

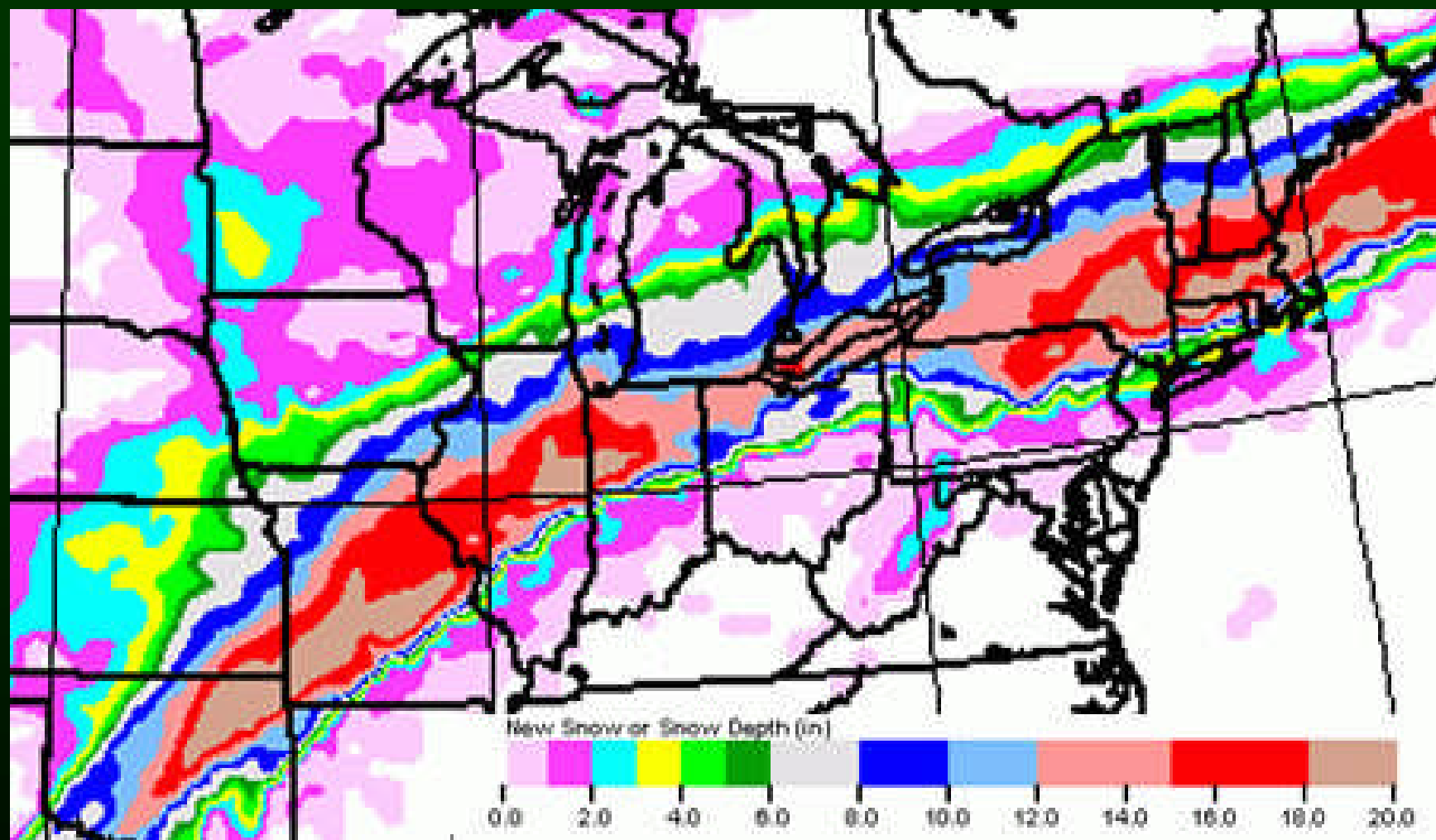
Recycling Initiative:

Moving Forward in Road Building, USA Style.

Several hundred million tons of Hot Mix Asphalt (HMA) are made in the USA each year. Agencies buy anywhere from 50 to 90 % / year!

Timothy R. Murphy, P.E.
President
Murphy Pavement Technology, Inc.





america (18) american (38) banks (12)
bring (7) budget (13) businesses (7) care (18) children (10)
college (10) confidence (7) congress (10) cost (15) country (12)
crisis (11) deficit (9) depend (8) dollars (8) don (10) economic (8)
economy (22) education (14) energy (14)
ensure (8) family (12) future (10) government (7) health (20)
help (12) invest (11) jobs (19) lending (8) meet (7) money (10)
nation (17) people (20) plan (21) power (7) problems (7)
recovery (12) reform (11) responsibility (12) school (13)
system (8) tax (11) times (8) tonight (11) ve (7) work (13) world (11)
years (15)

Transportation Research Board's Report 202



“Asphalt, more than any other single product, sustains the nation's highway system and facilitates the flow of commerce.”

