



U.S. Department of Transportation  
**Federal Highway Administration**

**Office of Pavement Technology**

# A National Perspective on RAP Use for Recycled Asphalt Pavements

***NCAT RAP Summit  
October 2008  
Auburn, AL***

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Federal Highway Administration***

# Presentation Outline

- **What is RAP?**
  - Hasn't it been used for years?
  - Economic drivers
  - Demand for aggregates
- **State-of-the practice**
  - State DOT and Contractor Perspective
  - Roadblocks
- **National perspective**
  - Objectives and essential steps for increasing pavement recycling
  - FHWA involvement and activities



# Reclaimed Asphalt Pavement (RAP)

## Sources of RAP

- Milling
- Pavement removal
- Plant waste

## Most Common Uses

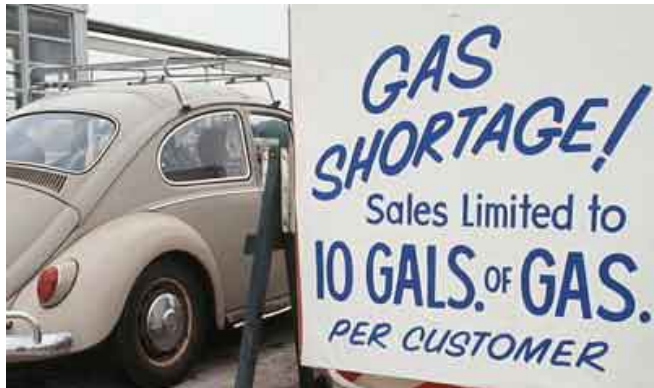
- Addition to HMA
- Aggregate in cold-mix
- Granular base
- Fill or embankment material





# Hasn't RAP been used for years?

## 1970s – Begins a recycling boom



## 1980s – 1990s – Technical Guidance

- NCHRP
- FHWA

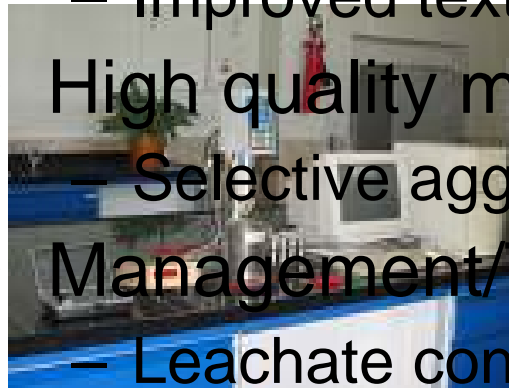


# Hasn't RAP been used for years?



## 1990s – Superpave developed

- Long life material design
- New mix design system
  - Crushed, angular aggregates
- New gradation controls
  - Manufactured sands
- State DOTs limit RAP allowed
- High friction demand
  - Improved texture – decreased wear
- High quality mixes
  - Selective aggregate sizes
- Management/Treatment of runoff
  - Leachate control



# You may recall...

- Superpave Mixture Expert Task Group (ETG) developed interim guidelines for the use of RAP in the Superpave method.





# Hasn't RAP been used for years?

## 2000s – Superpave implemented

- NCHRP Project 9-12  
*Recommended Use of RAP in Superpave*
- Contractors implement improved techniques
  - RAP processing
  - Gradation control

**NCHRP**  
REPORT 452

NATIONAL  
COOPERATIVE  
HIGHWAY  
RESEARCH  
PROGRAM

Recommended Use of  
Reclaimed Asphalt Pavement in  
the Superpave Mix Design Method:  
Technician's Manual

TRANSPORTATION RESEARCH BOARD

NATIONAL RESEARCH COUNCIL



# Current Specification for RAP Use

- AASHTO M 323 *Standard Specification for Superpave™ Volumetric Mix Design*

| <b>Recommended Virgin Asphalt Binder Grade</b>          | <b>Percent (%) RAP</b> |
|---|------------------------|
| No change in binder selection                           | < 15                   |
| Select virgin binder grade one grade softer than normal | 15 – 25                |
| Follow recommendations from blending charts             | > 25                   |

- Mixture with RAP must meet same requirements as virgin mixture.







## Economic Drivers for Using RAP

Growth in recycling occurs when it is economical to do so.



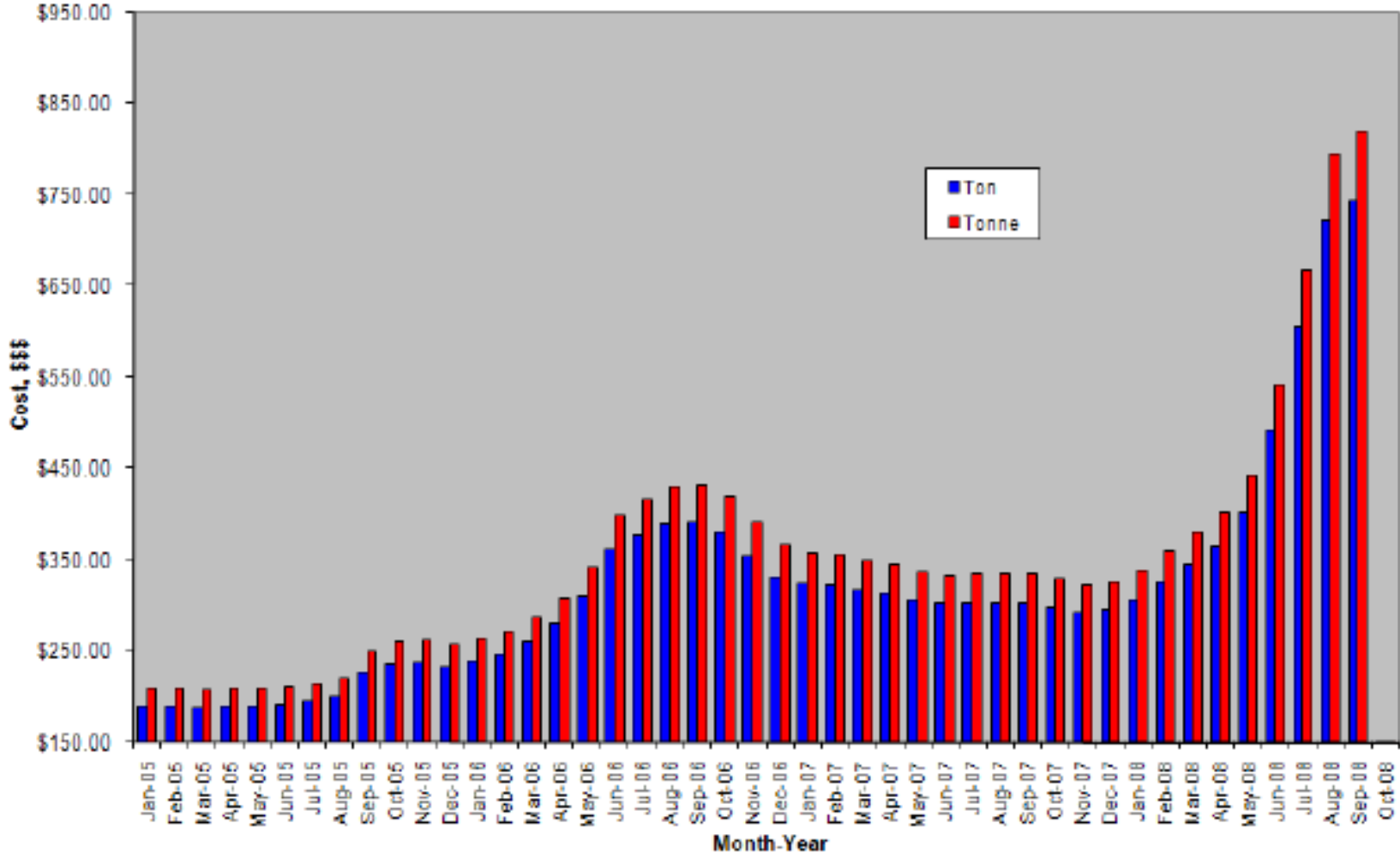
# Construction Materials Price Increases and Availability Issues

