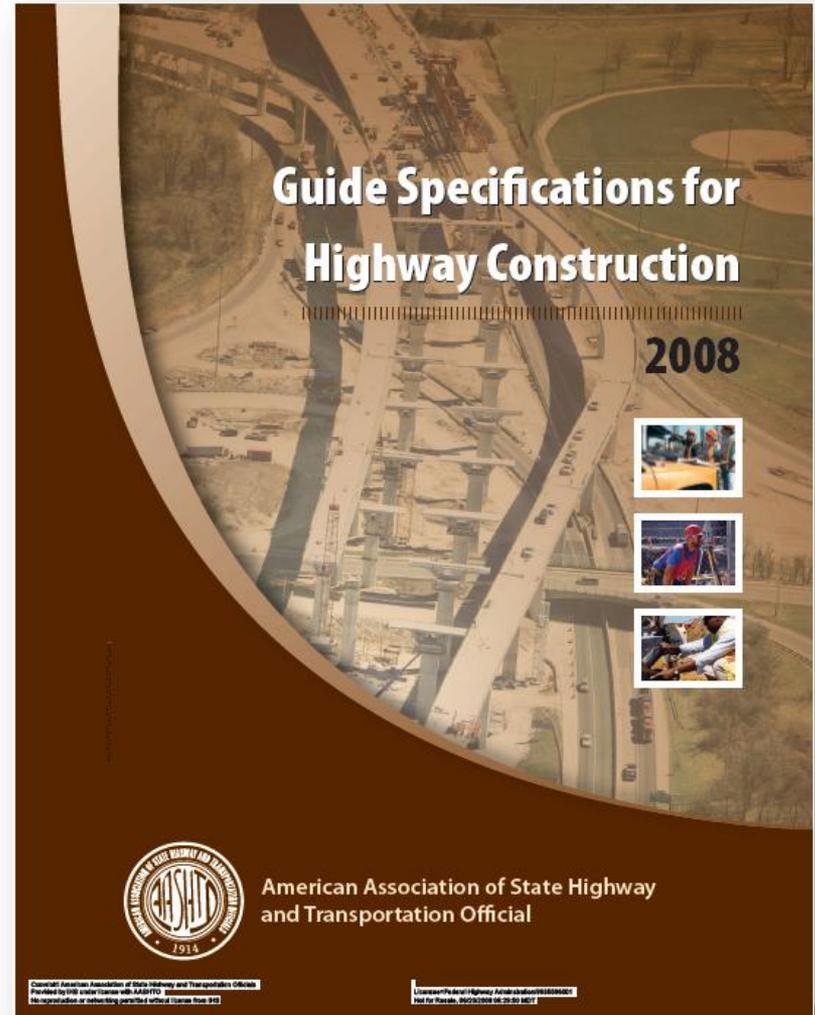
401.01 Description

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

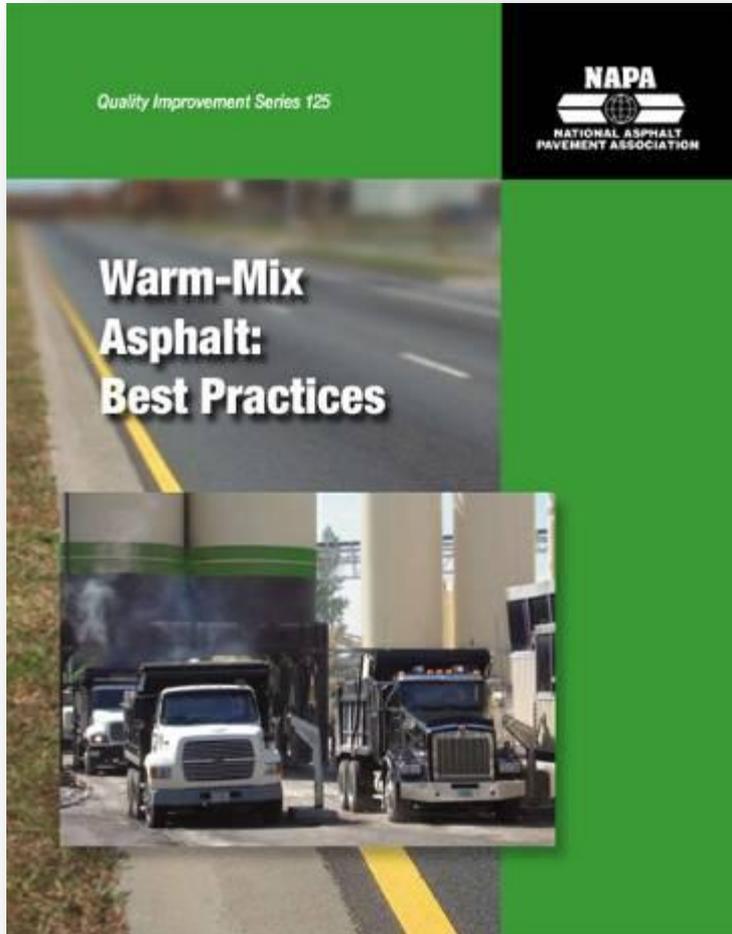
WMA may be produced by one or a combination of several technologies involving HMA plant foaming processes and equipment, mineral additives, or chemicals that allow the reduction of mix production temperatures to within 185°F to 275°F. (Note: The upper temperature range is appropriate for modified asphalt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

Provide materials as specified in:

Aggregate	Subsection XXXX
Liquid Antistrips	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



• Warm-Mix Asphalt: Best Practices

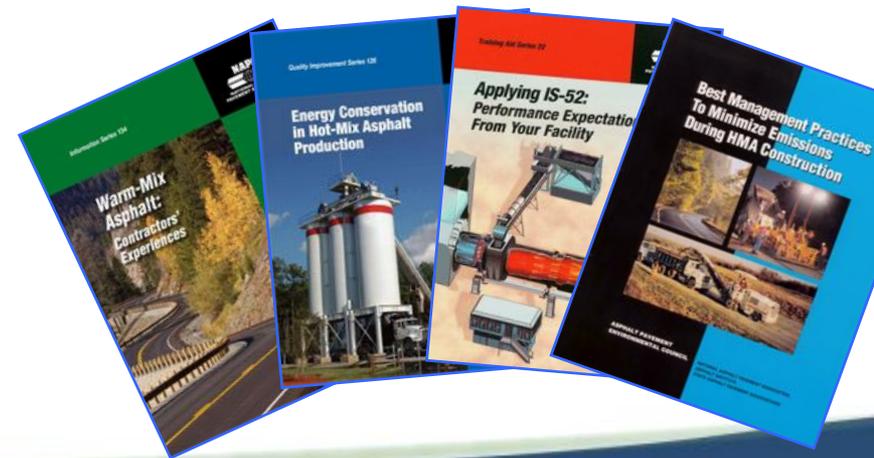


- Stockpile Moisture Management
- Burner Adjustments and Efficiency
- Aggregate Drying and Baghouse Temperatures
- Drum Slope and Flighting
- Combustion Air
- RAP usage
- *Placement Changes*

Quality Improvement Series 125

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”
- Environmental Council 101 (EC-101), “Best Management Practices to Minimize Emissions During HMA Construction”
- “The Fundamentals of the Operation and Maintenance of the Exhaust Gas System in a Hot Mix Asphalt Facility” (IS-52)





Summary of WMA:

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

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

Matthew Corrigan
[Office of Pavement Technology](#)
202-366-1549
[E-mail Matthew](#)

Done

Internet 100%



warmmixasphalt.com

QUICK FINDS

[WMA European Practice Report](#) >>>

[WMA at NAPA Annual Meeting](#) >>>

[WMA Best Practices](#) >>>

[December TWG Meeting](#) >>>

[WMA Test Frameworks](#) >>>

warmmixasphalt.com



Q. Which project is which?

A: Hot-Mix Asphalt

B: Warm Mix Asphalt



Project No. 1



Project No. 2



Memorable Message

- **I.C. = I.P.**

Improved Compaction = Improved Performance

- **F.E.W. key benefits**

- Fuel
- Emissions
- Worker Comfort





Your Questions



Use of Warm Mix Asphalt at NYSDOT

Christopher Euler

New York State Dept. of Transportation

Materials Bureau

Overview

- History of WMA at NYSDOT.
- Technologies used on NYSDOT Projects.
- What did we learn? The good and the bad.
- Current and Future Use of WMA at NYSDOT.

