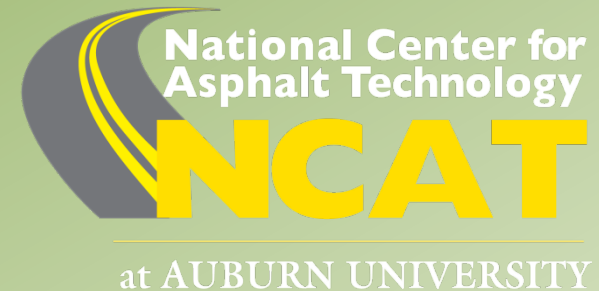


Engineering Properties and Field Performance of Warm Mix Asphalt

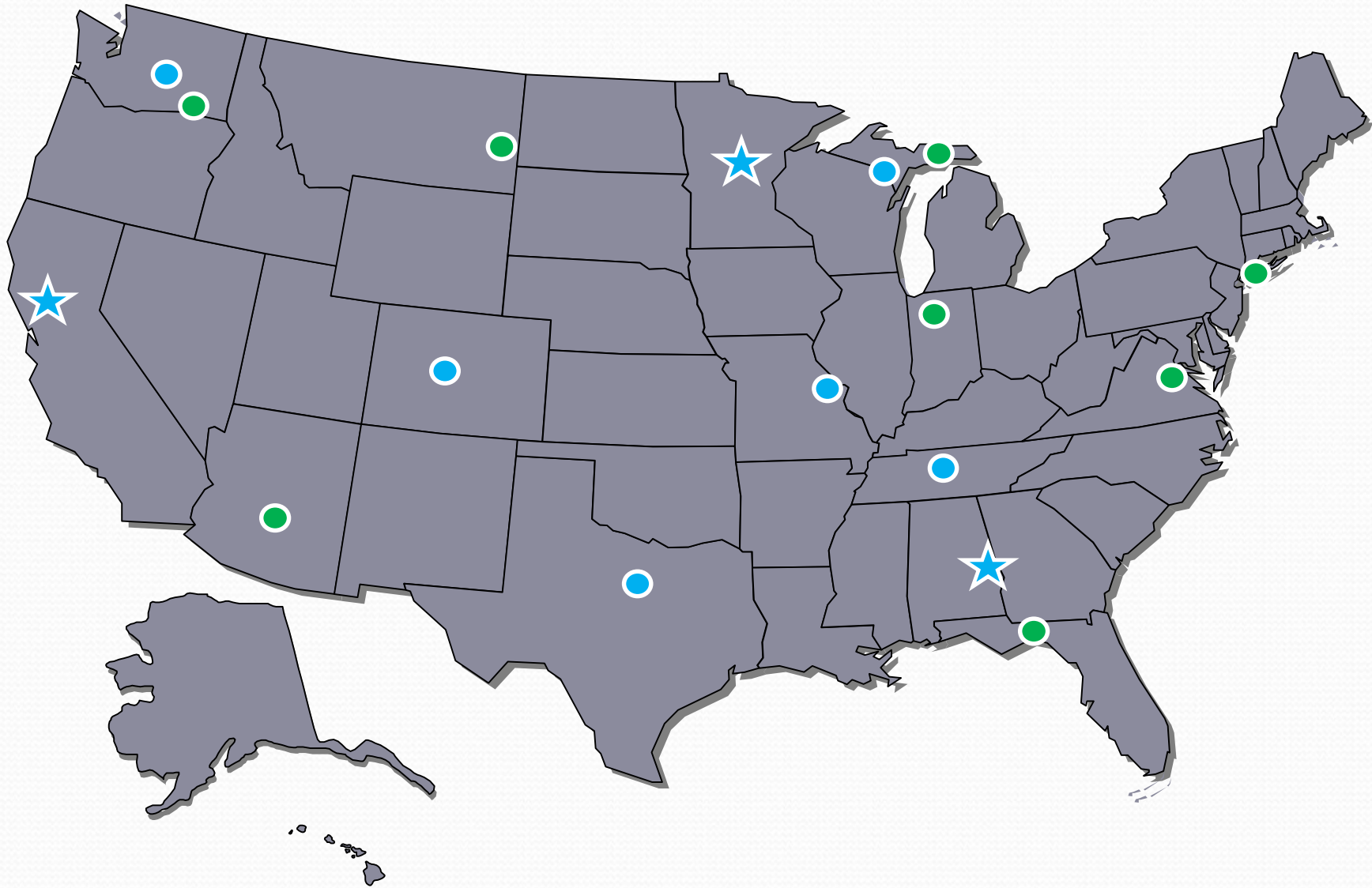
NCHRP Project 9-47A

NCHRP Report 779



Compliance
Monitoring Service LLC

NCHRP 9-47A Field Sites



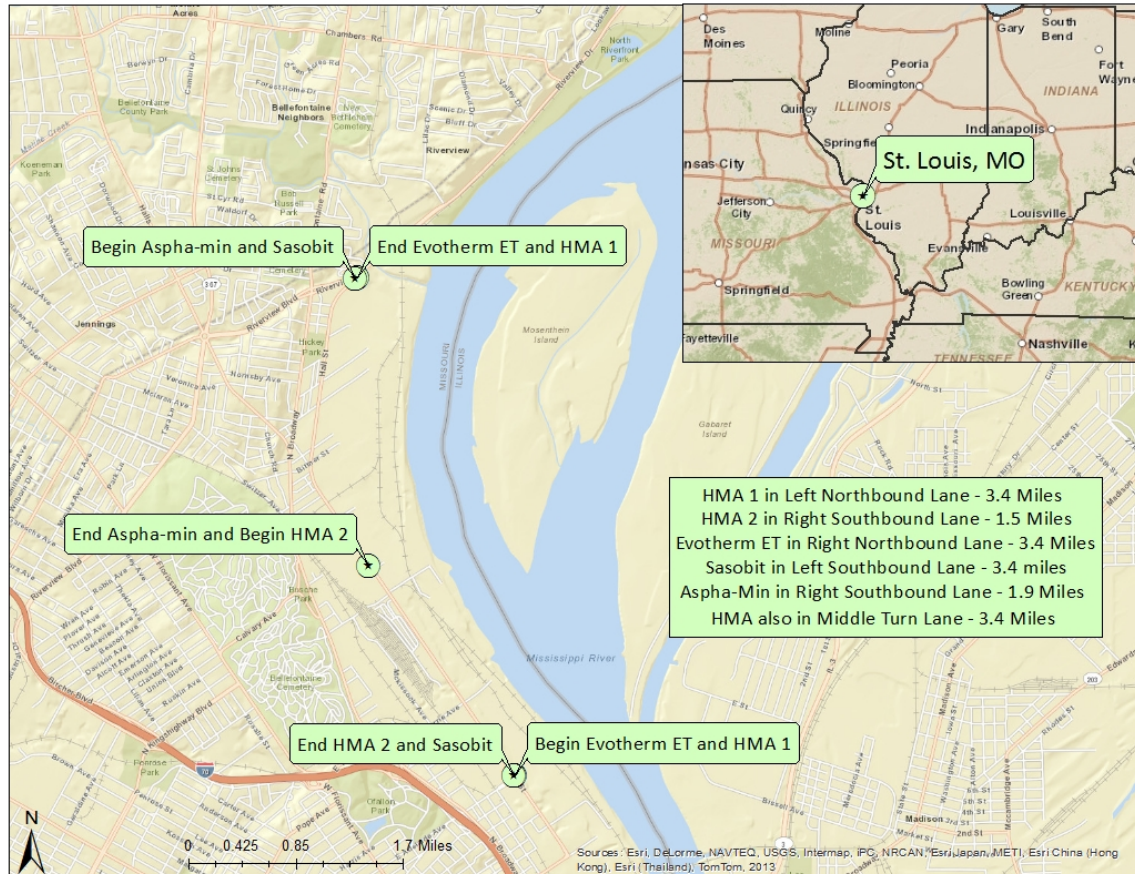
Field Performance



Field Performance Evaluation Procedure

- Three 200-foot analysis sections per mix section
 - Rutting and texture measured at beginning of each section
