Sustainability In Road Design

Linda Pierce, P.E.
Applied Pavement Technology, Inc.

October 24, 2012

applied pavement
TECHNOLOGY

providing engineering solutions to improve pavement performance

Outline

- Why now?
- Sustainability definitions
- How is sustainability measured?
- Why quantify?
- Sustainability tool kits
- What is life-cycle assessment?
- Sustainable pavements
- Summary

Why Now?

- Industry is under increasing scrutiny
- New regulations may pose immediate and long-term challenges
- Must have a means to rigorously quantify environmental impact
  - Establish baseline
- Rigorous approach will focus innovation and quantify improvement

Sustainability - Definitions

- The capacity to maintain a process or state of being into perpetuity (Van Dam and Taylor, 2009)
- An activity or development that meets the needs of the present without compromising the ability of future generations to meet their own needs (UN, 1987)
- A system characteristic that reflects the system's capacity to support natural laws and human values (Muench, et. al., 2010)

Sustainability – Triple Bottom Line

Why Quantify?

- If it is not quantified, it is not valued
  - Without value there is no incentive for doing it
  - If we don't quantify it, it won't get done
- Without quantifying it, it cannot be improved upon
- A life cycle assessment (LCA) allows for a robust, scientifically-based, method to quantify environmental factors

How is Sustainability Measured?

Economy

- Life-Cycle Cost Analysis (LCCA)
- Benefit/Cost, etc.

Environment

- CO_2e Calculators
- Grading Systems
- Life-Cycle Assessment (LCA)

Equity

- Analysis of Social Impacts, etc.

The Need for Tool Kits

- Educate engineers and decision makers on sustainability while giving them guidance to incrementally implement change
- Get tools into the hands of practitioners
  - Expect these tools to evolve from some type of checklist/rating system to full LCA
- Conduct focused research to fill the gaps in knowledge

Current Tools

- Sustainability metrics are being developed and will be required on Federally funded projects in the near future
  - Already adopted by some states and local agencies
- FHWA moving ahead on various initiatives including rating systems and a new sustainable pavements program

What Does the Final Tool Kit Look Like?

- Full LCCA w/user costs
- LCA that considers the entire life cycle
  - Embodied energy, global warming potential (CO_2, CH_4, and N_2O), other emissions, and water use
- Other factors
  - Noise, particulate, fuel consumption, air pollution, surface runoff, lighting, aesthetics, social disruption, etc.

Current Measurement Systems

Carbon Calculators

CHANGER

CO_2e

Point Systems

Greenroads

I-LAST

GreenLITES Evergreen | GreenLITES Gold | GreenLITES Silver | GreenLITES Certified