History of WMA at NYSDOT

- Tracking national efforts since 2004.
- Trial sections being placed on NYSDOT roads since 2006

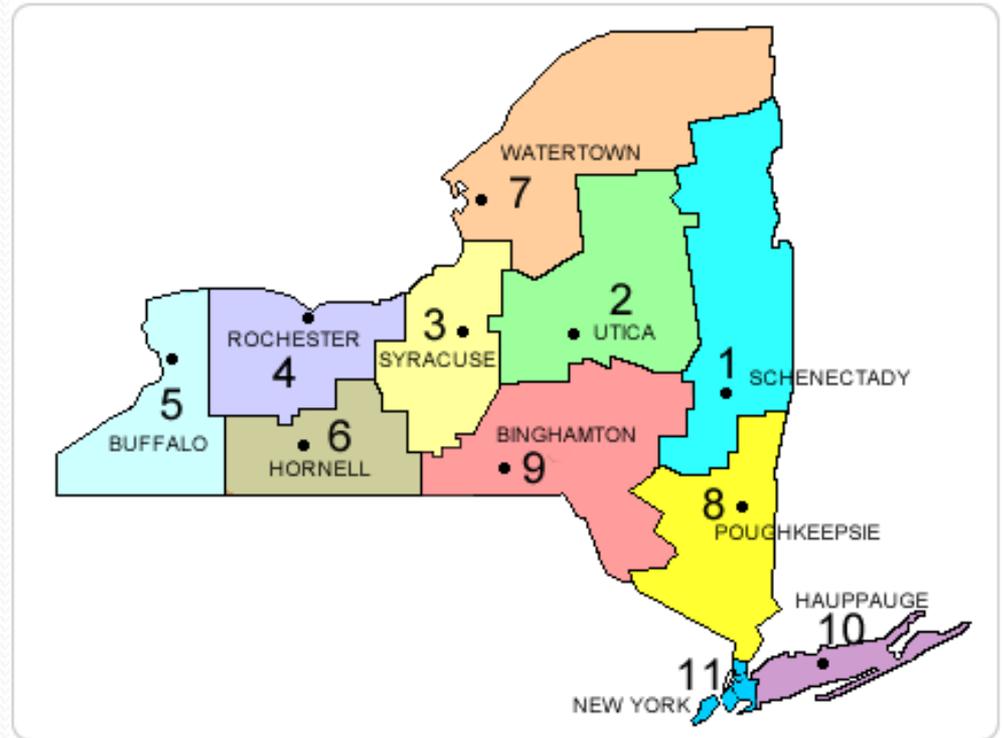


History of WMA at NYSDOT

- From 2006 through 2009.
 - Over 50,000 tons of WMA was placed on various NYSDOT projects.
 - These trial sections were proposed by the contractor/producer, and were allowed to be placed at no additional cost to the state.
 - These trial sections ranged in size from 400 tons to over 3000 tons.

History of WMA at NYSDOT

- Placed in 5 different Regions.
 - Majority of this work has been done in Region 3.
- 5 Different Technologies were used.



Technologies used on NYSDOT Projects

- **Region 1 (Albany)**
 - September 2008 – WMA using the Low Emission Asphalt (LEA) technology was placed on State Route 43 in the town of Stephentown.
 - December 2009 – Evotherm technology was used as a compaction aid on the approach ramp for the Crown Point Bridge ferry service.

Lake Champlain Bridge Crown Point, NY



12/15/2009

**Lake Champlain
Bridge
Crown Point, NY**



Technologies used on NYSDOT Projects

- **Region 3 (Syracuse)**
 - September 2006
 - WMA using the Low Emission Asphalt (LEA) technology was placed on State Route 11 just south of Cortland.
 - WMA using Sasobit technology was placed on State Route 80 in the town Tully.
 - 2007 – Almost 35,000 tons of WMA using the LEA technology was placed on various State roads in Cortland County.
 - October 2009 – WMA using the Terex technology was placed on State Route 104B near the city of Mexico.



**State Route 104B
Mexico, NY**

10/23/2009

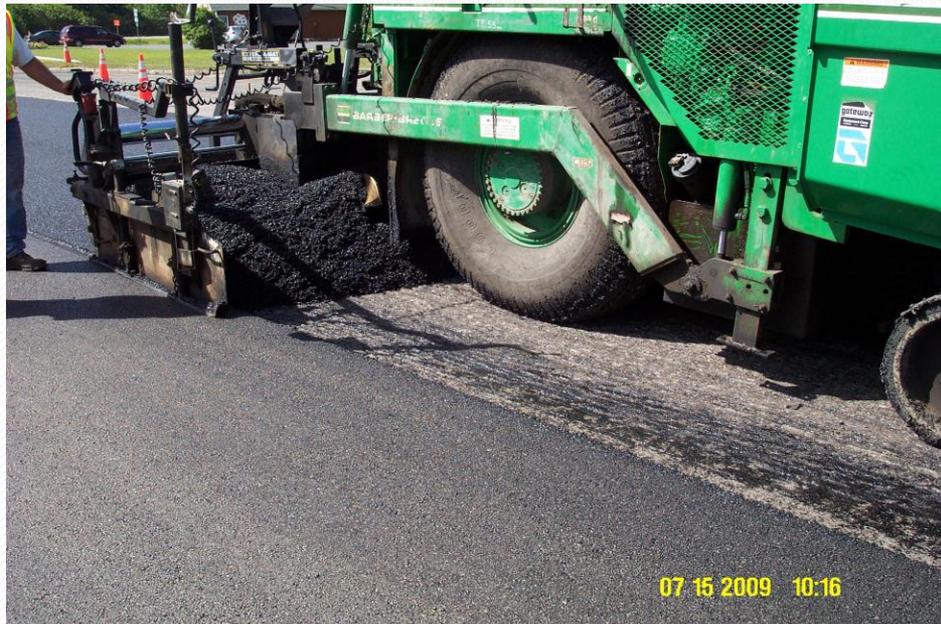
**State Route 104B
Mexico, NY**



10/23/2009

Technologies used on NYSDOT Projects

- **Region 5 (Buffalo)** - July 2009 – WMA using Hypertherm technology was placed on State Route 93 in Lockport.



Technologies used on NYSDOT Projects

- **Region 7 (Watertown)** - June 2008 – WMA using Sasobit technology was placed on State Route 12 in the town of Clayton.
- **Region 9 (Binghamton)** – July/August 2009 – WMA using the LEA technology was placed on State Route 23 in the town of Pitcher.

WMA at other agencies in New York State

- **NYCDOT** – Has used various products on several different projects.
- **NYSTA** – Has used various technologies.
- Various Counties have placed WMA trial sections, including **Albany, Washington, Jefferson, Erie, Westchester, Cortland**, and others.

What did we learn? The good.

- Early age rutting has not been an issue.
- Moisture susceptibility has not been an issue.
 - WMA mixtures meet existing specification requirements.
- Construction practices similar to conventional mixtures.
 - Handwork has not been a big issue.
 - Good pavement densities have been achieved using the same or less effort.

What did we learn? The bad.

