Warm Mix Asphalt in Minnesota

Tim Clyne
Mn/DOT

North Dakota Asphalt Conference

What is Warm Mix Asphalt (WMA)?

Technology that allows the reduction of mixing temperature by 20 to 100 F

- ★50 F typical

Acts as a lubricator, not viscosity reducer

- ★Reduces surface tension of asphalt binder
- ★Allows binder to flow and coat aggregates

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Environmental Benefits of WMA

Green Technology

- ★ Lower greenhouse gas emissions (~30-90%)
  - ★ CO_2, NO_x, SO_2, VOC, etc.
- ★ Lower fuel consumption (~30%)
- ★ Reduced exposure of workers to fumes
- ★ Eliminates the need for fume evacuation equipment on plant and paver

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Operational Benefits of WMA

Construction Practices

- ★Lower plant wear
- ★Longer haul distances
- ★Late season paving
- ★Better compaction
- ★Early site opening
- ★More comfortable working conditions for plant and paving crews

Performance Benefits of WMA

Better Pavement Performance

- ★Can use RAP and/or shingles with WMA
- ★Reduced binder aging
- ★Less susceptible to low temperature and fatigue cracking
- ★Eliminates bump at joint when overlaying concrete
- ★Rutting and stripping performance still being investigated

As good as or better than traditional HMA

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WMA Technologies

Foaming Technologies

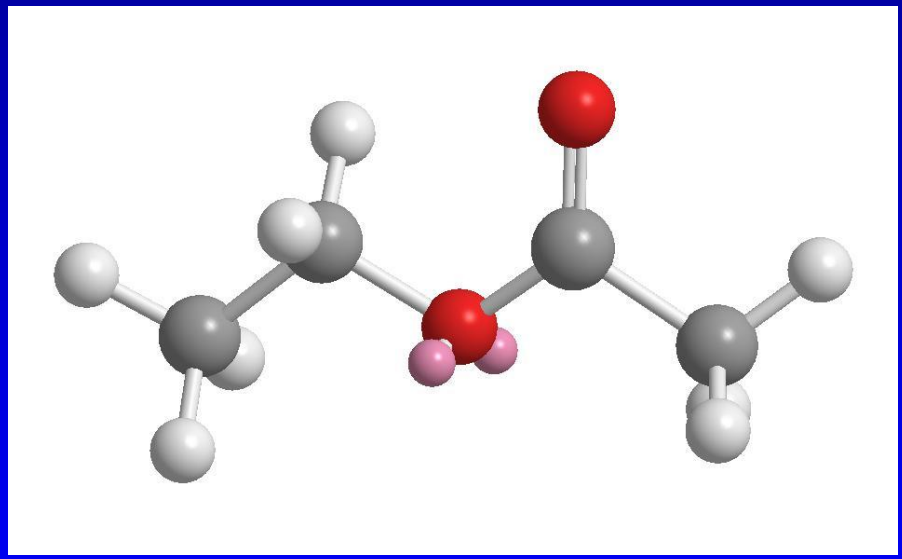
- ★Water
- ★Additive

Organic Additives

- ★Wax

Chemical Additives

- ★Surfactants
- ★Anti-strip agents



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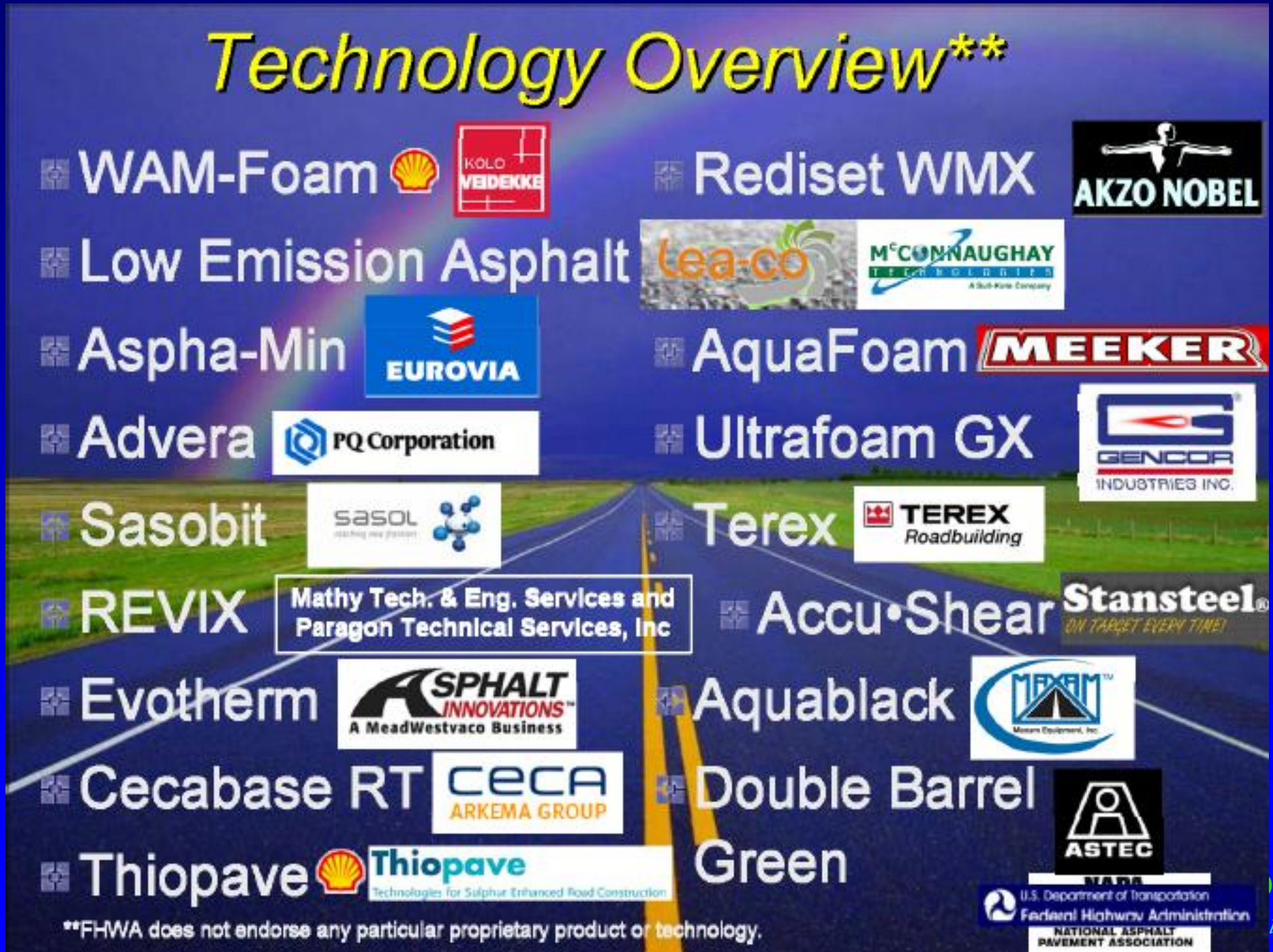
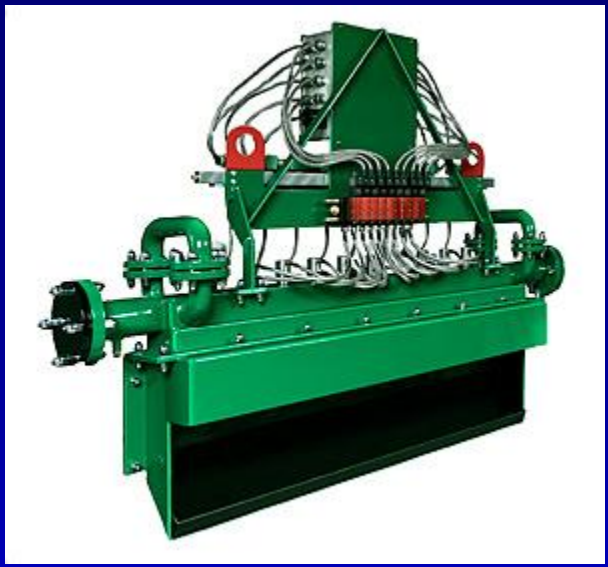


Courtesy: Matt Corrigan, Dave Newcomb

OVERVIEW OF WMA TECHNOLOGIES

Foam (water)

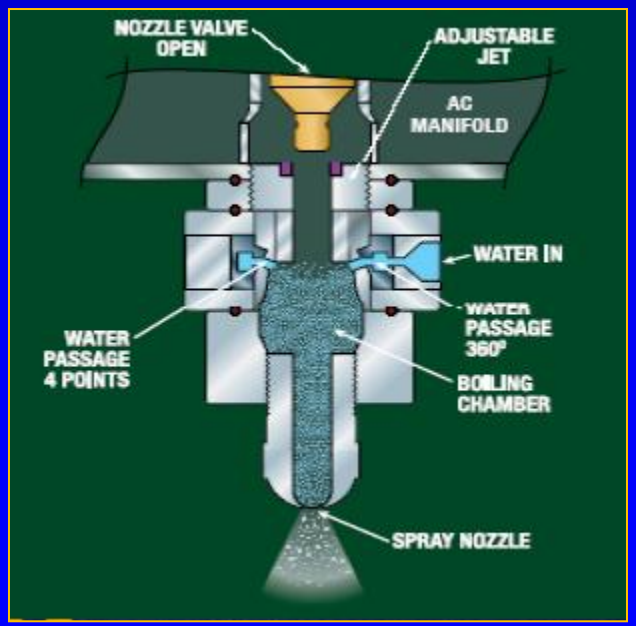


Astec Double Barrel Green

Gencor Ultrafoam GX

Maxam AQUABlack

Stansteel Accu-Shear

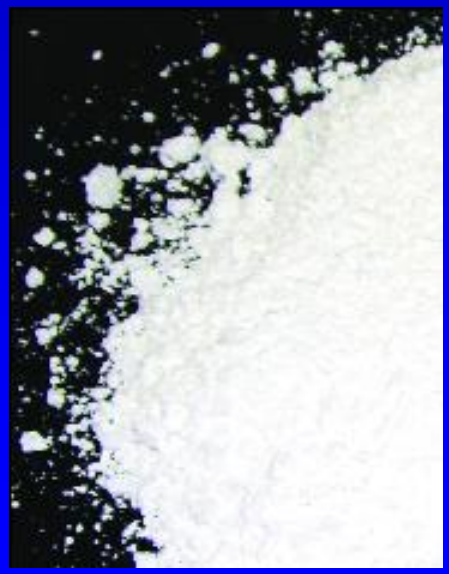


TEREX Warm Mix

Foam (additive)