 - Cracks and other distresses were mapped throughout each 200-foot section
- 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, MO



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

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

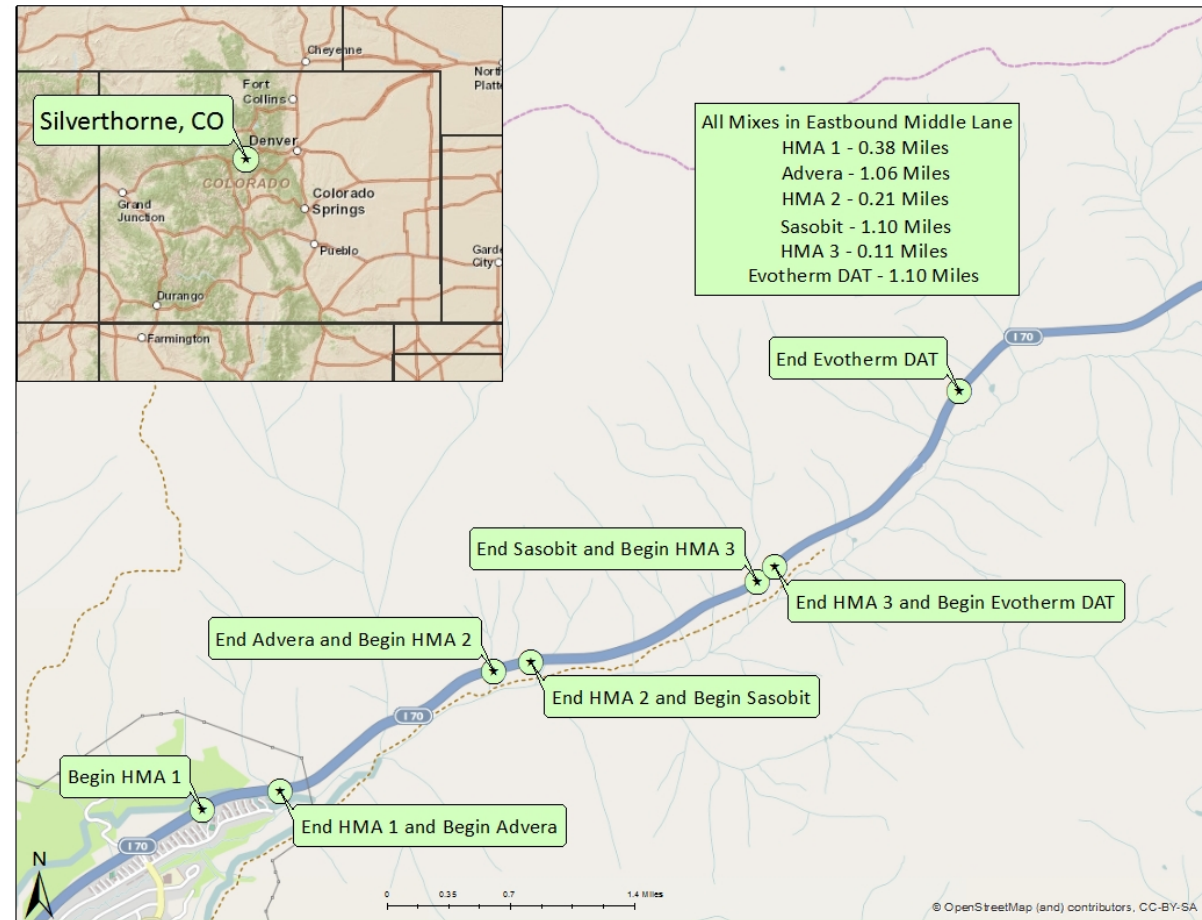
	HMA	Sasobit	Evotharm ET	Aspha min- Zeolite
Rutting (mm)	1.9	0.8	2.4	2.4
Total Length of Cracks (m)	628	1092	835	1310
Density (%G _{mm})	96.1	94.8	97.4	96.8