LCA Tools

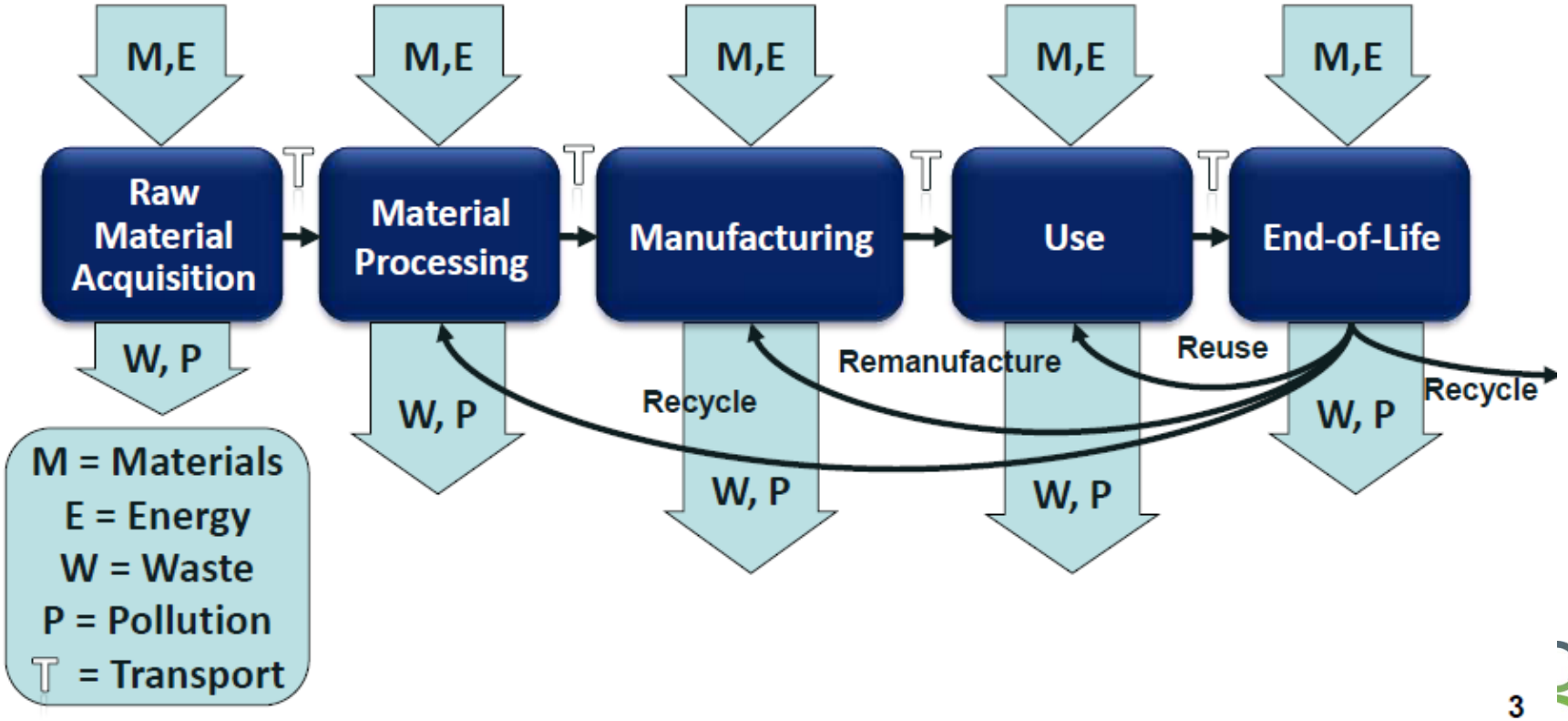
PaLATE v2.1

asPECT

Federal Highway Administration, U.S. Department of Transportation
Sustainable Highways Self-Evaluation Tool

What is Life Cycle Assessment?

