



Shingles in Paving Demonstration

WAPA Mid Year Meeting

June 4, 2010

Shingles in Paving Demonstration

Establish a local paving end market for recycled asphalt shingles (RAS) that captures the resource value of shingles and diverts this material from landfills

Develop RAS and HMA specifications

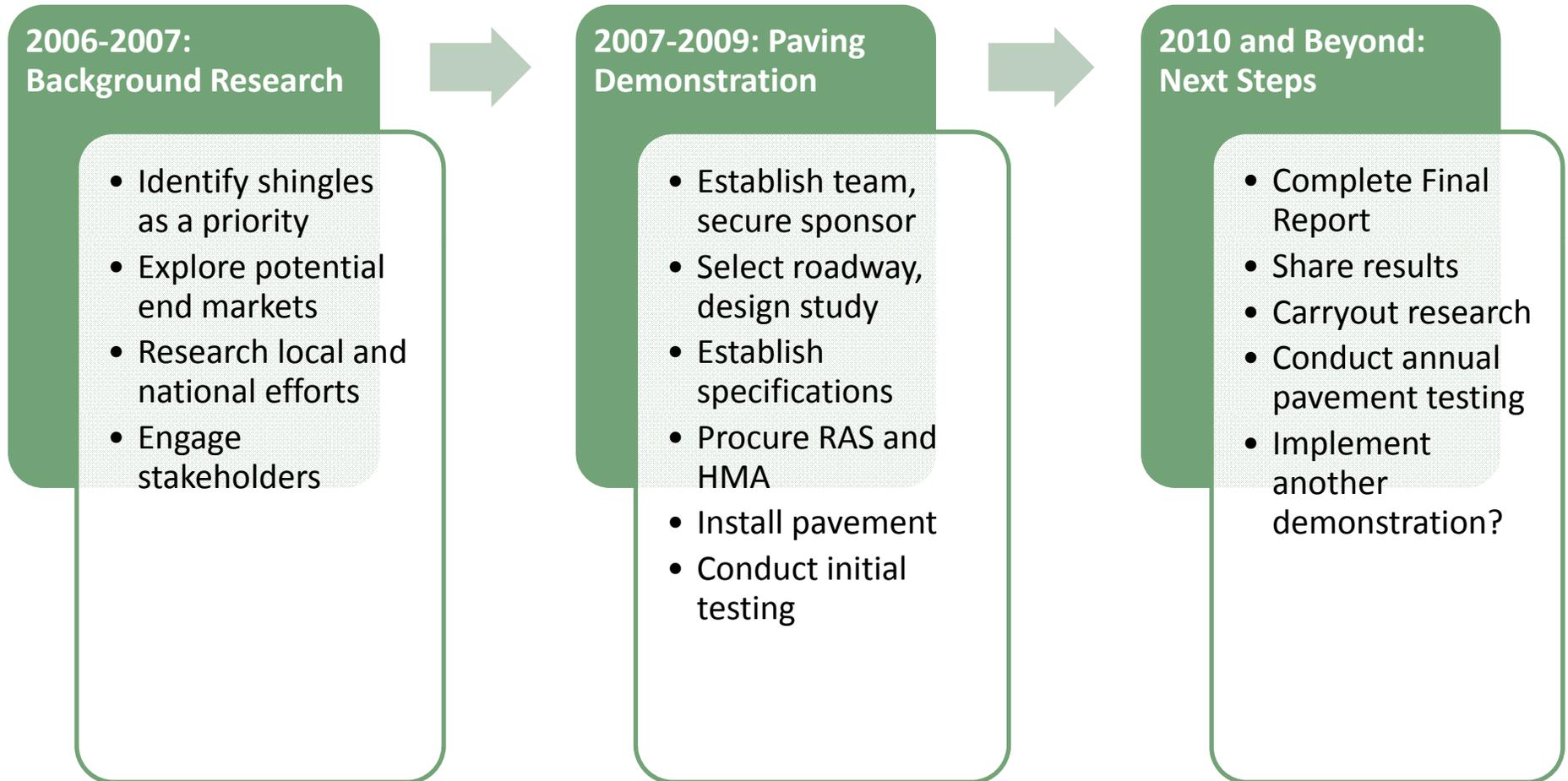
Pave wear course with 3% RAS with 15% RAP