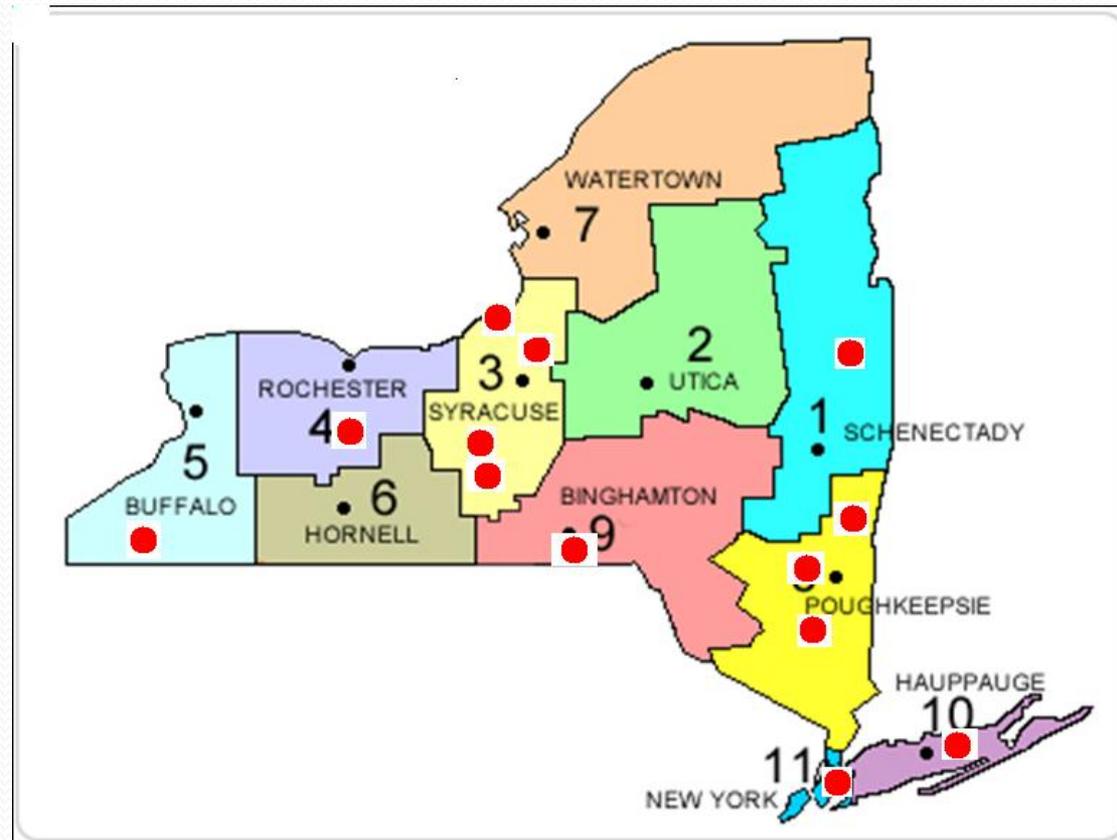
- Every technology is different – one size does not fit all.
 - Laboratory testing modification differ with technology.
 - Test sample conditioning varies.
 - Sample compaction temperature varies.
 - Some technologies require plant modification.
- Late Season paving may require 300°+ F temperatures.

Current and Future Use of WMA at NYSDOT

- In conjunction with other New York Agencies and Industry partners, we have developed
 - Specification.
 - Technology Approval Process.
 - Currently 6 Approved Technologies.
 - NEAUPG has adopted our Approval Process for the Northeast States.

Current and Future Use of WMA at NYSDOT

- 2010
 - 11 projects went out for bid.
 - >30 million ESAL level.
 - 3 courses of WMA over Rubbilized PCC.
 - 2 projects with WMA substitution.



Current and Future Use of WMA at NYSDOT

- 2011
 - Continue with Projects from 2010.
 - Put out more projects for bid.
 - WMA substitutions on selected projects.
- Future
 - Long term implementation looks very promising.
 - A specification that allows the Contractor/Mix Producer to use approved technologies at their discretion.

Thank You

Christopher Euler
New York State Dept. of Trans.
Materials Bureau
Phone 518-457-4581
ceuler@dot.state.ny.us

Warming Up To WMA

Michigan Department of Transportation

**Curtis Bleech
HMA Operations Engineer
June 1 2011**



MDOT Mission

“Providing the highest quality integrated transportation services for economic benefit and improved quality of life.”

Items to Cover

- History
- FHWA's "Every Day Counts"
- Warm Mix Asphalt (WMA)
- Mix Design
- MDOT Moving Forward

History: M-95

- 2006 Contractor Requested to Use WMA
- Payne Dolan – NCAT Sponsored
- Superpave 5E3 – Control & Pilot
- Sasobit Additive
- Original Mix Design Used
- Typical Construction Benefits
- Similar Perf. as the Control to Date

Every Day Counts (EDC)

- FHWA Initiative
- <http://www.fhwa.dot.gov/everydaycounts/>
- EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment.

5 Technologies Identified

- Adaptive Signal Control
- Geosynthetic Reinforced Soil Integration Bridge System
- Prefabricated Bridge
- Safety Edge
- Warm Mix Asphalt (WMA)

WMA: Proven technology

- Improve compaction that improves pavement performance.
- Reduce fuel or energy usage.
- Improve worker comfort by reducing exposure to higher temperatures, fuel emissions, fumes, and odors.
- In addition, WMA technologies allow asphalt mixtures to be hauled longer distances and can extend the paving season due to the ability to maintain workability at lower temperatures.
- The proper use of WMA may result in reduced overall paving costs.

WMA: Compaction Aid

- **Better compaction improves performance**
- Proper compaction is critical to well-performing pavements. One indication of proper compaction is the final density of the asphalt pavement. WMA is a compaction tool that can help achieve more uniform density and improve pavement performance

FHWA & WMA

- Action Plan for Michigan EDC Initiative
- The goal is to evaluate the use of WMA foaming technology, working to develop specifications and pilot WMA for evaluation and demonstration here in Michigan
- The expected outcome is for Michigan to develop a WMA permissive specification to be used on two pilot projects for evaluation and demonstration. *Currently MDOT is Pursuing 3 WMA Projects for 2011 Letting.*

WMA

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

WMA Specification

- Standard Superpave Mix Design
- Normal Mix Design Procedures
- Water Injection or Water Additive
- Informational Testing
- Gyro Temperature Based on Binder Suppliers Recommendation

MDOT Moving Forward

- Let 3 Projects in 2011 – Permissive, Mandatory & Alternate Bid
- Water Injection or Water Additive
- Monitor & Review Performance
- Develop Use Policy

The End





Warm Mix Asphalt for Wisconsin

**Warming up to WMA:
Applications by Northern States**
June 1, 20011



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

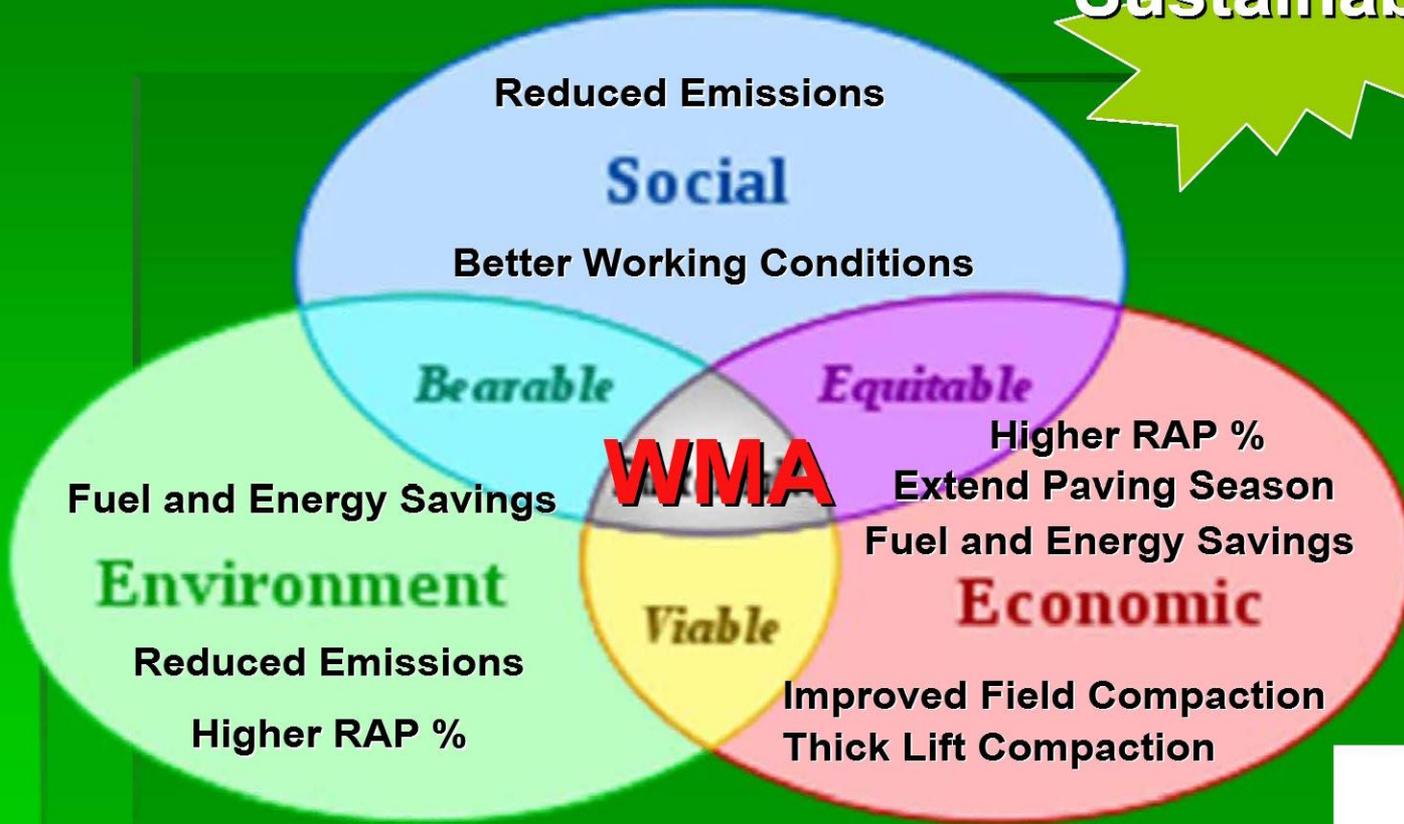
**

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



Why Warm Mix?