Recycling is Global: ConExpo ASIA 2007 - AEM







How to Market Recycling of HMA Successfully

People Working Together to Form

Alliances in Action

Academia - Agency - Association - Consultant - Contractor - Supplier

Build a team to work through the details

Illinois Seminar Locations

- District One (Chicagoland) @ 8 locations
- District Two – Nine @ 8 locations



**Consulting firms call for
in-house sessions.**

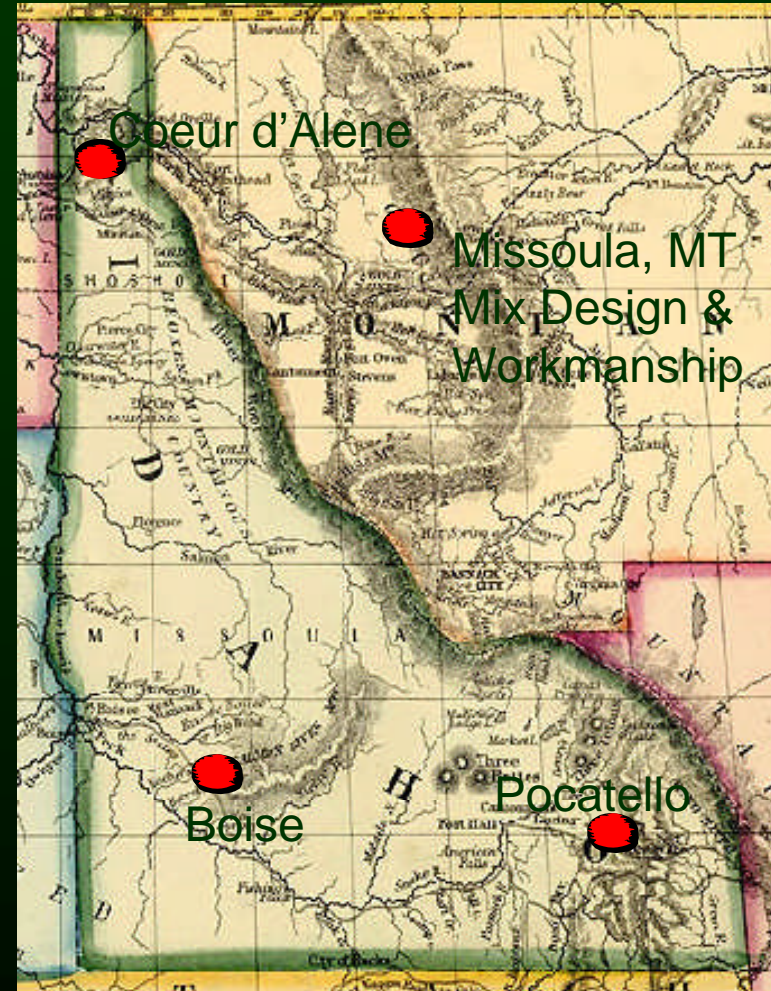
Hot Mix Asphalt Plant Tours

- Advanced
- Arrow Road
- Bigane
- Curran
- Gallagher
- Howell
- K-Five
- Peter Baker
- Plote
- Rockford Blacktop



Idaho Seminar Locations

- District One – Two
(Coeur d'Alene)
- District Three – Four
(Boise)
- District Five – Six
(Pocatello)



ITD calls this “outreach”



Quiet Pavement
SR 520 Near Bellevue, WA
14 July 2007



more sustainable roads for a better transportation future

Greenroads is a project-oriented system.

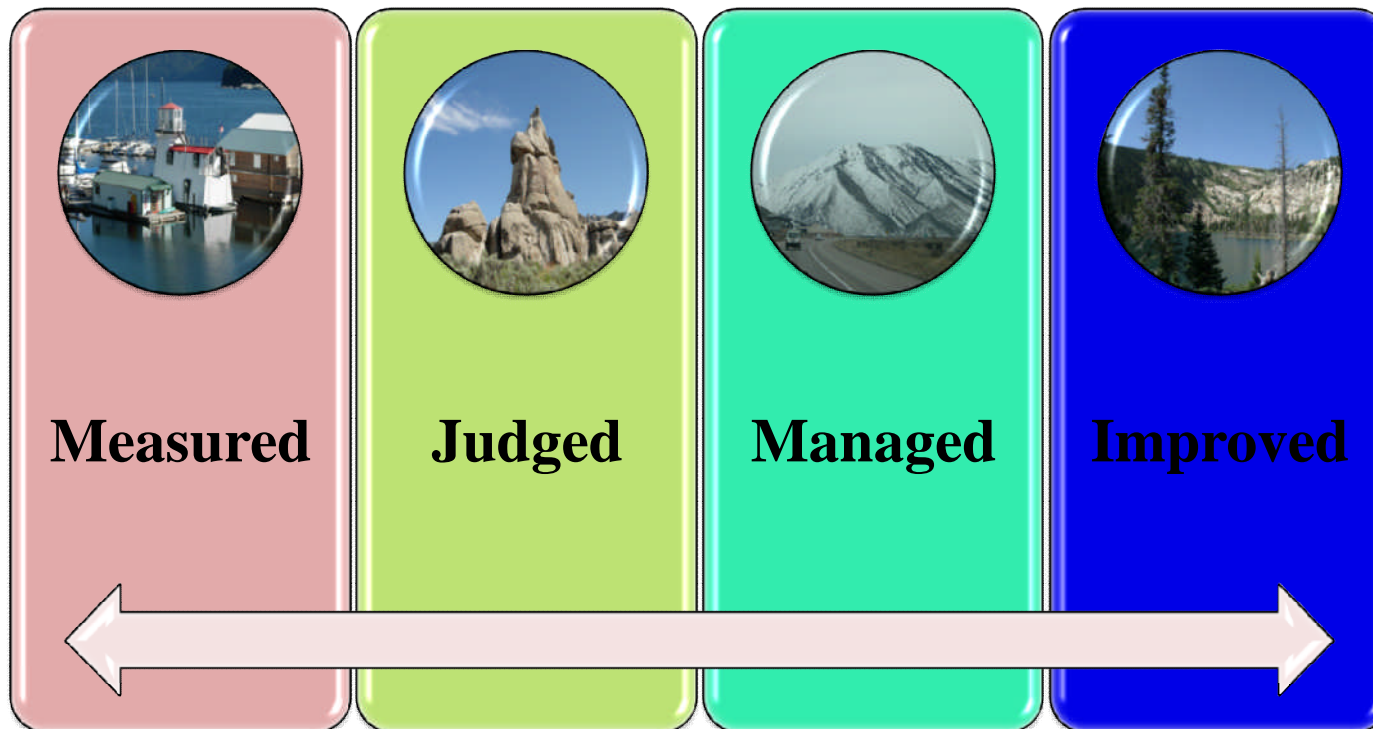
It does not deal with planning and it does not deal with operations.