Collect local engineering data; conduct performance testing

Design considerations:

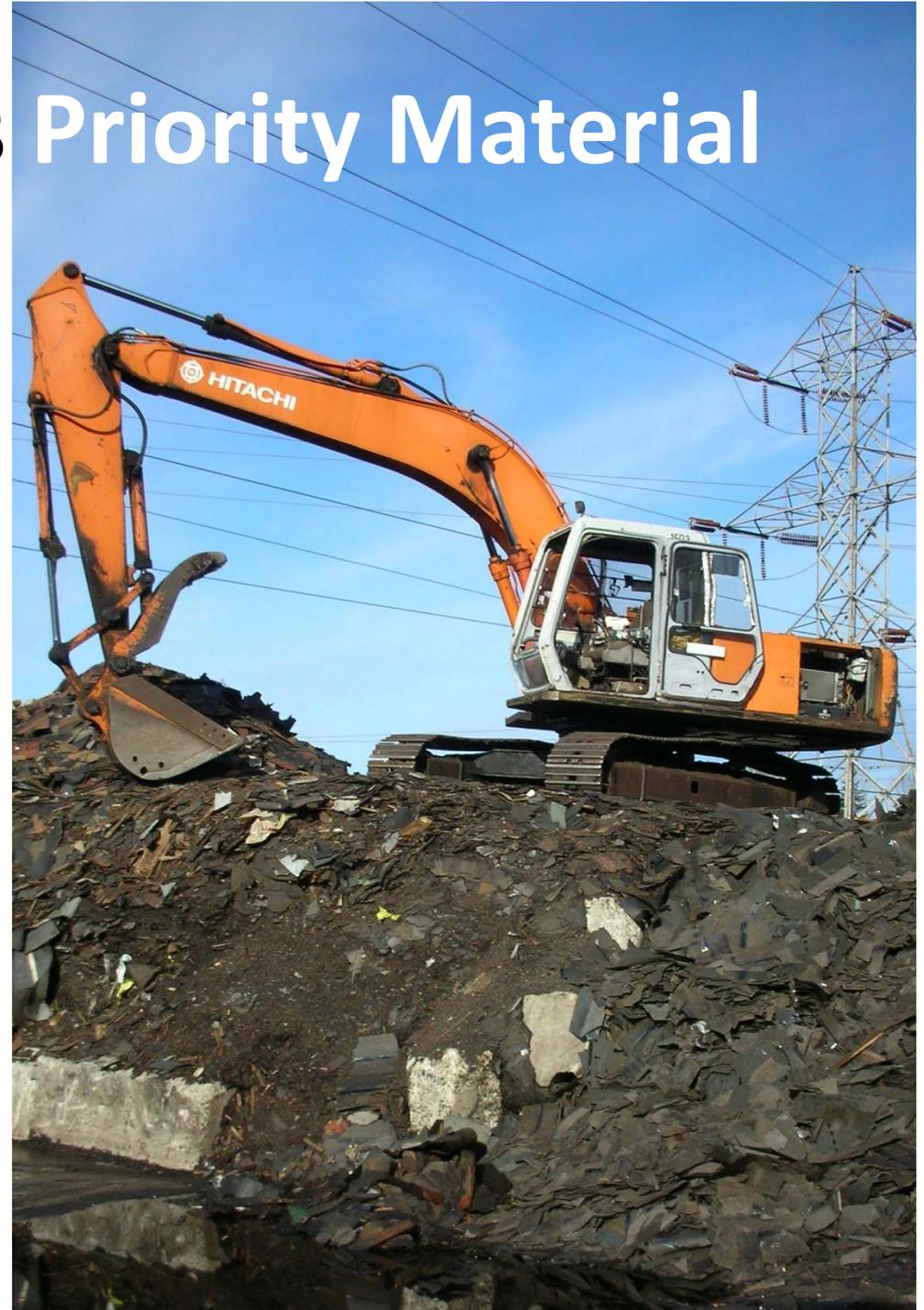
- Minimize risk
- Performance over time
- Health, environmental and safety standards
- Recognition by industry and public agencies

Shingles in Paving Project Overview



Asphalt Shingles Priority Material

- Large quantity of shingles is generated in King County and disposed in landfills
- Limited end use markets
- Local recycling infrastructure is not firmly established (though growing)
- Shingles are recycled in other parts of the country



