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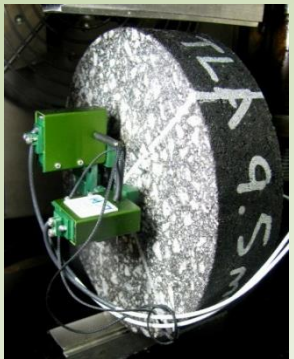
Performance and Implementation of Warm Mix Asphalt

Ray Brown



Topics to Cover

- Observed Performance
- Status of Implementation
- Guide Spec Items
- Product Acceptance List

First WMA section in US was constructed in 2004 so still new Process/Material

NCHRP 9-47A selected a number of older WMA projects along with some newer projects to monitor

NCHRP 9-47A Projects

Location	Route	WMA Technologies	Date Const.
St. Louis, MO	Hall Street	Evotherm ET, Sasobit, Aspha-min	May-2006
Iron Mtn., MI	M95	Sasobit	Sep-2006
Silverthorne, CO	I-70	Advera, Sasobit, Evotherm DAT	Aug-2007
Franklin, TN	SR45	Astec DBG, Advera, Evotherm DAT, Sasobit	Oct-2007
Graham, TX	US 380	Astec DBG	Jun-2008
George, WA	I-90	Sasobit	Jun-2008
Walla Walla, WA	US-12	Maxam Aquablack	Apr-2010
Centreville, VA	I-66	Astec DBG	Jun-2010
Rapid River, MI	CR-513	Evotherm 3G, and Advera	Jun-2010
Baker, MT	Route 322	Evotherm DAT	Aug-2010
Munster, IN	Calumet Ave.	Evotherm, Gencor foam, Heritage wax	Sep-2010
Jeff. Co., FL,	SR 30	Terex foaming system	Oct-2010
Queens, NY	Little Neck Pkwy	Cecabase, SonneWarmix, BituTech PER	Oct-2010
Case Grande, AZ	SR 84	Sasobit	Dec-2011

NCHRP 9-47A

Field Performance Evaluation Procedure

- Three 200-foot analysis sections per mix section
- Three 6” dia. cores from outside wheelpath, and four 6” dia cores from in between wheelpaths
- Cores used to determine the in-place density, indirect tensile strengths, specific gravity, gradation, asphalt content, and the true binder grade for each mix.

Hall Street, St. Louis

- Constructed May 2006
- WMA Tech.: Sasobit, Evotherm ET, Aspha-min
- Overlay of old concrete pavement in industrial area
- Mix Type: 12.5mm NMAS
- Binder Type: PG70-22
- N_{design} = 100gyrations
- Climate: Wet- Freeze

Hall Street, St. Louis, MO
Revisit Oct 2011 (5 years 5 months)

	HMA	Sasobit	Evotherm ET	Aspha min-Zeolite
Rutting (mm)	1.9	0.8	2.4	2.4
Total Length of Cracks (ft.)	628	1092	835	1310
Density (%G_{mm})	96.1	94.8	97.4	96.8

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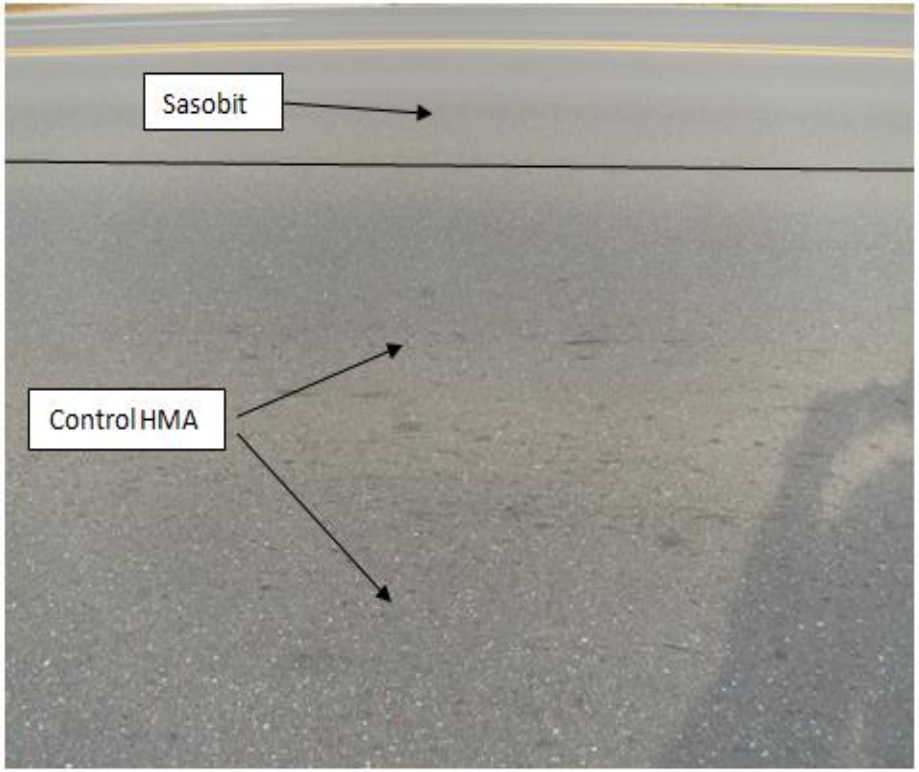
M95 Iron Mountain, MI

