Warm Mix Asphalt

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Garden Ridge, Texas

Asphalt Institute

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- US-based, international association of petroleum asphalt producers, manufacturers, and affiliated businesses, established in 1919
- Promotes the use, benefits and quality performance of petroleum asphalt through engineering, research and educational activities.
- HQ office-Lexington, KY
- Local office-Garden Ridge (San Antonio), Texas
  - Six other regional engineering offices scattered about the US

MEMBER COMPANIES

AFFILIATE MEMBERS

Warm Mix Asphalt-Definition

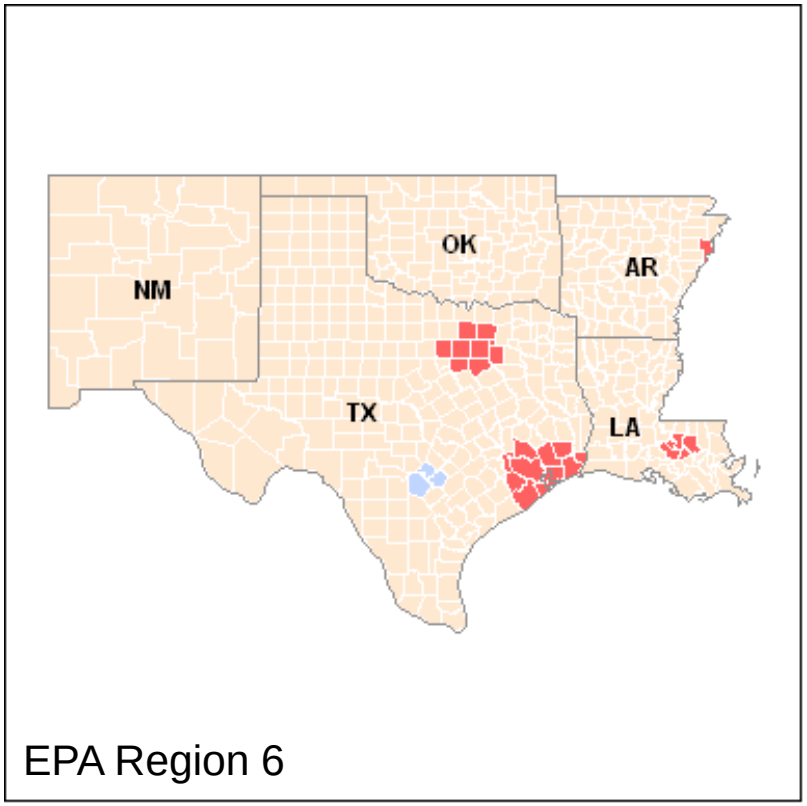
Hot Mix Asphalt designs that are modified to be produced, placed and compacted at 50-100F less than typical HMA

http://www.warmmixasphalt.com/

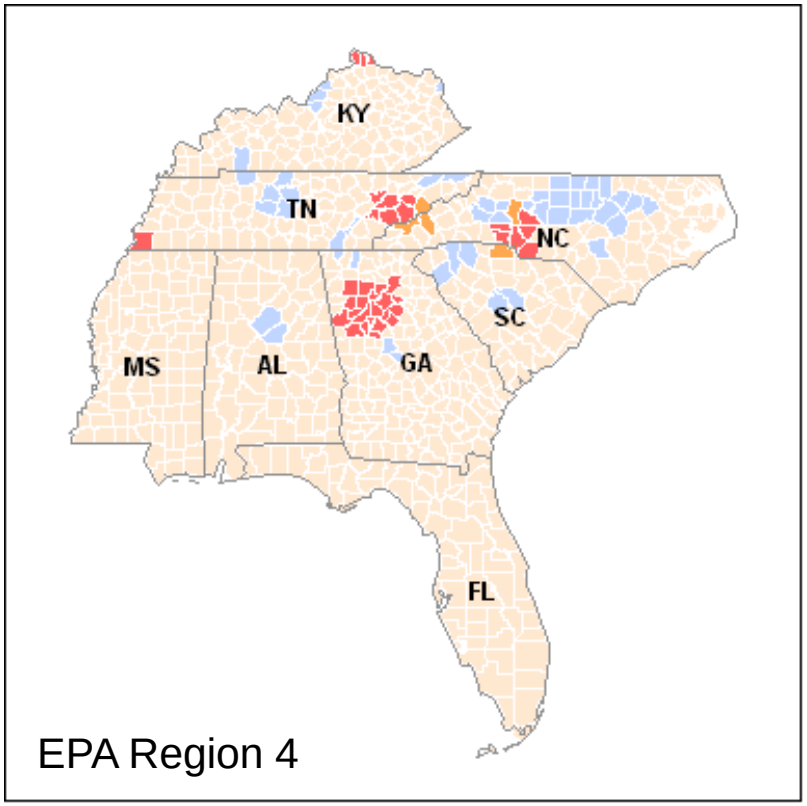
Potential Benefits of WMA

- Improved workability
  - Easier compaction, allows for extended hauls and construction season
  - Facilitates night work, especially thin-lift applications using polymer modified asphalt binders
- Reduced binder aging
- Reduced heating/energy requirements
  - Lower emissions during production
    - Visible and non-visible
  - Less fumes during handling
- Less plant wear

Ozone Non-attainment Areas



EPA Region 6



EPA Region 4

8-Hour Ozone Designations

- Attainment
- Nonattainment
- Nonattainment (part county)
- Redesignated to Attainment

Ground level ozone is considered to be a respiratory irritant. It is caused by chemical interaction between sunlight, nitrous oxides (NOx) and volatile organic compounds (VOC's).