1

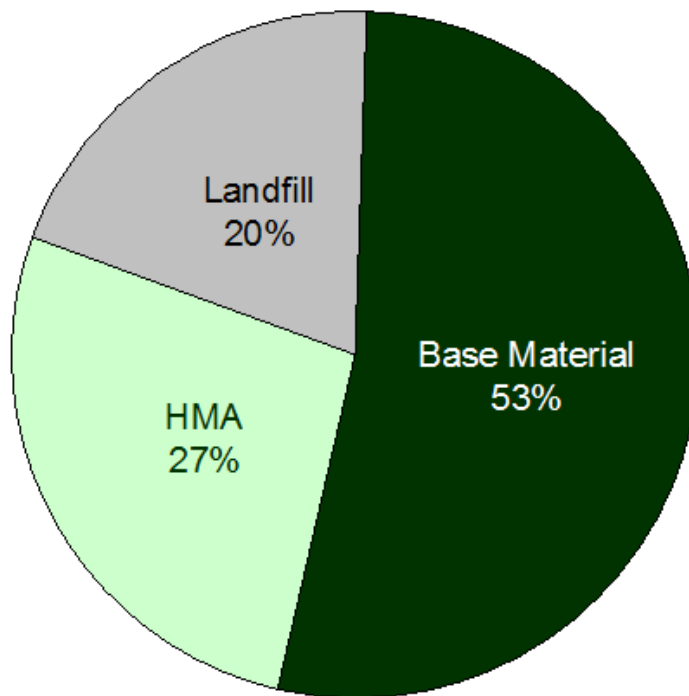
There are a lot of definitions for “sustainable” out there. Most are incomplete. This is what we think “sustainability” means.

Sustainability is a system characteristic which refers to the system’s capacity to support natural laws and human values.

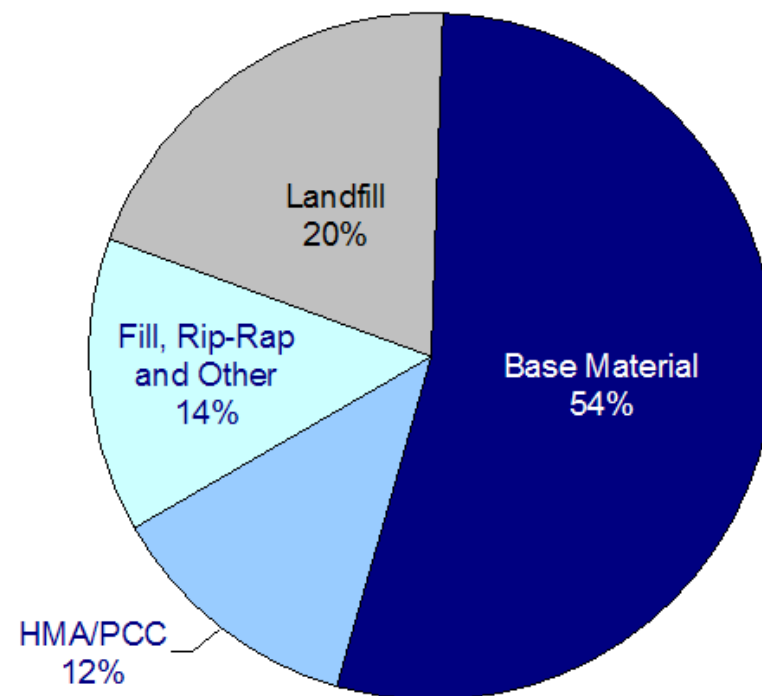


We can do better. We can reduce the amount to landfills, and increase the amount to high-value surfacings.