- Information and guidance from Office of Program Administration
  - Gerald Yakawenko – July 31, 2008
- Asphalt Cement Supply/Polymer Modified Asphalt Issues
- Structural and Reinforcing Steel Issues
- Contracting Considerations
- Price Adjustment Clauses



# TDOT Bituminous Materials Cost Index

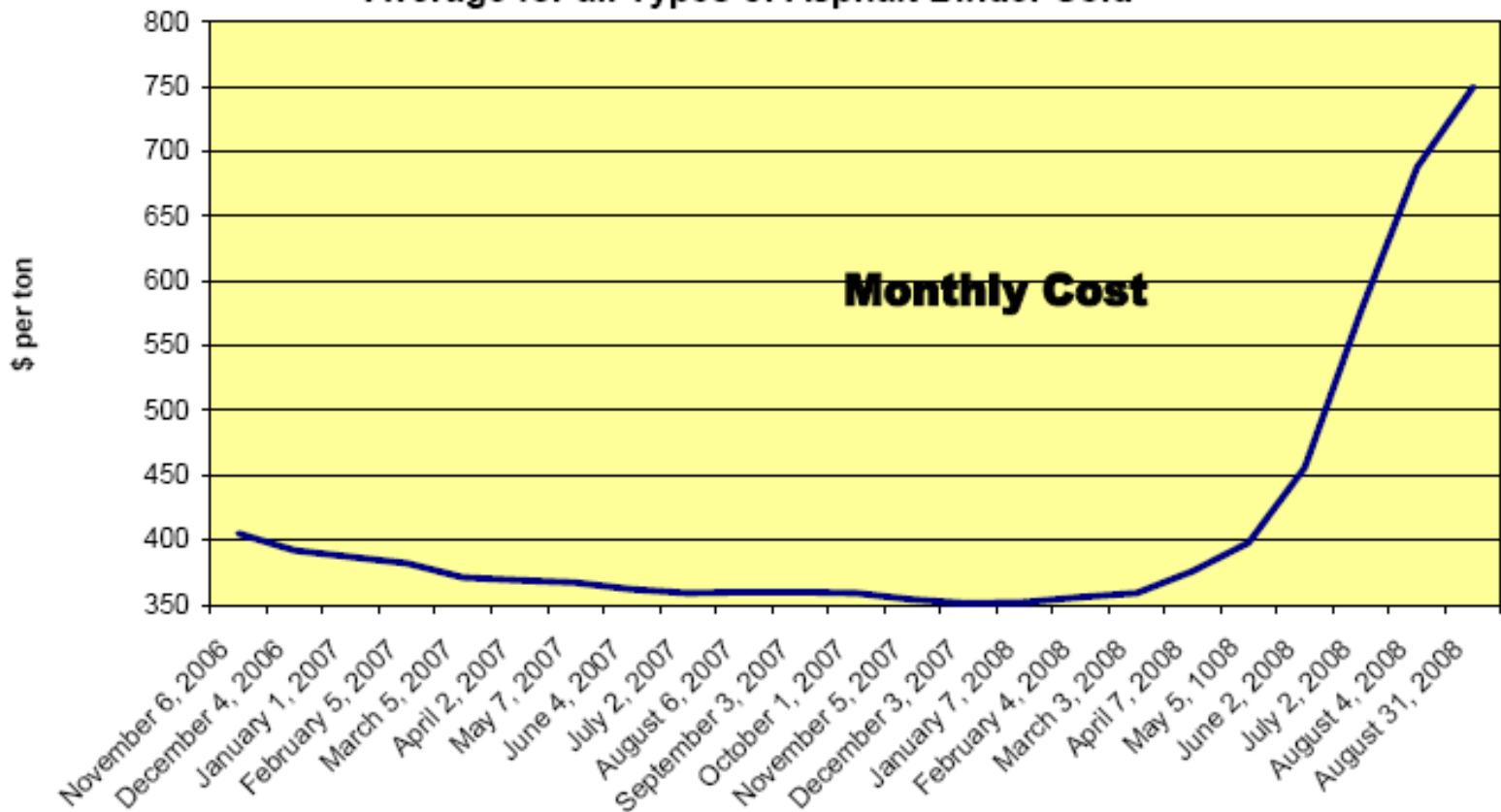
Bituminous Materials Index







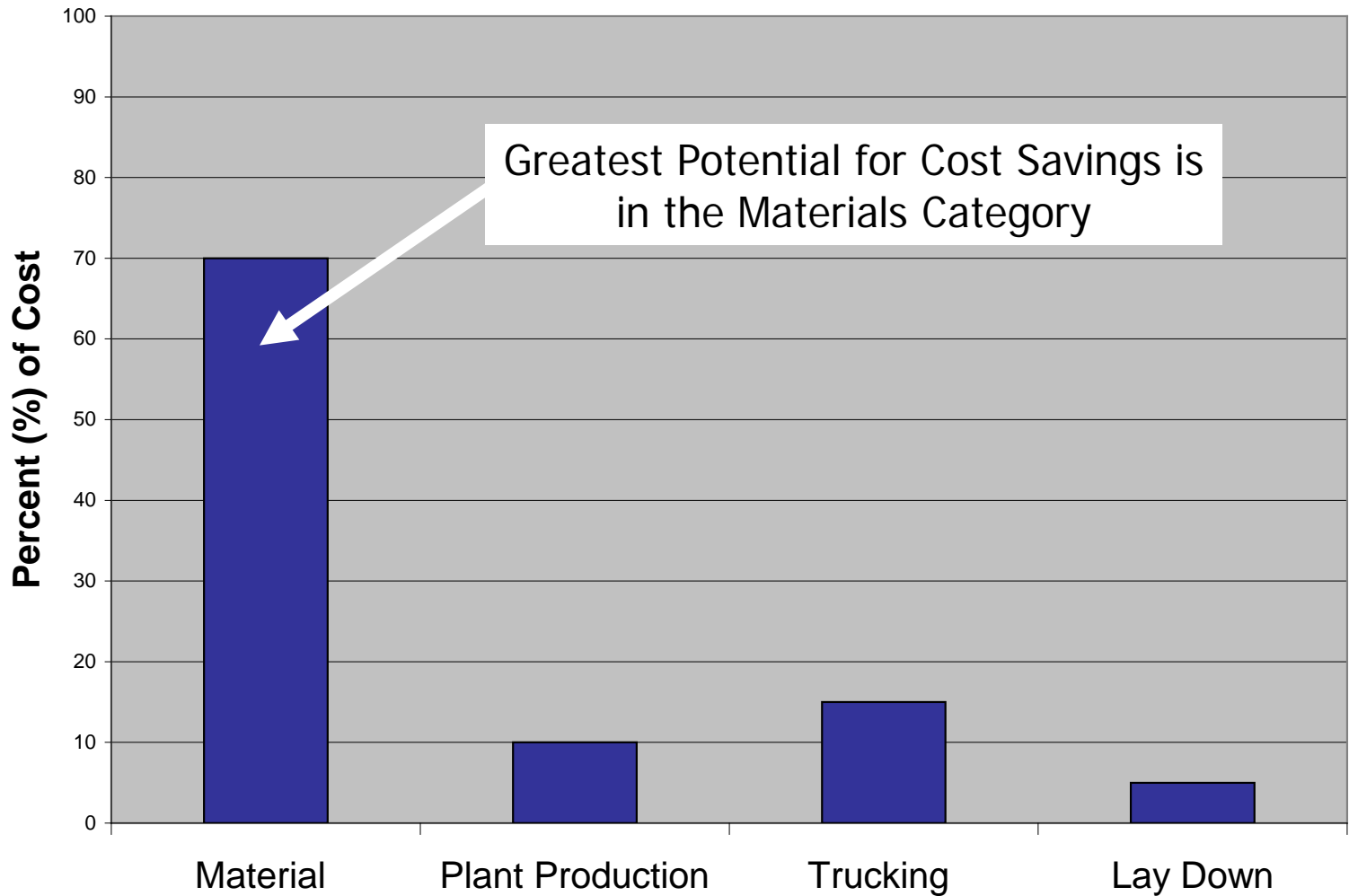
### Intermountain West Average for all Types of Asphalt Binder Sold



Produced by Utah Department of Transportation Materials Division.  
Based on information from Asphalt Weekly Monitor and Argus Report.



# Asphalt Production Cost Categories





# Why allow high RAP?

- Reduced costs
- For example...
  - **Upfront cost impact** - If specification allows high RAP, contractors may submit different bid prices on plant mix items or frequency of price adjustments and delays.
  - **Future cost impact** – higher RAP pavement may have different life-cycle properties
- The cost effectiveness of higher-RAP mixes depends on:
  - Unit cost of mixtures
  - Performance during and after placement