Aspha-Min

Readiset WMX



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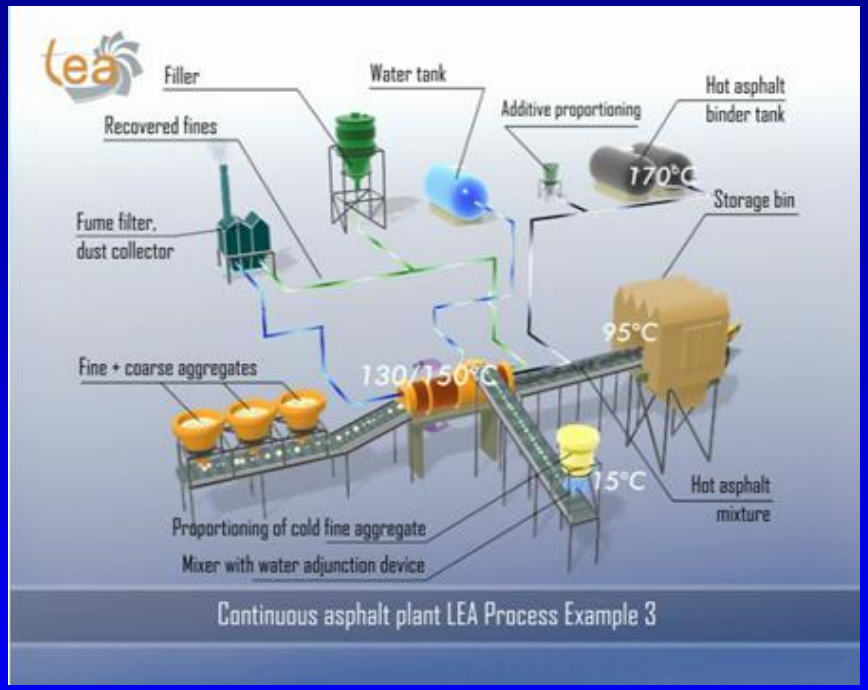

Low Emission Asphalt

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Organic

Sasobit

2000 lb “Supersack”

Shell Thiopave

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Chemical

Evotherm

REVIX

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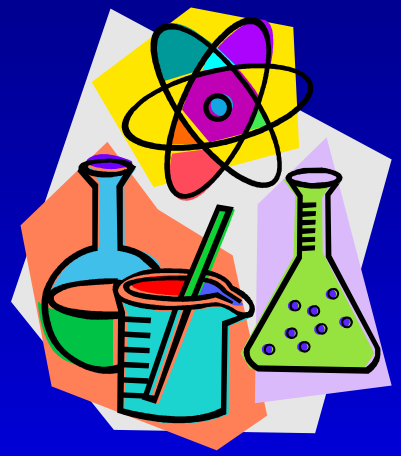
WMA Technology Applications

- Asphalt terminal blend
- Added to binder line at plant
- Added to aggregate stream at plant
- Mineral filler feed line



- Range from zero to moderate plant modifications

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WMA EXPERIENCE IN MINNESOTA

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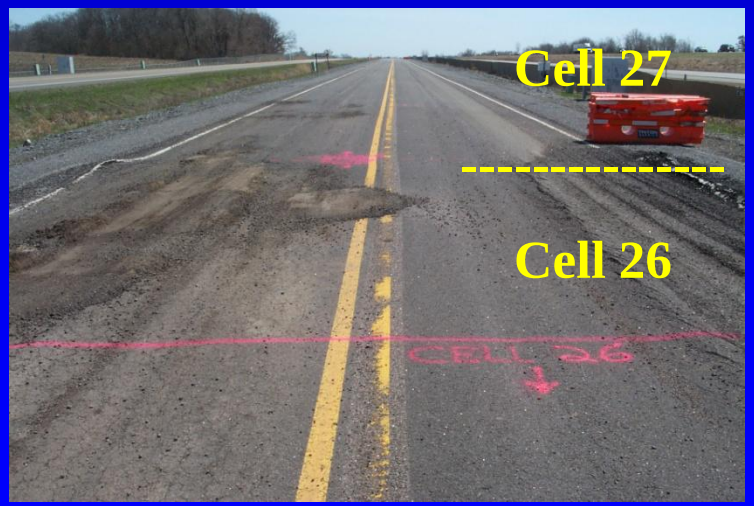
Oil Gravel

Cell 32 (1998) – Cold Mix Paving Practice
Cell 27 (1999) – Chip Seal / Large Stone Base
Cell 28 (1999) – Oil Gravel (luke warm mix) / Large Stone Base
Cell 26 (2000) – Oil Gravel (warm mix) / Reclaimed Base
Cell 27 (2000) – Oil Gravel (warm mix) / Large Stone Base
Several County Roads throughout Minnesota



★Oil Gravel requires solid base
★No Transverse Cracking or Rutting
★Some Fatigue and Rough Ride

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Olmsted & Goodhue Counties

First known true WMA jobs in MN (2007)

- ★Revix (Evotherm 3G) technology
- ★Olmsted CR 104
  - ★5 mile stretch
- ★Goodhue CSAH11
  - ★537 tons placed in 4,200 feet of the EB lanE

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Crow Wing County

County Road 108 (2008)

- ★2913 tons WMA, 272 tons HMA
- ★58-34 HMA vs. 58-28 WMA
  - ★WMA is $3-$4 lower than HMA
- ★Estimated 5 years of extended service life
  - ★Life cycle cost analyses are favorable for WMA
- ★*ASCE Cold Regions paper 2009*