Destination of Recovered HMA



Destination of Recovered PCC



Data from the USGS

A Position to Stand For...

We must be
environmentally
promoting
environmental
services.



...ing the
marketplace by
ase, and use of
cts and

Murphy Position Statement

There is a growth in the use of RAP in the USA, be committed to increasing the use of RAP successfully through proper engineering and production controls.



Position Statement

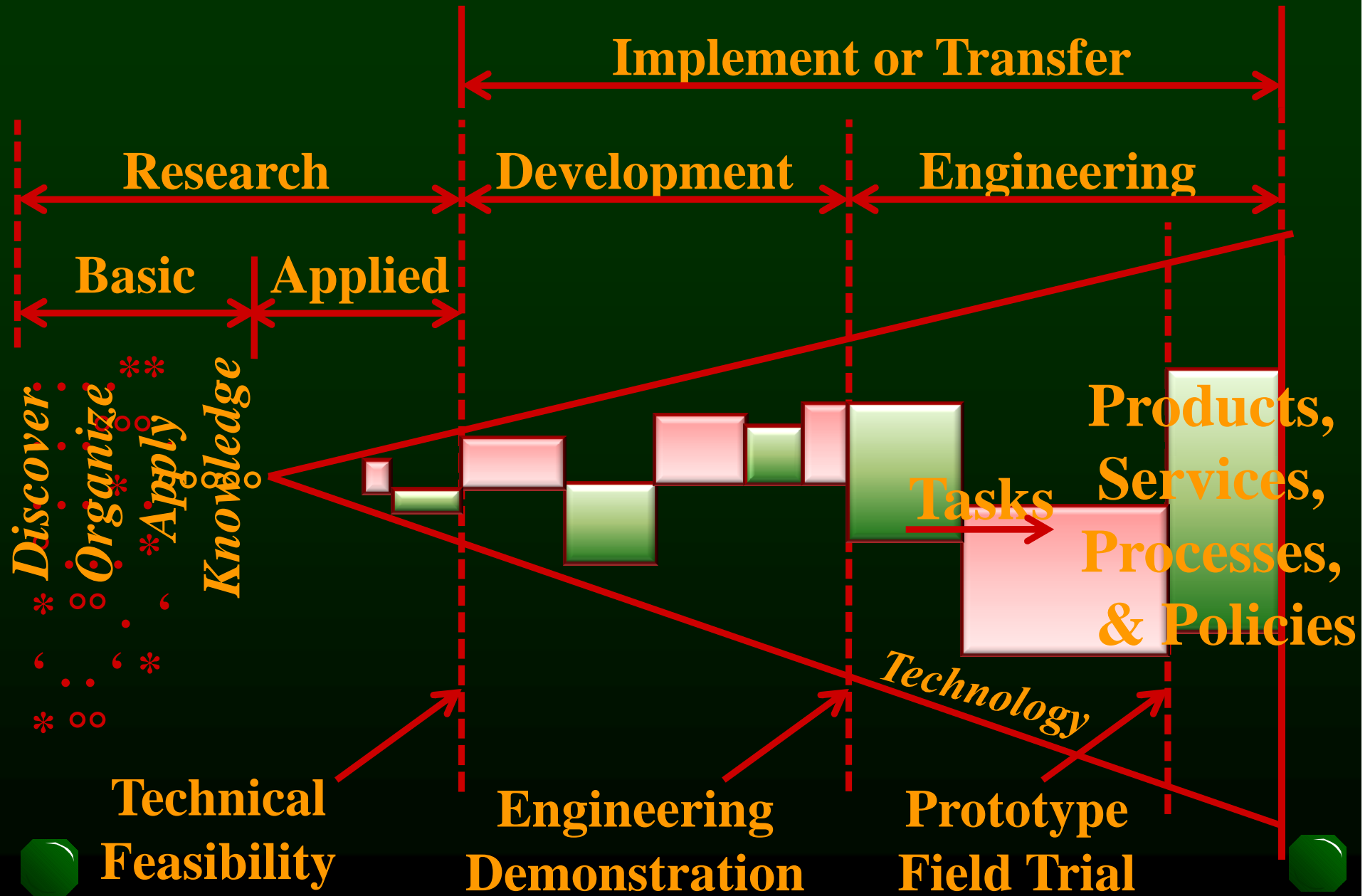
Volumetric, aggregate, and asphalt characteristics must meet or exceed the current specification requirements and these items will guide the future development and enhancements of your recycling specification.

Research Needs

- Performance test for evaluating RAP
- Best practices manual
- Solvent free method to characterize RAP
- Binder grade changes
- Field performance of high RAP mixes
- Replicating plant heating in lab

MODEL OF DEVELOPMENT OF TECHNOLOGY

- Oujian and Carne, 1987



High RAP Mixtures – Who's Involved?