Sustainability



Technology Overview**

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

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

Technology Overview**

TLA-X



Lake Asphalt of
Trinidad and Tobago

Iterlow-T & HyperTherm



Static Inline Vortex Asphalt Blender



Ad-RAP (ECOBIT)



More to come ...

Many other technologies are also used
Internationally.

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

2006 Warm Mix Asphalt Open House
 June 19 & 20, 2006
 Comfort Suites Milwaukee Airport
 6362 South 13th Street, Oak Creek, WI 53154, (414) 570-3333

Presented by:



PAYNE & DOLAN
 INCORPORATED



AGENDA

Monday, June 19, 2006

9:00-10:00

Registration and continental breakfast

10:00 – 11:30

Welcoming Remarks

Lenny Makowski Wisconsin DOT

Warm Mix Asphalt Overview

Brian Prowell, NCAT

Additives To Make Warm Mix:

Sasobit & Evotherrm

The Highway 100 (Ryan Road)

Project

Wisconsin DOT & Payne & Dolan

11:45

Board bus to visit the plant & project
 (Box lunches will be provided)

2:30

Return to the hotel

Tuesday, June 20, 2006

8:00-8:30

Registration and Continental Breakfast

8:30-9:15

Remarks and Overview

9:20

Board bus to visit the plant and project

12:00

Return to the hotel

REGISTRATION

Registration is free for this event. You can register online at www.wispave.org, or by calling the WAPA office at 608-255-3114 by **June 9, 2006**.

HOTEL

Rooms are available on June 18th & 19th at the Comfort Suites Milwaukee Airport where the classroom session will take place. The rate for these rooms is \$94 per night. Refer to the Warm Mix meeting when making your reservation. To ensure you get the special room rate, call the hotel at (414) 570-1111 by June 4.

If you have questions or need more information, please feel free to contact:

Lenny Makowski, Wisconsin Department of Transportation
 (262) 548-5618 or leonard.makowski@dot.state.wi.us

Pat Goss, Wisconsin Asphalt Pavement Association
 (608) 255-3114 or pat@wispave.org



The Wisconsin Department of Transportation-Southeast Region, Payne & Dolan Incorporated, the Asphalt Pavement Alliance and the Wisconsin Asphalt Pavement Association are hosting an open house on June 19 & 20, 2006, on Warm Mix Asphalt. This two day session will include class time both mornings on Warm Mix Asphalt, its potential benefits, applications and future. The afternoon of June 19th, attendees will visit Payne & Dolan's plant to observe the production of the Warm Mix Asphalt using Sasobit. Attendees will then visit the job site and observe the Warm Mix on the project. The second day will include another trip to the plant following the class time to observe the production of Warm Mix Asphalt using Evotherrm and a visit to the project. Visit www.wispave.org for more information.



Where is WisDOT Going with Warm Mix Asphalt?

Current Status

- Development of specification, along with needed guidance, currently being developed by HMA Technical Team/Subcommittee
- Draft language currently being reviewed for inclusion in 2012 Standard Specifications
- May be implemented sooner through use of ASP-6
- Current draft allows use of WMA as contractor option
- Will attempt to bid several projects with both HMA and WMA in late spring.

Current Draft Specification

Sect. 450:

450.2.1 Acronyms and Definitions

(1) Interpret materials related acronyms used in sections 450 through 499 as follows:

WMA Warm mix asphalt

(2) Interpret materials related definitions used in sections 450 through 499 as follows:

Warm mix asphalt Any asphaltic mixture that contains a warm mix additive, or utilizes a warm mix process, as part of its mixture design that has the ability to reduce the mixing and compaction temperature requirements below the typical temperatures used for that application.

Current Draft Specification

Sect. 460:

460.1 Description

- (1) This section describes HMA mixture design, providing and maintaining a quality management program for HMA mixtures, and constructing HMA pavement. **Unless specifically indicated, all references in Sect. 460 to HMA shall also apply to WMA.**

460.2 Materials

460.2.1 General

- (1) Furnish a homogeneous mixture of coarse aggregate, fine aggregate, mineral filler if required, SMA stabilizer if required, recycled material if used, **warm mix asphalt additive or process if used**, and asphaltic material.

Current Draft Specification

460.2.4 Additives

460.2.4.4 Warm Mix Asphalt Additive or Process

- (1) The department will maintain an approved products list for warm mix asphalt additives and processes. The contractor may use additives or processes included in the current approved products list.
- (2) Follow supplier or manufacturer recommendations for additives or processes when producing WMA mixtures.

Current Draft Specification

460.5.2 HMA Pavement

460.5.2.1 General

- (2) Payment for HMA Pavement Type E-0.3, E-1, E-3, E-10, E-30, and E-30x is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting mixture; for QMP testing and aggregate source testing; and for all materials, **including warm mix asphalt additives or processes if used**, except asphaltic materials.
- (3) Payment for HMA Pavement Type SMA, is full compensation for providing HMA mixture designs; for preparing foundation; for furnishing, preparing, hauling, mixing, placing, and compacting the mixture; for QMP testing and aggregate source testing; and for all materials including asphaltic materials **and warm mix asphalt additives or processes if used**; for stabilizer, hydrated lime, and liquid antistripping agent if required.

● Where is WisDOT Going with Warm Mix Asphalt?

✦ Future?

- Research through WHRP investigating dynamic modulus and flow numbers for WMA
- Determine applications where it may be beneficial for us to require WMA.

- **Cold weather paving**

The greater the differential between the mix and ambient temperatures, the faster the mix cools

WMA cools slower

WMA allows compaction at lower temperatures

- **Night paving**

- **Long haul distances**

- **Paving over large amounts of crack filler**

Warm Mix Asphalt

✦ Questions????

- Changes to mix design procedures (recommendation from NCHRP 9-43)
- QMP requirements (reheat factor)
- Approval of additives/systems
- Training (HTCP, project manager, etc.)
- Warm mix vs use as a compaction aid
- Moisture concerns (foaming for late season paving?)



Warm Mix is the Future of Asphaltic Mixtures

WMA production is expected to exceed HMA production in a few years

And

Experts are predicting the WMA will comprise 90% of HMA being produced in approximately 5 years



