TRB TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

RECLAIMED ASPHALT SHINGLES

Current Status of Use in U.S. A.

Gerry Huber

Heritage Research Group

Current Use

* 1,100,000 tons (2010)
* 1,200,000 tons (2011)

* Manufacture waste
* Post Consumer (tear off)

Information Series 138

2nd Annual Asphalt Pavement Industry Survey on

Reclaimed Asphalt Pavement, Reclaimed Asphalt Shingles, and Warm-Mix Asphalt Usage: 2009–2011

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION

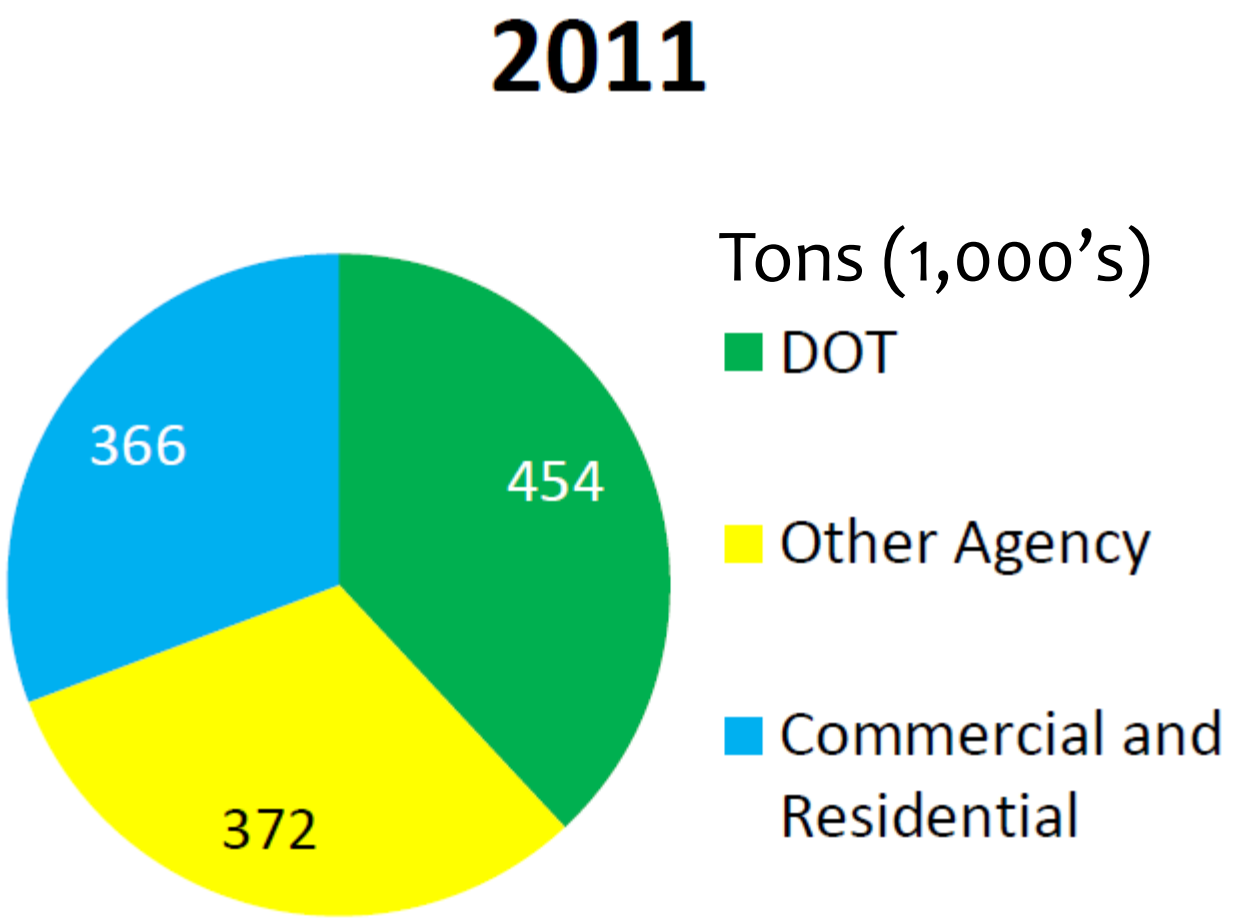
Asphalt Shingle Availability

* Supply
  * Manufacture Waste 1,000,000 tons
  * Post Consumer (tear off) 10,000,000 tons