- Effect on asphalt characteristics and material supply – Asphalt Institute and Liquid Suppliers,
- Coating all particles – increased temps. for drying, heating, and mixing – equipment manufacturers,
- Stripping – visual strip rating – DOT's Central Office,
- Loss of any performance measure that we deem to be valuable – Agency led Academia,
- Production – APA / AGC HMA Members.

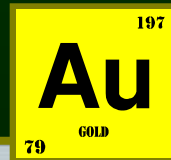
500-TPH

**There are 3,000 Hot Mix Asphalt plants
in operation today in the USA!**



What Jeff Foxworthy might say...

“If you have large RAP stockpiles... You know you’re an ~~redneck~~ urbanite.”



100,000+ tons of ^ at various locations



Photo Dan Gallagher

$S = I - O$



State Bituminous Engineer
The Captain of our Ship

Asphalt plant quality inputs

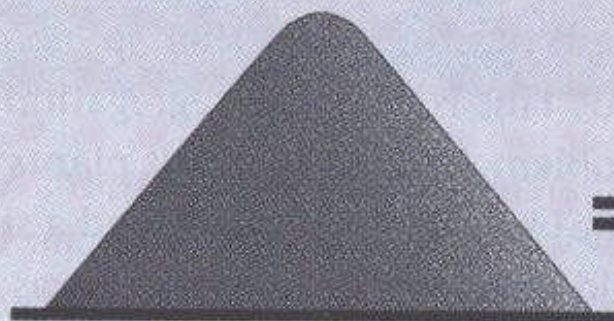
Virgin Aggregates

RAP



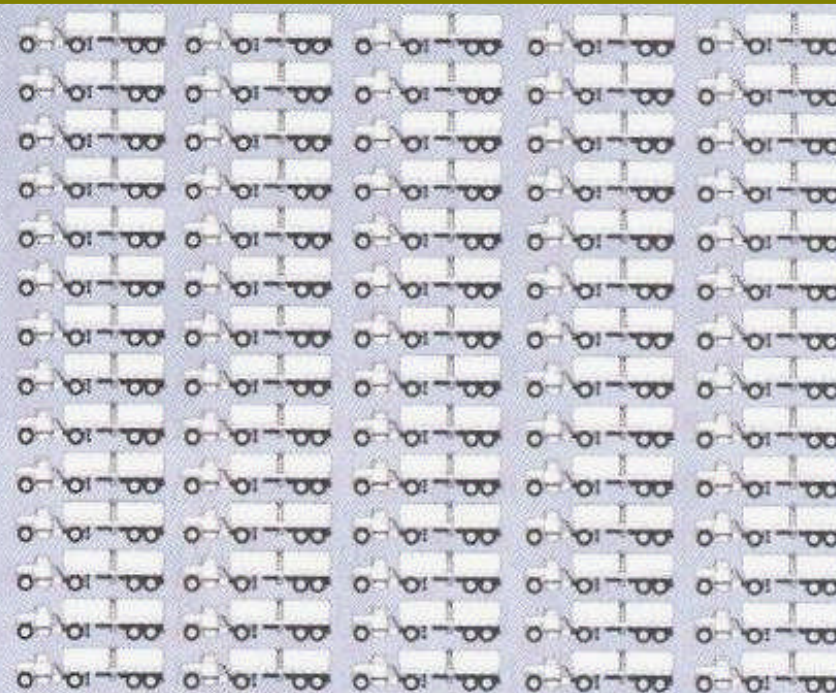
Slag

Look at the Volumes!!!