All cracks were
reflection cracks



I-70, Silverthorne, CO

- Constructed August 2007
- WMA tech.: Advera, Sasobit, Evotherm DAT
- Mix type: 9.5 mm NMAS
- Overlay of thermal cracked asphalt pavement
- Climate: Dry Freeze
- Binder Grade: PG 58-28



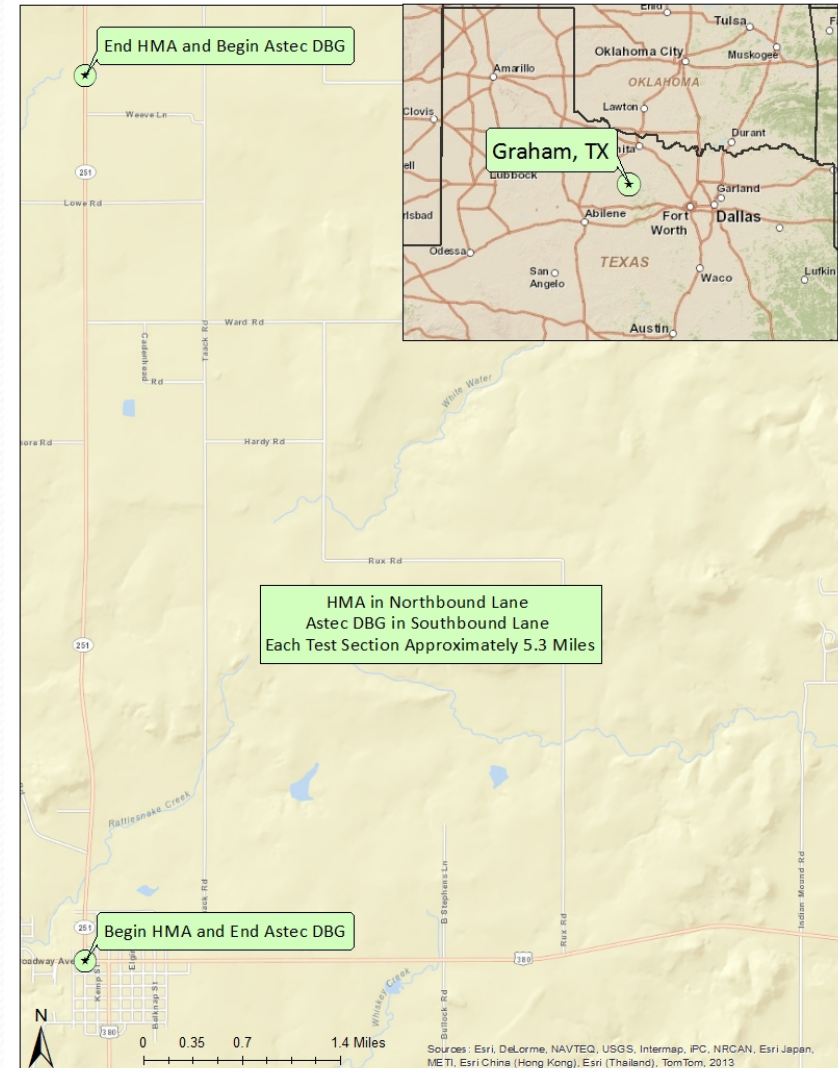
I-70, Silverthorne, CO (3 years 2 months)

	HMA-1	Advera	HMA-2	Sasobit	HMA-3	Evotherm DAT
Rut Depth (mm)	5	4	5	6	8	6
Total Length of Cracks (m)	0	0.3 NWP Long.	0	0.9 NWP Long.	9.4 mostly NWP Long.	5.5 Transverse
Density (%G _{mm})	97.3	98.1	97.3	96.5	97.3	96.9