- Constructed Sept. 2006
- WMA Tech.: Sasobit
- Mix type: 9.5 mm NMAS
- N_{design} = 86 gyrations
- Binder Grade: PG 58-34
- Climate: Wet- freeze

M95 Iron Mountain, MI
Revisit Jun 2011 (4 years 9 months)

	HMA	Sasobit
Rut Depth (mm)	1.4	0
Total Length of Cracks (ft.)	3	46
Density (%G_{mm})	97.3	95.7



Silverthorne, Co

- Constructed August 2007
- WMA Tech.: Advera, Sasobit, Evotherm DAT
- Mix type: 9.5 mm NMAS
- Climate: Dry Freeze
- Binder Grade: PG 58-28

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Silverthorne, Co
Revisit Oct 2010 (3 years 2 months)

	HMA	Advera	Sasobit	Evotherm DAT
Rut Depth (mm)	6	4	6	6
Total Length of Cracks (ft.)	11	1	3	3
Density (%G_{mm})	96.7	97.8	97.1	97.1



Franklin, TN

- Constructed Oct. 2007
- WMA Tech.: Evotherm DAT, Advera, Sasobit, Astec Double Barrel Green
- Mix type: Marshall 12.5 mm NMAS
- Climate: Wet, No Freeze
- Binder Type: PG 70-22

Franklin, TN
Revisit March 2011(3 years 5 months)

	HMA	Advera	Astec DBG	Evotherm DAT	Sasobit
Rut Depth (mm)	0	0.5	0.4	0	0
Total Length of Cracks (ft.)	30	105	58	4	314
Density (%Gmm)	92.8	88.6	88.2	89.9	86.8

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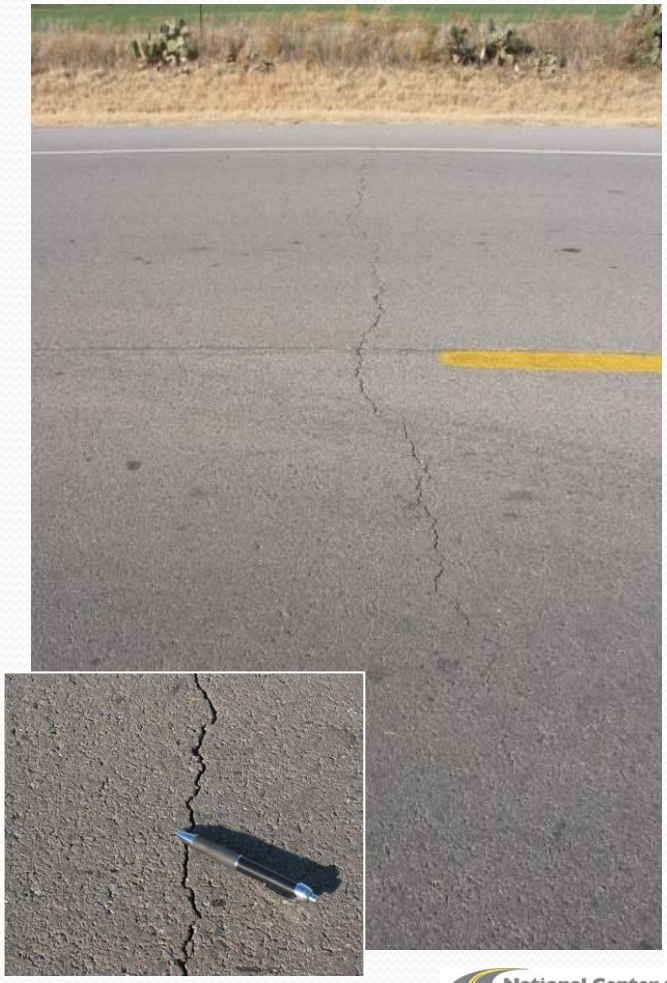
Graham, TX-Jun 2008