30,000 Tons of RAP

=



**70 - 6,000 Gallon Transport Trailers
and 28,200 Tons of Clean Aggregate**

from NAPA

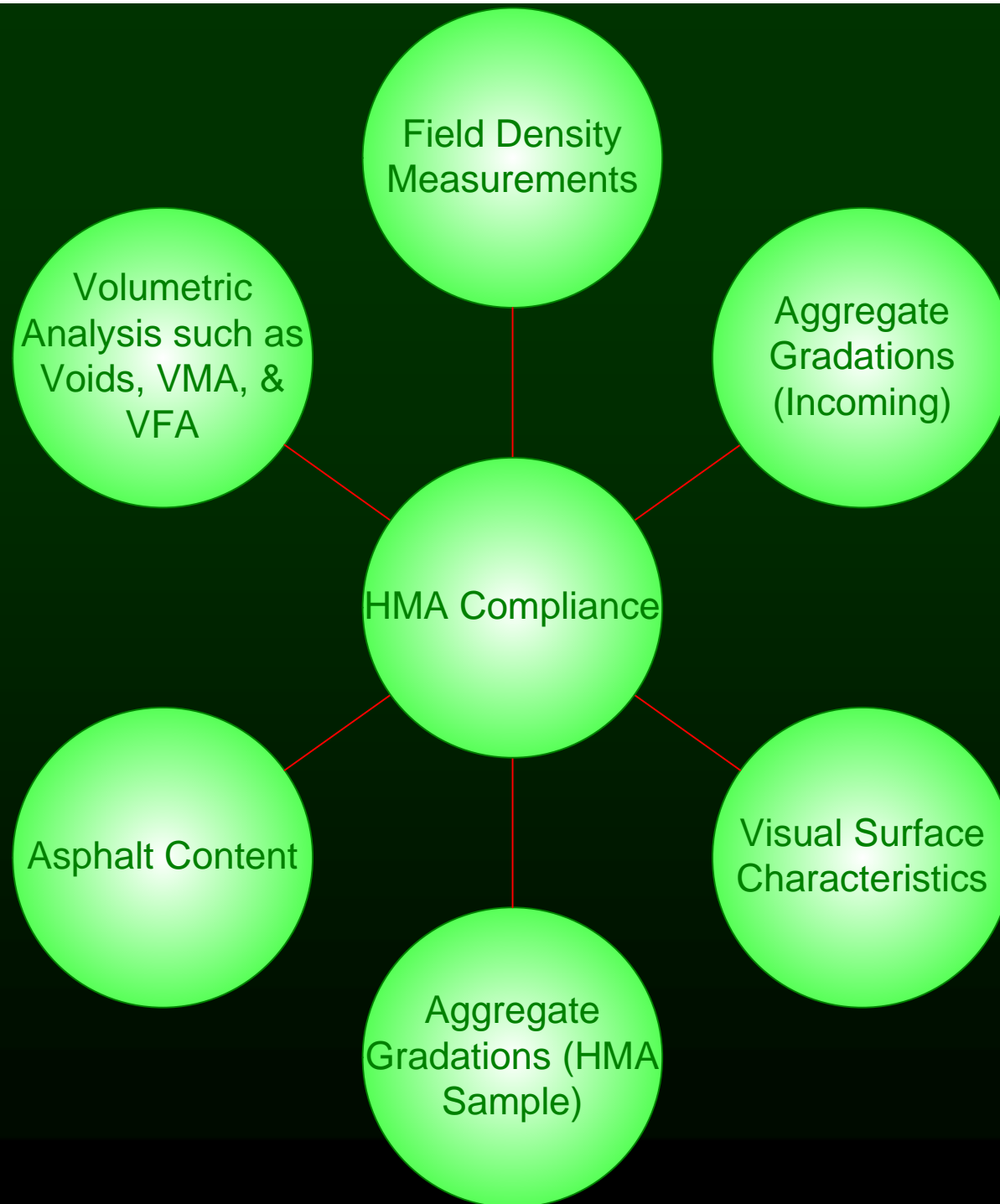


RAP is Worth the Virgin Material It Replaces

Recycling Usage = f (Quality, Quantity)

Quality = How good it is.

Quantity = How much we have.



We have been successful up to now;
how will we continue to be successful?

QC / QA

Research

Training

The Essentials to Our Success

1. Create and sustain a breakthrough value proposition.
[The Past]
2. Cultivate inner networks. [Today]
3. Customer centric. [The User]
4. Adaptability or finding a better way. [Research]
5. Opportunity focused. [The Specification]
6. Pack your board with industry experts. [The Doers]
7. Use blue-chip customers to gain credibility.
[The Future]

Cultivate Inner Networks [Today]

Recycling is increasingly important in the transportation sector. The Federal Highway Administration has a leadership team focused on promoting use of recycled materials, and a number of state transportation agencies have recycling coordinator positions **focused on new technologies, research, and getting the word out.**

Conferences

- Society of Professional Engineers
- American Public Works Association (APWA)
- Association of Asphalt Pavement Technologists (AAPT)
- National Asphalt Pavement Association (NAPA)
- Numerous State Agencies

Federal Highway Administration
Policy Memorandums -
Infrastructure Core Business Unit