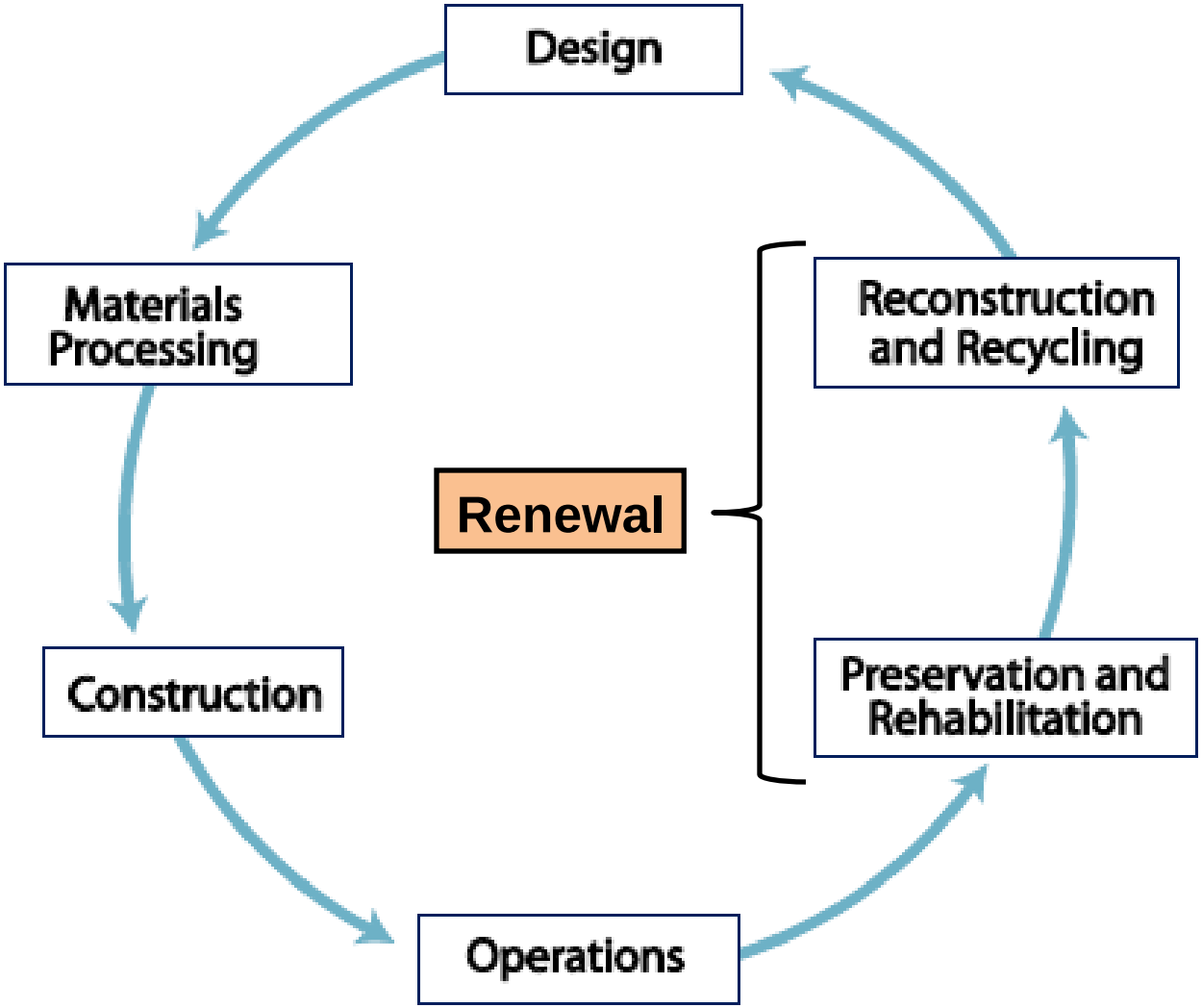
- Compares the full range of environmental and social impacts assignable to products and services



Sustainable Pavements

- Safe ⇒ Optimized surface properties
- Healthy ⇒ Long lasting, well preserved
- Affordable ⇒ Life-cycle cost analysis
- Renewable ⇒ Maximize reuse & recycle
- Operates fairly ⇒ Asset management
- Limits emissions & resources ⇒ LCA-optimized materials, processes, & policies