County now allows alternate bids on several projects

- ★20,000 tons WMA in 2009 (CR 2)

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2008 MnROAD Construction

Warm Mix Asphalt						Control
15	16	17	18	19	23	24
3" WM	5" WM 58-34	5" WM 58-34	5" WM 58-34	5" WM 58-34	5" WM 58-34	3" 58-34
						4" Cl6sp
11.1" 64-22 1993 HMA	12" 100% recycle PCC	12" 50% RePCC 50% Class 5	12" 100% RAP	12" Cl-5	12" Mesabi Ballast	Sand
Clay	12" Cl3sp	12" Cl3sp	12" Cl3sp	12" Cl3sp	12" Cl3sp	100' Fog Seal 2008
58-34 Surface Binder	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	100' Chip Seals 2009 2010 2011 2012
	Clay	Clay	Clay	Clay	Clay	

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Mix Design Requirements

Wear and Non-Wear

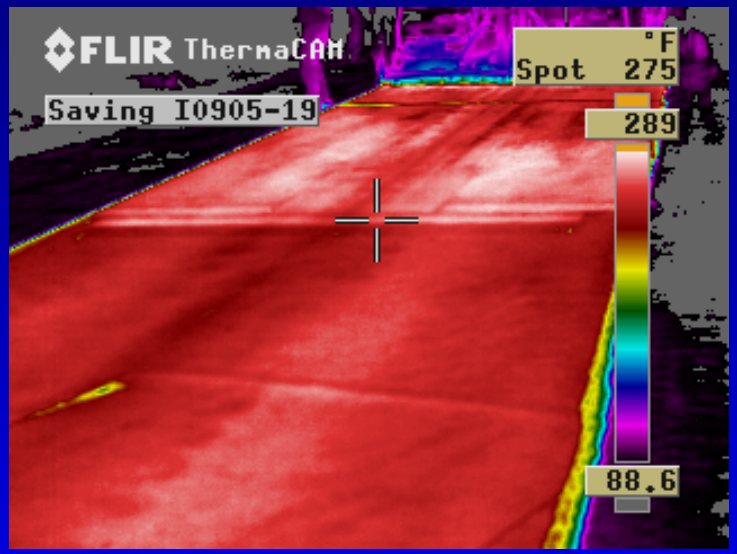
12.5 mm NMAS

Traffic Level 4

PG 58-34

20% RAP from MnROAD

No requirements for WMA technology



Next several slides courtesy of Chris Miller, Hardrives

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REVIX™ Technology

Developed by Mathy Technology and Engineering and Paragon Technical Services, Inc.

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

This technology is now marketed as Evotherm 3G

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Mix Design

- Existing SPWEB440 Mix Design
  - ¾” 100% Crushed Stone
  - ½” Granite Chips
  - Washed Granite Sand
  - Crushed Millings from MnROAD
- Replaced Standard Binder with WMA Binder
  - Lab compaction temperature 235° - 245° F
- Ran points to find optimum AC content for SPWEB440
- Non-Wear MDR written from trial point data

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WMA Production

Day 1 – 990 tons of SPNWB430C

- ★ No change in GMM from design
- ★ Drastic increase in Gmb (about 0.040)
- ★ Lower than expected Air Voids and VMA
- ★ Lower gyrating temperature gave equal results

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WMA Production

Day 2 – 1996 tons of SPWEB440C

- ★ Aggregate proportion change as well as add AC% reduction
- ★ Air Voids on target
- ★ VMA drop of about 1.0

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WMA Laydown

Business as usual – only cooler

Positive comments from the crew

Rolling Pattern Challenges

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Laydown Temp (224 F)