Hot Mix Asphalt

National Precedent

- Pooled Fund study
- 10 states have specifications and procedures that allow for RAS in HMA
- American Association of State Highway and Transportation Officials specifications for using RAS in HMA

Drivers

- Costs: asphalt and landfill
- Sustainability: Zero Waste, C&D waste stream, GHG emissions, LEED, Greenroads

Regional Developments

- Shingles in HMA is an acceptable use (Ecology)
- Shingles no longer on suspect ACM list (PSCAA)
- Metro Vancouver pilot
- Oregon State University/ODOT mix design research
- Local jurisdictions expressing interest



Alabama

Georgia

Iowa

Minnesota

Missouri

Pennsylvania

South Carolina

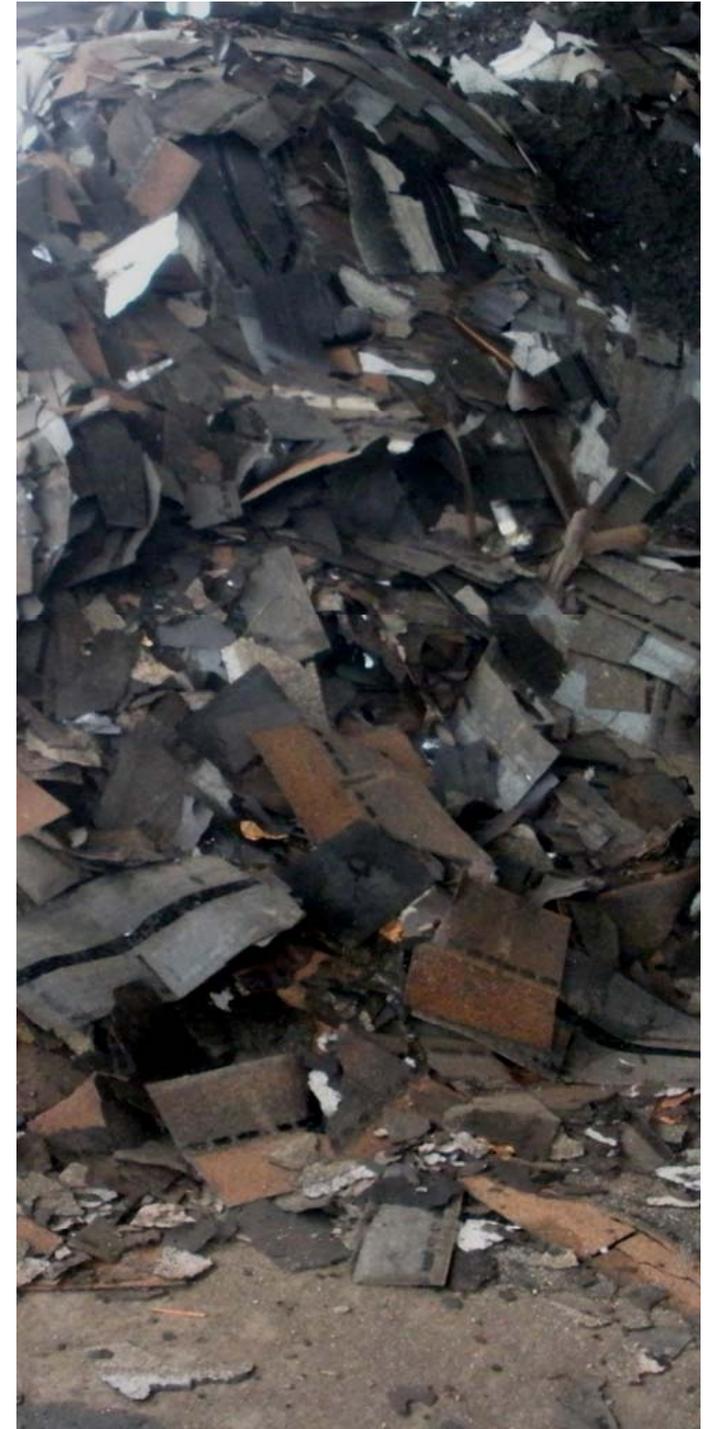
Texas

Virginia

Wisconsin

RAS Market Research

- **Purpose:** Understand current use, opportunities, and barriers to using RAS in HMA in Washington State
- **Methodology:** Phone interviews conducted with 11 pavers and 17 haulers/recyclers in May 2010
- **Results: High interest, need for specifications**
 - Three pavers using RAS; several recyclers handling shingles
 - Paving benefits cited were cost savings and comparable performance
 - Concerns were lack of permissive specifications, environmental/safety issues, and shingles storage requirements
 - Need for more pilots, permissive specs, relaxed storage requirements, roofer outreach