Global Increase in CO_2

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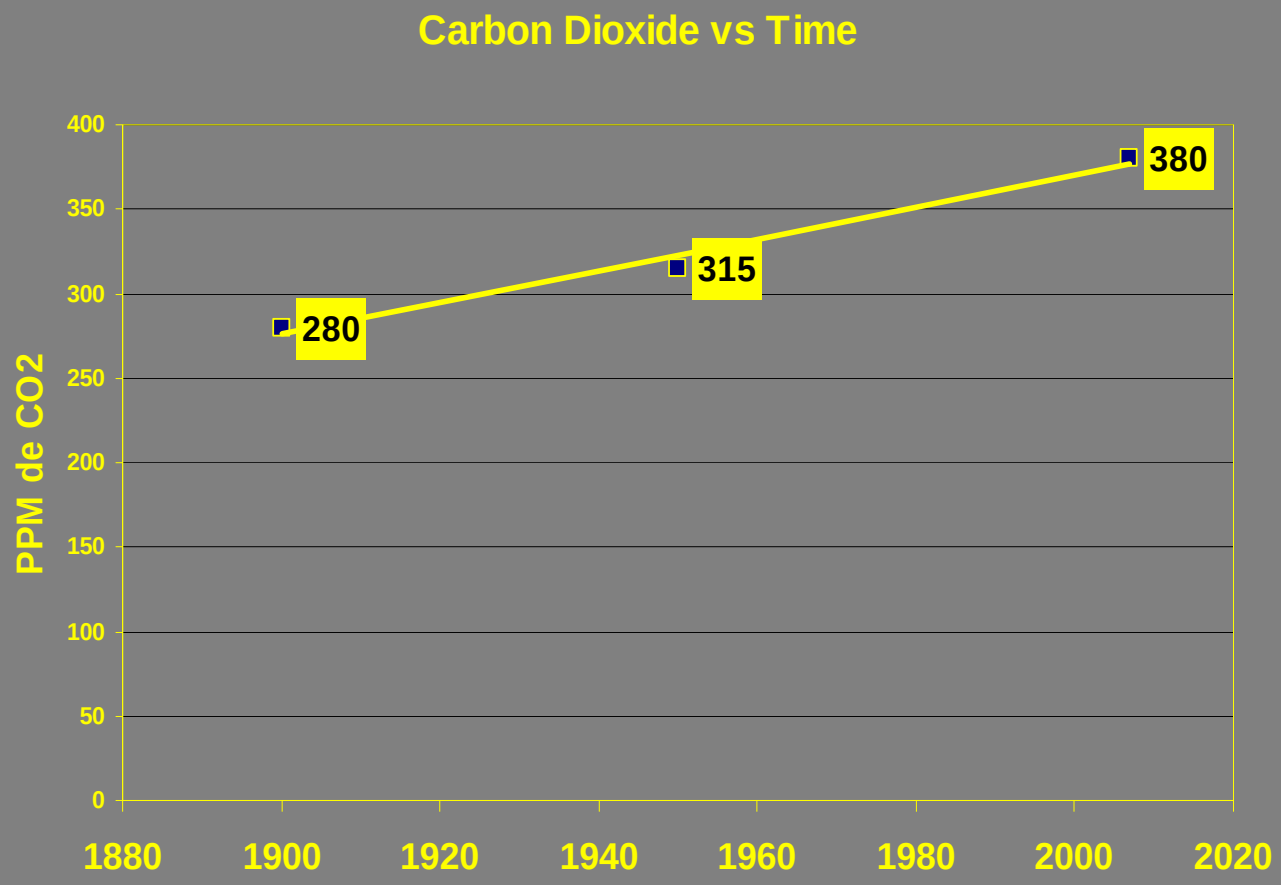

WMA Benefit: Reduced Emissions

Table 4. Reported reductions in plant emissions (percent) with WMA.[10, 11, 12]

Emission	Norway	Italy	Netherlands	France
CO_2	31.5	30–40	15–30	23
SO_2	NA	35	NA	18
VOC	NA	50	NA	19
CO	28.5	10–30	NA	NA
NO_x	61.5	60–70	NA	18*
Dust	54.0	25–55	NA	NA

**Reported as NO_2*
NA—not available

From: *Warm-Mix Asphalt: European Practice*

HMA vs WMA

Warm Mix Asphalt-Approaches

- Chemical binder additives
- Chemical mixture additives
- Foaming admixtures
- Plant modifications/foaming

www.warmmixasphalt.com

WMA Technologies

- Chemical binder additives:
  - Cecabase RT®
  - Evotherm™
  - Rediset™WMX
  - REVIX™
- Chemical mixture additives:
  - Asphaltan®
  - Sasobit®
- Foaming admixtures:
  - Advera®
  - Aspha-Min®
  - Low Energy Asphalt
- Plant modification:
  - Double-Barrel® Green
  - Terex® WMA System
  - WAM-Foam

www.warmmixasphalt.com

Chemical Binder Additives

- Examples:
  - Cecabase RT®
  - Evotherm™
  - Rediset™WMX
  - REVIX™

- Make the asphalt “wetter” so it more readily coats and lubricates aggregate particles

- Added directly to the asphalt binder

Evotherm™ Overview Technology Highlights

- Chemical structure developed & optimized for warm mix performance
  - Coating
  - Workability
  - Strength
  - Adhesion
- Dispersed Asphalt Technology (D.A.T.) delivery system
  - ~5% by weight of asphalt binder

Evotherm™ Overview
Production

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- Mix & compaction temperatures from 110-60C (230-140F)
- No plant modifications required
- No unit operations problems encountered
- Reduced dust generation
- Mixes can be stored in a silo