Density Results

Non-Wear

- ★ All cores > 93.0%
- ★ Low air voids

Wear

- ★ Cores averaged 92%

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WMA vs HMA

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WMA vs. HMA

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WMA vs. HMA

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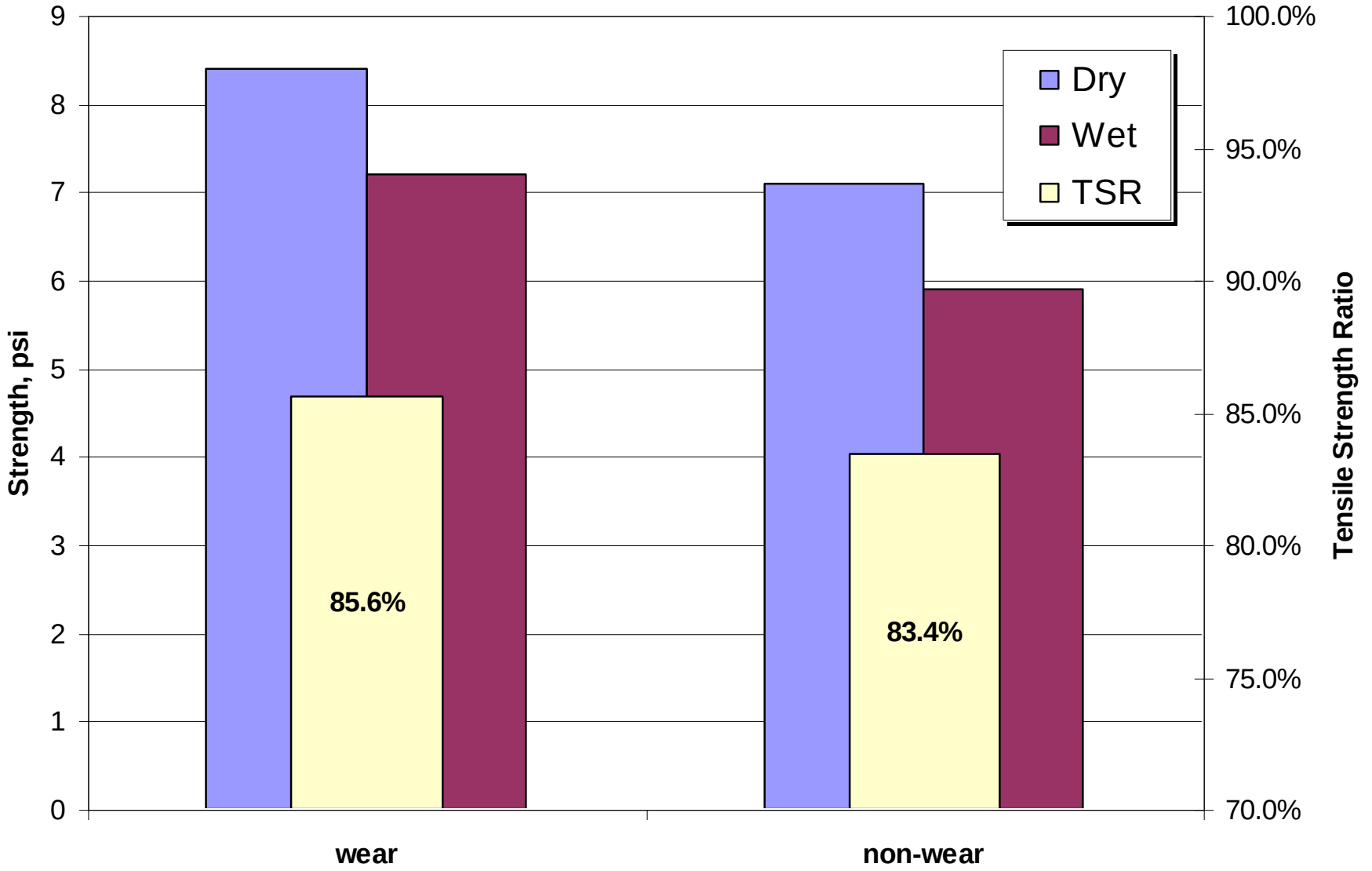
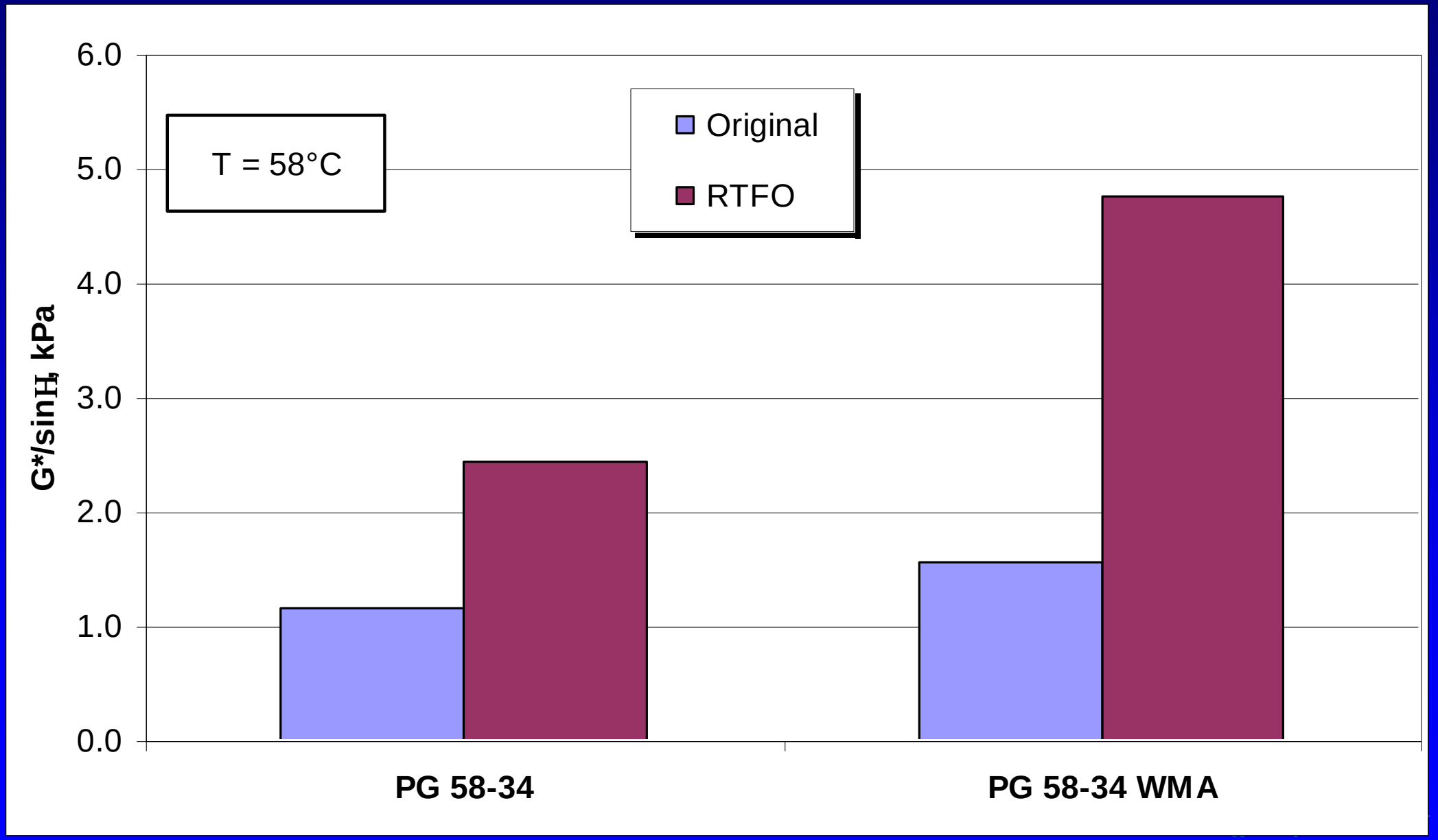
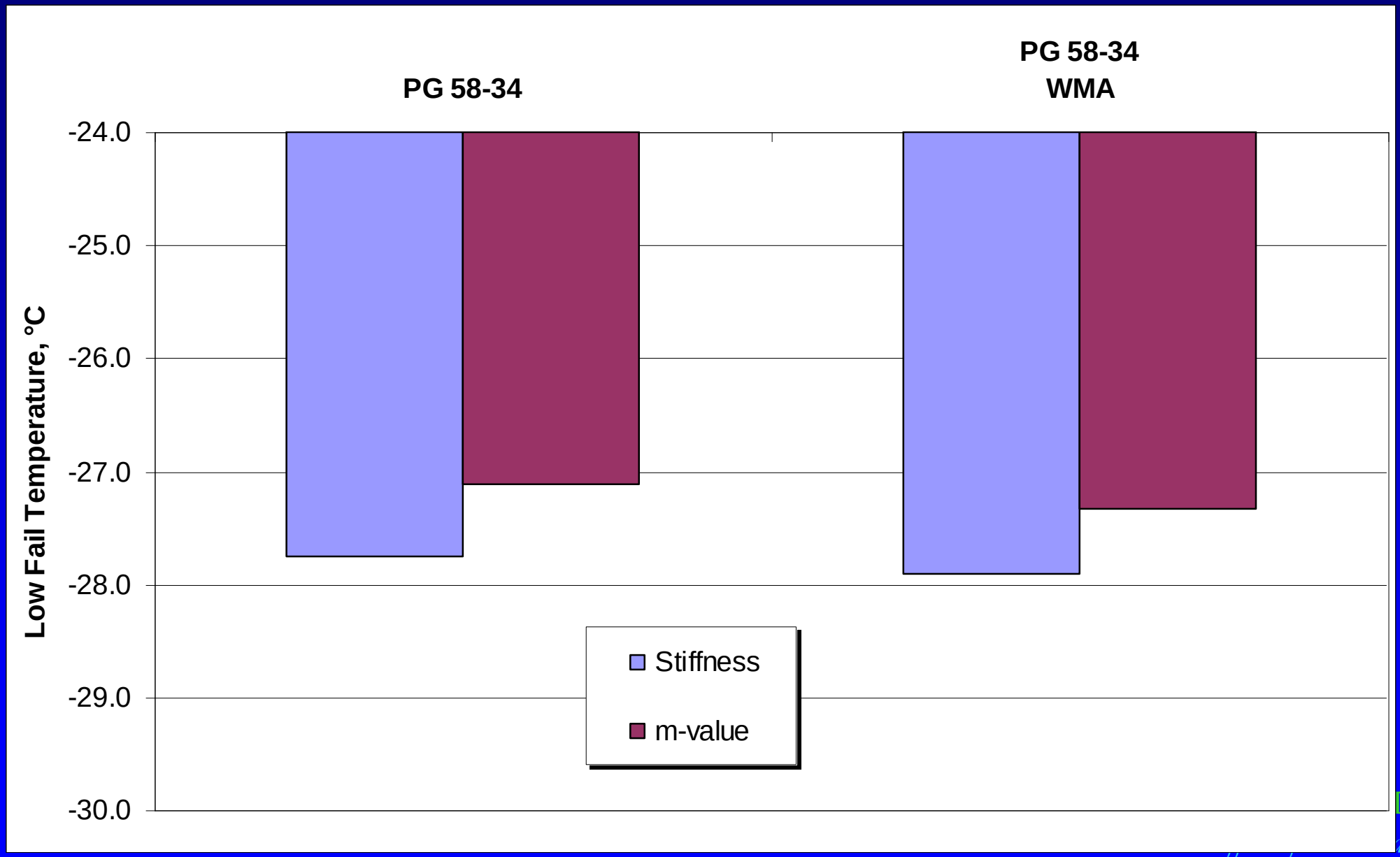
Stripping Potential