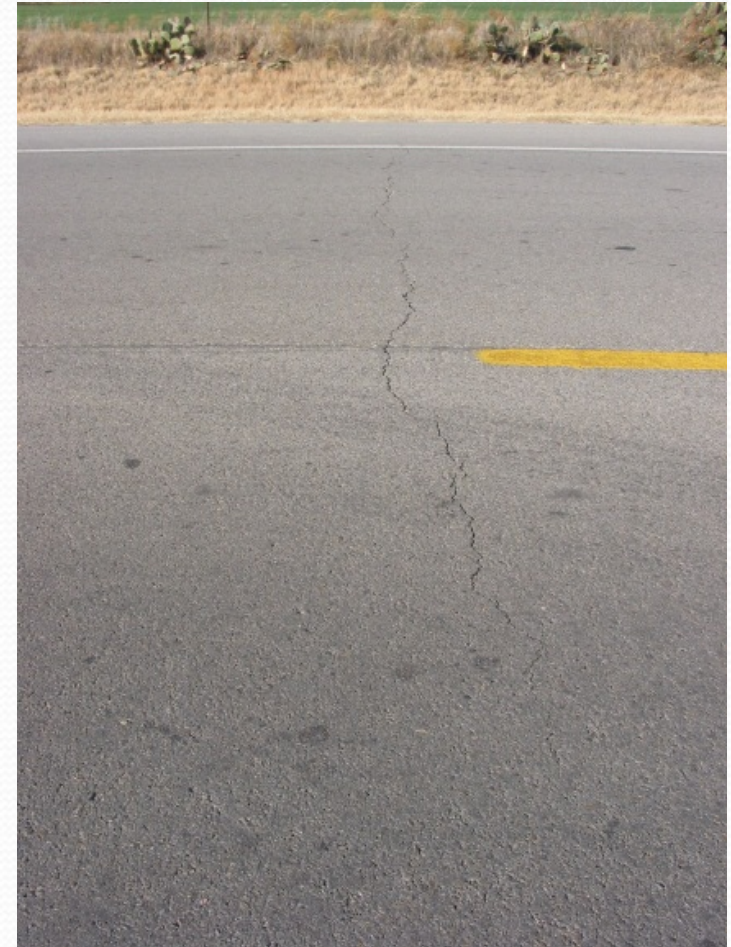
US 380, Graham, TX

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



US 380, Graham, TX (2 year 6 months)

	HMA	Astec DBG
Rut Depth (mm)	0	0
Total Length of Cracks (m)	17.7	24.8
Density (%Gmm)	96.0	94.3



I-90, George, WA

- Constructed June 2008
- WMA Tech.: Sasobit
- Mix Type: 12.5 mm NMAS
- Binder Grade: PG 76-28
- Climate: Dry freeze



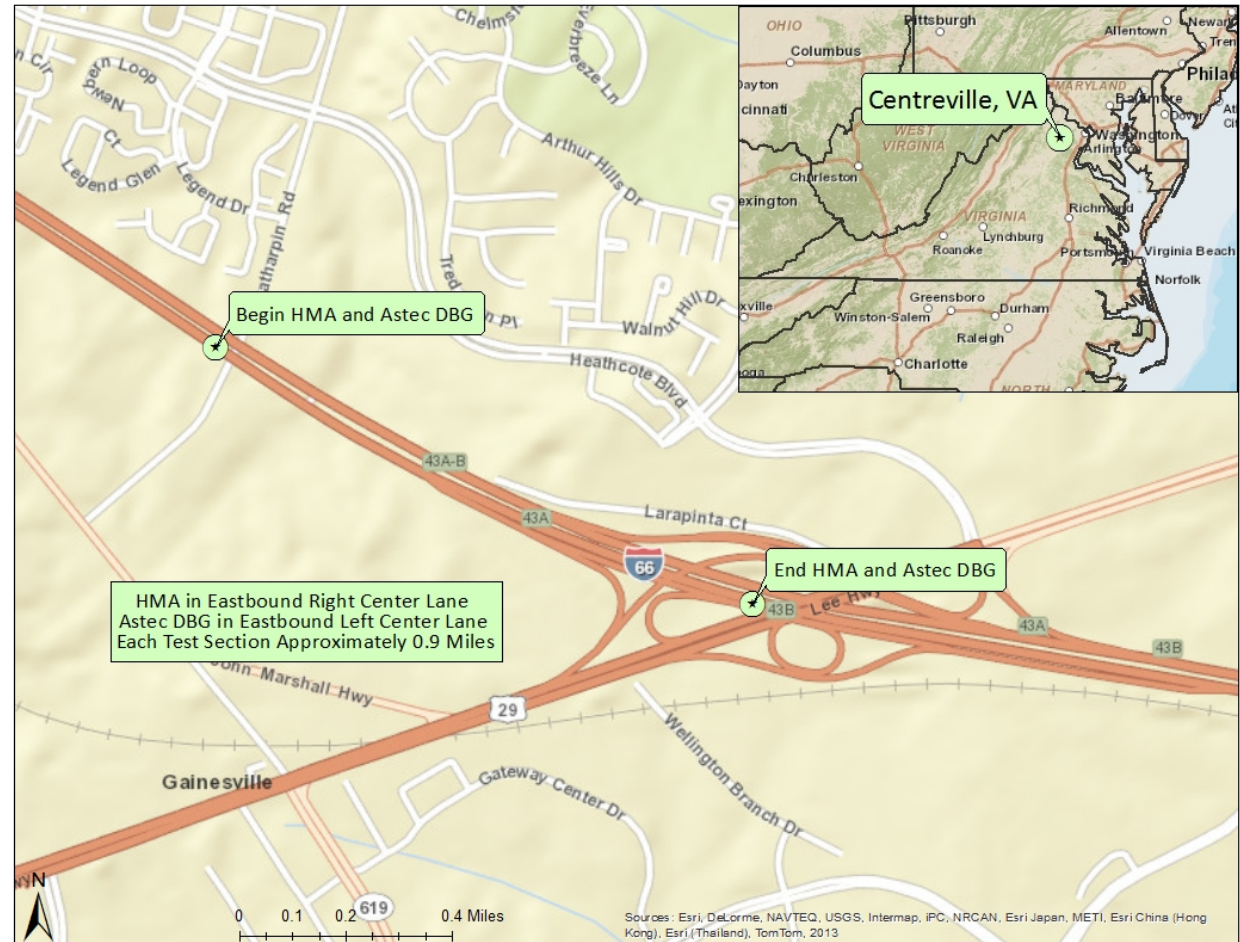
I-90, George, WA (4 years 2 months)