- Constructed June 2008
- WMA Tech.: Astec DBG
- Mix Type: 9.5 mm NMAS
- Binder Type: PG 64-22
- Climate: Dry-no freeze

Graham, TX
Revisit Dec 2010 (2 year 6 months)

	HMA	Astec DBG
Rutting (mm)	0	0
Total Length of Cracks (ft.)	58.0	81.5
Density (%Gmm)	97.0	94.2



Walla Walla, WA, 1 and 2 years Revisits

- WMA Technology: Maxam Aquablack
- Mix Type: 12.5 mm NMAS
- N_{design} = 100 gyrations
- Binder Grade: PG 64-28
- Climate: Dry -Freeze

	HMA		Maxam Aquablack	
Density at Constr. (%Gmm)	94.7		94.4	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	95.9	96.3	95.2	95.7
Rut Depth (mm)	1	5	0	0
Cracking (ft/600)	0	0	0	0

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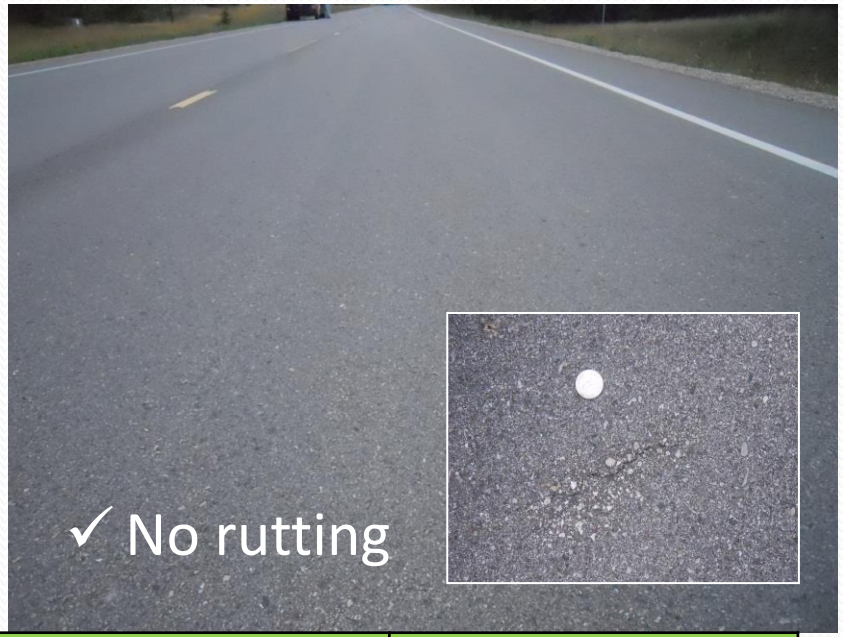
Centreville, VA, 1 and 2 Years Revisits

- WMA Tech.: Astec DBG
- Mix Type: 12.5 mm NMAS
- Binder Type: PG 76-22
- N_{design} = 65 gyrations
- Climate: Wet- freeze

	HMA		Astec DBG	
Density at Constr. (%Gmm)	89.1		89.9	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	94.4	93.8	93.5	93.4
Rut Depth (mm)	0	3	0	3
Cracking (ft/600)	0	0	0	0

Rapid River, MI, 1and 2 Years Revisits

- WMA Tech: Advera and Evotherm 3G
- Mix Type: 12.5 mm NMAS
- Binder Type: PG 52-34
- Climate: Wet-Freeze



	HMA		Advera		Evotherm	
Density at Constr. (%Gmm)	94.1		95		94.3	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	97.6	96.6	96.5	97	96.9	96
Rut Depth (mm)	0	0	0	0	0	0
Cracking (ft/600)	0	0.5	0.5	0.5	2	2

Baker, MT, 1 and 2 Years Revisits

- WMA Tech.: Evotherm DAT
- Mix Type: 12.5 mm NMAS
- Binder Type: PG 64-28
- N_{design} = 75 gyrations
- Climate: Dry-Freeze