For Further Information

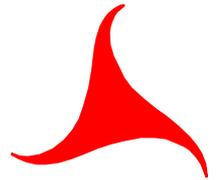
Thomas Brokaw

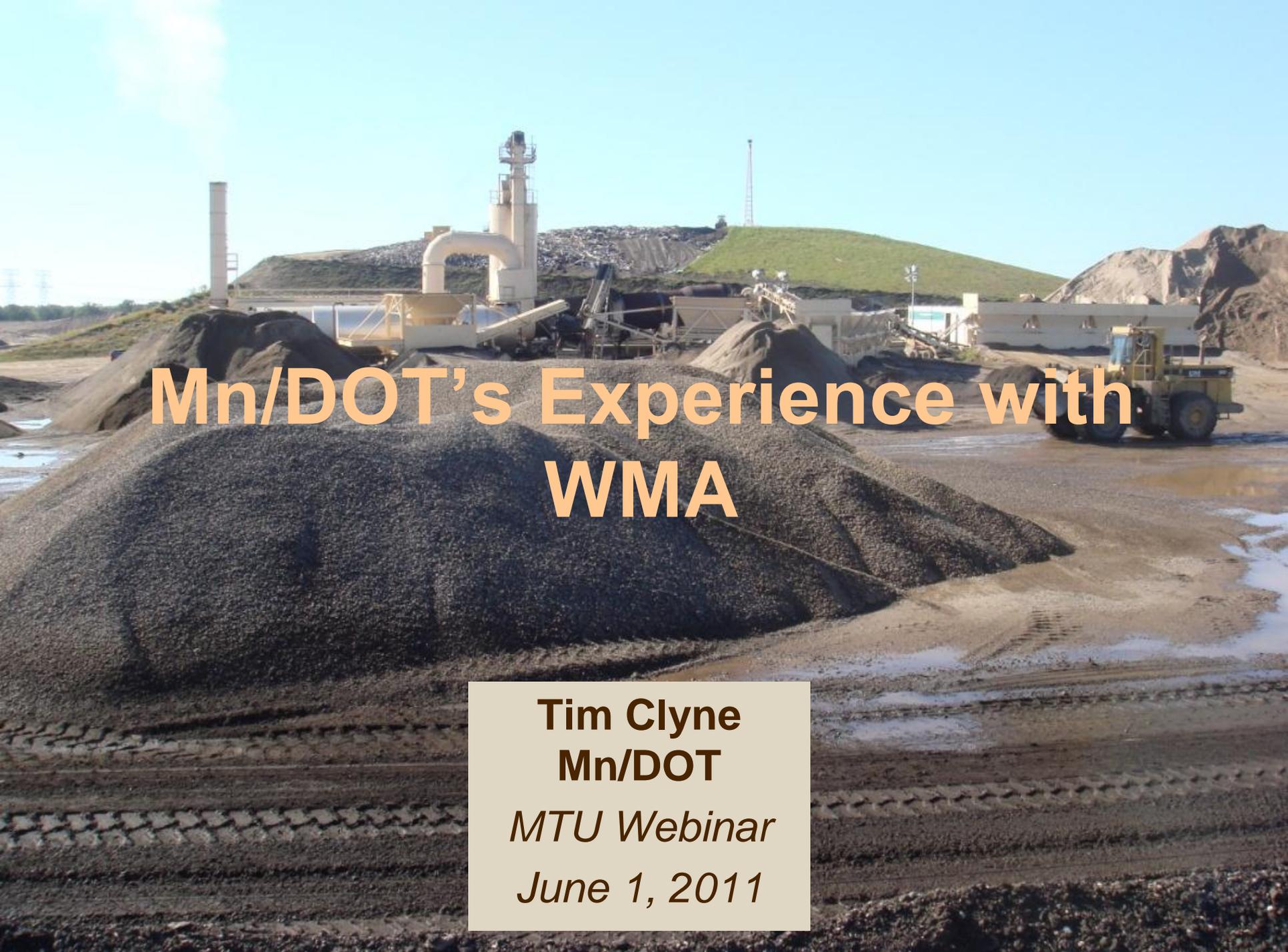
Materials Laboratory Engineer

WisDOT Bureau of Technical Services

(608)246-7934

thomas.brokaw@dot.wi.gov





Mn/DOT's Experience with WMA

Tim Clyne
Mn/DOT

MTU Webinar

June 1, 2011

Acknowledgements

Mn/DOT

- **John Garrity, Greg Johnson, Greg Schneider**
- **Roger Olson, Ed Johnson**

Industry

- **Gerald Reinke, MTE**
- **Chris Miller, Hardrives**
- **Rich Wolters & Jill Thomas, MAPA**

Potential Benefits of WMA

Environmental

- Lower greenhouse gas emissions
- Lower fuel consumption

Operational

- Better compaction
- More comfortable working conditions

Performance

- Can use RAP and/or shingles with WMA
- Eliminates bumps in overlays
- Reduced binder aging – reduced cracking

WMA EXPERIENCE IN MN/DOT

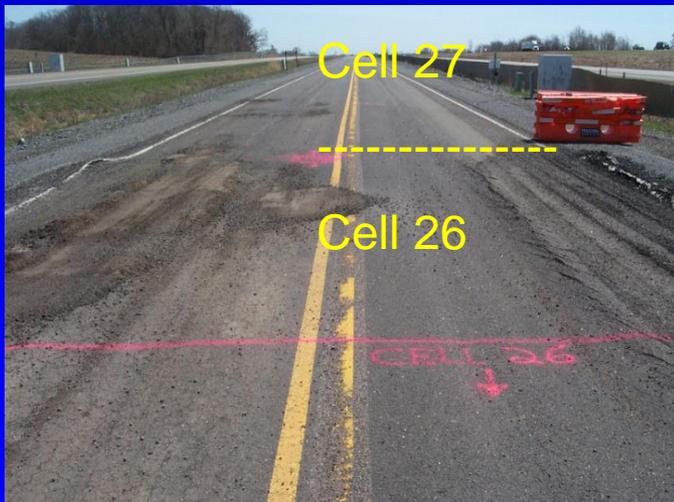
Oil Gravel

Early WMA by Another Name

TRB LVR Conference (1995) – Demo Project Outside MnROAD

1998 - 2000 – Five LVR Test Sections (cold, lukewarm, warm mix) over various base types

Several County Roads throughout Minnesota in 1990's



- Emulsion or Cutback Asphalt
- Oil Gravel Requires Solid Base
- No Transverse Cracking or Rutting
- Some Fatigue and Rough Ride

2008 MnROAD Construction

6 Cells on Mainline
Wear and Non-Wear
12.5 mm NMAS
Traffic Level 4
PG 58-34
20% RAP from
MnROAD
No requirements for
WMA technology



Mn/DOT Trunk Highway 95

Late season paving (2009)

- Contractor was delayed, needed to finish paving before winter
- Supplemental Agreement – Mn/DOT paid extra \$0.60 per ton for WMA
- Business as usual (mostly)
 - Good density 2nd day after going back to HMA rolling pattern



Mn/DOT District 3 and 7 Projects in 2010

First “regular” Mn/DOT projects requiring WMA

S-1 (2360) PLANT MIXED ASPHALT PAVEMENT – USE OF WARM MIX ASPHALT TECHNOLOGIES

The provisions of the attached 2360 Plant Mixed Asphalt Pavement (Gyratory Design) Specification is hereby modified as follows in order to use Warm Mix Asphalt (WMA)

All provisions for the production and placement of WMA will be the same as the conventional HMA mixtures as stipulated in 2360 Plant Mixed Asphalt Pavement (Gyratory Design) Specification except as noted below.

S-2.1 MIXTURE DESIGN

The contractor is responsible to use the same design used to produce the Hot Mix Asphalt, then modifying it to accommodate products or processes to meet the Warm mix criteria. This modification process will be limited to the same as described by the WMA Technical Working Group and found at <http://www.warmmixasphalt.com/WmaTechnologies.aspx>

Recycled Asphalt Shingles will not be allowed in any mixes on this project.

S-3.1 MIXTURE QUALITY MANAGEMENT

The Warm Mix Asphalt produced will not be allowed to exceed temperatures greater than 275 °F. Any WMA over that temperature will not be allowed to be used.



REVIX / Evotherm 3G

REVIX™ developed by Mathy Technology & Engineering and Paragon Technical Services, Inc.