Evotherm Injection Method

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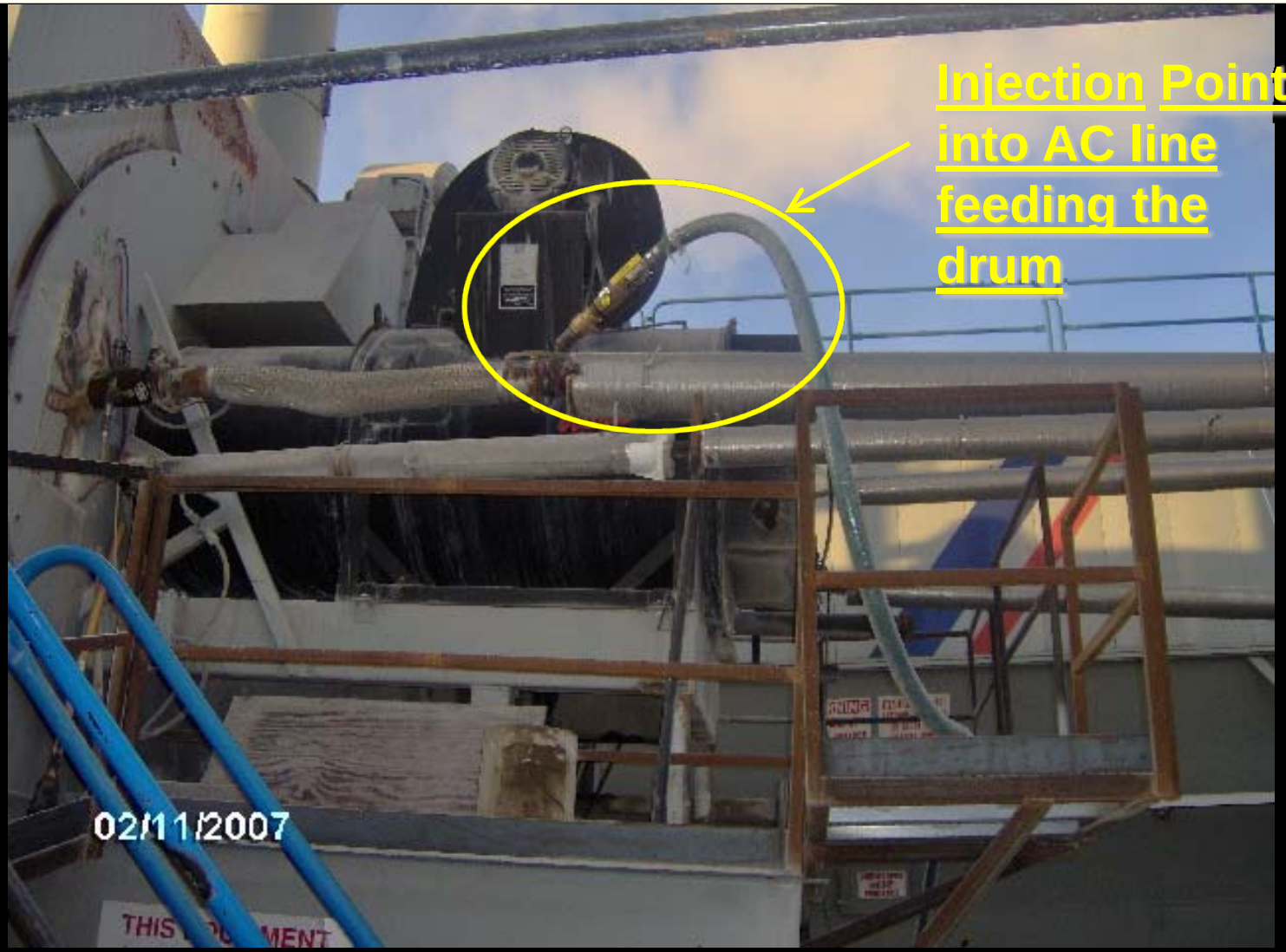

Evotherm™ Field Trials

Superpave and conventional mixes, using standard production, laydown, & compaction methods

Evotherm™ Demo: September 2006 San Antonio

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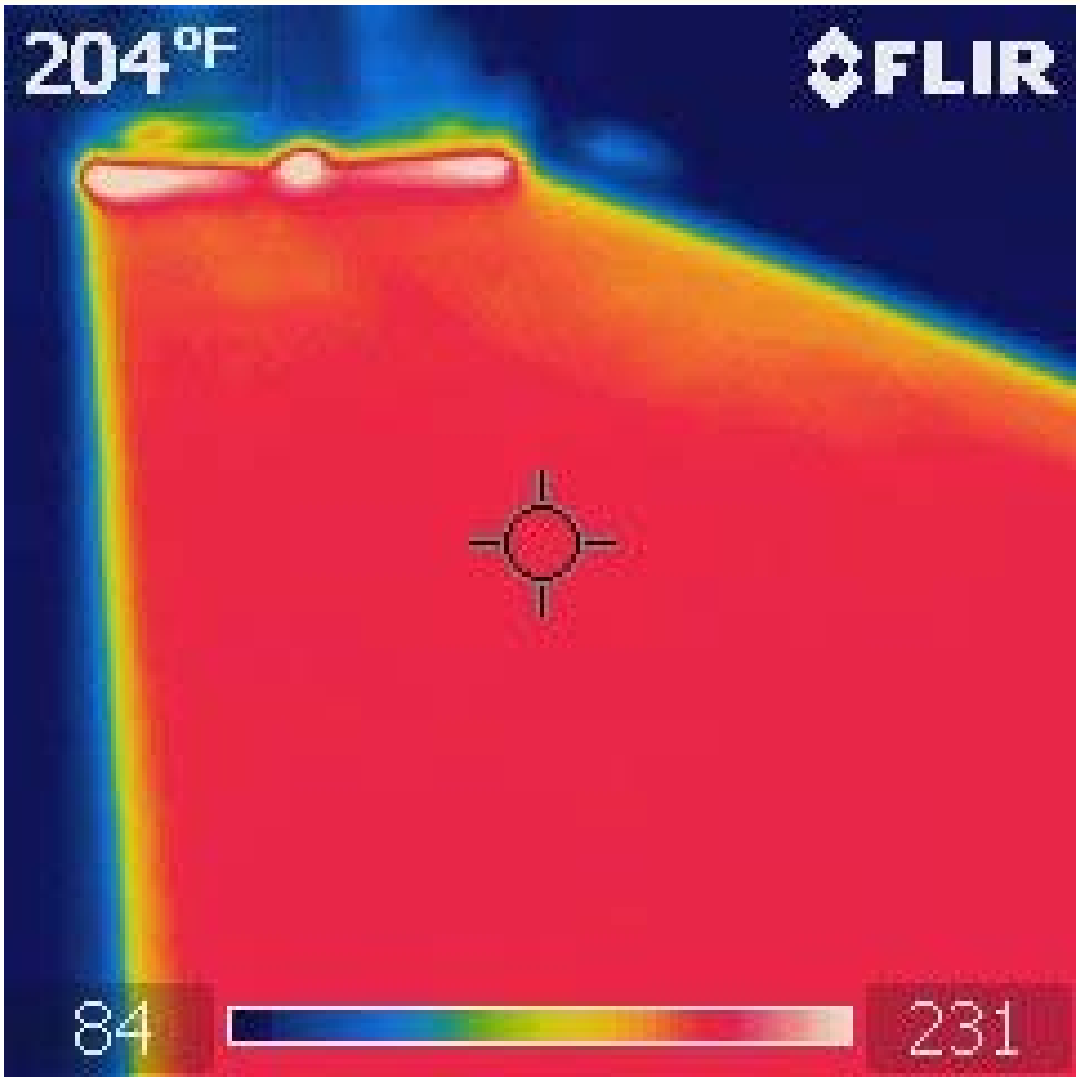