	HMA	Sasobit
Rut Depth (mm)	5.6	6.0
Total Length of Cracks (m)	24.7	3.7
Density (%Gmm)	95.7	96.3



I-66, Centreville, VA

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



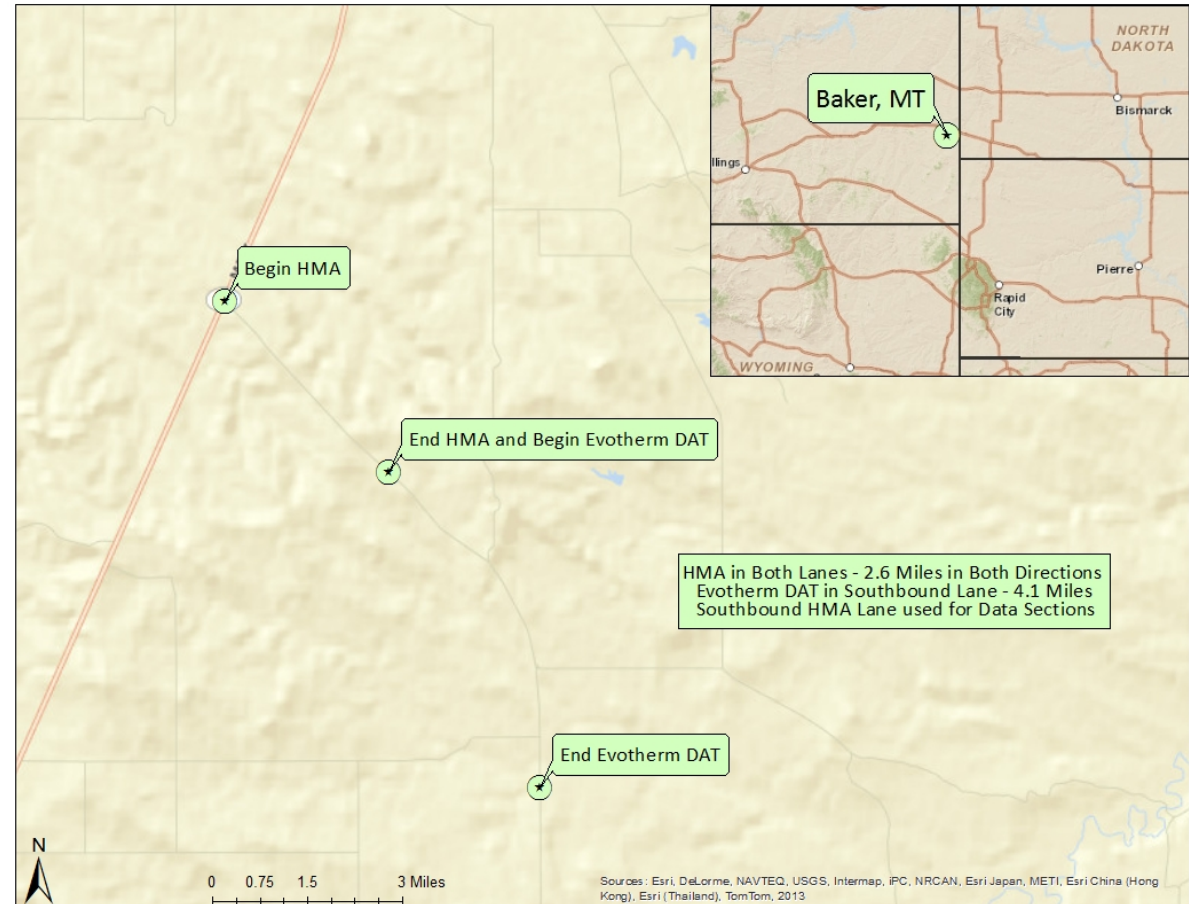
I-66, Centreville, VA (2 years)

	HMA	Astec DBG
Rut Depth (mm)	3.2	2.7
Density (%Gmm)	93.8	93.4
Mean Texture Depth (mm)	0.6	0.6
Cracking (m)	0	0



Route 322, Baker, MT

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



Route 322, Baker, MT (1 year 10 months)