Cradle-to-Cradle Life Cycle



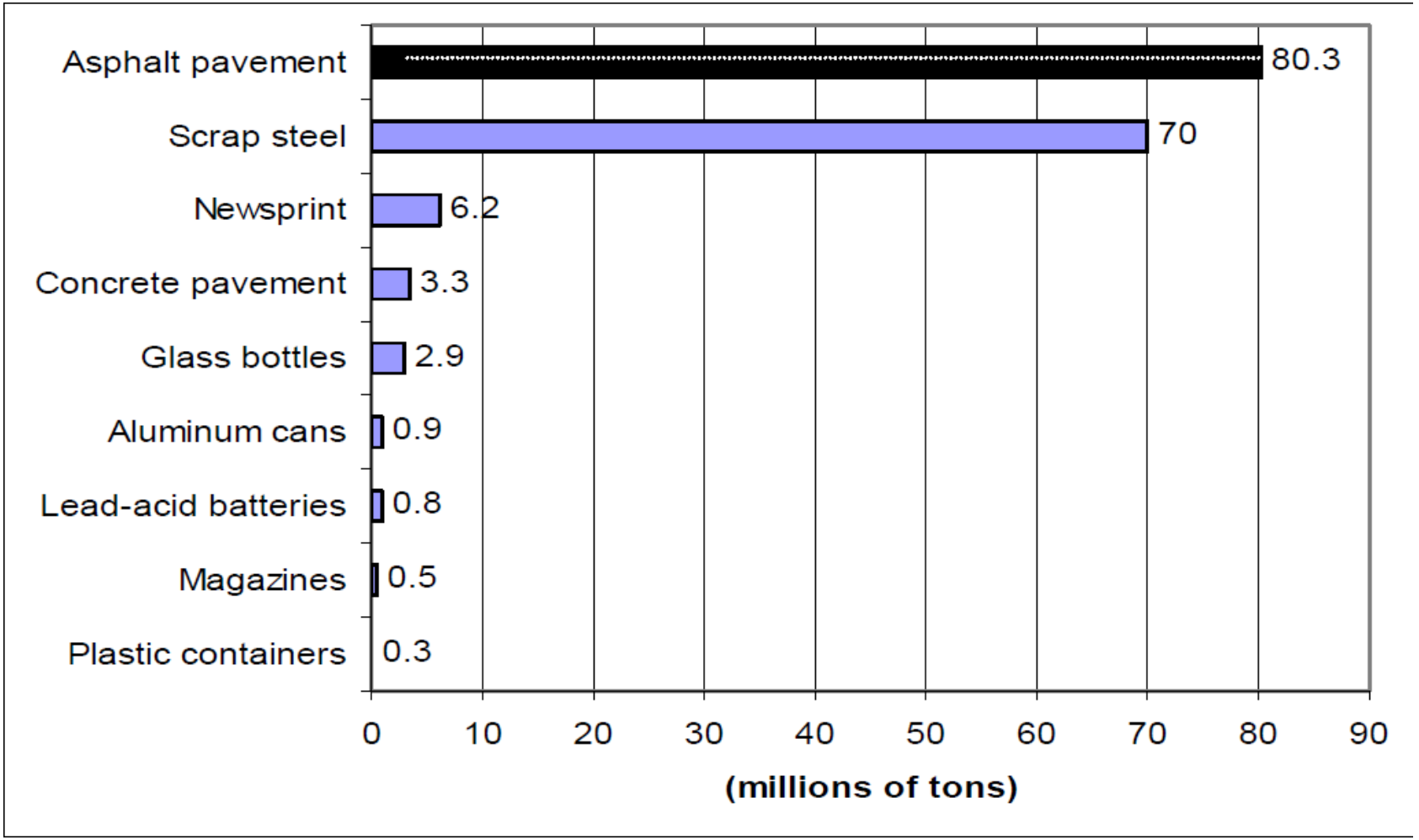
Sustainable Technologies

- RECYCLING APPLICATIONS
  - Reclaimed Asphalt Pavement
  - Recycled Concrete Aggregate
  - In-Place Recycling
- REUSE APPLICATIONS
  - Fly Ash/Coal Ash
  - Tire Rubber
  - Shingles
  - Slag
  - Foundry Sand
- “NEW” TECHNOLOGY
  - Warm-Mix Asphalt

