

# SEAUPG 2004 Conference - Baton Rouge

## Presented By Dr. Athar Saeed, Sr. Pavement Engineer

EXPANDING THE REALM OF POSSIBILITY

# Recycled Asphalt Pavement

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**APPLIED RESEARCH ASSOCIATES, INC.**  
An Employee-Owned Company

SEAPUG  
2004 Annual Meeting

## My Purpose

- Benefits of Recycling
- Recycled Asphalt Pavement (Product) – RAP
  - Production
  - Evaluation
  - Utilization
- Information Resources
- Summary

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## Benefits of Recycling

- Reduction in Construction Costs
  - Disposal
  - Transportation
  - Virgin aggregate
- Conservation of Aggregates and Binders
- Conservation of Energy
- Preservation of Environment
- Preservation of existing pavement geometrics
- Reduction in User Delay

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## Production of RAP

- Existing HMA layer is removed
  - Cold milling
  - Hot Scarification/Planing
  - Ripping and crushing
- Partially or wholly coated part



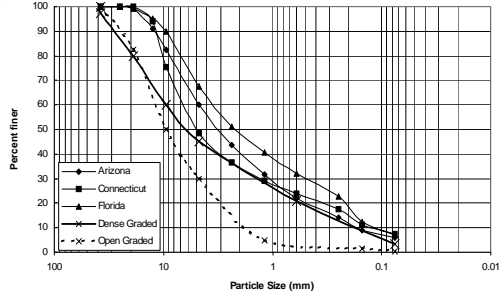
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## Properties of Processed RAP

Property Type	Property	Typical Value
Physical	Unit weight of original HMA	120 - 140 lbs/ft <sup>3</sup>
	Moisture content	Normal: up to 5 percent Maximum: 7 - 8 percent
	Asphalt content	Normal: 4.5 - 8 percent Maximum Range: 3 - 7 percent
	Asphalt penetration	10 - 80 at 77 °F (25 °C)
	Absolute viscosity of recovered asphalt binder	4,000 - 25,000 poises at 140 °F (60 °C)
Mechanical	Unit weight of RAP	100 - 125 lbs/ft <sup>3</sup>
	California bearing ratio	100 % RAP: 20 - 25 % 40 % RAP & 60 % aggregate: ≥150%

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## RAP Gradation



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### RAP Evaluation Criteria

- Based on intended use
- Equal or better
  - Engineering
  - Economic
- Acceptable
  - Environmentally
  - Socially

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### Technical Evaluation

- Initial Screening Tests
  - Sieve analysis, density, . . . . .
- Strength/Stiffness Tests
  - Static and repeated load triaxial,  $M_R$ , strain, . . . . .
- Other Tests
  - Toughness, durability, . . . . .

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### Economic Evaluation

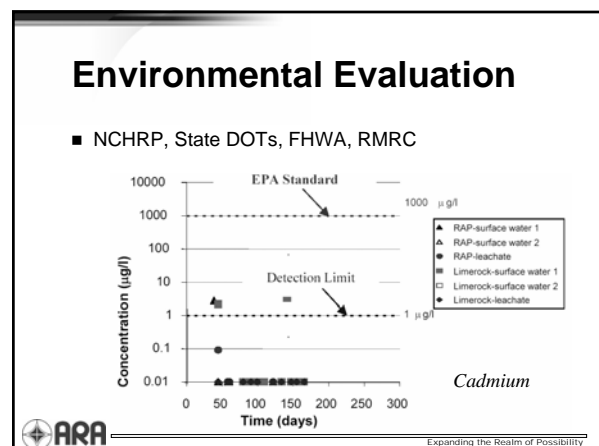
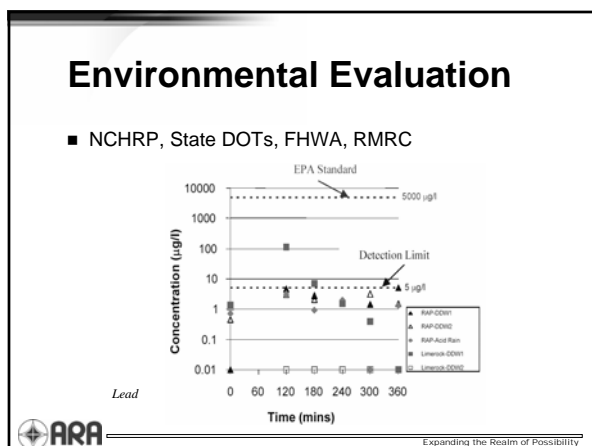
- Quantity
- Disposal Saving
- Transportation Saving
- Processing Cost
- Additional Material Cost