Chemical Mixture Additives

- May be added to mixture or to the asphalt binder
- Waxes provide fluidity (workability) above their melting point
- Types of waxes
  - Fischer-Tropsch
  - Montan

Sasobit®

- Product of Sasol Wax GmbH (Germany)
  - Used in Germany since 1997
- Fischer-Tropsch (synthetic) wax
  - Byproduct of Fischer-Tropsch process used to create liquid fuels from coal or natural gas feedstock
  - Different chemical and physical characteristics than petroleum waxes
  - Sasobit is a food-grade material used in packaging
- Available in beads, flakes or powdered form
  - 2, 5, 20, and 600 kg bags
- Normal dosage: ~1.5% by weight of asphalt binder
  - About 1½ lbs per ton of mixture

Fischer-Tropsch Waxes

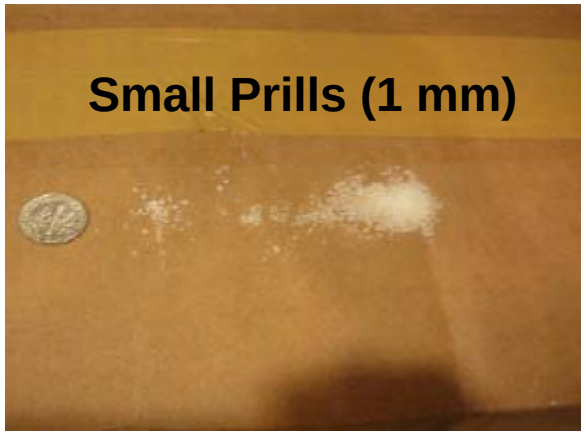
- Different than naturally occurring petroleum waxes in structure and physical properties
  - Higher molecular weight
  - Higher melting point (~98C)
    - Above melting point temp-lower viscosity than asphalt binder
    - Below melting point temp-higher viscosity
- Allows mixture to remain workable until the wax solidifies

Sasobit®

Pneumatic feed

Sasobit®

Prills (5 mm/0.25”)



Small Prills (1 mm)

Flaked

Photos from Sasol

Sasobit®

- Airports
  - *Frankfurt Airport -Frankfurt, Germany*
  - *Doha airport, Qatar*
  - *Svalbard Airport–Most northern commercial airport in the world*
  - *Logan Airport, Boston, MA*
- Container Ports
  - *Heavy duty paving in some of the worlds busiest ports*
- Race Tracks
  - *Talladega, Homestead and Watkins Glen*
- Extra long hauls
  - *750 kilometers (466 miles) in Australia*

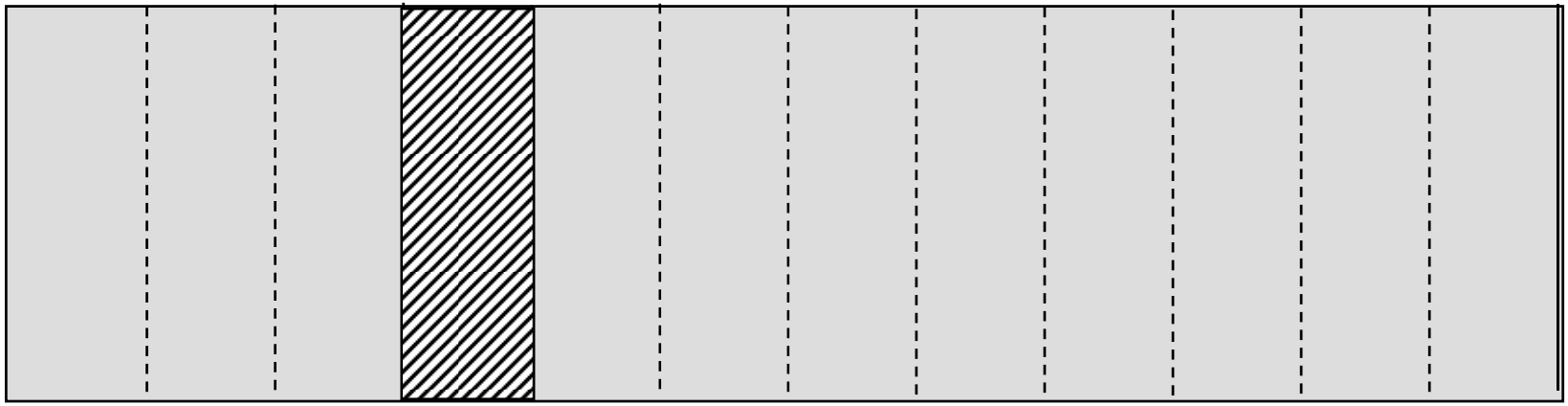
Port of Hamburg, Germany

Frankfurt Airport

- Asphalt mixture laid at low temperature
- Better compactability
- Increased resistance to deformation at high temperatures