FHWA Recycled Materials Policy
for the National Highway System

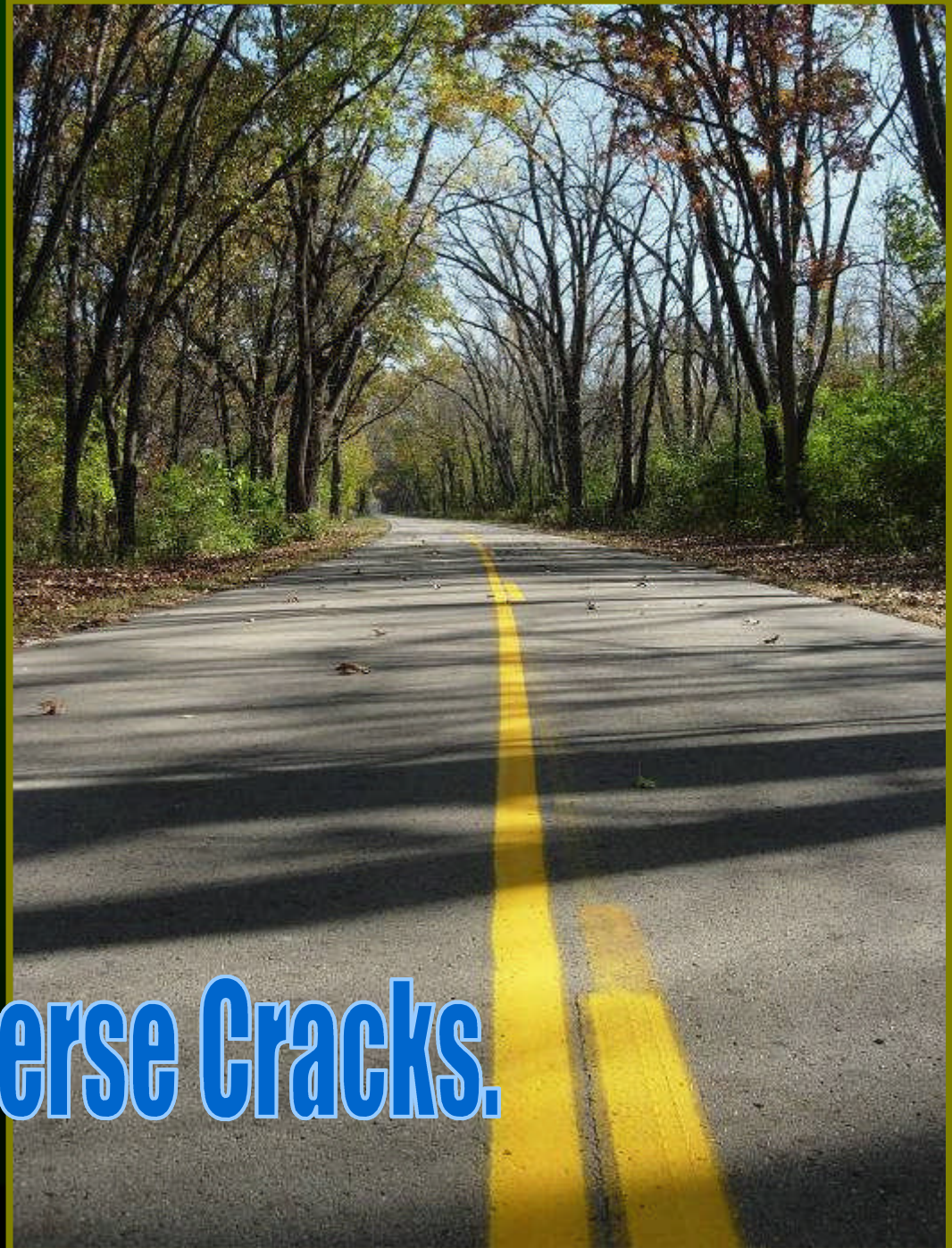
Evaluating Products and Posting Results

Nationally, the overall results indicate that the majority of recycled-content products are as good or better than their virgin material counterparts.

- [FHWA / DOT / DOD]

- Carper Road in Grundy Co., IL
- First 30% RAP surface and binder lifts of HMA placed in Illinois in 1998.

Zero Transverse Cracks.



10-Year Old Pavement w/ 30% RAP

‘... I was pleasantly surprised to find it in such good condition.

... we paved the road in 1998. It looks like it could have been paved last year.

... We have many township and County roads which have been paved more recently which are not performing nearly as well.

... it sure appears that this has been the ideal mix for such a road. Thanks for enlightening us on the use of this mix.’

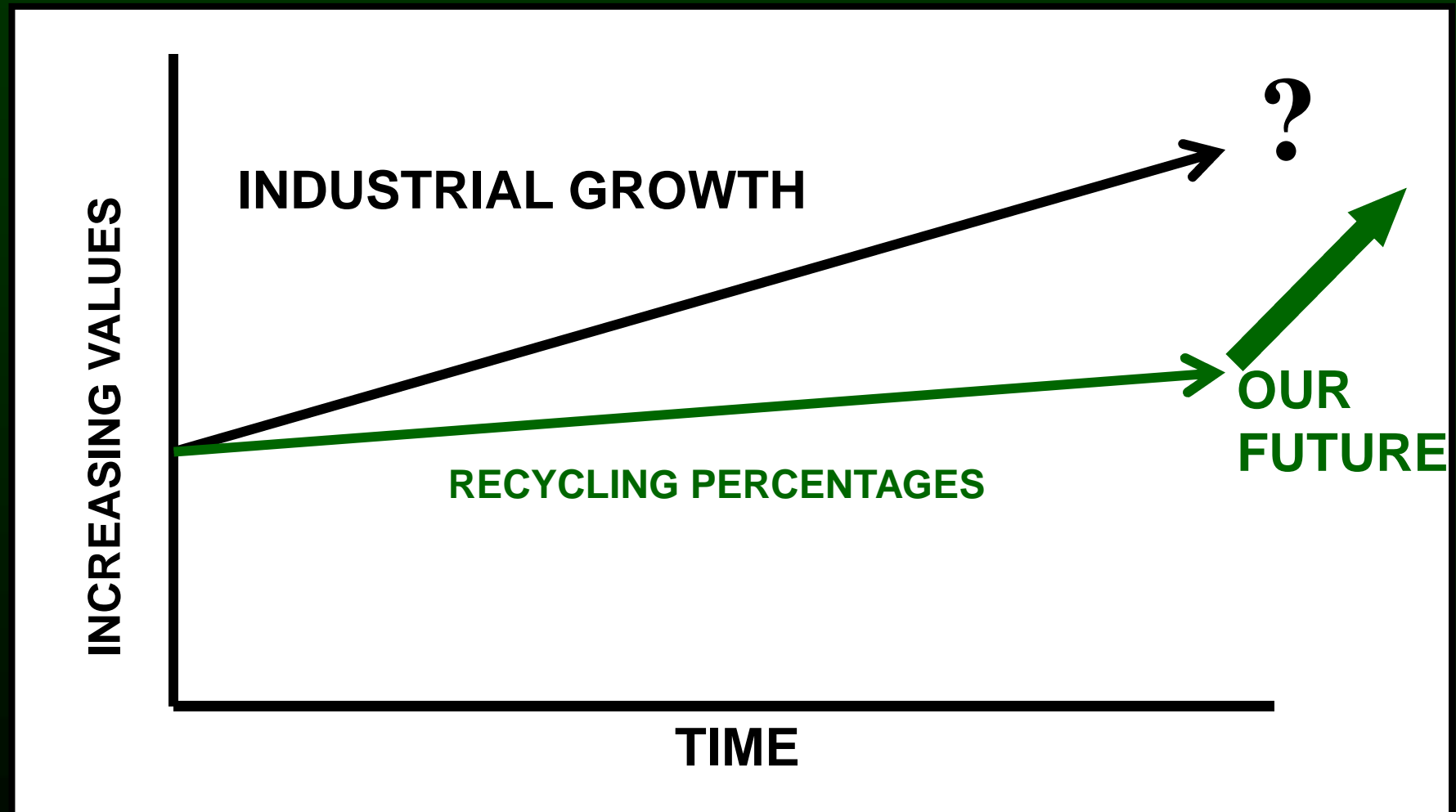
- Craig Cassem, County Engineer; Nov. 2007