Binder DSR Testing



Binder BBR Testing



Lessons Learned

- More lab work needed at mix design to determine compaction temperature range
- Definite energy savings
- Appears as though fumes/emissions were less
- Equal density appears to be achievable with equal or less effort

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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 – good density, etc.

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Bituminous Roadways

Maxam AquaBlack

- ★ Installed on 2 local plants
- ★ 15% of production was WMA

Paving on Lake Street, Uptown Minneapolis

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Mn/DOT District 7 and 3 Projects in 2010

First 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

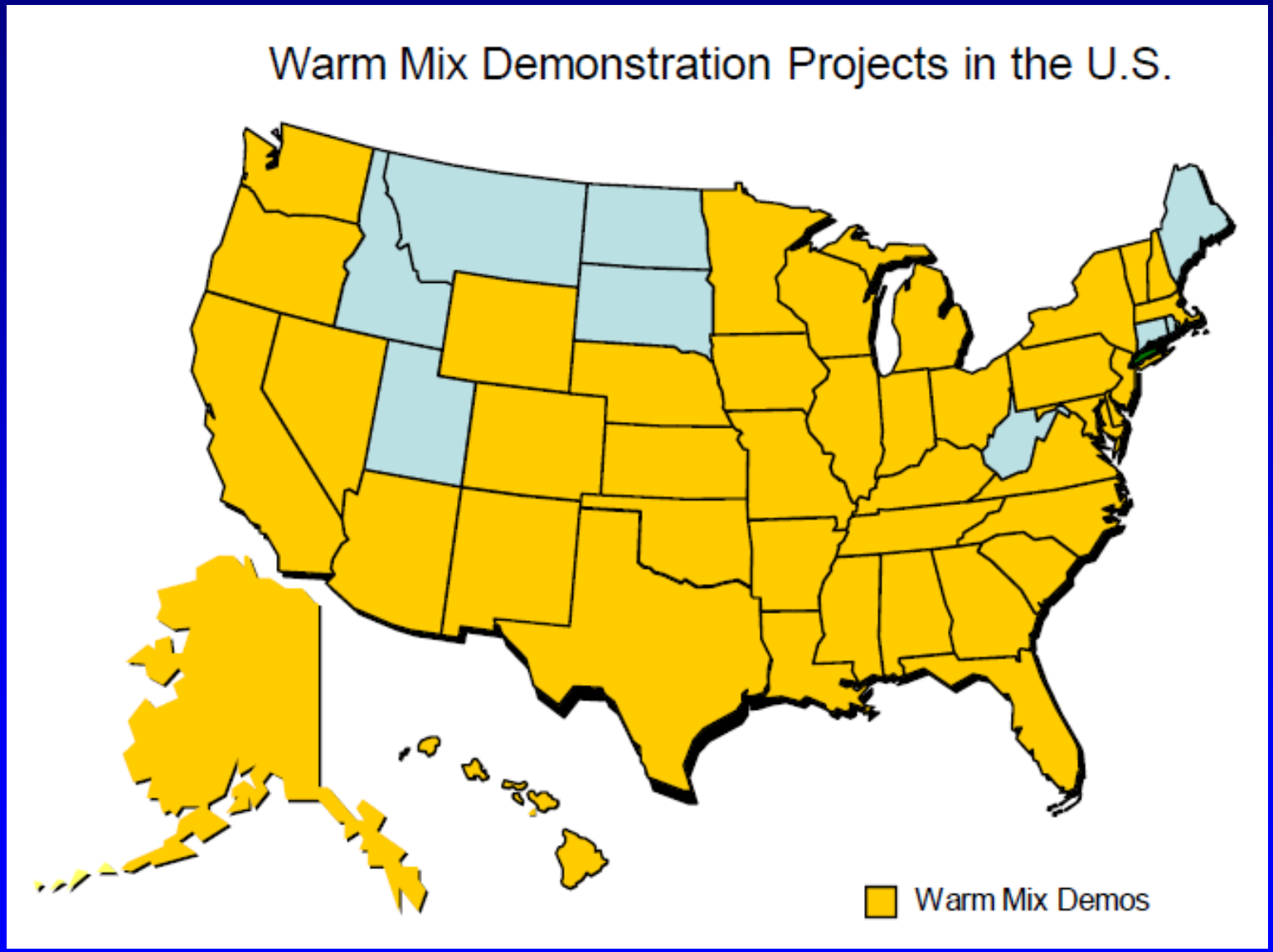
The contractor is responsible to use the same design used to produce the Hot Mix Asphalt, then modifying it to accommodate products or processes to meet the Warm mix criteria. This modification process will be limited to the same as described by the WMA Technical Working Group and found at http://www.warmmixasphalt.com/WmaTechnologies.aspx

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.

WMA Projects in the U.S. (Dec 2009)



Courtesy: Dave Newcomb

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Outstanding Issues

Early Rutting

- ★No known problems have occurred
- ★Binder grade bump may be needed

Moisture Damage

Long Term Performance

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Research In Progress

- NCHRP 09-43, Mix Design Practices for Warm Mix Asphalt
- NCHRP 09-47A, Properties and Performance of Warm Mix Asphalt Technologies
- NCHRP 09-49, Performance of WMA Technologies: Stage I - Moisture Susceptibility

Mn/DOT 2010 Bituminous Specification

- Previously WMA was handled on a case-by-case basis
  - ★2009 Position Memo
  - ★www.dot.state.mn.us/materials/bituminous.html

Table 2360.6-C5
Mixture Temperature Control[C]

Air Temperature	Compacted Mat Thickness, inches[A]			
°F [°C]	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.