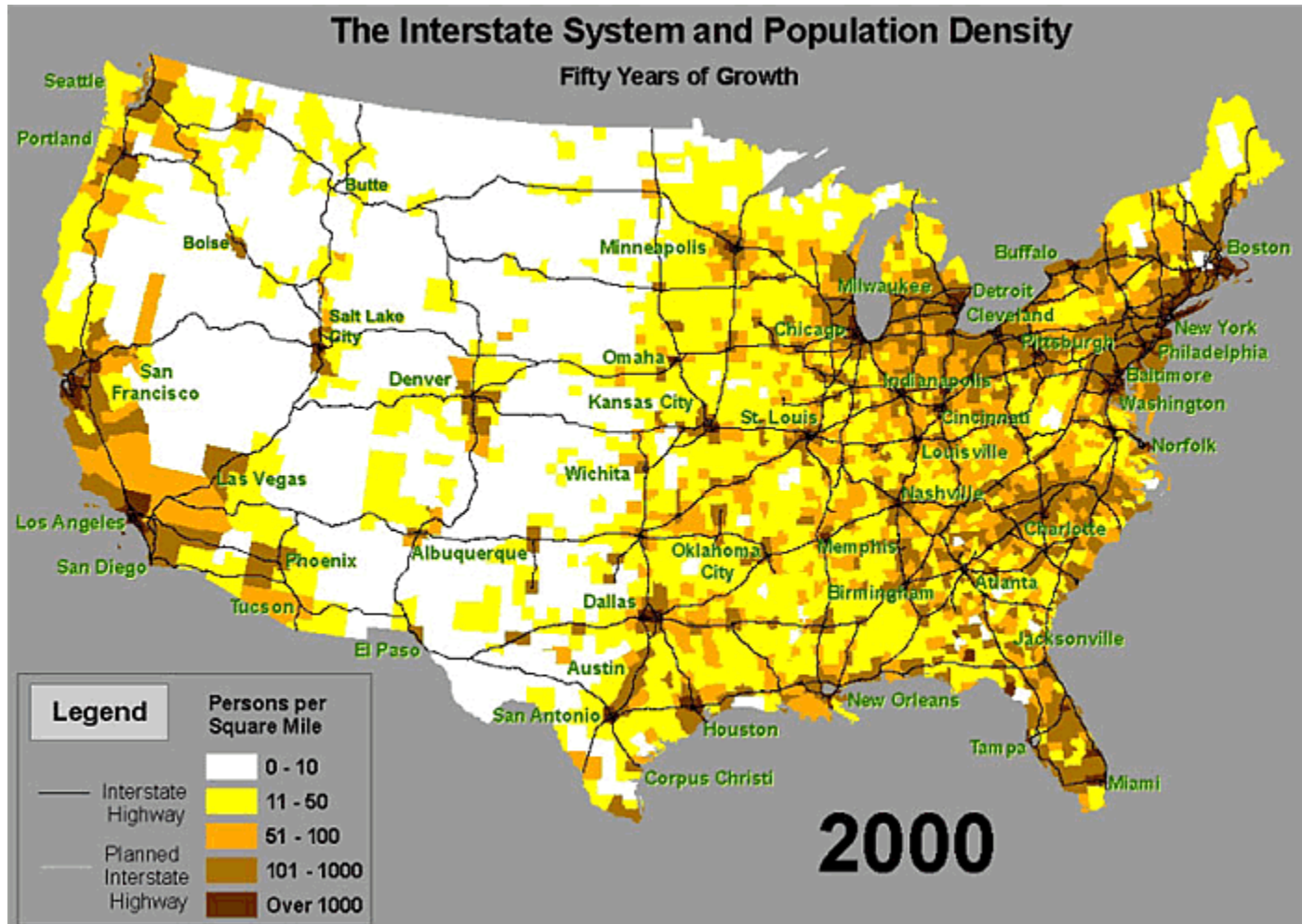




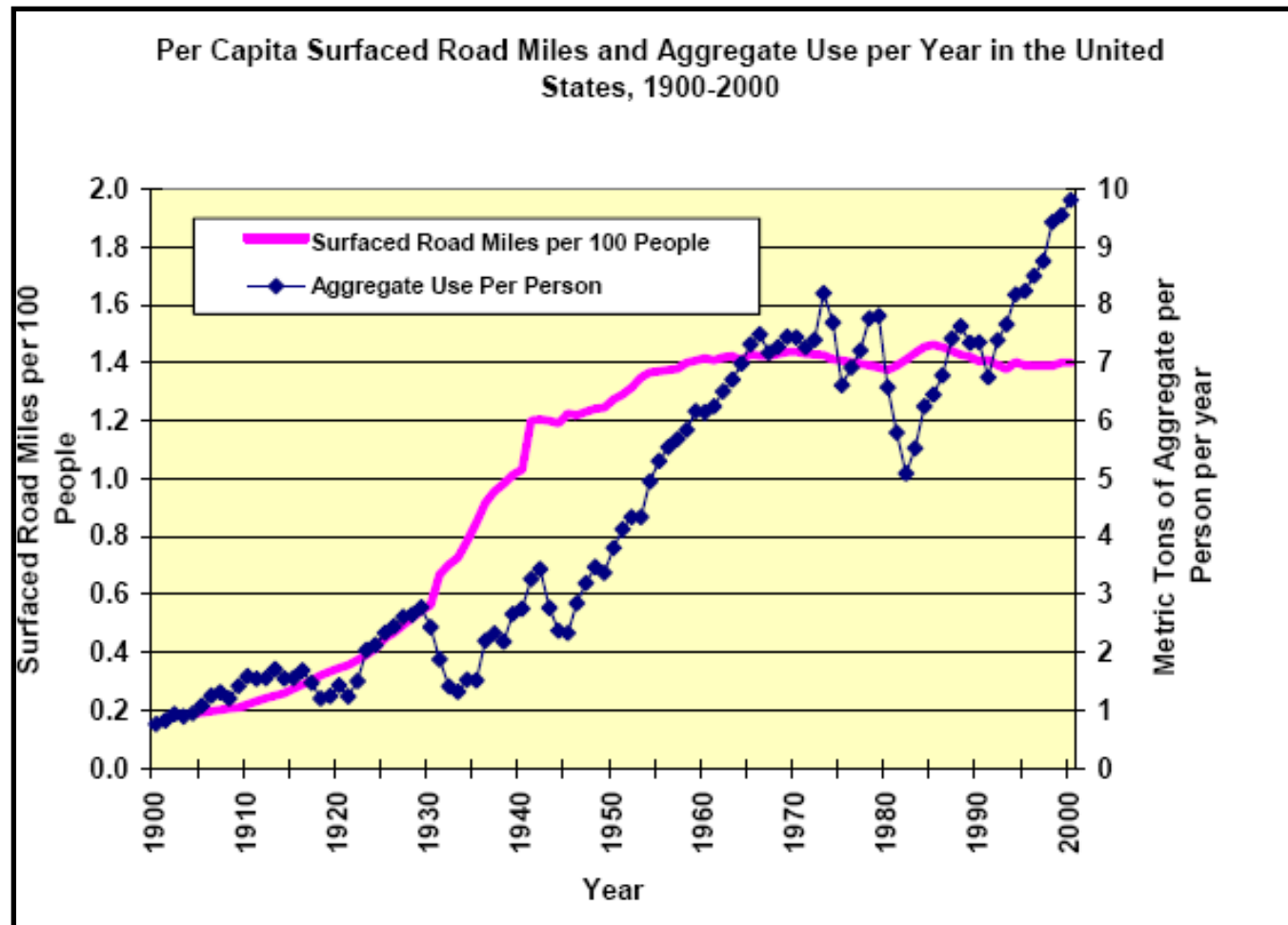
## Demand for Materials

Demand for high quality aggregates is becoming difficult to meet.