Implementing the Demonstration

A large yellow steamroller is shown from a low angle, paving a road. The machine's large, heavy-duty wheels and metal frame are prominent. The background consists of a dense forest of tall, thin trees under a bright sky. The overall scene is outdoors, likely at a construction or demonstration site.

Connected with the national experience

- Specification development
- Environmental issues and regulatory protocols
- Research memos and conferences

Engaged stakeholders, kept them engaged

- 100 representatives of recyclers, paving contractors, transportation agencies, health departments, regulatory agencies and solid waste agencies
- 18-member project advisory group to guide and steer the design and development

Recruited key transportation agency partners

- King County Department of Transportation
- Washington State Department of Transportation



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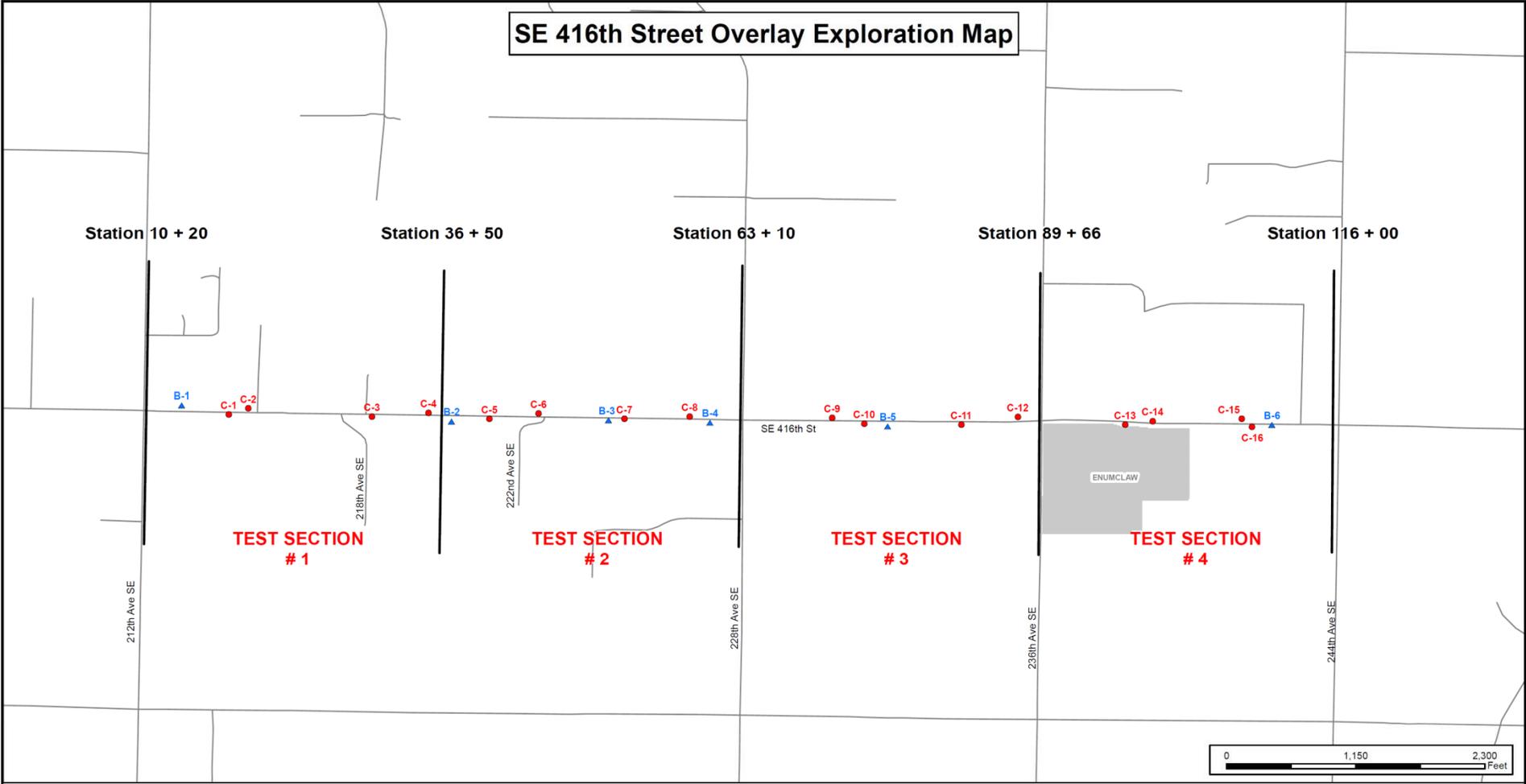
Core Project Team