	HMA		Evotherm	
Density at Constr. (%Gmm)	91.3		91.2	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	93.6	94	93.7	93.3
Rut Depth (mm)	<1	<1	<1	<1
Cracking (ft/600)	0	12	0	24

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Munster, IN, 1 and 2 Years Revisits

- Mix Type: 9.5 mm NMAS
- Binder Type: PG 64-22
- N_{design} = 75 gyrations
- Climate: Wet-Freeze
- WMA Tech.: Evotherm, Gencor foam, Heritage wax

	HMA		Evotherm		Gencor Foam		Heritage Wax	
Density at Constr. (%Gmm)	88.7		90.3		90.4		88.7	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	92.9	93.5	93.0	93.3	94.0	93.5	92.9	93.2
Rut Depth (mm)	0	0	0	0	0	0	0	0
Cracking (ft/600)	1	14	0	0	14	97	0	0

Jefferson Co, FL, 1 and 2 Years Revisits

- Mix Type: 9.5 mm NMAS
- Binder Type: PG 76-22
- N_{design} = 75 gyrations
- Climate: Wet-No Freeze
- WMA Tech.: Terex foaming system

	HMA		Terex Foam	
Density at Constr. (%Gmm)	93		92.1	
Density At Revisits (%Gmm)	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	92.6	91.5	91.8	91.8
Rut Depth (mm)	2	2	3	3
Cracking (ft/600)	0	0	0	0

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NYC, NY, 1 and 2 Years Revisits

- WMA Tech.: Cecabase, SonneWarmix, BituTech PER
- Mix Type: 9.5 mm NMAS
- Binder Type: PG 64-22
- N_{design} = 75 gyrations
- Climate: Wet- Freeze

	HMA		BituTech PER		Cecabase		SonneWarmix	
Density at Constr. (%G_{mm})	90.8		92.4		92.1		89.9	
Density At Revisit (%G_{mm})	Revisit 1	Revisit 2	Revisit 1	Revisit 2	Revisit 1	Revisit 2	Revisit 1	Revisit 2
	93.9	94.8	94.4	95.5	93.4	94.6	95.7	94.7
Rut Depth (mm)	1	1.9	<1	2.7	<0.5	<0.5	0	0
Cracking (ft)	0	18	0	0	0	16	0	0

Casagrande, AZ, 1 Year Revisit

- Mix Type: 19 mm NMAS
- Binder Type: PG 70-10
- 75 blows (Marshall Mix Design)
- Climate: Dry- Freeze
- WMA Tech.: Sasobit

	HMA	Sasobit
Density at Constr. (%Gmm)	90.6	92.4
Density At Revisits (%Gmm)	93.8	94.5
Rut Depth (mm)	3	3
Cracking (ft/600)	0	0

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Summary of Field Performance