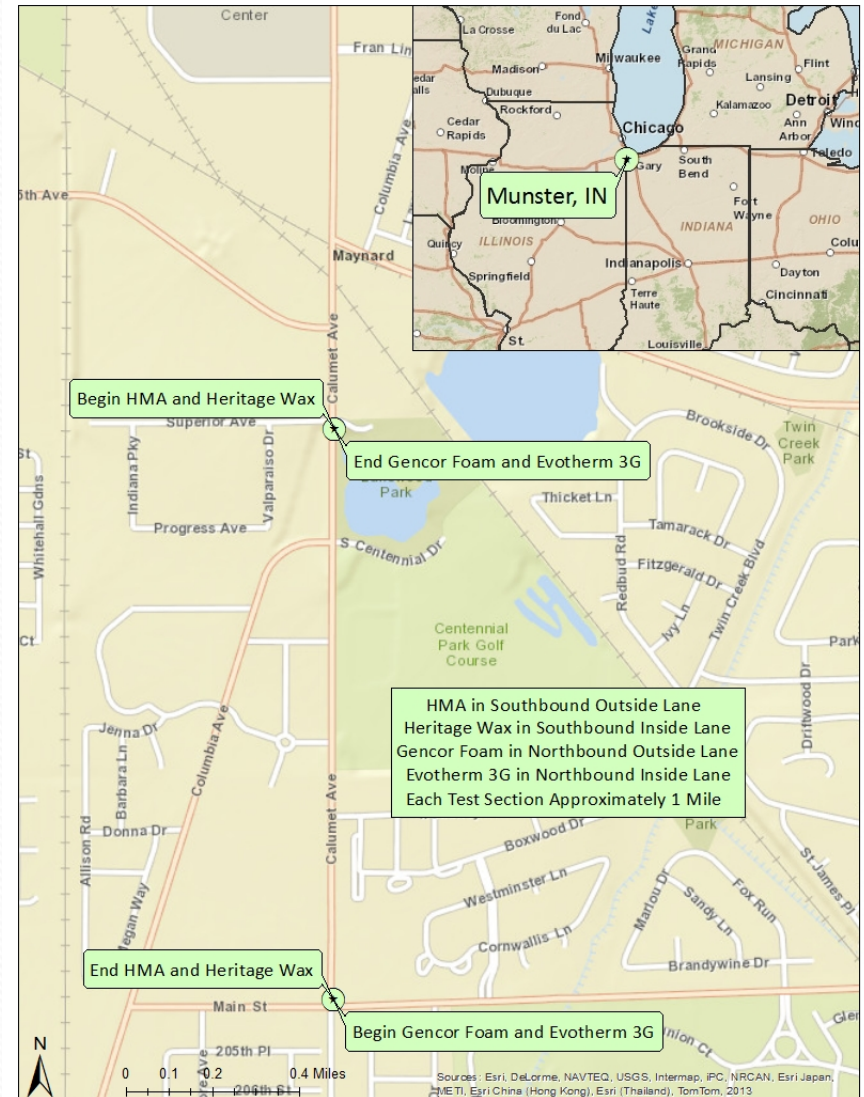


A chip seal was applied to roadway after about 8 months, a standard practice in MT

	HMA	Evotherm
Rut Depth (mm)	0.5	0.2
Density (%Gmm)	94.0	93.3
Cracking (m)	7.3	3.7

Calumet Ave., Munster, IN

- WMA tech.: Evotherm 3G, Gencor Ultrafoam, Heritage wax
- Mix Type: 9.5 mm NMAS
- Binder Grade: PG 64-22
- $N_{\text{design}} = 75$ gyrations
- Climate: Wet-Freeze



Calumet Ave., Munster, IN (2 years)



	HMA	Evotherm	Gencor Foam	Heritage Wax
Rut Depth (mm)	0	0	0	0
Density (%Gmm)	93.5	93.3	93.5	93.2
Mean Texture Depth (mm)	0.6	0.5	0.5	0.6
Cracking (m)	4.4	0	25.7	0

Little Neck Parkway, Queens, NY

- WMA tech.: Cecabase, SonneWarmix, Bitutech PER
- Mix Type: 9.5 mm NMAS
- Binder Grade: PG 64-22
- $N_{\text{design}} = 75$ gyrations
- Climate: Wet- Freeze
- Original pavement: jointed concrete, previously overlayed



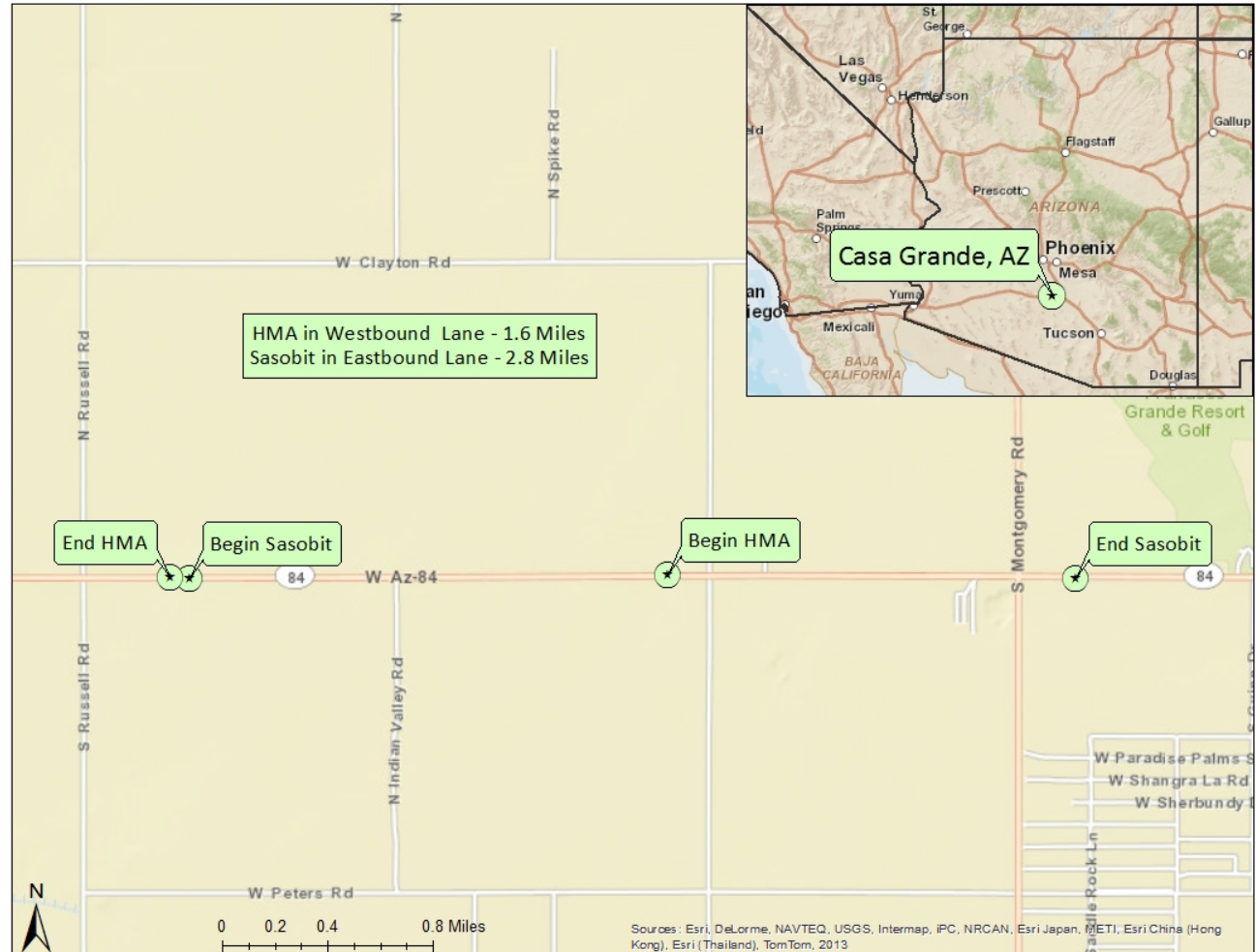
Little Neck Pkwy., Queens, NY (2 yrs. 2 months)