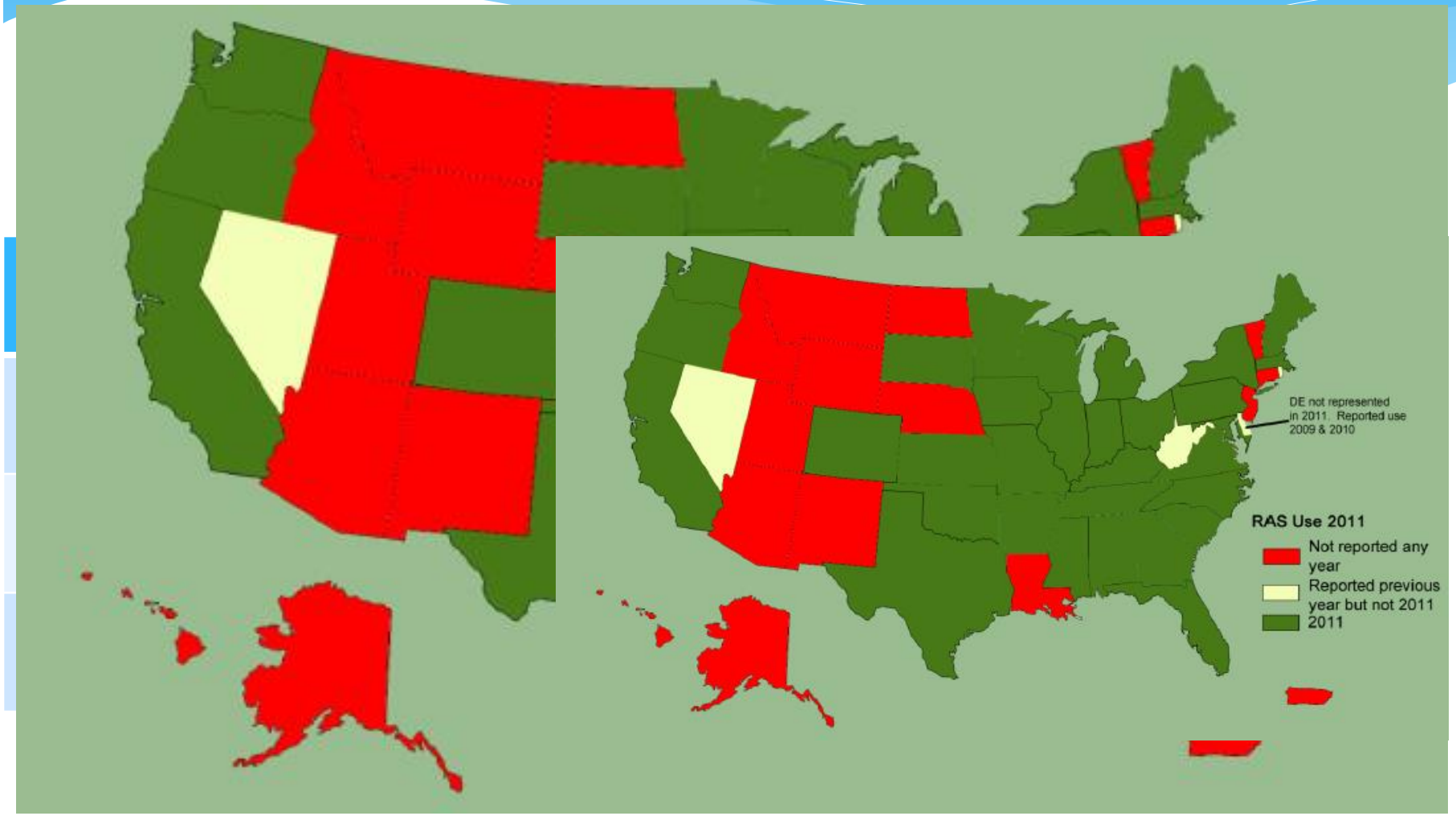
* Use
  * 1,200,000 tons

11%

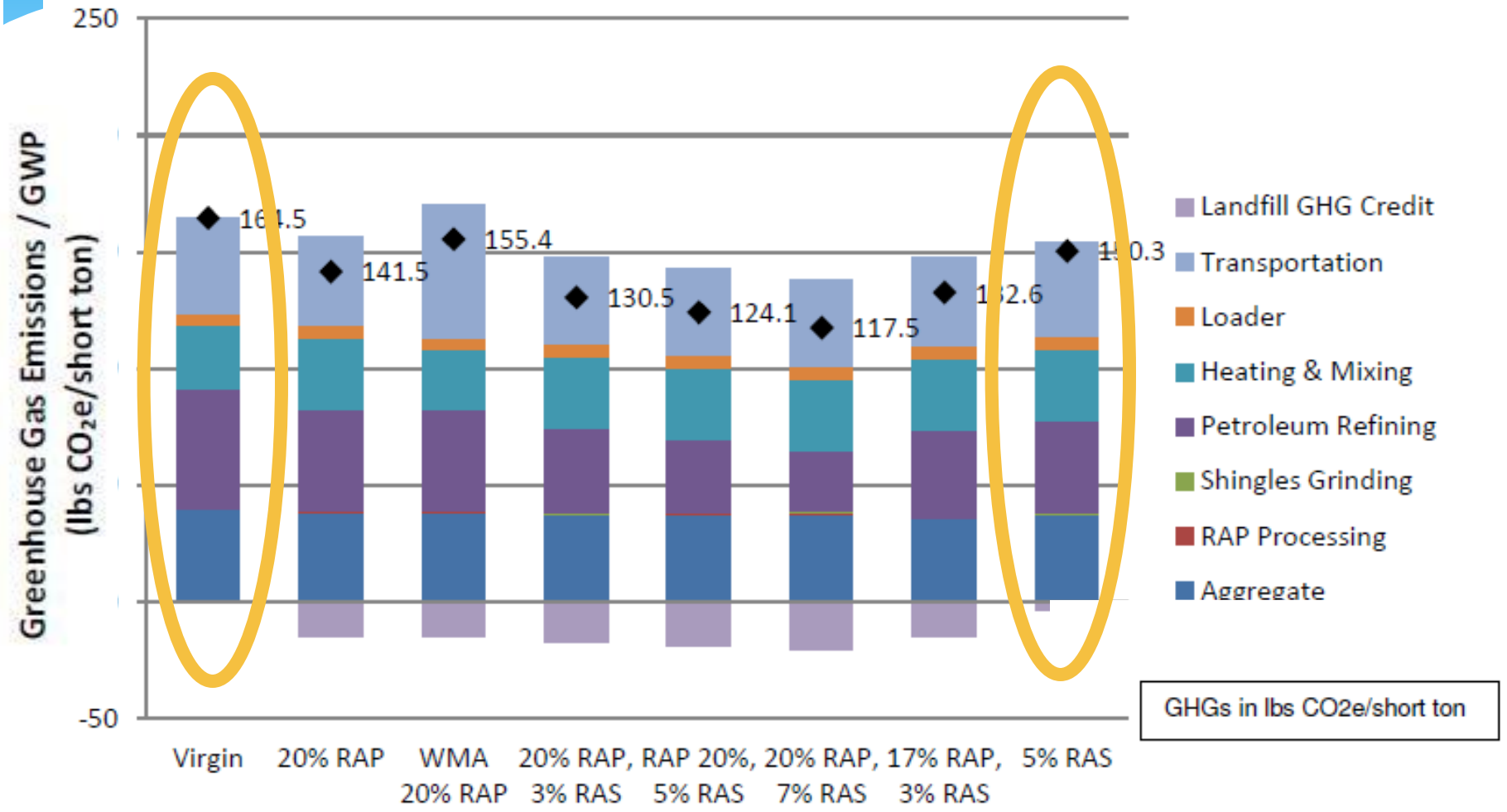
RAS Use by Customers



Geographic Distribution of RAS Use



Greenhouse Gas Emissions, U.S. EPA



Analysis of Recycling of Asphalt Shingles in Pavement Mixes from a Life Cycle Perspective, US EPA – Region 8

Why Use Shingles?