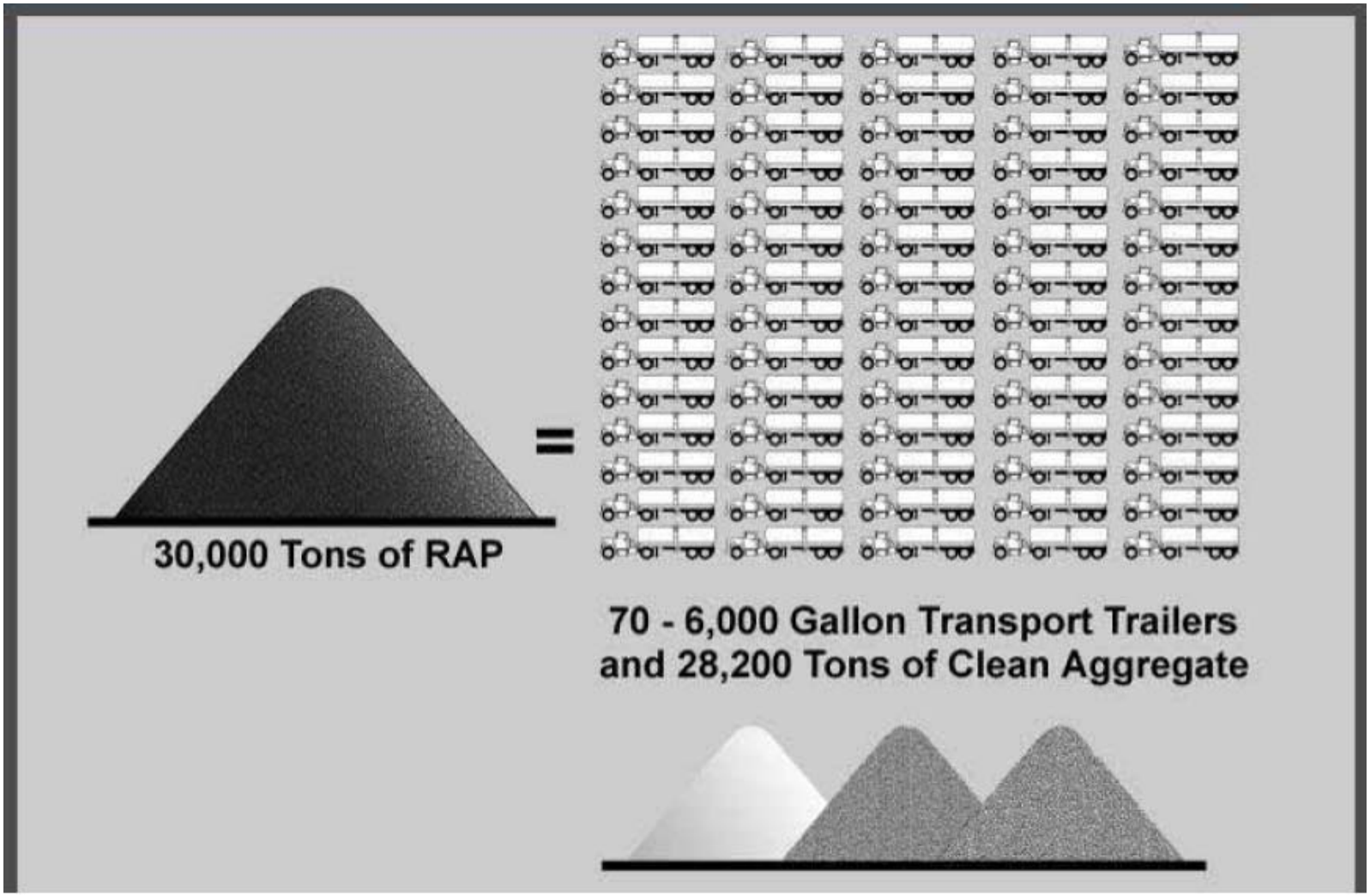
Recycling Benefits

- Reduced project costs
- Conserves materials
- Dwindling supply of high quality aggregates
- Dwindling landfill space
- Increased disposal costs

Materials Recycling – Tons/yr.