Existing Projects

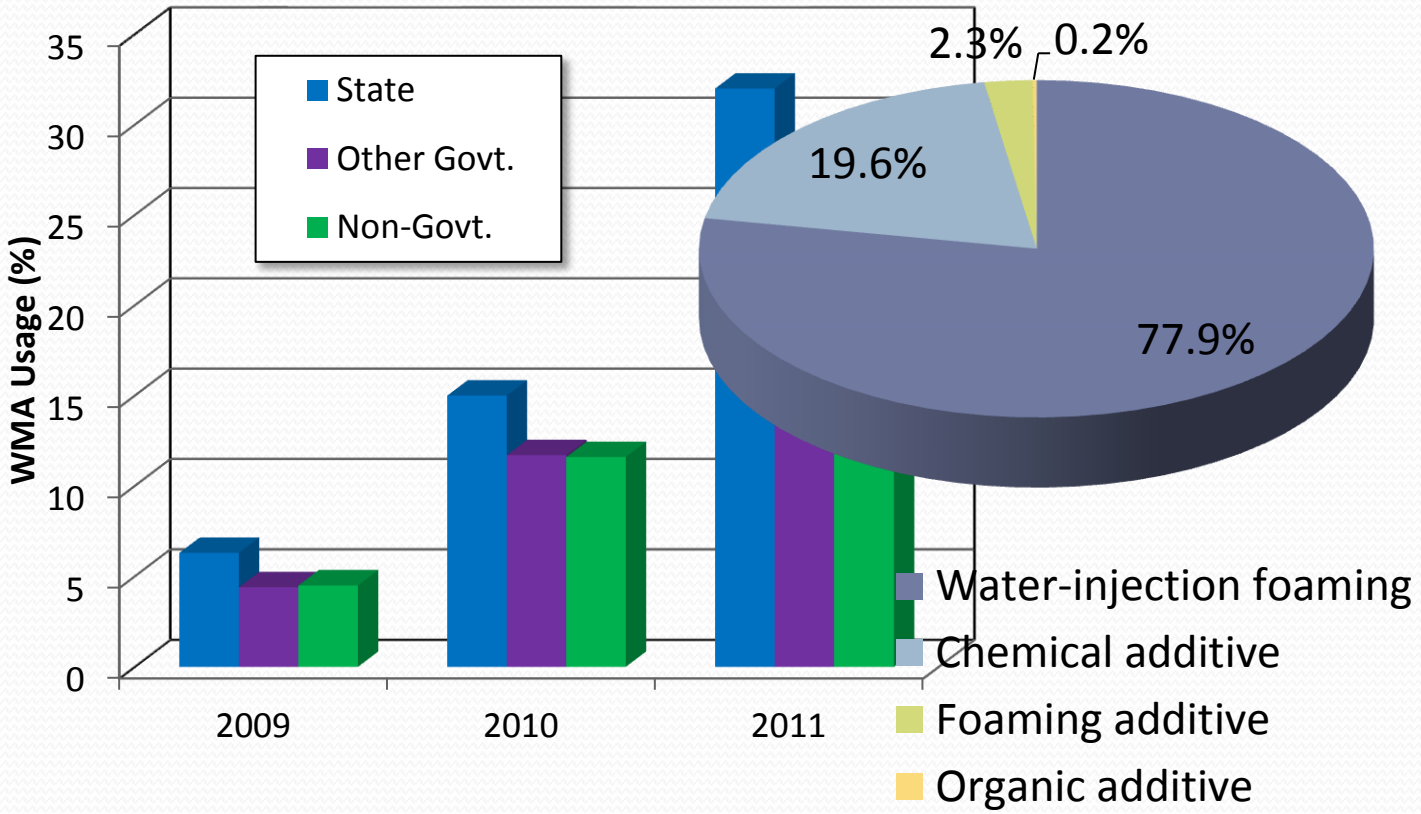
- Age range: 2 ½ years to 5 ½ years
- No cracking in 1 of 5 projects
- Max crack length 1310 ft. (St. Louis, MO)
- Max rutting 6mm (Silverthorne, CO)

Summary of Field Performance

New Projects

- No cracking in 4 of 8 projects after 2 years (No second revisit for AZ)
- No rutting in 2 of 8 new projects after 2 years
- Max crack length (WMA mixes) 97 ft (Griffith, IN-Gencor Foam)
- Max rutting (WMA Mixes) -3mm (Virginia, Astec BDG and Jefferson Co, FL; Terex Foam)