PRACTICAL SOLUTIONS

Frankfurt Airport, Germany



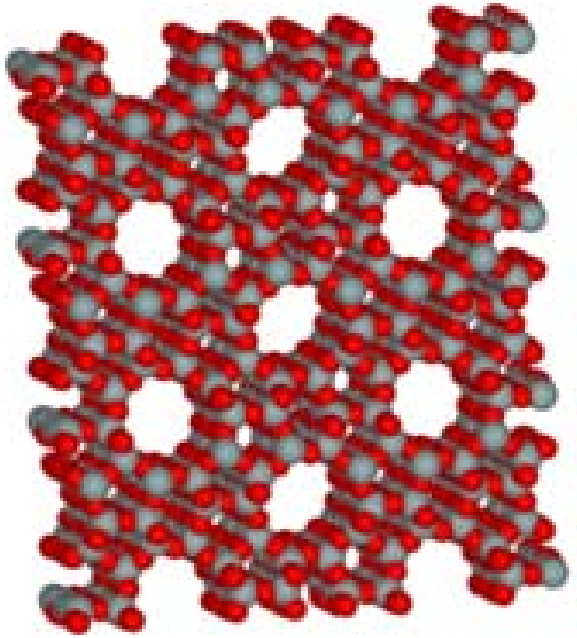
- Worked in strips, removing and replacing ~20 inches of material each night
  - Used Sasobit® WMA technology
- When the entire length was completed, milled and resurfaced w/SMA

Foaming Admixtures

- Release small amounts of steam at temperatures above 212F (100C), foaming the asphalt binder
- Admixtures include synthetic zeolites or moistened fine aggregates
  - Zeolites: Advera®, Aspha-Min®
  - Moistened fine aggregates: Low energy asphalt

Synthetic Zeolites

- Synthetic particles consisting of crystalline hydrated aluminum silicate containing a latticed internal void structure (~20%)
- Water is stored in the internal voids, gradually released as steam
- Only 0.25-0.3% by weight of total mixture is typically used



From *Wikipedia*

Aspha-min®

Advera®

HMA - 315° F

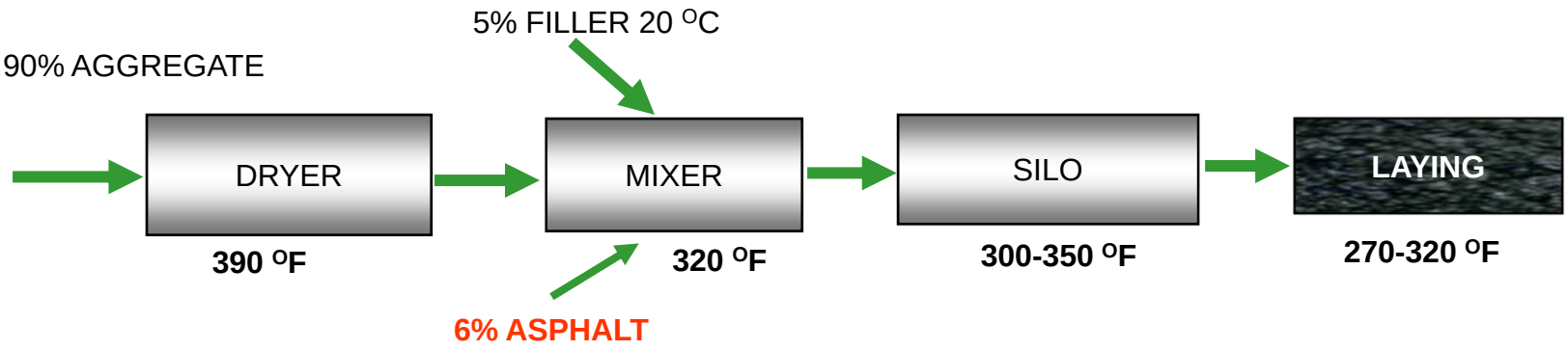
Aspha-Min
WMA - 265° F

Plant Modifications-Foaming

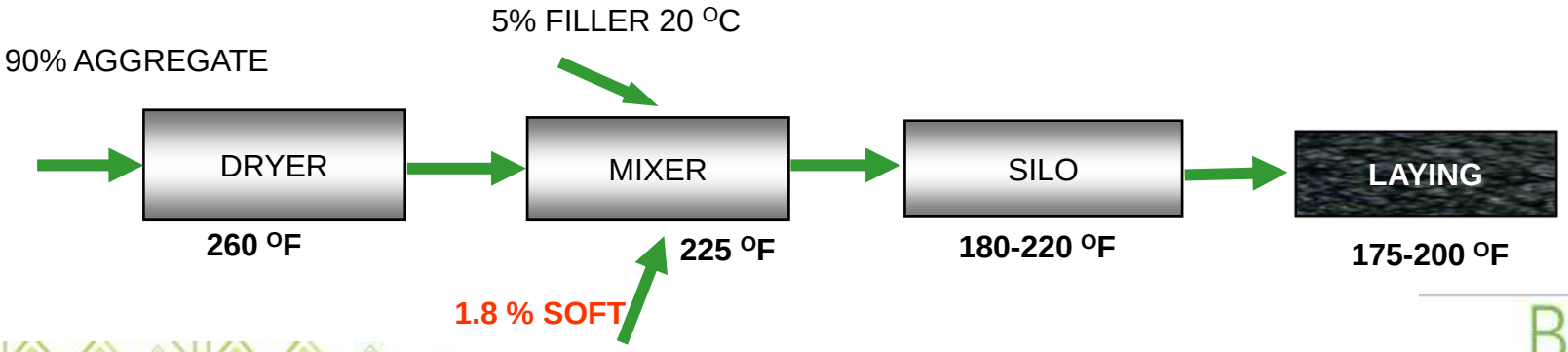
- Two-stage mixing
  - Used in Norway (WAM-Foam) where it is common for plants to have different (hard and soft) asphalt binders available for blending
  - First, soft binder is mixed with aggregates, followed by coating with foamed hard asphalt
- Provide water injection system, mixing chamber to foam the asphalt binder before it contacts the aggregates
  - Examples: Astec “Double Barrel® Green,” Terex WMA System