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SUMMARY

Production and Paving Best Practices

- Work to minimize aggregate moisture
- Make sure the burner is tuned for the temperature
- Keep baghouse temperature above condensation point
- Consider superheating aggregate ahead of RAP
- Follow normal placement practices

WMA Investigation and Implementation

- FHWA working in partnership with AASHTO and Industry to established clear targets for implementation
- WMA Technical Working Group (TWG)
- FHWA Expert Task Groups
- First projects requiring WMA
  - ★ Binder, Mixture, and Models
- Regional User-Producer Groups
  - ★ Share data and information
- Move out of demonstration phase
- Training and Education

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Online Resources

www.warmmixasphalt.com

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

www.hotmix.org

www.asphaltisbest.com

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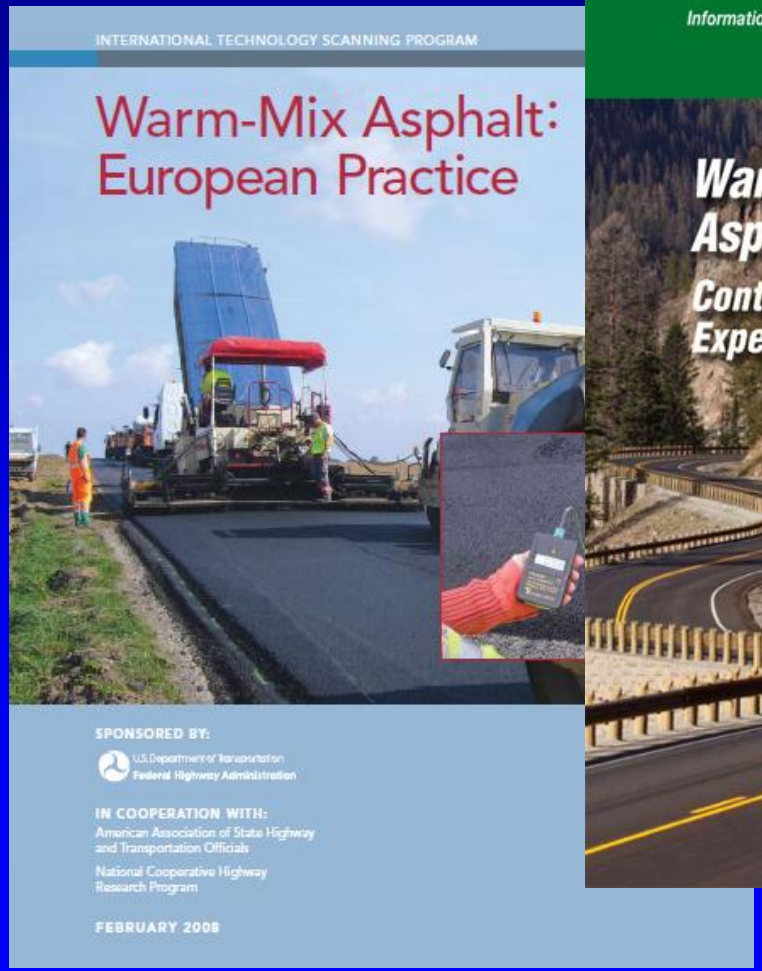
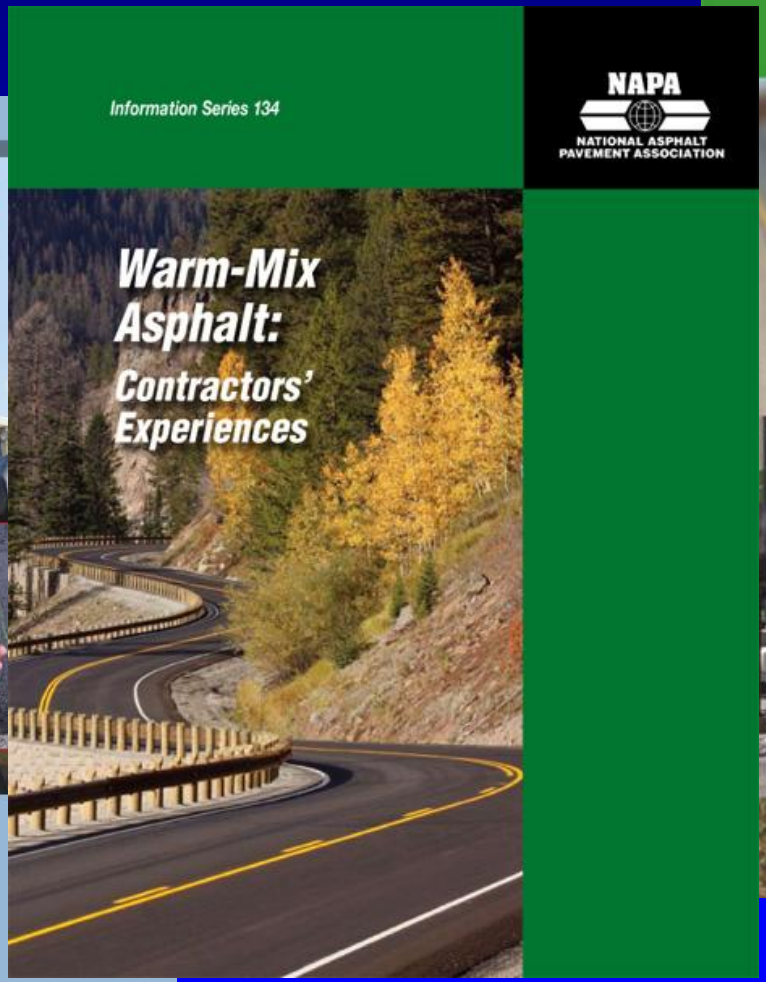
Publications





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Conclusions

- WMA should meet all Superpave requirements
- Warm mix is the future of asphalt mixtures
- Technology providers coming forward
- Industry and agencies must work together to make it happen
- Advantages far outweigh concerns

Thank You!

Tim Clyne
MnROAD
tim.clyne@state.mn.us
651-366-5473

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