Demonstration Objectives

- Reflect the interests and standards of stakeholders
- Evaluate performance of HMA with RAS with a high degree of certainty
- Capture objective engineering data to gain wide acceptance of performance test results

SE 416th Street Overlay Exploration Map



King County Materials Laboratory
 SE 416th Street Overlay
 Shingles in Paving Demonstration
SITE EXPLORATION MAP

- ▲ Approximate Boring Location
- Approximate Core Location
- Station Line
- Street Network
- City



January 7, 2010

File Name:
 KG_TU\development\ArcMap\ArcMapProjects\SE_416th_ST_exploration_map.mxd
 Data Sources:
 Standard King County datasets used include: trans_network, City
 Roads Datasets Include: SE416thSt_stationing, Boring_Location, Core_Location

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Road Selection and Study Design

Road selection criteria

- Overlay paving
- Two miles in length
- Consistent pavement and subsurface conditions
- Two-lane, relatively straight with limited variable surface conditions

	Test Section #1	Test Section #2	Test Section #3	Test Section #4
1000 tons/day	½ mile	½ mile	½ mile	½ mile
Lane 1 (eastbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP
Lane 2 (westbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP

RAS Specification

- Designed to ensure a high quality product that performs and meets health, safety, and environmental standards
- Guidance from national research and the American Association of State Highway and Transportation Officials (AASHTO)
- Collaborative process with leading transportation and regulatory agencies
- Involvement of private industry to ground requirements in reality
 - Product samples
 - Specification review
 - Outcome-oriented approach

Specification

- **Asphalt shingles only**
- **Extraneous waste up to 3%**
- **Moisture content up to 5%**
- **Gradation 100% ½", 95% 3/8"**
- **Sampling per AASHTO**
- **Asbestos sampling and testing on incoming shingles**
- **Other regulatory issues**

Environmental, Health, and Safety Standards

Key agencies, regulations and rules

- Washington State Department of Ecology – solid waste handling and storage
- Washington State Department of Labor & Industries – workplace safety rules
- Puget Sound Clean Air Agency – asbestos testing and handling
- Local Health Department(s) – general compliance, notification of grinding

Took asbestos issue seriously

- Restricted supply to asphalt shingles only
- Inspections of incoming loads
- Rigorous sampling and testing standards confirmed no asbestos in shingles
 - *Suspect materials include felt paper, mastic, built up roofing, and shingles with patching or aluminum coating*





Paving completed in South King County in September, 2009

Results from extensive initial material engineering tests indicate that using RAS in HMA has no negative impact on pavement performance.

- All but one Test Section substantially met project specifications and materials standards.
- The finished roadway surface is in near perfect visual condition.
- Skid resistance testing shows no noticeable change in resistance.
- Further testing, analysis, and documentation will continue to verify the impact on using RAS on public roadways.

Pavement Condition Indices (PCI) • Pavement Structural Condition (PSC) • Pavement Rutting Condition (PRC) • International Roughness Index (IRI) • Coring • Subsurface Boring • Falling Weight Deflectometer (FWD) • Skid Resistance/Drag Factors



HMA Specifications

- Design considerations
 - Amount of RAS
 - Estimated binder replacement from RAS
 - Use of recycled asphalt pavement (RAP)
- Design process
 - RAS samples
 - AASHTO guidance
 - Testing and team discussions