	HMA	BituTech PER	Cecabase	Sonne Warmix
Rut Depth (mm)	1.9	2.7	0.3	0
Density (%G _{mm})	94.8	95.5	94.6	94.7
Mean Texture Depth (mm)	0.8	0.7	0.6	0.6
Cracking	8.8	5.2	20.1	5.2

SR 84, Casa Grande, AZ

- WMA tech.: Sasobit
- Mix Type: 19 mm NMAS
- Binder Grade: PG 70-10
- 75 blows (Marshall mix design)
- Climate: Dry- Freeze



SR 84, Casa Grande, AZ (9 months)

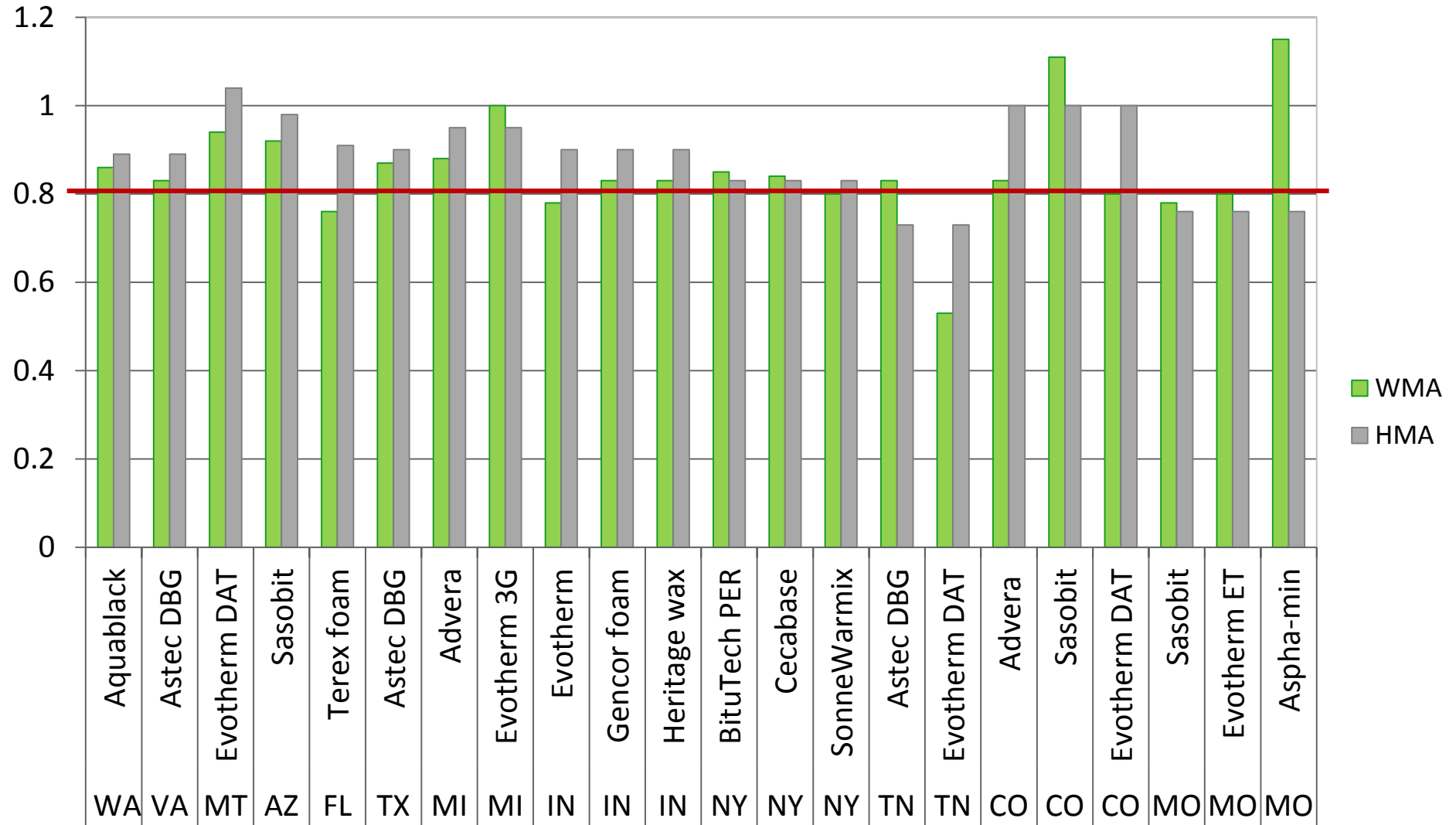
	HMA	Sasobit
Rut Depth (mm)	3.2	0
Density (%Gmm)	93.8	94.5
Cracking (m)	0	0