# Growth of the Interstate



# Demand for Aggregates



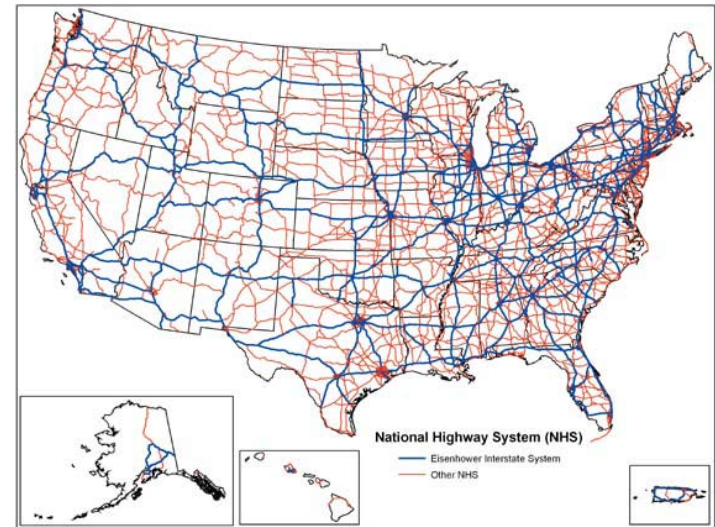
USGS Report: "Sociocultural Dimensions of Supply and Demand for Natural Aggregates"





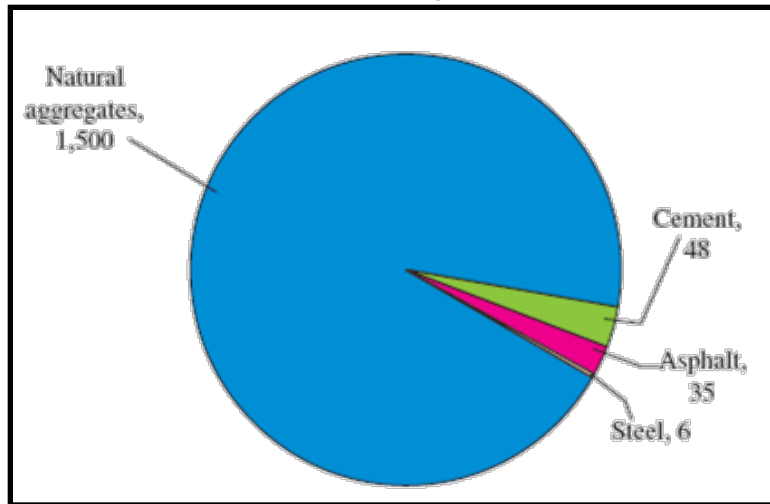
# Demand for Materials

- 160,000 mile National Highway System
- 4 million miles of public roads
- Produce over 600 million tons of HMA annually & 85+ million SY of concrete for paving annually
- \$70 billion capital outlay to maintain pavements
- Demand for aggregates considerable requiring an estimated 700+ million tons to meet annual demand (15%-25% of annual production)

