REDUCING COST

RAP and RAS Considerations
Historical Perspective on HMA Recycling

- In 2007, a NAPA survey indicated that the national average RAP content for all HMA in the USA was 12%.

- A survey in 2010 indicates that the average RAP content had increased to 19%.
RAP Sources

Pavement Milling

Asphalt Pavement Removal

Plant Waste Material
Goals of Processing RAP

- Uniform stockpile from a collection of different RAP materials
- RAP agglomerations to a size used during production
- Reduce the max aggregate size (surface mixes)
- Minimize P200 generation
  - Screening prior to crushing helps
Processing Millings

Millings from single project are consistent:
- Gradation
- Binder content
- Aggregate properties
- Binder properties

Processing only to:
- Eliminate agglomerations
- Reduce max aggregate size

Recommended Processing Options
- Sample and test multiple locations to determine RAP quality
- If max aggregate size too large:
  - Fractionate the RAP for use in different mixes
  - Process by crushing to the desired aggregate size
Processing Millings

- Considered best practice *not* to crush, but to use “as is” or to screen to remove larger particles.
Processing RAP from Multiple Sources

1. RAP from multiple sources must be processed to create a uniform material
   - Data suggest very consistent material can be produced

2. Key is careful blending as part of the processing operation
   - Bulldozer, excavator, loader can be used to blend materials from different areas of the stockpile

3. In most cases, processed RAP will be moved to the plant site for convenient use
   - Remix the RAP to improve its consistency
   - Use the loader to mix the RAP from different locations in the processed RAP stockpile
Screening RAP During Processing

- Crushing RAP will create more fines
  - RAP should be screened before crushing to remove particles which do not need to be processed
A variety of crusher types are used for processing RAP
- Cone crusher
- Jaw crusher
- Vertical Shaft Impactor
- Horizontal Shaft Impactor
- Roller/Mill-type Breakers

HSI are preferred because they break up chunks of pavement or agglomerations of RAP rather than downsizing aggregate size.
Fractionating RAP

- Primary advantage is to provide flexibility in mix design
- Typical Sizes
  - 3/4” – 3/8”
  - 3/8” – 3/16”
  - Minus 3/16”
- Fractionate when:
  - Mixes contain more than 20% RAP
  - Typical specifications allow more than 20% RAP
  - RAP is readily available
  - Plant site has space for multiple RAP stockpiles
  - Problems meeting mix design requirements
  - Problems meeting project QC requirements
Fractionating RAP

3/4 x 3/16” RAP
In back

3/16” RAP

+3/4” RAP
Asphalt Roofing Shingles

11 million tons of waste asphalt roofing shingles are generated in the US per year.
- Manufacturing Waste ~ 1 million
- Roofing tear-offs ~ 10 million

Reclaimed Asphalt Shingles - RAS
- Crushed/ground and screened
- Used in hot mix asphalt
- High beneficial reuse
What Are Shingles Made of?

- 35% granules
- 30% asphalt
- 15% fiberglass
- 20% mineral filler
Shingle Sources

- **Pre Consumer**
  - Off Specification shingles
  - Switching Production Runs
- **Post Consumer**
  - Re-roofing at end of life
  - Storm damage
Mixed Waste
Typical Spec

2% Deleterious
Placement

County Road resurfacing
  - 50 mm base
    - 19.0-mm mix
  - 38 mm surface
Existing Condition
Laydown Operation
Uncompacted Mat
Compaction
Materials savings based on...

- Virgin binder cost
- Asphalt content of the mix design
- Aggregate cost
- RAP cost
- Asphalt content of the RAP
- Percentage of RAP
## Economics Savings Example

<table>
<thead>
<tr>
<th>Material</th>
<th>0% RAP</th>
<th>12% RAP</th>
<th>25% RAP</th>
<th>25% RAP with 3% Shingles</th>
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<tbody>
<tr>
<td>Aggregate</td>
<td>$14.25</td>
<td>$12.45</td>
<td>$10.50</td>
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<td>Asphalt</td>
<td>$27.50</td>
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<td>$20.63</td>
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<td>RAP</td>
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<td>$2.25</td>
<td>$2.25</td>
<td>2.25</td>
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<tr>
<td>Shingles</td>
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<td></td>
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<td>1.25</td>
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<tr>
<td>Total</td>
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<td>$37.73</td>
<td>$33.38</td>
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<td>% Savings</td>
<td>9.6%</td>
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<td>$20.1%</td>
<td>24.9%</td>
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</table>
RAP and RAS
Green As The Wind

Thanks
RAP in HMA

- **Black Rock?**
  - Limestone
    - 3 million – 12 million psi
  - Aged Asphalt Binder
    - 150,000 psi glassy stiffness
    - 1,500 psi (50F)

- **Homogenous Blending?**
  - No

- **Partial Blending??**
Partial Blending

- Composite Material
  - Virgin Binder
  - Reclaimed Binder