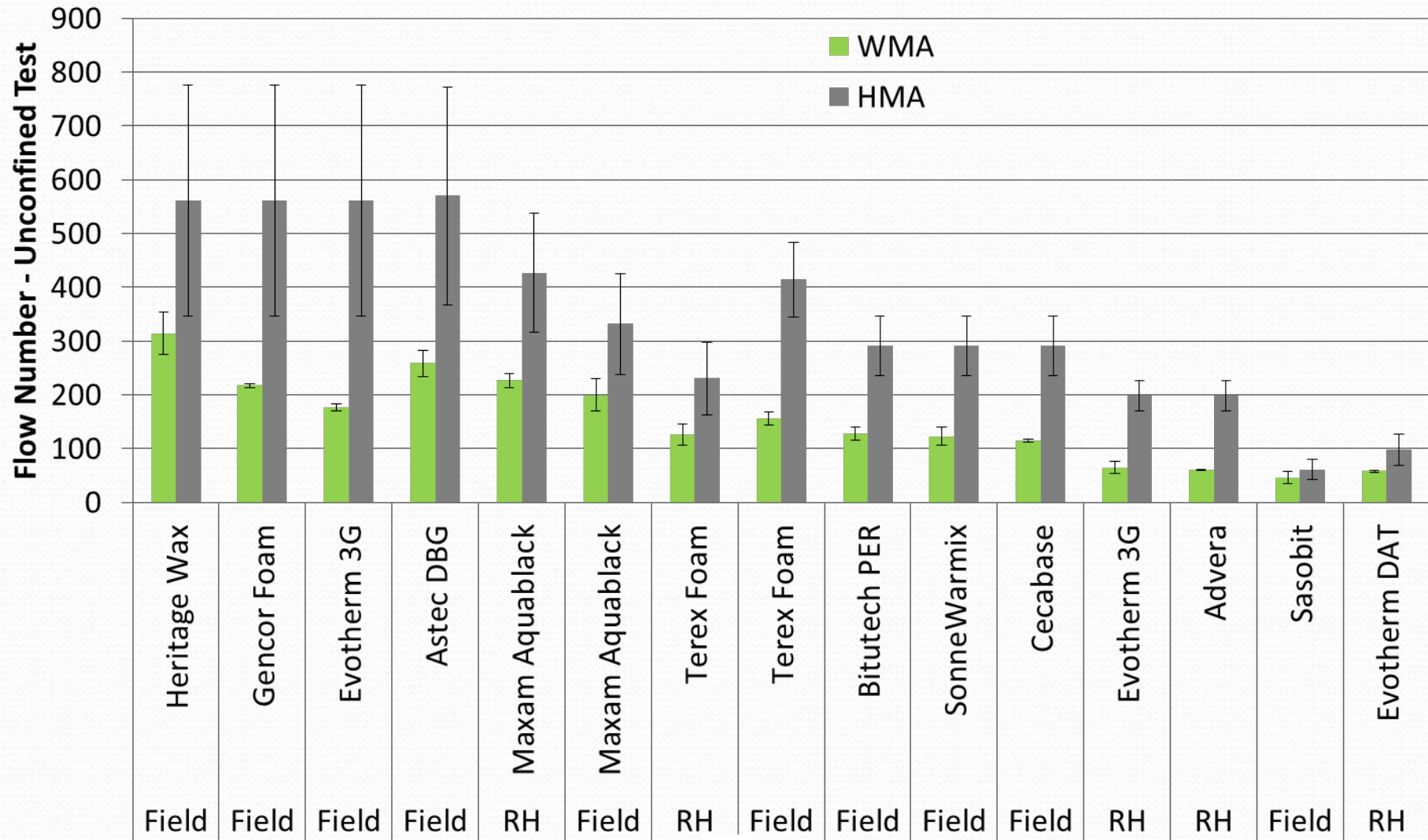
Summary of Field Performance of NCHRP 9-47A Projects

- 14 projects thoroughly evaluated
- All WMA sections used HMA mix designs
- Most projects were mill and fill surface rehab. projects
- Traffic ranges: low to very heavy
- Climates: hot to very cold
- Ages at last inspection were 1 to 6 years old
- WMA sections compare equal to HMA with regard to:
 - Rutting
 - Reflection cracking
 - Raveling
- All sections (WMA and HMA) are performing well.

TSR-AASHTO M323 (= or ↓)



FN Test Results- WMA vs. HMA



- WMA & high RAP/RAS/GTR mixes
- Optimized structural design
- Pavement preservation
- Implementation



Pavement Test Track Conference

March 3-5, 2015

The Hotel at Auburn University
and Dixon Conference Center

www.ncat.us