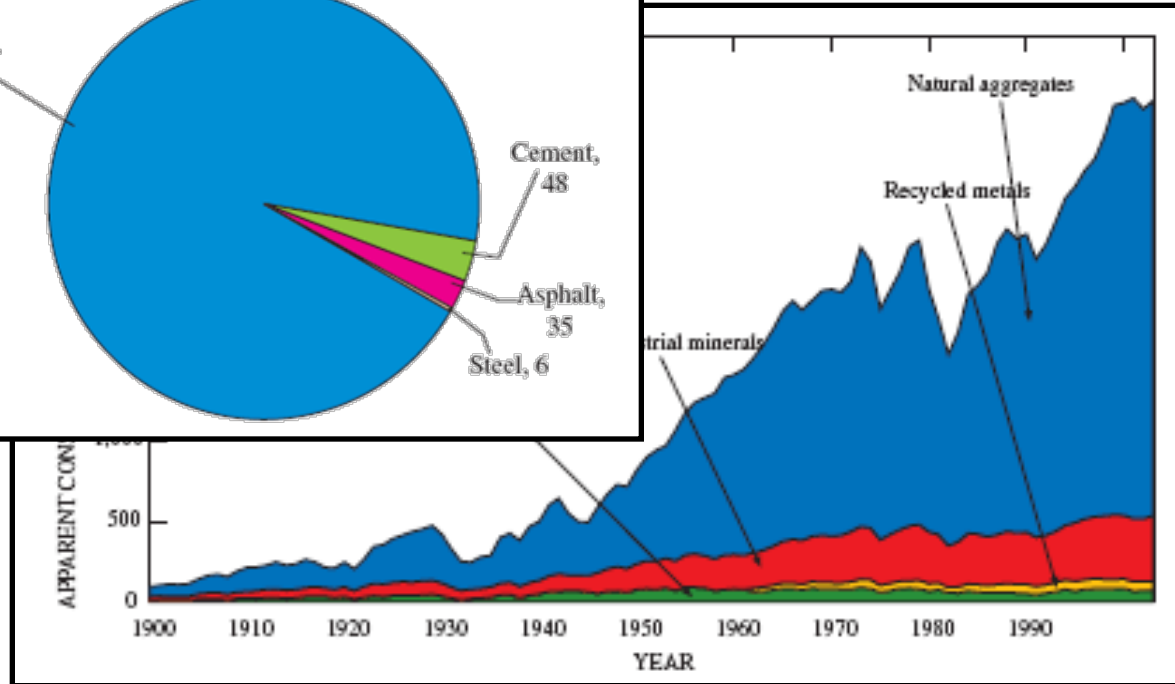


# Aggregates in Pavements

NHS Highway Consumption



Total Consumption

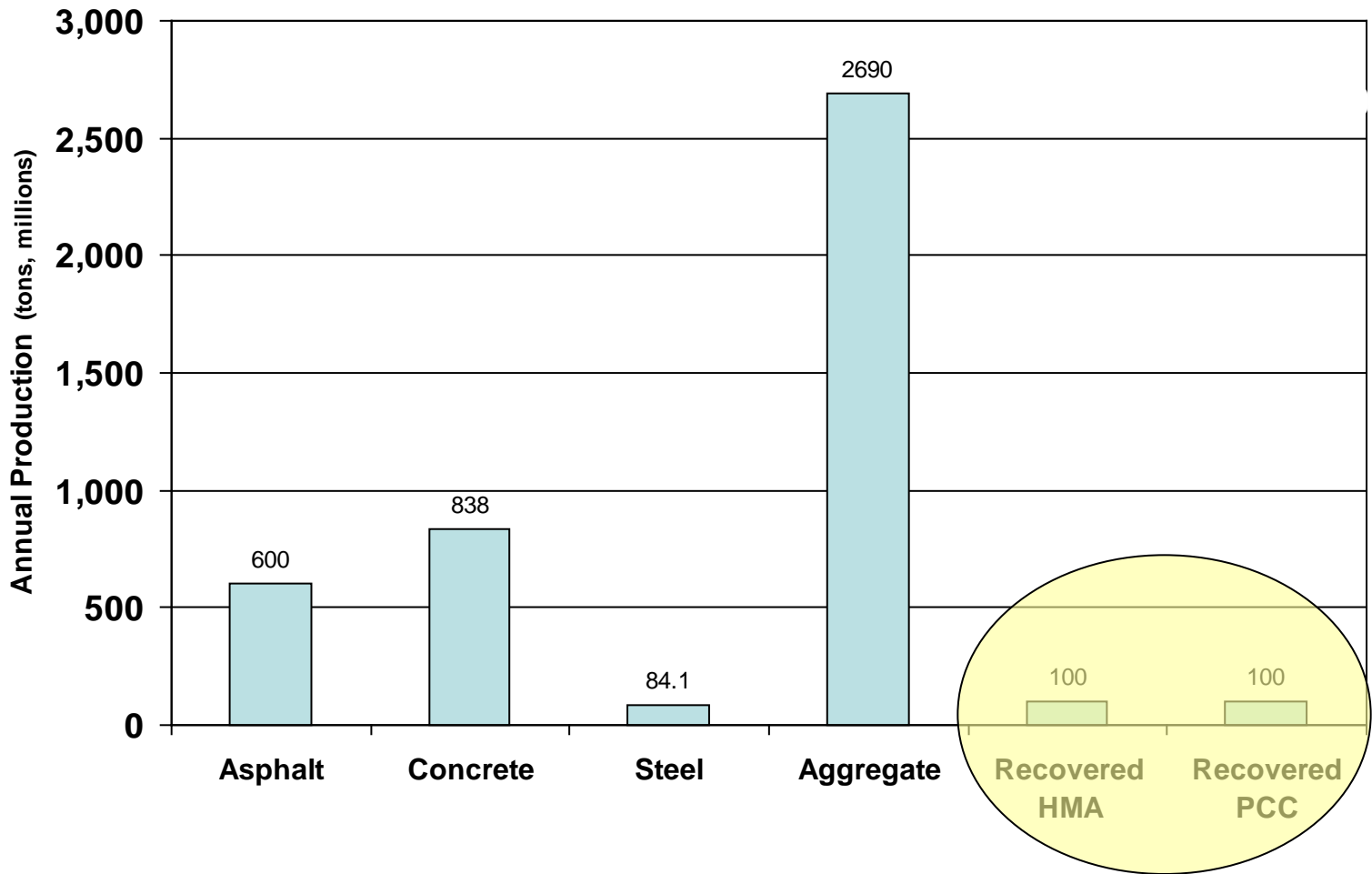


USGS – Materials in Use in US Interstate Highways





# Material Production Quantities - US





U.S. Department of Transportation  
**Federal Highway Administration**

**Office of Pavement Technology**

# FHWA Involvement and Activities

## A National Perspective





# Our Objectives

- Encourage the use of recycled materials in the construction of highways to the maximum economical and practical extent possible with *equal or improved performance*.
- Greatest impact in pavement recycling can be realized through the promotion of Reclaimed Asphalt Pavement (RAP).



# What's Needed?

1. Clear engineering and environmental **standards and policy** for the use of RAP.
2. Funded, coordinated **research** to support standards.
3. Public and industry **working groups**.
4. Education.



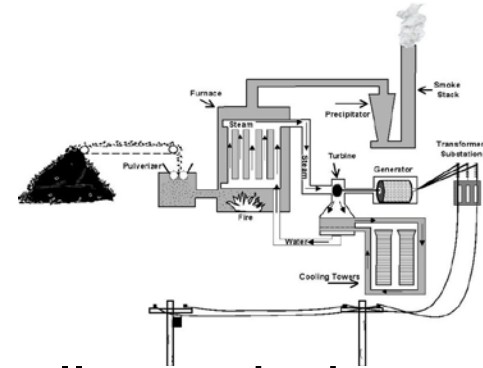
# FHWA Policy - 2002

- Recycled/Re-Use materials are viable resources
- Recycled materials should get 1<sup>st</sup> consideration
- Consider use of recycled materials early in the planning/design process
- Economic benefits should be considered in the material selection process
- Restricting the use of materials should be technically based
- Material should not adversely impact the environment and should perform as intended



# How Do We Get There?

- Use of industrial by-products
  - Coal combustion products
  - Steel Slag
  - Foundry sand
- Use of materials that are traditionally wasted
  - Glass
  - Shingles
  - Crumb rubber
- Maximize existing pavement materials
  - Asphalt
  - Concrete
  - Aggregate
  - Steel





# Why Aren't We There Now?

- What are the material properties?