* Shingles contain:
  * Asphalt binder
    * Tear-offs : 25 – 30% binder
    * Manufacture waste: 18 – 22% binder
  * Mineral matter
    * 40 to 60%
    * granules and fillers
  * Fibers
    * 8 to 12%

* Theoretical value
  * Asphalt binder
    * $125 / ton
  * Mineral aggregates
    * $15 / ton

* Cost
  * Sorting
  * Shredding
    * $25 / ton

Positive Economics

* Material Replacement
  * Liquid asphalt
  * Aggregates
  * Fibers
* Net materials savings
  * $3 to $6 per ton of mix

CALCULATED	**Material Costs (As Used in Mix)**		
	RAP Cost / Mix Ton, $		1.15
	RAS Cost / Mix Ton, $		0.75
	RAP and RAS Cost / Mix Ton, $		1.90
	Binder Replacement		
	RAP Binder Replacement, %		1.15
	RAS Binder Replacement, %		0.60
	Total Binder Replacement, %		1.75
	Actual Percent Binder Replacement, %		35.00
	(Allowable - Actual) Binder Replacement, %		0.00
	(Allowable - Actual) Asphalt Content, %		0.00
	Savings		
	RAP Savings / Mix Ton, $		10.10
	RAS Savings / Mix Ton, $		3.90
	RAP and RAS Savings / Mix Ton, $		14.00
	Net Savings / Mix Ton, $		12.10
	OPTIMIZE RAP AND RAS	RAP %	23
		RAS %	3

AASHTO Standard Practice

MP 15-06

* Use of Reclaimed Asphalt Shingle in HMA
  * Standard definitions for RAS
  * RAS to be processed
    * 100% passing 12.5-mm sieve
    * Allows blending of RAS with fine aggregate
      * Prevent agglomeration
  * Addresses deleterious materials

AASHTO Standard Practice

PP 53-06

* Design Considerations when Using Reclaimed Asphalt Shingles in New HMA
  * Design considerations
    * RAS size can affect the fraction of RAS binder that contribute to the final blended binder
    * fibers in RAS may require additional virgin asphalt binder

Previous Grind Specification


Finer Grind

RAS Asphalt Binder Availability

* AASHTO PP 53, Section 6
* Volumetric design w/o shingles
  * Virgin asphalt content
* Add Shingles to design
  * Asphalt content increases

5.8%

6.9%
5.45% virgin
1.55% RAS

Calculate Availability (Initial)

Virgin Asphalt no Shingles

Virgin Asphalt with Shingles

Initial Estimate Contribution

$$F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})}$$

Percent of Shingles

Asphalt Content of Shingles

Calculate Availability (Initial)

5.8%

5.45%

28%

$$F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})}$$

5.0%

30.6%

Final Estimate of Asphalt Binder Availability

* Section 6.2.6
  * True availability factor is always greater than the estimated value.
  * True value defined calcula n 2

28%

64%

$$F = 100\left(\frac{1 + F_c}{2}\right)$$

Final Estimate of Asphalt Binder Availability

* Section 6.2.6

WHAT'S WRONG?

* True value defined calcula[illegible] n 2

64%

$$F = 100\left(\frac{1 + F_c}{2}\right)$$

Experiment

* Design mixture with no shingles
* Add shingles (with full asphalt content)
  * Calculate VMA and air voids
* Add shingles (with half normal asphalt content)
  * Calculate VMA and air voids
* Add shingles (with no asphalt content)
  * Calculate VMA and air voids

Properties of Shingles in Study

Source	Maximum Specific Gravity, G_{mm}	Average Asphalt Content, %	Effective Specific Gravity of the Aggregate, G_{se}
Chicago MW	2.204	19.0	2.615
Indianapolis TOS	1.908	23.2	2.573
Stockton TOS	1.779	30.6	2.619

Design with Stockton Shingles

	Mix Design Material Blend			
	Virgin Blend	100% Extracted	50% Extracted RAS	0% Extracted RAS
% AC Virgin	5.8			
% RAS AC	0.0			
% AC, Total	5.8			
VMA, %	15.5			
Air Voids, %	4.0			