Schematics of the typical process conditions

TRADITIONAL HOT MIX ASPHALT

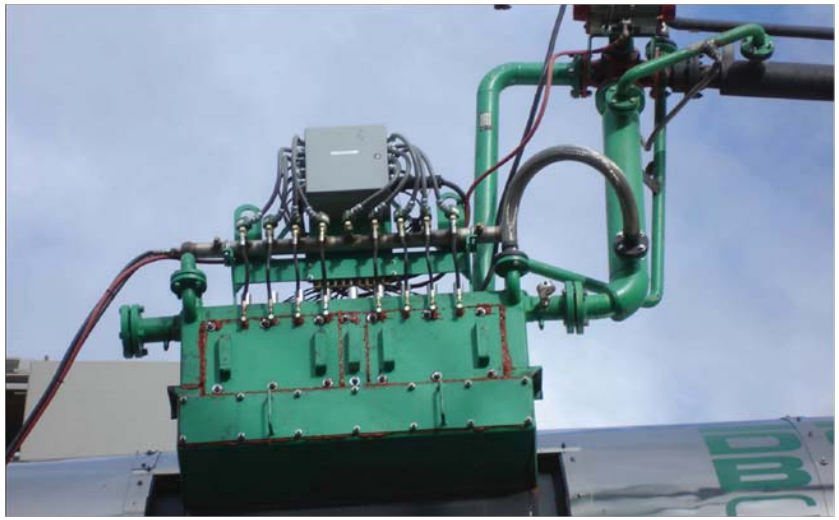


WAM Foam ASPHALT MIX PROCESS

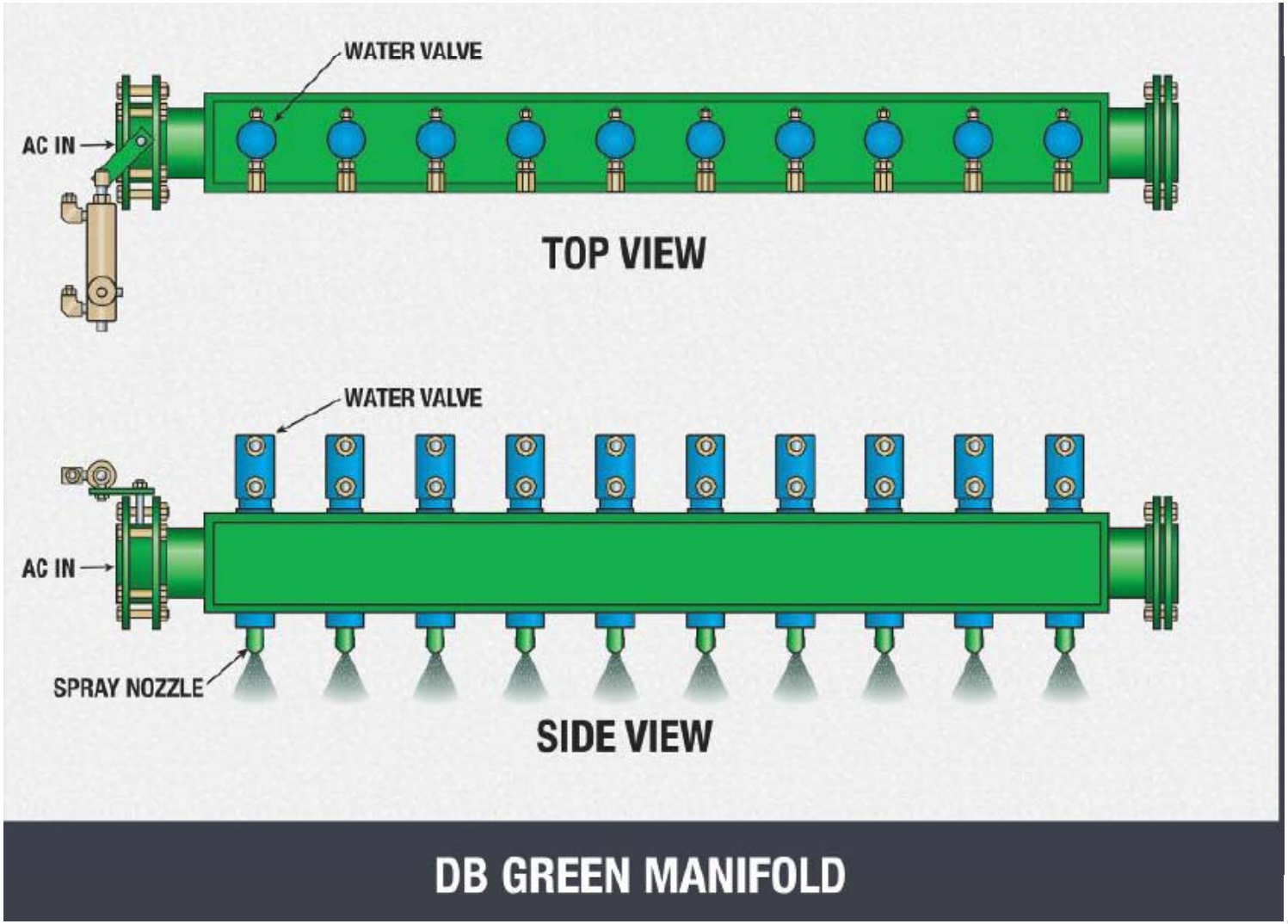


Bitumen
successful inroads, moving ahead

Plant Modifications-Astec



Plant Modifications, Astec



WMA Temperature Reduction

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WMA Technology	Process Type	Decreases Production Temperatures by 30 to 50 F° (17 to 28 C°)	Decreases Production Temperatures by More Than 50 F° (28 C°)
Double Barrel® Green	Foaming	XX[1]	X[2]
Evotherm™	Chemical Additive	XX	XX
(LEA) Low Energy Asphalt	Foaming		XX
Rediset™ WMX	Chemical Additive	XX	X
REVIX™	Chemical Additive	X	XX
Sasobit	Organic Additive	XX	X
Synthetic Zeolite	Foaming	XX	X
WAM-Foam	Foaming		XX

[1]Frequently observed; [2]Observed

Courtesy Brian Prowell, PhD, PE

Questions about WMA

- Performance
  - Moisture sensitivity
  - Early resistance to deformation
- Economics
  - Do cost savings in fuel, equipment, labor overcome increased costs?
- Specifications
  - Binder qualities
  - Laboratory procedures
  - Sampling/conditioning methods

These are promising technologies that we can expect to see more of in the future!