Estimated WMA Production



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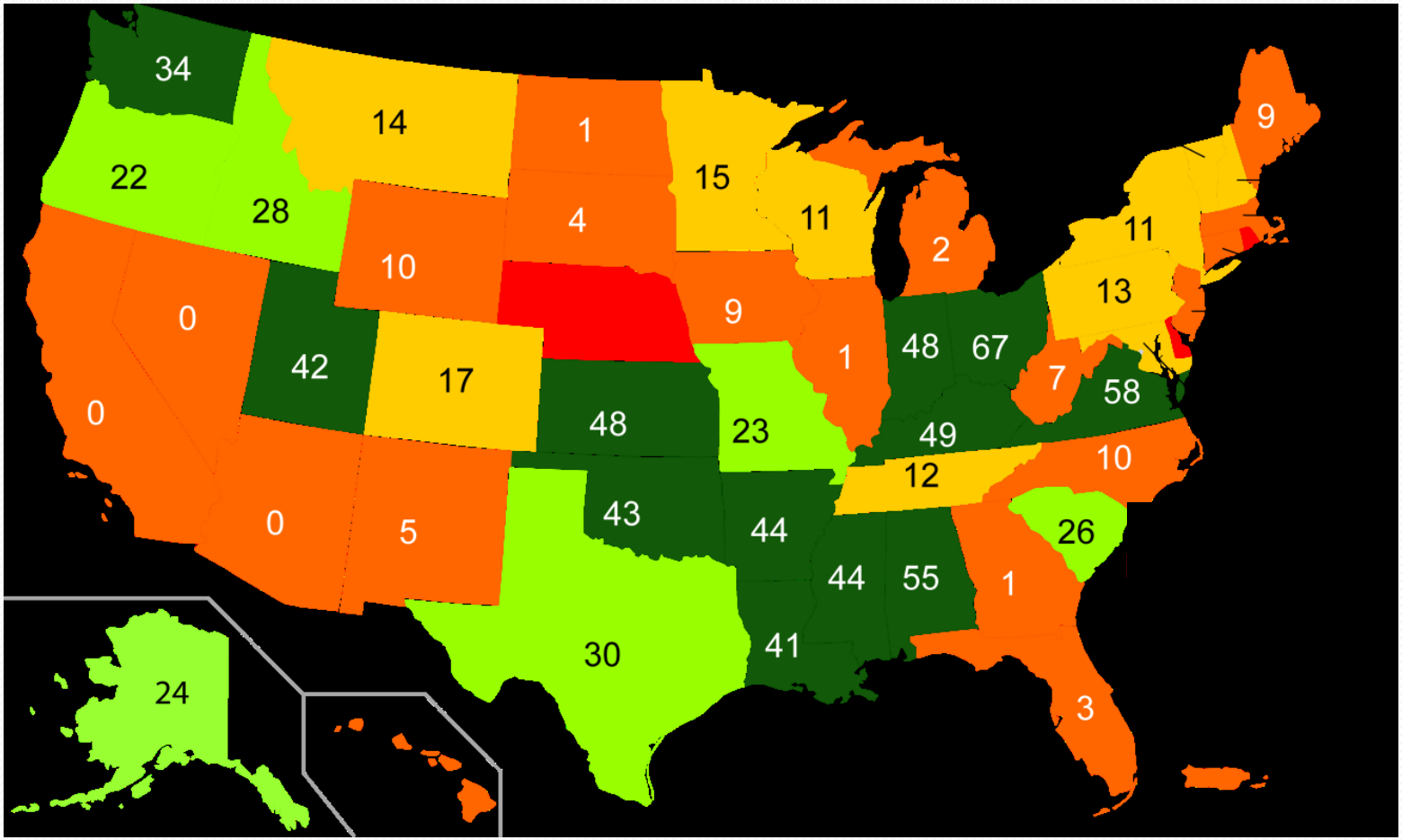
WMA in 2011 (NAPA)



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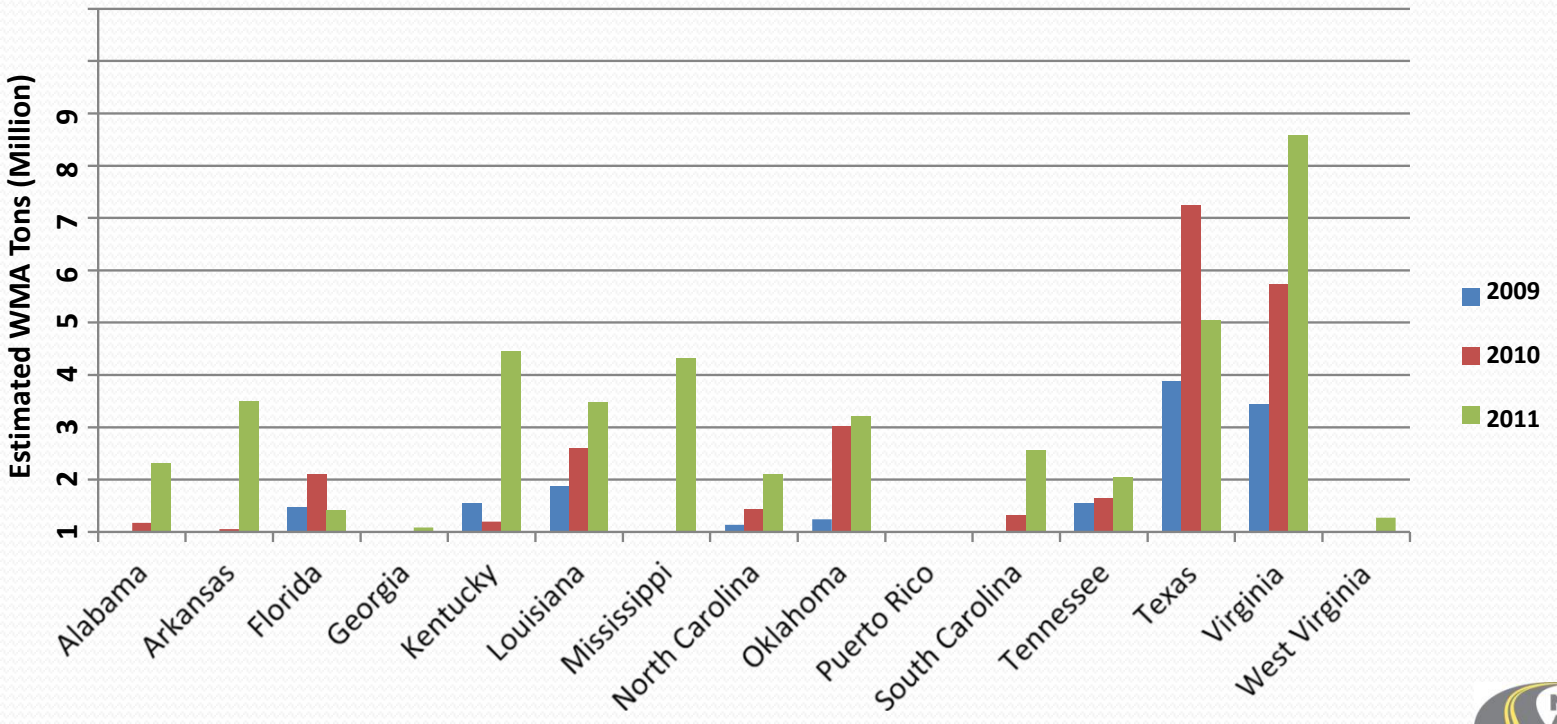
NAPA Survey, 2013