Volumetric Comparisons of Preliminary RAS Samples

Mix Design	Material %			Volumetric Data											
	Virgin	RAP	RAS	Pb	Gmb	Gmm	Gmm @ Ndes	Gmm @ Nini	Va	VMA	VFA	Pbe	Gse	D/A	
Virgin	100	0	0	5.5	2.378	2.478	96.0	86.3	4.0	14.4	72	4.5	2.700	1.4	
RAP	80	20	0	5.5	2.392	2.478	96.5	86.8	3.5	13.9	75	4.5	2.700	1.4	
RAS #1	97	0	3	5.5	2.359	2.466	95.7	86.1	4.3	15.1	72	4.7	2.685	1.3	
RAS #1	95	0	5	5.5	2.323	2.464	94.3	85.4	5.7	16.4	65	4.7	2.682	1.3	
RAS #1	77	20	3	5.5	2.365	2.474	95.6	86.0	4.4	14.9	71	4.5	2.695	1.4	
RAS #1	75	20	5	5.5	2.350	2.460	95.5	86.4	4.5	15.4	71	4.8	2.677	1.3	
RAS #2	97	0	3	5.5	2.351	2.472	95.1	85.9	4.9	15.4	68	4.6	2.692	1.3	
RAS #2	95	0	5	5.5	2.349	2.458	95.6	86.4	4.4	15.4	71	4.8	2.675	1.3	
RAS #2	77	20	3	5.5	2.385	2.466	96.7	87.5	3.3	14.1	77	4.7	2.685	1.3	
RAS #2	75	20	5	5.5	2.363	2.468	95.7	85.8	4.3	14.9	71	4.6	2.687	1.3	
RAS #3	97	0	3	5.5	2.345	2.467	95.1	85.5	4.9	15.6	69	4.7	2.686	1.3	
RAS #3	95	0	5	5.5	2.317	2.485	93.2	84.2	6.8	16.6	59	4.4	2.708	1.4	
RAS #3	77	20	3	5.5	2.368	2.463	96.1	86.7	3.9	14.8	74	4.7	2.681	1.3	
RAS #3	75	20	5	5.5	2.327	2.463	94.5	85.2	5.5	16.2	66	4.7	2.681	1.3	
Specifications							Approx. 96.0%	≤ 89.0	Approx. 4.0%	Min. 14.0%	65 - 75			0.6 - 1.6	

Mix Design Volumetric Data Comparison

Mix Design	Material %			Volumetric Data											
	<i>Virgin</i>	<i>RAP</i>	<i>RAS</i>	<i>Pb</i>	<i>Gmb</i>	<i>Gmm</i>	<i>Gmm @ Ndes</i>	<i>Gmm @ Nini</i>	<i>Va</i>	<i>VMA</i>	<i>VFA</i>	<i>Pbe</i>	<i>Gse</i>	<i>D/A</i>	
Contractor's Blend	82	15	3	5.4	2.382	2.478	96.1	N/A	3.9	14.3	73	4.5	2.695	1.4	
WSDOT's Blend #1	82	15	3	5.1	2.350	2.478	94.9	85.9	5.2	14.6	65	4.1	2.633	1.5	
WSDOT's Blend #2	82	15	3	5.6	2.374	2.463	96.4	87.0	3.7	14.1	74	4.5	2.632	1.4	
WSDOT's Blend #3	82	15	3	6.1	2.389	2.444	97.8	87.8	2.3	14.1	84	5.1	2.635	1.2	

	<i>Virgin</i>	<i>RAP</i>	<i>RAS</i>	<i>Total HMA</i>
Pb Breakdown	4.3	0.6	0.7	5.6

Volumetric Data for Test Sections 4 and 1 (RAP only)

Test Section	Material %			Volumetric Data										
	<i>Virgin</i>	<i>RAP</i>	<i>RAS</i>	<i>Pb</i>	<i>Gmb</i>	<i>Gmm</i>	<i>Gmm @ Ndes</i>	<i>Gmm @ Nini</i>	<i>Va</i>	<i>VMA</i>	<i>VFA</i>	<i>Pbe</i>	<i>Gse</i>	<i>D/A</i>
Section 4 (9/22/2009)	85	15	0	5.3	2.399	2.485	96.5	N/A	3.5	13.9	75	4.5	N/A	1.3
Section 4 (9/22/2009)	85	15	0	5.5	2.409	2.483	97.0	N/A	3	13.7	78	4.6	N/A	1.3
Section 1 (9/24/2009)	85	15	0	5.7	2.426	2.481	97.8	N/A	2.2	13.3	84	4.7	N/A	1.4
Section 1 (9/24/2009)	85	15	0	5.4	2.426	2.485	97.6	N/A	2.4	13	82	4.5	N/A	1.4
Average				5.5	2.415	2.484	97.2	N/A	2.8	13.5	80	4.6	N/A	1.4
JMF	100	0	0	5.3	2.374	2.475	95.9	86.4	4.1	14.4	71	4.5	2.686	1.4