Add Asphalt for 4% Air Voids

Calculate Availability

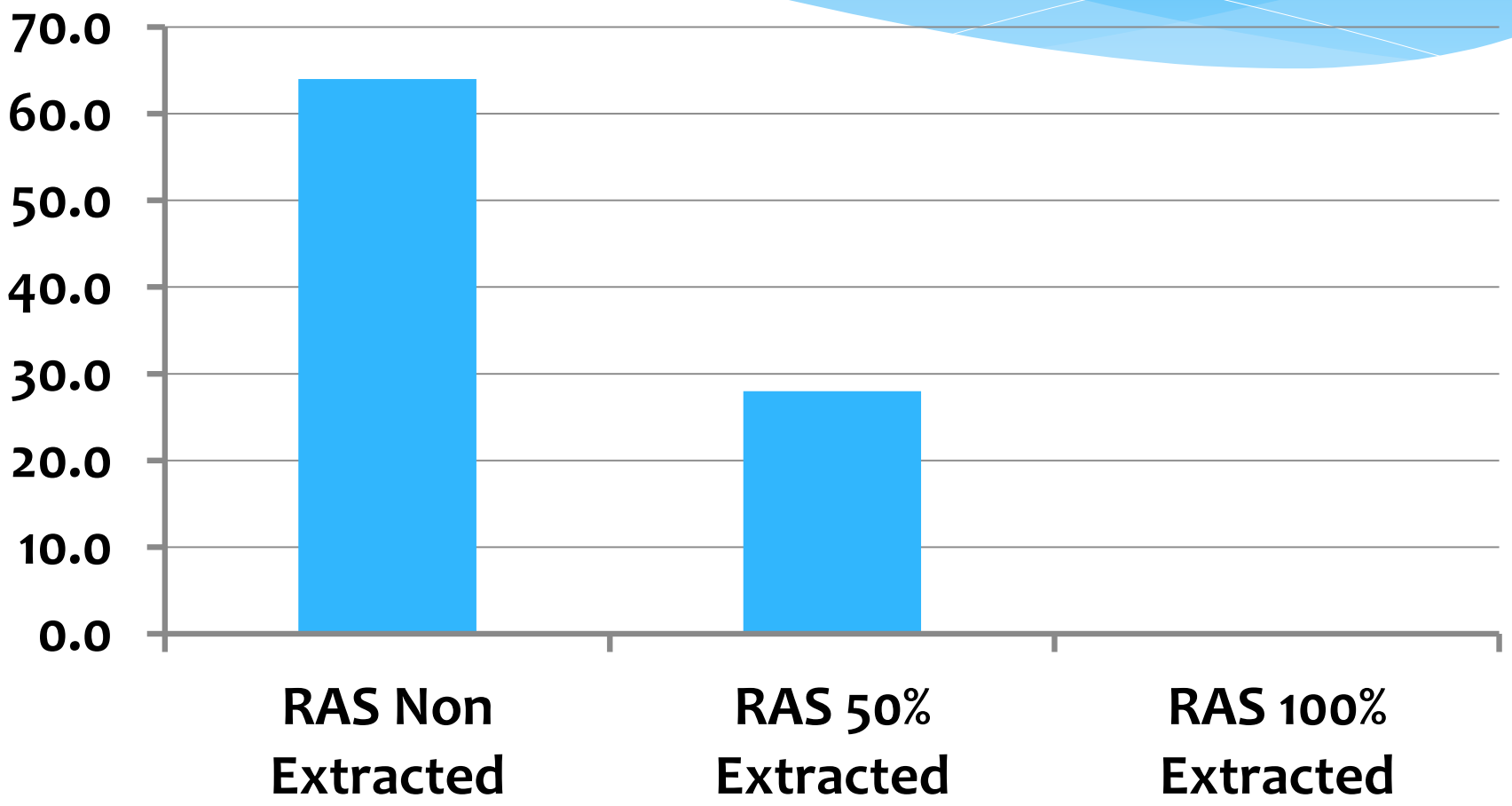
$$F_c = \frac{P_{bv} - P_{bvr}}{(P_{sr})(P_{br})}$$