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WMA Guide Spec

- Temperature reductions may be achieved through approved additives and/or water injection systems. A common spec requirement is a maximum mixing temperature of 275 F.
- All specification requirements for HMA shall apply to WMA except as noted herein.
- The mixture shall be produced with a WMA technology from the approved list and in accordance with the WMA technology provider's guidelines for dosage rate, plant mixing temperature, and laboratory compaction temperature.

Warm Mix Asphalt

- An approved HMA mix design may be used for the WMA provided that:
  a. The asphalt absorption of the HMA mix design is less than 2.0%, and
  b. An initial field trial of the WMA produced with the plant designated for the mix design meets all asphalt mixture specifications.
- If either a or b are not met, then the WMA shall be designed in accordance with the procedures and criteria in NCHRP Report 691.
- The WMA mix design submitted by the contractor shall include the name of the WMA technology, dosage rate, plant mixing temperature, and laboratory compaction temperature.

Warm Mix Asphalt

- The antistrip-additive may be eliminated from the WMA mixture provided that:
  a. The WMA additive contains active antistripping components as certified by the WMA technology provider.
  b. The WMA mixture without an additional antistripping agent meets the standard HMA moisture damage test criteria.

Warm Mix Asphalt

- Plant operations for WMA production
  - The burner shall be properly tuned to operate at the WMA mix temperature such that the fuel is entirely consumed in the combustion zone of the drier. Production shall immediately cease if evidence of unburned fuel is detected in the produced asphalt mixture or in the baghouse.
  - The plant discharge temperature of the WMA shall be within 20°F of the temperature designated on the WMA mix design. During plant start up or at project transition points, the mix temperature may be above the designated WMA mix temperature, but no greater than 340°F.

Warm Mix Asphalt

- Plant operations for WMA production
  - The addition of WMA additives, including water, shall be controlled by a calibrated metering system interlocked with the plant's controls.
  - Chemical additives may be added at the asphalt terminal at the dosage rate recommended by the WMA technology provider. The dosage rate and additive name shall be printed on the Bill of Lading for the asphalt binder.

Challenges for WMA

1. Keeping track of new WMA Technologies
2. Developing a Mix Design Process that works for all WMA Technologies
3. Improving plant burner efficiencies
4. Lab tests better correlated to field performance. Many tests now contradict observed field performance.

States have a list of acceptable technologies for WMA

Sources of Info for WMA

- NAPA Survey for WMA, RAP, RAS for years 2009, 2010, and 2011
- NAPA: WMA Best Practices Manual
- First and Second International Conference on WMA
- NCAT website: ncat.us
- warmmixasphalt.com
- WMA producers

Summary

- Performance has been good
- Quickly being implemented in most states

Any Questions???