- ❑ Chemical additive added at terminal or HMA plant
- ❑ Requires no plant modification
- ❑ Binder shipped from supplier with WMA chemical package already added

This technology is now marketed as Evotherm 3G



Maxam AquaBlack



Bituminous Roadways

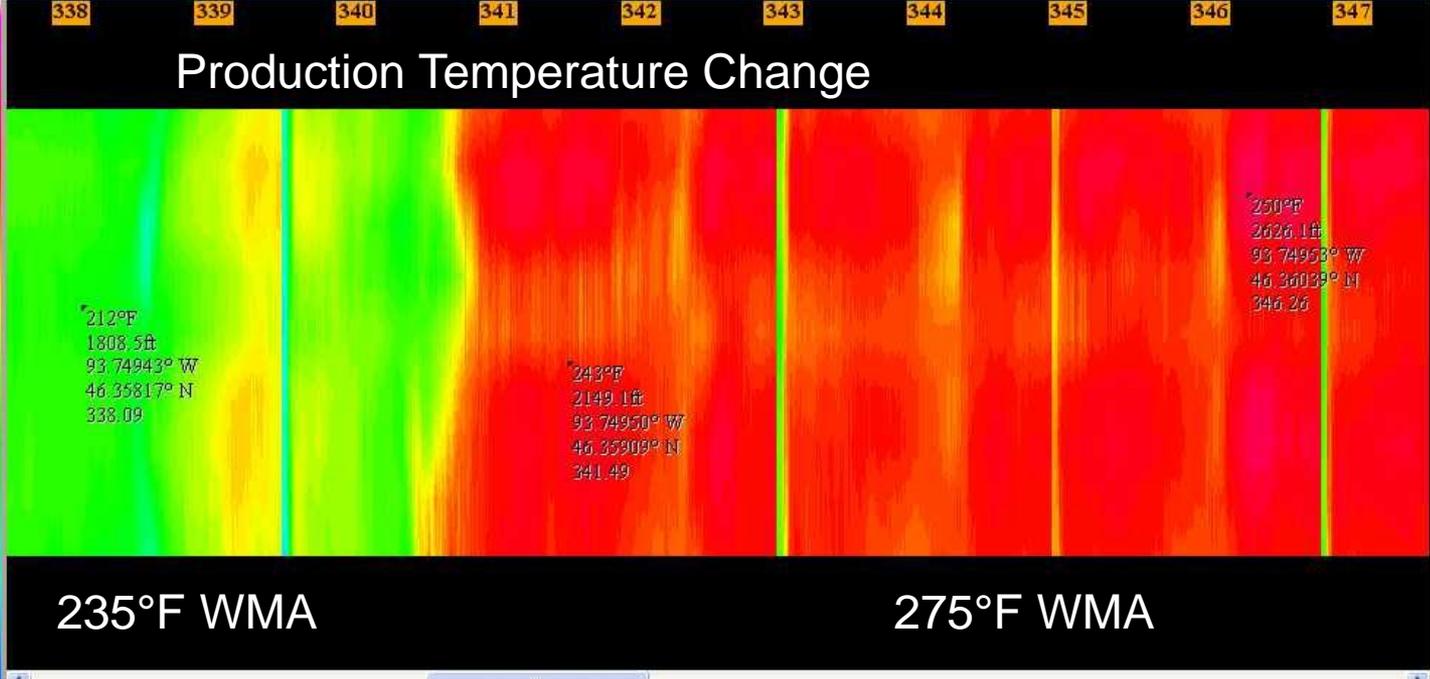
- Installed on 2 local plants
 - Try for a 3rd failed
- 15% of production was WMA



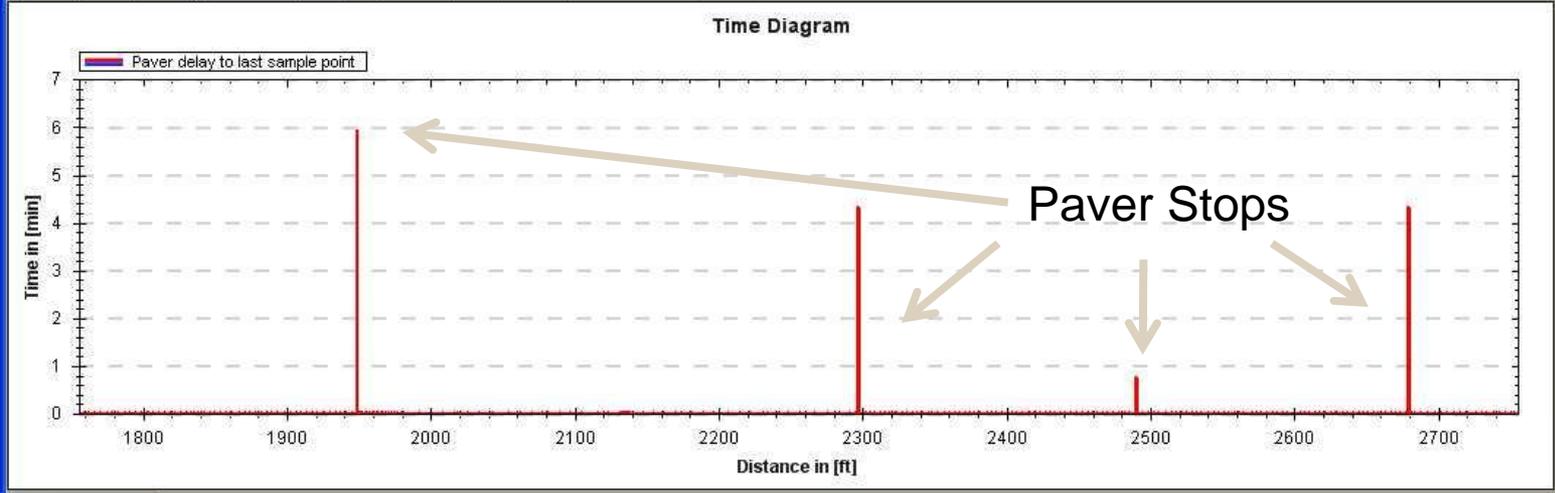
Knife River

Duininck Brothers

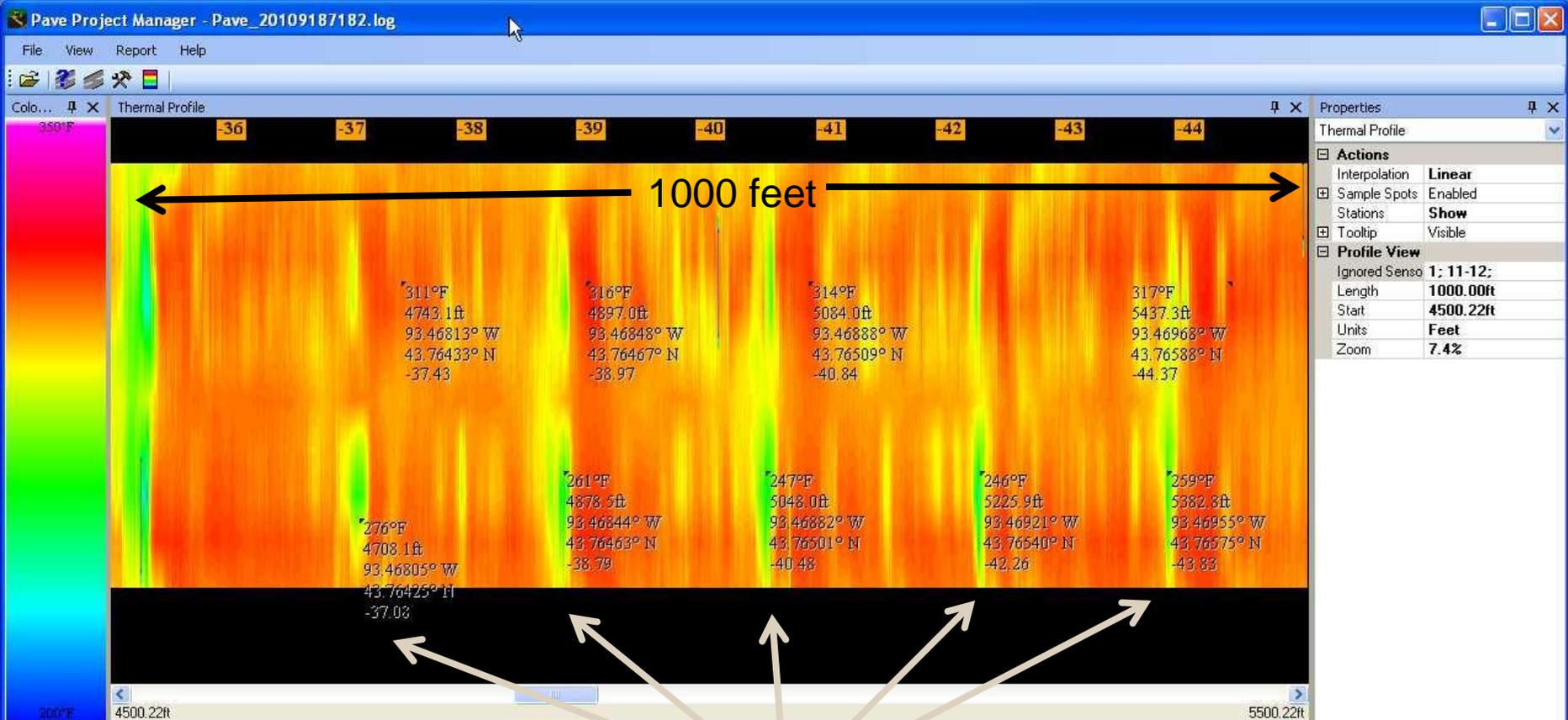
Central Specialties



Thermal Profile	
Actions	
Interpolation	Linear
Sample Spots	Enabled
Stations	Show
Tooltip	Visible
Profile View	
Ignored Senses	1-2; 11-12;
Length	1000.00ft
Start	1755.25ft
Units	Feet
Zoom	16.3%



Length
The Profile's length in the Profile Window.