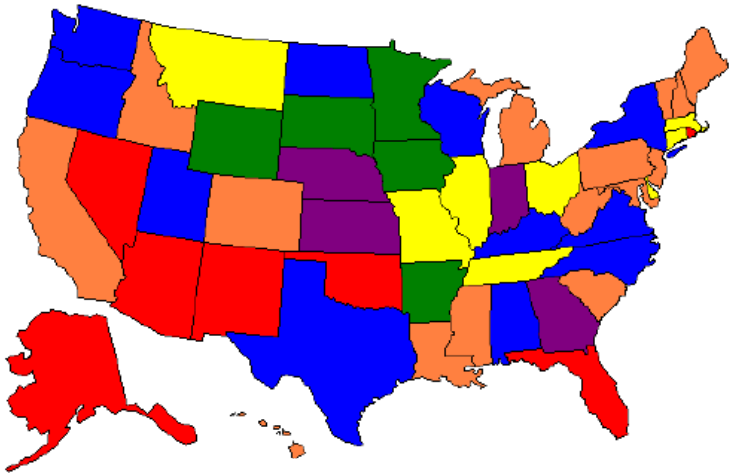


Recycled Asphalt Pavement



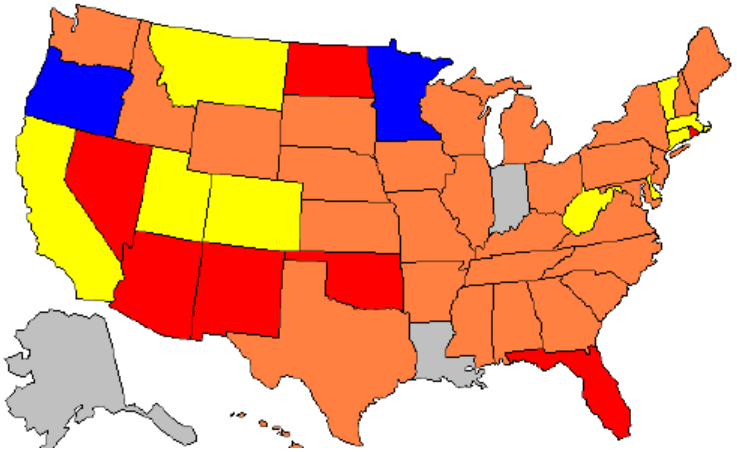
States use of RAP

Specifications



0%
10%
15%
20%
25%
≥30%
n/a

Average Use

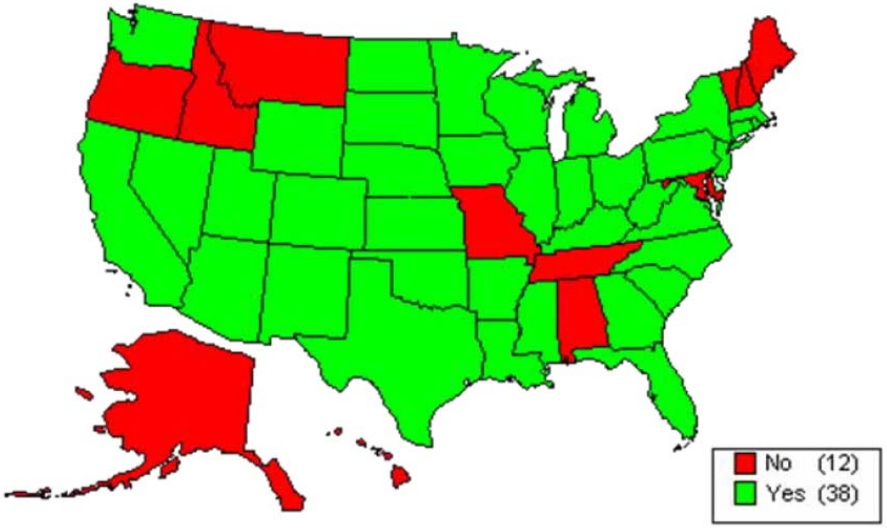


0%
1 - 10%
10 - 20%
20 - 30%
≥30%
n/a

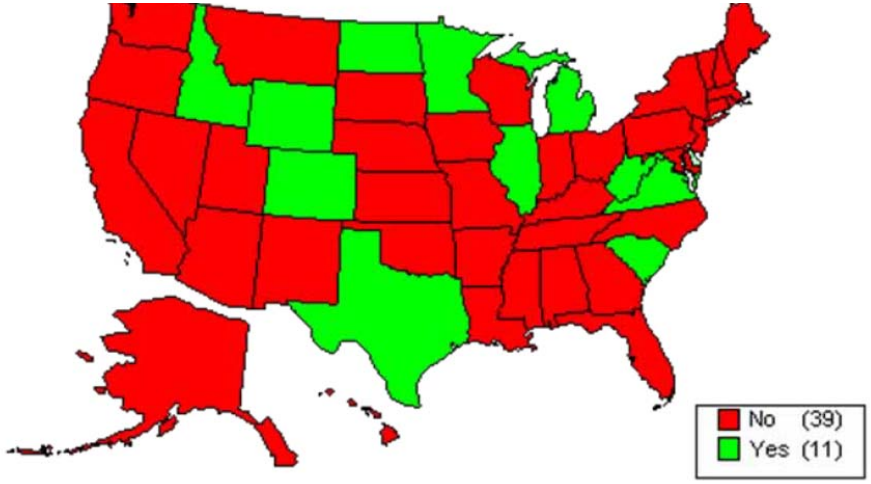
Recycled Concrete Aggregate

States Use of Recycled Concrete Aggregate

As Base Materials



In PCCP



Cold In-Place Recycling

Description:
Milling, rejuvenating, and replacement of the top portion of the HMA surface (performed without heat)

Purpose:
Rework the HMA to a depth of 2-4 inches. Correct surface distress, improve profile, crown and cross slope.

FHWA CIR Review

- 41/52 State DOT responses
- 20 states – no use
- 21 states use CIR
  - 9 use CIR frequently
  - 4 have specs but use very little
  - 3 use only on local/county roads

Hot In-Place Recycling

Description:
Milling, rejuvenating, and replacement of the top portion of the HMA surface (performed with heat)

Purpose:
Rework the HMA to a depth of 1-2 inches. Correct surface distress, improve profile, crown and cross slope.

Reuse Applications

- Fly Ash/Coal Ash – Substitute for cement in concrete, and stabilizing agent in base and subgrade.
- Tire Rubber – Ground and used as HMA additive.
- Shingles – Recyclable to HMA Pavement. Mainly used for parking lots thus far.
- Slag – Byproduct of steel production, works well as aggregate. High skid resistance.