Aggregate Gradation and Asphalt Content Results for Test Sections 4 and 1 (RAP only)

Test Section	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	Pb
Section 4 (9/22/2009)	100	94	82	58	39	26	18	12	9	5.9	5.3
Section 4 (9/22/2009)	100	95	83	55	36	25	18	12	9	5.9	5.5
Section 1 (9/24/2009)	100	92	83	57	38	26	18	13	9	6.5	5.7
Section 1 (9/24/2009)	100	95	84	57	37	26	18	13	9	6.4	5.4
Average	100	94	83	57	38	26	18	13	9	6.2	5.5
JMF	100	93	82	55	36	25	17	12	8	6.0	5.3

Volumetric Data for Test Sections 3 and 2 (RAP and RAS)

Test Section	Material %			Volumetric Data										
	<i>Virgin</i>	<i>RAP</i>	<i>RAS</i>	<i>Pb</i>	<i>Gmb</i>	<i>Gmm</i>	<i>Gmm @ Ndes</i>	<i>Gmm @ Nini</i>	<i>Va</i>	<i>VMA</i>	<i>VFA</i>	<i>Pbe</i>	<i>Gse</i>	<i>D/A</i>
Section 3 (9/23/2009)	82	15	3	6.4	2.423	2.450	98.8	N/A	1.1	14.0	92	5.5	N/A	1.3
Section 3 (9/23/2009)	82	15	3	6.3	2.428	2.451	99.1	N/A	0.9	13.7	93	5.4	N/A	1.3
Section 2 (9/25/2009)	82	15	3	5.5	2.383	2.489	95.7	N/A	4.3	14.6	71	4.5	N/A	1.6
Section 2 (9/25/2009)	82	15	3	5.7	2.404	2.464	97.6	N/A	2.4	14.0	83	5	N/A	1.4
Section 2 (9/25/2009)	82	15	3	5.8	2.405	2.472	97.3	N/A	2.7	14.1	81	4.9	N/A	1.4
Average				5.9	2.409	2.465	97.4	N/A	2.3	14.1	84	5.1	N/A	1.4
JMF	82	15	3	5.6	2.369	2.466	96.1	86.7	3.9	14.2	72	4.4	2.632	1.4

Aggregate Gradation and Asphalt Content Results for Test Sections 3 and 2 (RAP and RAS)

Test Section	3/4"	1/2"	3/8"	#4	#8	#16	#30	#50	#100	#200	Pb
Section 3 (9/23/2009)	100	91	82	58	39	27	19	14	10	7.2	6.4
Section 3 (9/23/2009)	100	91	81	56	38	27	19	13	9	6.8	6.3
Section 2 (9/25/2009)	100	95	87	61	42	29	21	15	11	7.0	5.5
Section 2 (9/25/2009)	100	95	84	57	39	27	19	14	10	7.2	5.7
Section 2 (9/25/2009)	100	92	83	57	38	26	19	13	10	6.8	5.8
Average	100	93	83	58	39	27	19	14	10	7.0	5.9
JMF	100	94	84	57	39	27	19	13	8	6.3	5.6

Production and Paving

- Contractor perspective
- Was it successful, was it beneficial to Woodworth?
- Lessons learned and what's on the horizon



Next Steps

- **Sharing results with local stakeholders**

- HMA producers, transportation agencies, recyclers, roofers
- Place articles in trade publications (Better Roads, HMA Magazine, Asphalt)

- **Research**

- Revising the RAS specification
- Asbestos sampling and testing
- Cost study?

- **Conducting ongoing performance testing of King County paving demonstration**

- **Coordinating with regional and national efforts**

- **Supporting additional pilots?**

- King County Solid Waste Division
- City of Mercer Island
- Pierce County
- WSDOT

Thank You and Questions

King County LinkUp www.kingcounty.gov/linkup

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Shingle Recycling.Org www.shinglerecycling.org