- How should the material be extracted, processed and stored?
- How is the manufacturing process controlled to maximize consistency?
- How will the material perform?
- How can we quantify the benefits?
- What incentives are appropriate?
- How do existing specs generate waste?
- How can we remove the prohibition of materials?



# Environmental Stewardship

- **Recycled Materials**

The use of recycled materials... is maximized to the extent economical and practical with equal or improved performance.

- **Re-Use**

The use of consumer, industrial, agricultural, or energy bi-products in pavements/materials is optimized to the extent economical and practical with equal or improved performance.

- **Environmental Innovations**

The highway industry utilizes innovative technologies which are environmentally-sound and applies sustainable approaches to pavement design and material selections and construction/preservation.

- **Workforce Capability**

The highway industry workforce is well-trained, well-connected, qualified and experienced to conduct environmentally-sound paving and material practices.



# Performance Measures

- Recycled Material Potential
  - Self assessment of specs, policies, etc.
- Recycled Material Use
  - Production quantities
- Implementation of New Technology
  - New technology penetration nationally
- Qualification of Workforce
  - Self assessment of staff proficiency
- Outreach Impact
  - Assessment of awareness nationally



# Guidance Documents



[www.fhwa.dot.gov/pavement/recycling/rap](http://www.fhwa.dot.gov/pavement/recycling/rap)







# High RAP Mix Design

- NCHRP 9-46 Mix Design and Evaluation Procedure for High Reclaimed Asphalt Pavement Content in Hot Mix Asphalt
- Objective: Develop mix design method and specification for HMA containing up to **50% RAP**.