- Foundry Sand – Used as fine aggregate in HMA.

Reuse Applications – Industrial Byproducts

Byproduct	Recycled in Highway Applications (percent of production)	Application
Blast Furnace Slag	90	Concrete
Coal Bottom Ash	30	Asphalt, Base
Coal Fly Ash	27	Cement production, structural fill
Foundry Sands	Unknown	Flowable fill, Asphalt
Cement Kiln Dust	64	Stabilizer
Bottom Ash	Unknown	Asphalt, Base
Nonferrous Slags	Unknown	Base, Asphalt
Steel Slags	Unknown	Base, Asphalt, Concrete
Recycled Asphalt Pavement	80	Asphalt, Base
Reclaimed Concrete	Unknown	Base, Concrete

“New” Technology – Warm Mix Asphalt

- Use of additives allows production and placement of HMA at lower temperatures.
- Less energy usage, lower emissions
- Performance currently under study
- www.warmmixasphalt.com

Summing It Up

- It will require new thinking
- We must “Confront the Brutal Facts”
- Not even at the “End of the Beginning”
- Sustainability is NOT just an environmental initiative, but instead an approach to balance economic, environmental, and social benefits and impacts
- Opportunities abound to improve the sustainability of pavements

Summing It Up (continued)

- LCA is a way of quantifying environmental factors over the life-cycle of the pavement
- Provides a measurement tool that will drive innovation
- Currently can be used to “pick low hanging fruit”
  - Will evolve over time

applied pavement TECHNOLOGY

providing engineering solutions to improve pavement performance