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### Societal Evaluation

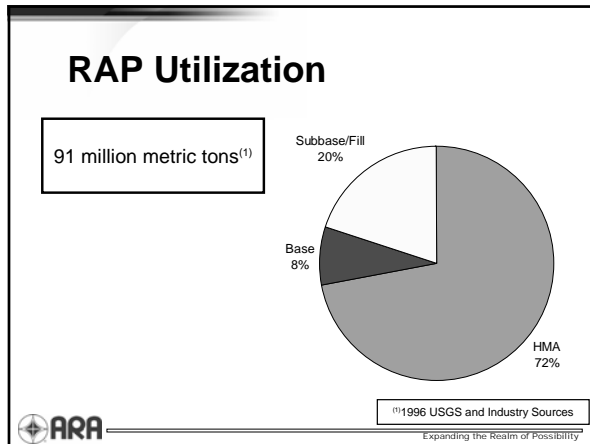
- Storage Site Aesthetics
- Safety/Health Hazard
- Government/Special Interest Group

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- ### RAP Uses
- Hot Mix Asphalt Recycling
  - Hot In-Place Recycling
  - Cold In-Place Recycling
  - Full Depth Reclamation
  - Unbound Base/Subbase
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- ### RAP in HMA
- Typically 10 – 30 percent RAP in recycled HMA mixes
  - RAP obtained by milling or ripping and crushing
  - RAP combined with aggregate, binder, . . .
  - Production, placement, compaction
    - No difference
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- ### Hot In-Place Recycling
- Existing pavement heated and softened
  - Scarified/milled to a specified depth (up to 2 inch)
  - Single pass operation
  - Multiple pass operation
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- ### Cold In-Place Recycling
- Reuse of existing pavement material without heat
  - Virgin aggregate and/or asphalt emulsion can be added if needed
  - Placement and compaction
  - Use of a recycling train common
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- ### Full Depth Reclamation
- All asphalt pavement section and some base
  - Similar to CIR but produces a stabilized base
  - Asphalt emulsions, aggregate (if needed) added
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## Unbound Base/Subbase


- RAP obtained by milling or ripping and crushing
- RAP combined with virgin aggregate if needed
- Production, placement, compaction
  - No difference



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## Available Resources

- FHWA
  - <http://www.fhwa.dot.gov/pavement/recycle.htm>
  - The User Guidelines for Waste and Byproduct . . . .
- National Cooperative Highway Research Program
  - NCHRP 4-21
  - NCHRP 4-23
  - . . . . .
- Recycled Materials Resource Center
  - Several research projects
- State DOTs





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## NCHRP


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## FHWA

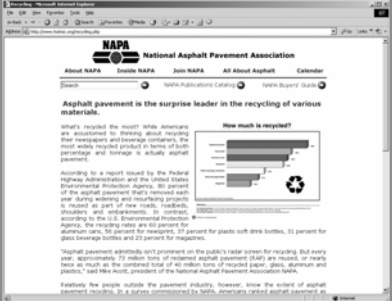

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## RMRC




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## NAPA

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## ARRA



## Summary

- Proven successful technology
- Environmentally sound
- Economical
- Conservation of natural resources



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