Cyclic End of Truckload Thermal Segregation

**This picture is HMA
WMA paving did not see same
segregation at end of truck**

Mn/DOT's Experiences

Successes

- ❑ Better compaction
- ❑ Reduced reflective cracking
- ❑ Better uniformity
- ❑ RAP & RAS used
- ❑ Comfortable working conditions
- ❑ Business as usual at plant and paver
- ❑ Becoming everyday reality

Issues

- ❑ Less compaction
- ❑ Equal reflective cracking
- ❑ Lab compaction temperature for QA
- ❑ Increased cost (at times)
- ❑ Consistent specs

Mn/DOT 2011 Bituminous Specification

2009 & 2011 Position Memos

Permissive Spec

www.dot.state.mn.us/materials/bituminous.html

Table 2360.6-C5
Mixture Temperature Control^(C)

Air Temperature °F [°C]	Compacted Mat Thickness, inches ^(A)			
	1 inch [25 mm]	1-1/2 inch [40 mm]	2 inch [50 mm]	≥3 inch [75 mm]
+32-40 [0-5]	--	265 ^(B) [129]	255 [124]	250 [121]
+ 41-50 [6-10]	270 ^(B) [130]	260 [127]	250 [121]	245 [118]
+ 51-60 [11-15]	260 ^(B) [127]	255 [124]	245 [118]	240 [115]
+ 61-70 [16-21]	250 ^(B) [121]	245 [118]	240 [115]	235 [113]
+ 71-80 [22-27]	245 [118]	240 [115]	235 [113]	235 [113]
+ 81-90 [28-32]	235 [113]	230 [110]	230 [110]	230 [110]
91+ [+ 33]	230 [110]	230 [110]	230 [110]	225 [107]

(A) Based on approved or specified compacted lift thickness.

(B) A minimum of one pneumatic-tire roller shall be used for intermediate rolling unless otherwise directed by the Engineer. The Engineer may specify or modify in writing (with concurrence from the Department Bituminous Engineer) a minimum laydown temperature.

(C) Not applicable if a WMA additive or process is used.

WMA Frequently Asked Questions

Frequently Asked Questions about Warm Mix Asphalt (WMA)

Warm Mix Asphalt (WMA) is a relatively new technology in the United States, and in Minnesota in particular. The list below is not an exhaustive list of questions about warm mix, but it does try to answer some of the most common questions about this technology.

What is Warm Mix Asphalt?

Warm Mix Asphalt (WMA) is the generic term for any technology (additive or water foaming technique) added to an asphalt mixture that allows the mixing and compaction temperature to be reduced by 20 to 100°F. It allows the mix to remain workable at lower temperatures, and has potential environmental, operational, and performance benefits over traditional hot mix asphalt (HMA).

The contractor has approached us (local agencies) about substituting WMA for HMA. Should we use WMA on our project?

Mn/DOT supports the use of WMA as an alternate to HMA on most projects.

Should we pay an additional cost for warm mix?

The use of WMA may add between \$0.60 to \$2.00 per ton of mix, although as WMA becomes more commonly used that price differential should be reduced. However, agencies should not pay the additional costs if WMA is proposed after the project has already been let.

Are there any pavement performance issues with WMA?

The oldest WMA projects in the US are only 6 years old, so no long term performance data is available. Early rutting and moisture damage are potentially of concern, although no known WMA projects have shown these distresses to date.



Thank You!

Tim Clyne

MnROAD

651-366-5473

tim.clyne@state.mn.

us



Office of Materials

Cass County Road Commission

Warm Mix Experience
2005

Why Sasobit

- Good reports from Maryland DOT
- Terminal blending did not require plant modifications
- Discovery of cross linking properties with polymer

Barron Lake Road Issues

- All Season route
- ADT 3000-4500
- % Trucks (Class 8-13) as high as 9.1 %
- Heavy truck traffic from gravel pit
- Extensive rutting and flushing
- Sections paved in 1990 and 1992
- Resurfacing would be with PG 64-28 instead of 58-28

Test Site Mix Comparison

- Cook Street to White Street
 - PG 64-28 (2.5% polymer)
 - Plant temp = 310°
 - Site temp = 285°
- White Street to Pokagon Highway
 - PG 64-28 (1% polymer + 1.5% Sasobit)
 - Added anti-strip agent
 - Plant temp = 275° (start) then lowered to 265°
 - Site Temp = 265° (start) then lowered to 260°

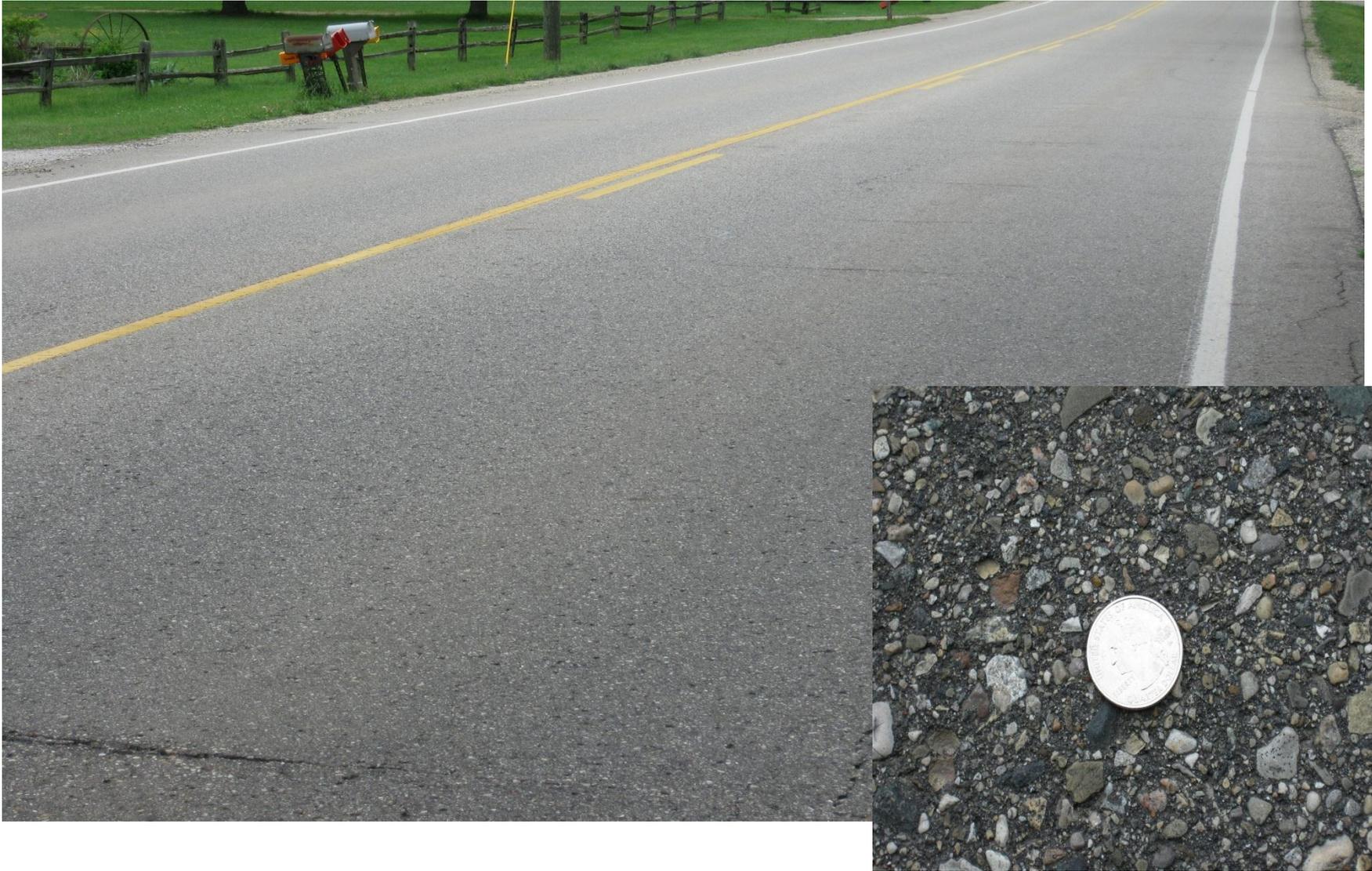
WMA Comparisons

- Less fuel use at plant 0.4-0.5 gal/ton
 - Decrease costs and plant emissions
- Ease of mix compaction
- Decreased road closure time
 - Decreased manpower costs
 - Decreased public inconvenience
- Increased worker safety and comfort