WMA Trials & Demos

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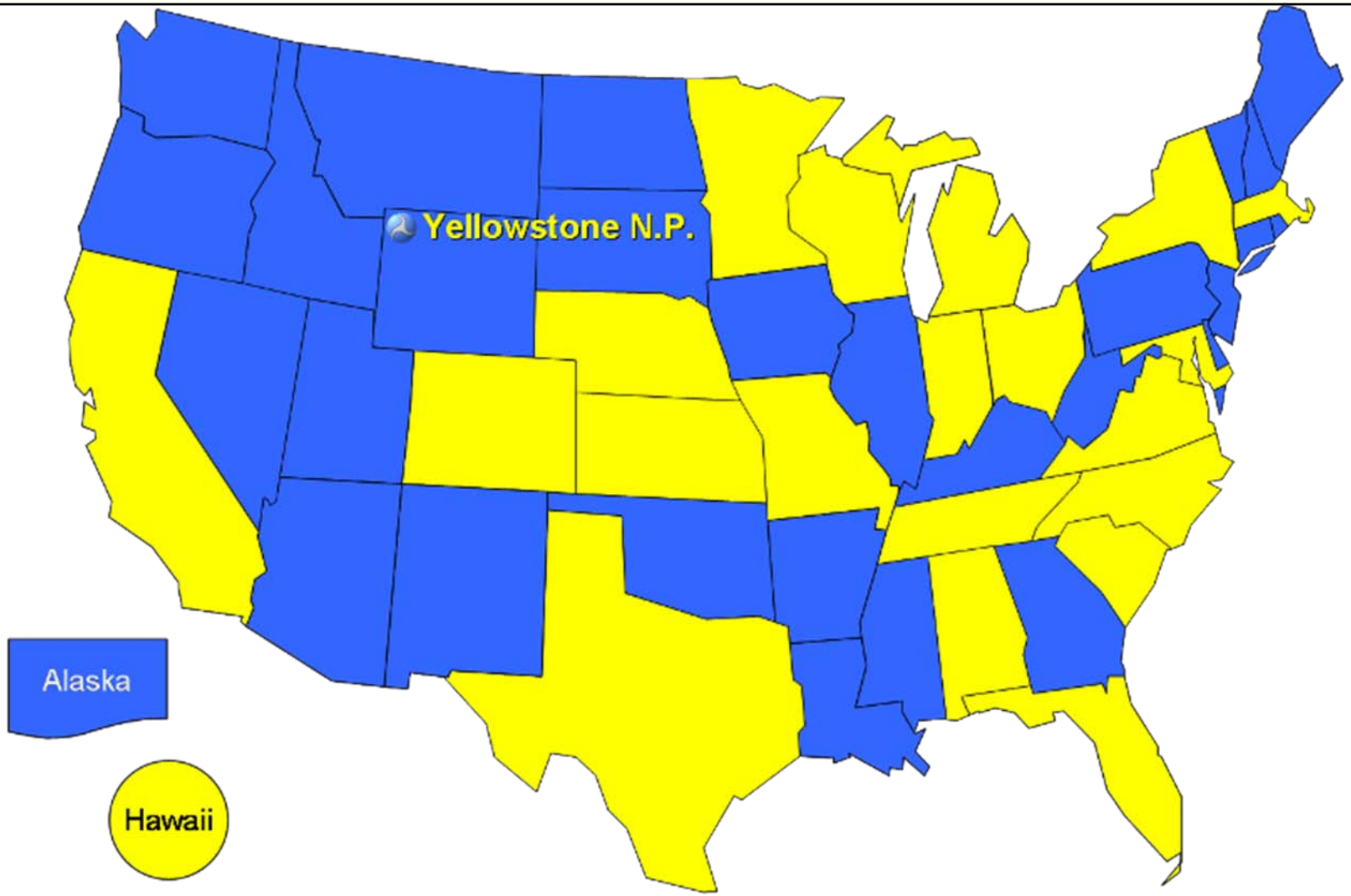


U.S. Department of Transportation
Federal Highway Administration

Warm Mix Research-National Level

- NCHRP 09-43, Mix Design Practices for Warm Mix Asphalt
  - Advanced Asphalt Technologies, LLC
  - PI: Dr. Ramon Bonaquist
  - 3-year project, anticipated completion in March 2010
- NCHRP 09-47, Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies
  - Asphalt Institute
  - PI: Mike Anderson
  - 3-year project, anticipated completion in March 2011

NCHRP 9-47 Research Team

- Asphalt Institute (Mike Anderson, Phil Blankenship, Earl Arp, Wayne Jones)
- MTE Services (Gerald Reinke, Erv Dukatz, Stacy Glidden)
- Paragon Technical Services (Gaylon Baumgardner, Mike Hemsley)
- **Kentucky Transportation Center**
- **University of California-Davis (Dave Jones)**
- **Consultants (Jim Scherocman, Gary Blackburn, Gavin Braithwaite)**