* Initial

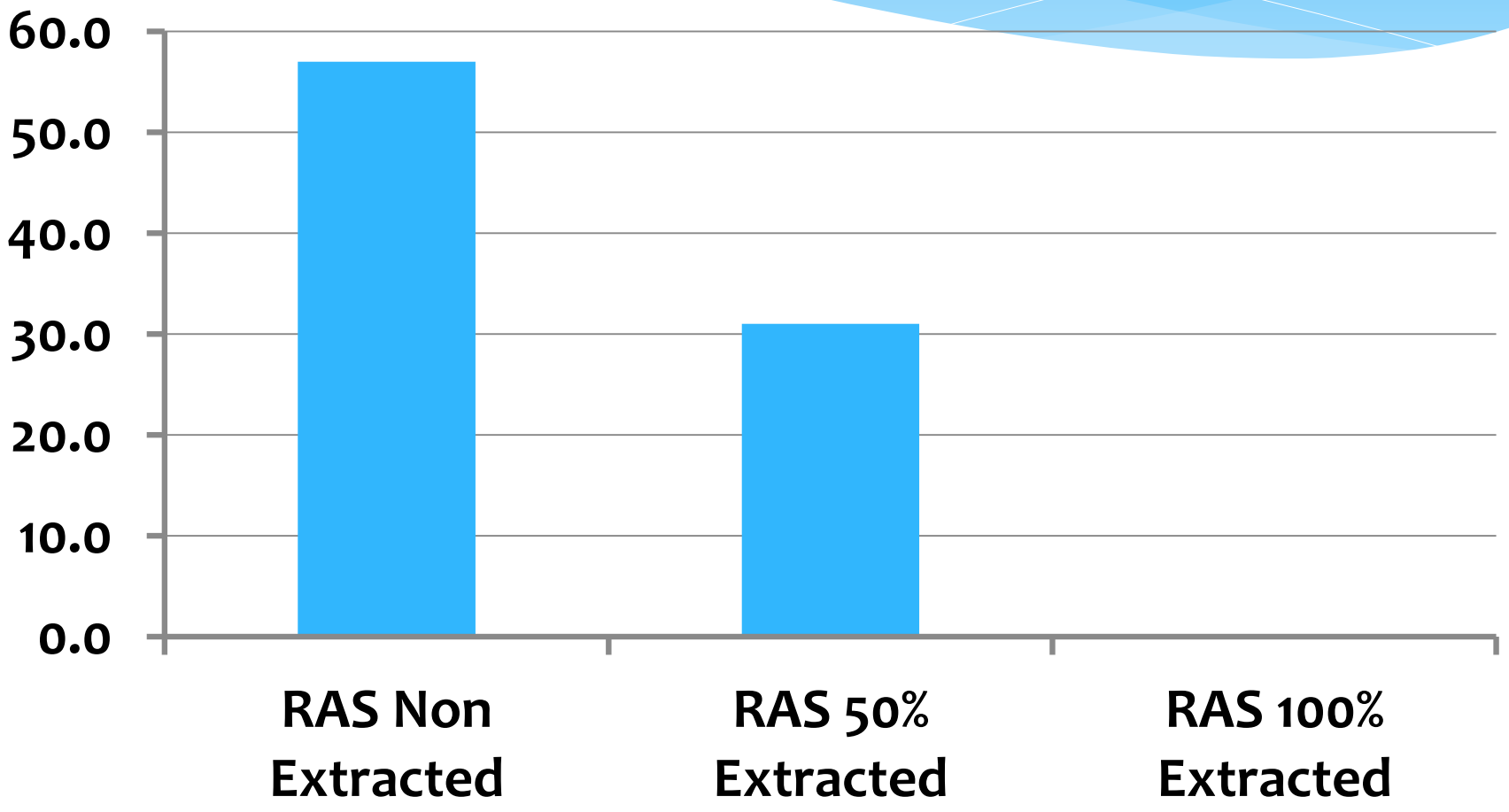
* Final

$$F = 100\left(\frac{1 + F_c}{2}\right)$$

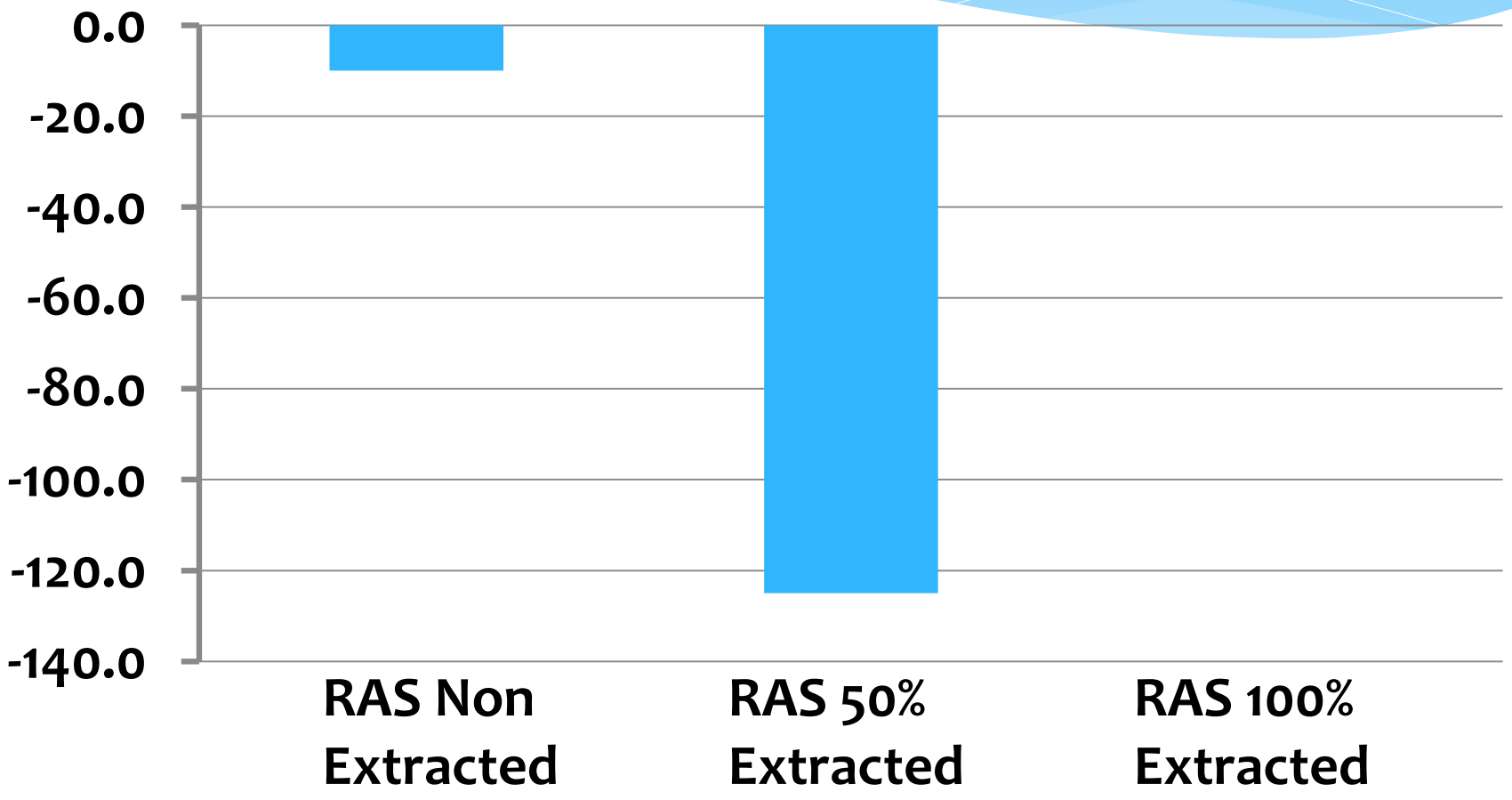
Stockton Asphalt Binder Availability, %



Indianapolis Asphalt Binder Availability, %



Chicago Asphalt Binder Availability, %



Finding

* “Asphalt Binder Availability” not related to asphalt binder properties
  * Dependent on mineral matter in shingles
  * Dependent on %AC in the RAS
  * Worst for manufacture waste

Next Steps

* Change PP53
  * Remove asphalt binder availability method
    * Replace with user defined value
  * Require finer grind

  * Balloted December 2013

NCHRP 9-55 Study

* Recycled Asphalt Shingles in Asphalt Mixtures with Warm Mix Technologies
  * Started June 2013
  * To be completed September 2016
* Evaluate characteristics of RAS
* Minimize risk of poor durability

NCHRP 9-55 Study

* Determine effect of shingle asphalt binder on asphalt mix performance properties
  * Fatigue
  * Low Temperature Cracking

Outcome??

* Set design guidelines for performance
  * Grade of new asphalt binder?
    * Maximum asphalt binder ratio?
  * Finer grind size?
    * Homogeneity of the blend

Summary

* RAS Use is Increasing
* Positive Greenhouse Gas Benefits
* Driven by Economics
* Current AASHTO Specifications Updated
* NCHRP Study to Address Design Method


RAP and RAS
Green As The Wind
Thanks