Results Over Time

PASER Rating	HMA Mix	WMA Mix
2005 before paving	4	4-5
2006	9	9
2007	8	8
2008		8
2009	7	7
2010		7

HMA May 27, 2011



WMA May 27, 2011



Warm Mix Asphalt from Crow-Wing County's Perspective

**By:
Wayne Dosh**

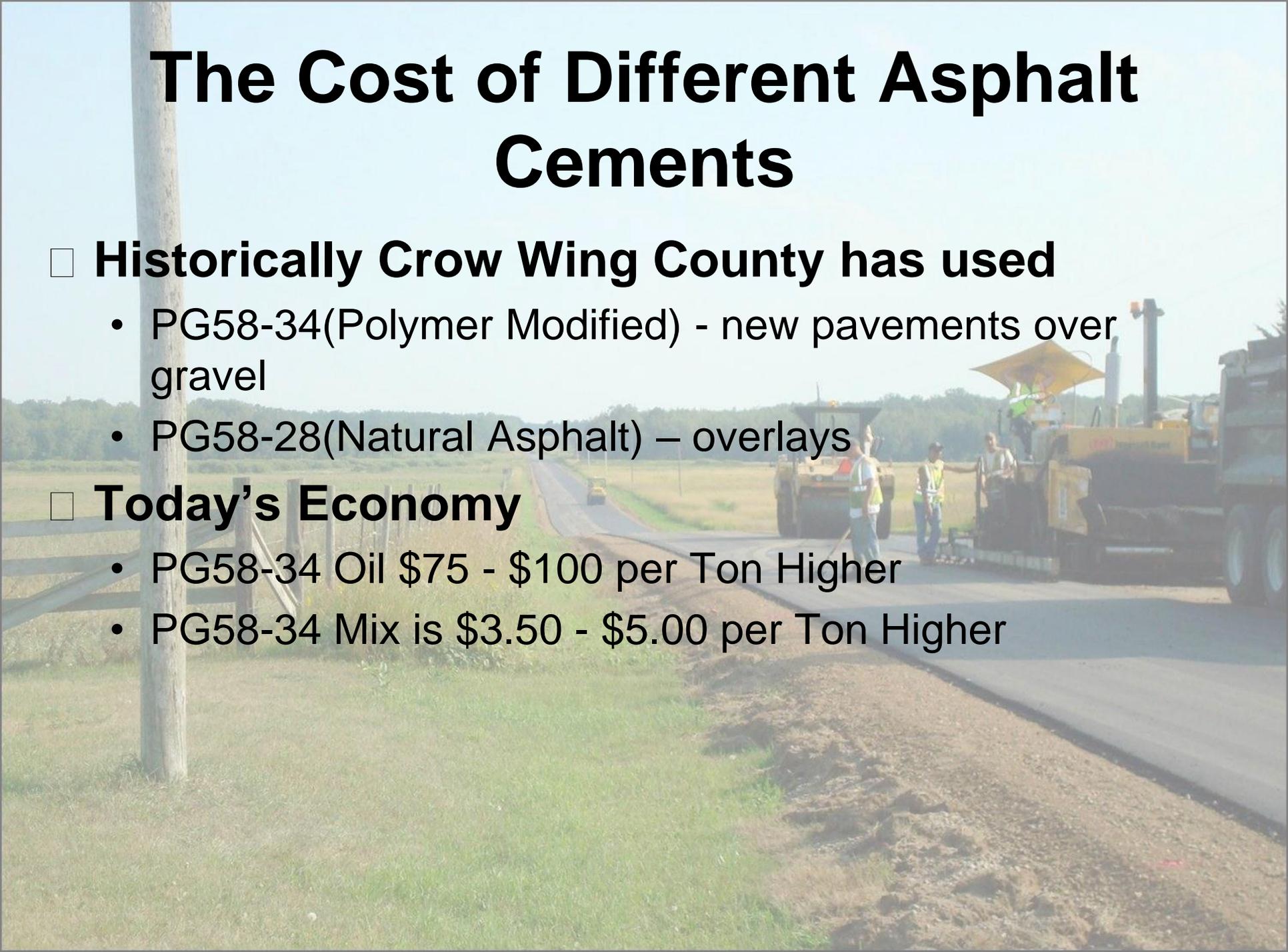


The Lower Production Temperatures of WMA May provide



- Resistance to Cracking and Reduced Thermal Cracking
- Longer Pavement Life Due to Slower Binder Aging

The Cost of Different Asphalt Cements

The background image shows a road construction site. A large yellow asphalt paver is in the process of laying a new layer of asphalt on a road. Several workers in high-visibility vests are standing near the paver, and a large truck is visible on the right side of the frame. The scene is set in a rural area with green grass and a clear sky.

- **Historically Crow Wing County has used**
 - PG58-34(Polymer Modified) - new pavements over gravel
 - PG58-28(Natural Asphalt) – overlays
- **Today's Economy**
 - PG58-34 Oil \$75 - \$100 per Ton Higher
 - PG58-34 Mix is \$3.50 - \$5.00 per Ton Higher

Where Does WMA Fit?



- Crow-Wing Co. has used PG58-28 WMA as an Alternate to PG58-34 HMA
 - Recent Bids Show PG58-28 WMA with a Surfactant to be Less Expensive than PG58-34 HMA

PG58-28 Oil Using a Surfactant was Specified for Crow-Wing Co. WMA Projects

- Foaming Rejected
 - Too Small of a Temperature gain to Suit Our Needs
- Waxes Rejected
 - Susceptible to Thermal Cracking



Why is the Production Temperature Important?



- Estimated every 25° Reduction in Production Temperature Reduces Oxidation 50%
 - Softer Asphalt (Resistant to Cracking)
 - Increase in Service Life



- Theorized Some WMA Increases Cold Performance by 3° to 4°
- WMA Utilizing Surfactants Artificially Aged 10 Years have Shown Properties Similar to 6 Month Old HMA

Crow Wing Projects

- All are placed over gravel.
- All used EVOTHERM 3G WMA technology.



Crow Wing Projects

CR 108

- Paved in August 2008
- 2913 tons of WMA
- 2000 foot HMA control strip
- 230-235° Ave.
Production Temp.
- 2 inch mat over gravel
- \$10,000 more expensive than HMA
(additional 4.7% of total project cost.)



Crow Wing Projects

CSAH 2

- Paved in June 2009
- 21,329 tons of WMA
- 1000 foot HMA control strip
- 225-235° Ave. Production Temp.
- 3.5 inch mat over gravel
- \$53,000 savings over HMA
(2.2% of the total project cost)

Crow Wing Projects

CSAH 10

- Paved in November 2009 & May 2010
- 26,438 tons of WMA
- No HMA control strip
- 235-240° Ave. Production Temp.
- 4 inch mat over gravel
- \$95,000 savings over HMA
(2.5% of the total project cost)

PG58-28 HMA Paved June 2009

(Recorded 02-17-11)



PG58-28 WMA Paved June 2009

(Recorded 02-17-11)



Other Observations

- Cold Weather Paving
- Warm Weather Paving
- Densities
- Moisture
- Higher Effective Asphalt Content



Basic Lifecycle Cost Analysis

- Based on CSAH 10 bid prices
 - Assuming PG 58-28 WMA performs equal to PG 58-34 HMA Crow Wing county would see a saving of \$250,000 a year.

Conclusions

- The Initial Rate of Oxidation is Less for WMA Which Should Result in ...
 - Longer service Life
 - Slower Binder Aging Process
- Crow-Wing County Plans to place an additional 3,500 tons of WMA this summer.

A scenic view of a lake with a white boat in the foreground, surrounded by green trees and a blue sky. The text "Thank You" is overlaid in the center.

Thank You