NCHRP 9-47 Research Objectives

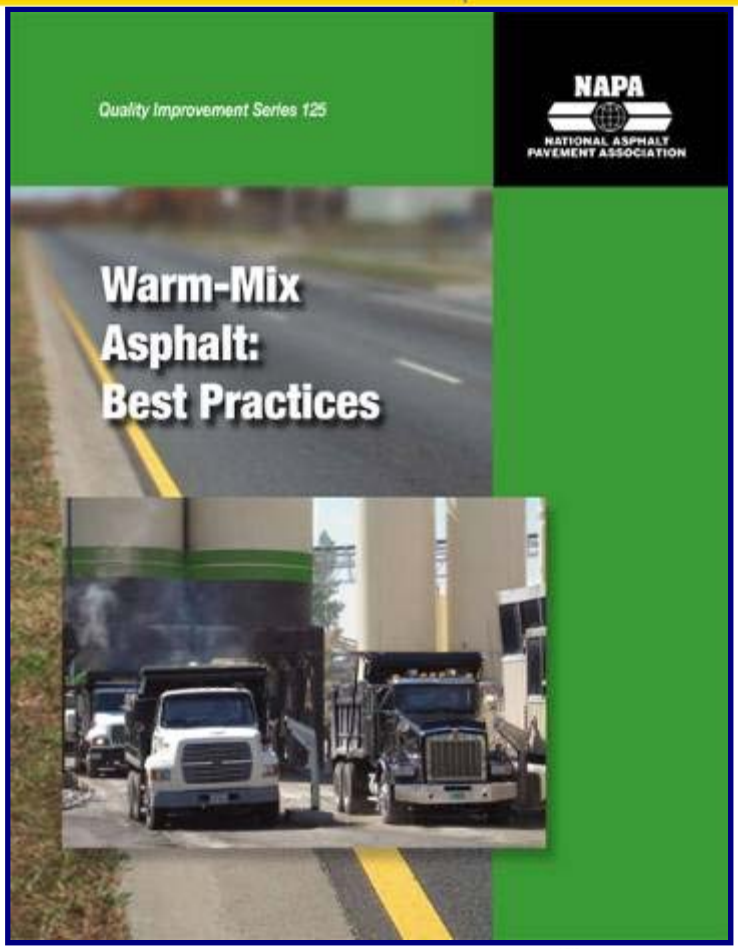
Evaluation of the Environmental and Performance Properties of Warm Mix Asphalt Technologies

- Evaluate the type and level of emissions from WMA during production and placement compared with those from HMA
- Compare initial field performance of pavements constructed with WMA with that of conventional HMA
- Correlate the engineering properties of WMA technologies with their field performance

http://www.warmmixasphalt.com/

Warm Mix Asphalt: Best Practices

- NAPA 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



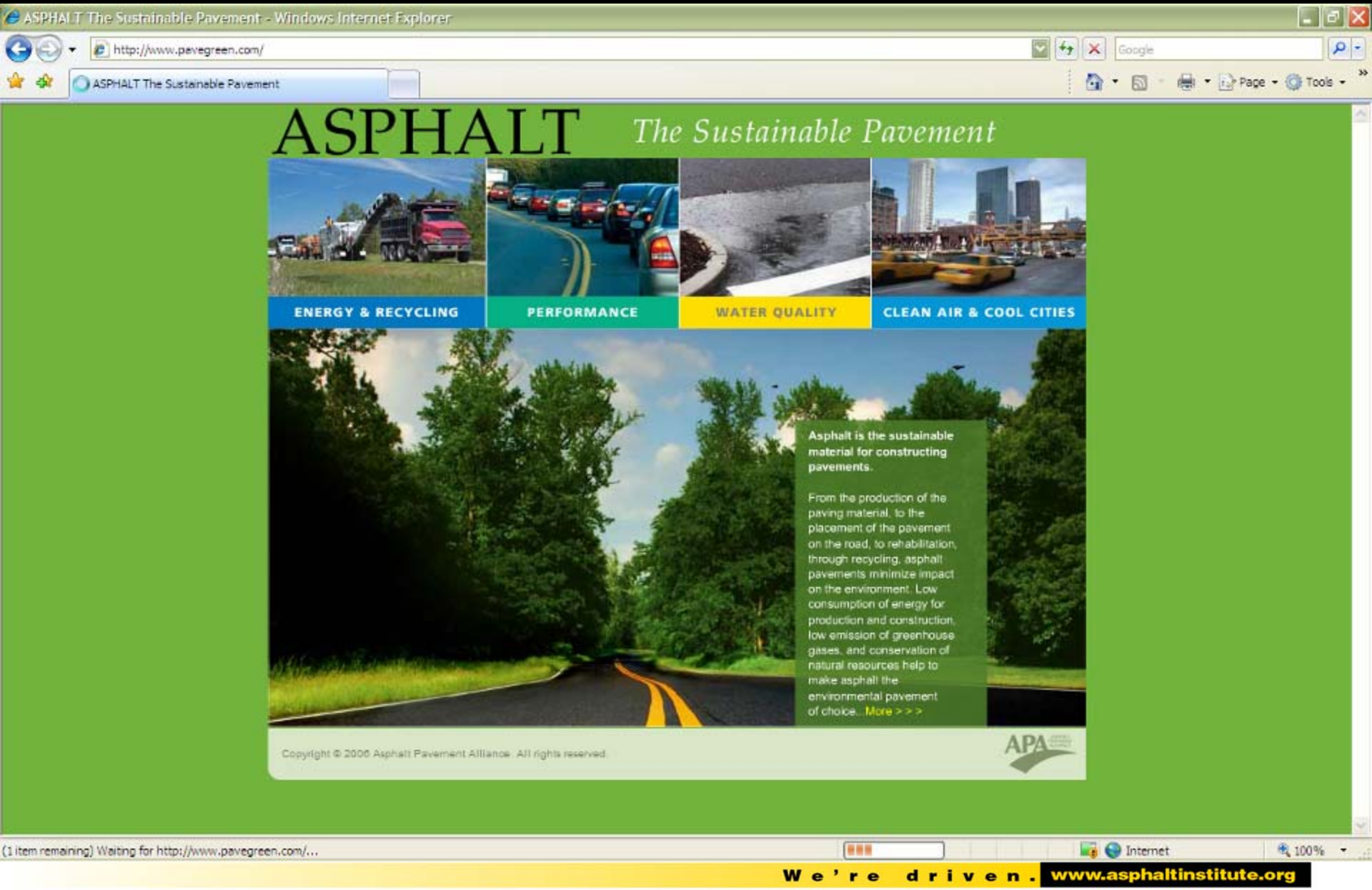
WMA Scan-2007

- Summary of scanning tour visit of European countries in May 2007
  - Reviewed processes, mix design and construction practices, performance, limitations, and benefits
  - Belgium, France, Germany, Norway
  - Included industry & government engineers

- PDF available at no charge from:

http://www.warmmixasphalt.com/

http://www.pavegreen.com/



Thanks!

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