# Other Nationally Funded Research

## Asphalt Research Consortium (ARC)

– FHWA Cooperative Agreement

 Western Research Institute



 ADVANCED ASPHALT TECHNOLOGIES



## Investigation of Properties of Plant Produced RAP Mixtures

Performance characteristics of HMA mixtures with RAP in low temperatures  
Provide knowledge regarding plant-produced HMA mixtures with RAP.



# Recycled Materials Resource Center

- Created under TEA-21 in FY1999
- Continued under SAFETEA-LU with FHWA, EPA, State and Industry contributions
- Have developed several specifications for AASHTO consideration
- 43 Projects with a wide variety of products available online



# RAP Expert Task Group (ETG)

- FHWA Sponsored
- Membership
  - State DOT
  - AASHTO
  - NCAT
  - NAPA
  - Hot Mix Asphalt Industry
  - North Central Superpave Center
  - Academia
- Chairman
  - Gerry Huber, Heritage Research Group
- Secretary
  - Andrea Kvaznak, NCAT





# HMA Asphalt Pavement Recycling Expert Task Group



Advance the use of RAP in asphalt paving applications by providing highway agencies with critical information regarding the use of RAP, technical guidance on high-RAP projects, and direction on research activities.

The members consist of representatives from highway agencies, industry, and academia.

Website: [www.ncat.us/rap/rap](http://www.ncat.us/rap/rap)



# High RAP Field Project Assistance provided by FHWA Mobile Asphalt Laboratory

- Assist State Highway Agencies in mix design process, production, and construction
- Provide performance testing
- Develop information for future mix design, quality control procedures, and impact on performance



# Green Highway Partnership

The screenshot shows the homepage of the Green Highways Partnership. At the top left is a logo featuring a green leaf and a road, with the text "Green Highways Partnership" and "Stewardship, Safety, & Sustainability". To the right of the logo is a search bar. Below the logo and search bar is a navigation menu with links for Home, About, Partnerships, Recognition, Opportunities, Theme Teams, and Resources. The main content area is divided into three columns. The left column is titled "The Partnership" and contains a paragraph describing the GHP as a voluntary, public/private initiative that is revolutionizing transportation infrastructure. The middle column is titled "Spotlight" and features two items: "GHPodcast" and "ACPA Award", each with a small image and a "READ >>" link. The right column is titled "What's New?" and contains three items: "2007 LID Leadership Awards Announced", "GHP Reuse/Recycling Workshop", and "Strategic Conservation Planning Course in Shepherdstown", each with a brief description and a "READ >>" link. At the bottom of the page, there is a yellow box with the text "Enter email address to sign up for e-newsletter".

**Green Highways Partnership**  
Stewardship, Safety, & Sustainability

SEARCH:

Home About Partnerships Recognition Opportunities Theme Teams Resources

**The Partnership**

The Green Highways Partnership (GHP) is a voluntary, public/private initiative that is revolutionizing our nation's transportation infrastructure. Through concepts such as **integrated planning**, **regulatory flexibility**, and **market-based rewards**, GHP seeks to incorporate **environmental streamlining and stewardship** into all aspects of the highway lifecycle.

With an extensive network of environmental, industrial and governmental collaborators, GHP believes active cooperation and regulatory progressiveness are critical in moving beyond the current paradigm. The combined resources of our partner base allow Green Highways to ensure that sustainability becomes the driving force behind infrastructure development. By harnessing the power of the marketplace to build better, safer highways, GHP is transforming transportation.

The Green Highways Partnership is supported by an ever growing list of

**Spotlight**

**GHPodcast**  
New GHPodcasts feature the latest GHP developments. [READ >>](#)

**ACPA Award**  
EPA's Dominique Lueckenhoff, first recipient of Outstanding Health, Safety & Environmental Stewardship Award. [READ >>](#)

**What's New?**

- 2007 LID Leadership Awards Announced**  
The winners of the Leadership in Low Impact Development Recognition Program have been announced.
- GHP Reuse/Recycling Workshop**  
The GHP Aug. 29 recycling workshop goes off without a hitch.
- Strategic Conservation Planning Course in Shepherdstown**  
The Conservation Fund is offering a Strategic

Enter email address to sign up for e-newsletter

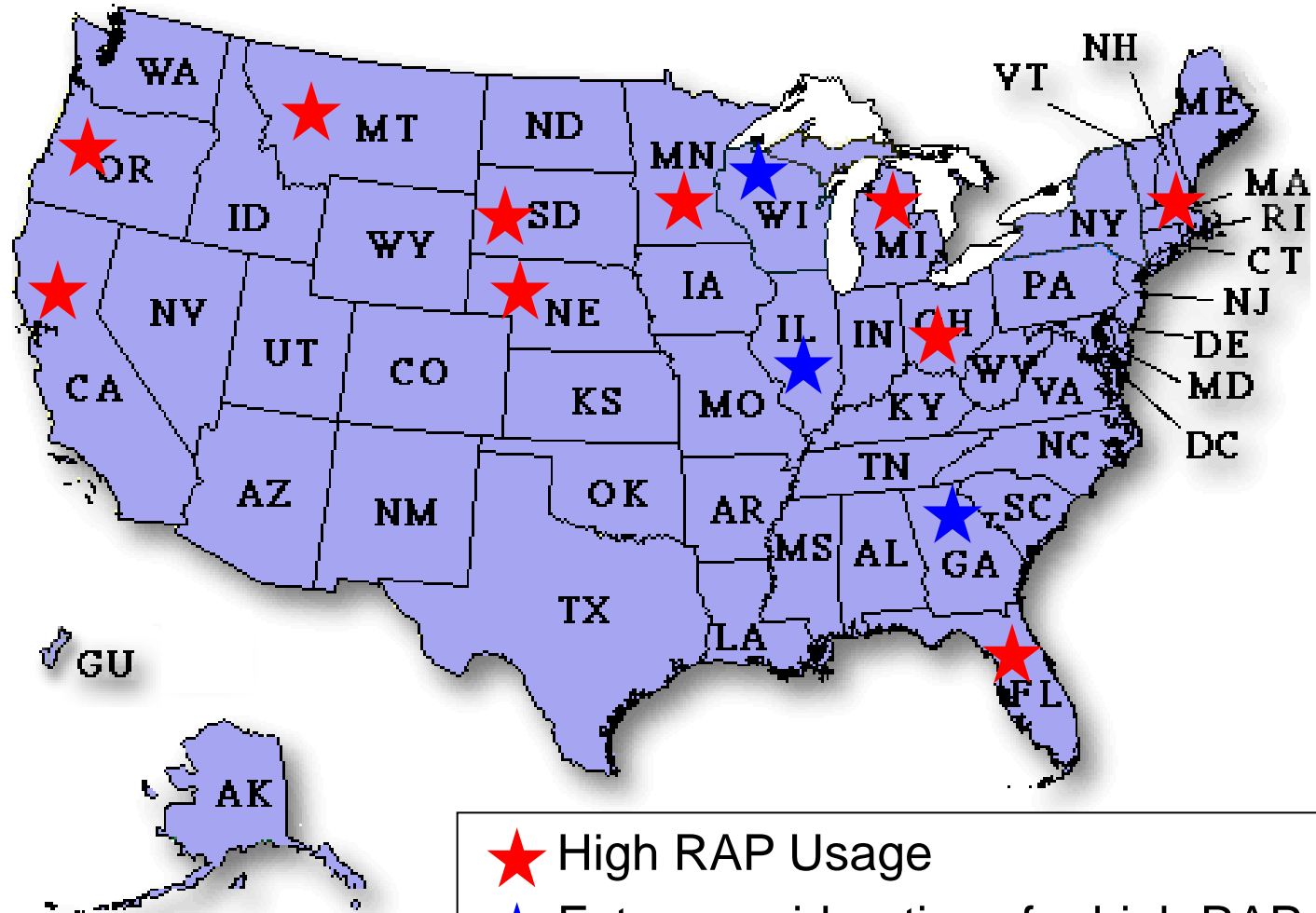
## Themes:

- Watershed Driven Storm Water Management
- Re-Use and Recycling
- Conservation & Ecosystem Protection





# Are we making an impact?

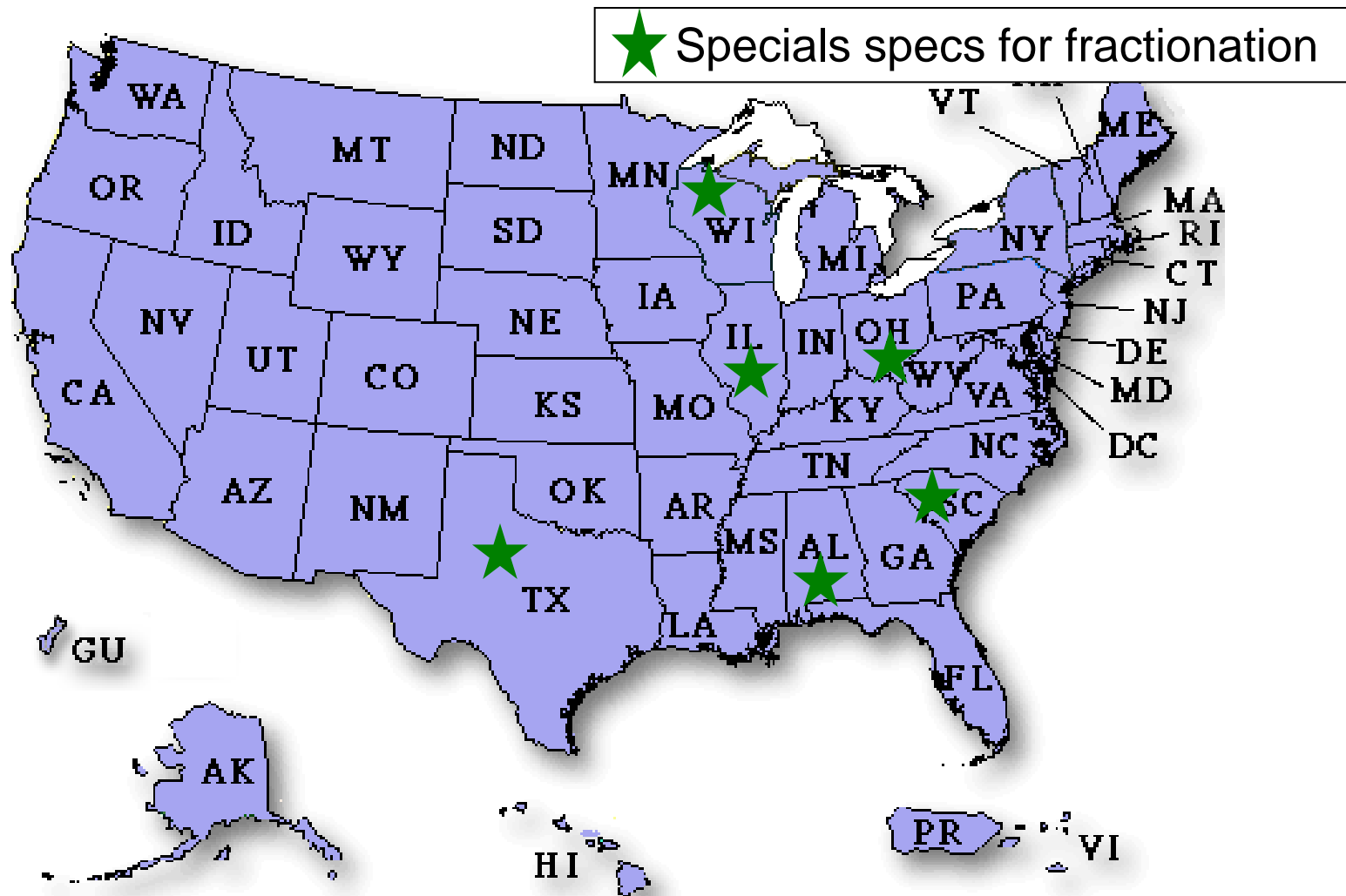


- ★ High RAP Usage
- ★ Extra considerations for high RAP acceptability





# Are we having an impact?





U.S. Department of Transportation  
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**Office of Pavement Technology**

*Thank you! Questions?*

**[www.fhwa.dot.gov/pavement/recycling/rap](http://www.fhwa.dot.gov/pavement/recycling/rap)**

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