The USA Contractor...

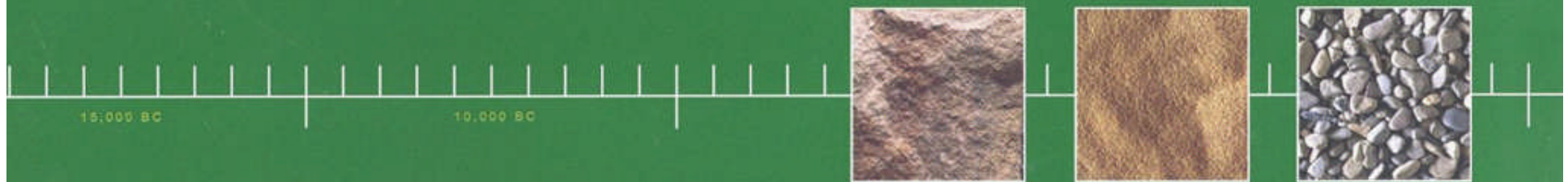
... is encouraged to provide reused or recycled materials to the maximum extent possible.

Recycled materials currently approved by the Department include glass, recycled asphalt pavement (RAP), recycled portland cement concrete aggregate (RCA), blast furnace slag, fly ash, microsilica, waste stream plastics, and tires.

Growth vs. Recycling over Time



We can applaud others efforts



50 Fascinating Facts about Stone, Sand & Gravel

FUNDAMENTAL RESOURCES FOR MORE THAN 5000 YEARS

401725 3000BC 1988
1420-4-5 235

Example

Extended Life Pavement Interstates around the nation (total reconstruction)

**Can 100% re-use of
old pavement occur?**

On-site Excavation



Trucking to recycling facility



Crushing & screening feed



Finished product

- Rework stockpile to mitigate segregation and improve consistency.
- Pay special attention to head pulley.



Steel recycling



We've come a long way with The Engineering of RAP



Potential Savings, 2011

Rock (\$10/ton)	New Asphalt (\$410/ton)	RAP w/5% AC (\$6/ton)	Mix
94% = \$9.40	6% = \$24.60		Cost = \$34.00
75% = \$7.50	5% = \$20.50	20% = \$1.20	Cost = \$29.20
Total Savings			\$2.40 @ 10% \$4.80 @ 20%

If placed cost /ton = \$50.00
this represents a 10% savings.

Governor, we need to talk...

What we know:

0% RAP costs approximately \$5.00/ton more than a 20% RAP mixture

50-miles @ 4" = \$1M
State of Michigan Dept. of Transportation, 4000 of HMA

Question: What can you pave?

25-miles @ 8" = \$1M

Asphalt density = $[112 \text{ lb./sq.yd./inch}] / [2,000 \text{ lb./ton}]$

Sq.yds. = $[5,280 \text{ ft./mile} \times 30 \text{ ft.}] = 17,600$

16.6 miles @ 12" = \$1M

Tons = $[17,600 \text{ sq.yds.} \times 4' \times \text{Asphalt density}] = 3,942$



Opportunity is from Agency knowledge on measuring performance with Academia and from Contractor knowledge of their operations.

OPPORTUNITY FOCUSED SPECIFICATION

New Maximum RAP in HMA

- Category 1 & tested Category 2; unlimited.
- Category 2; 10% top lift, 30% all other.

**Processed RAP,
crushed and screened over 5/8" screen**

Proper Signing is Required



Why Process RAP ?

- Uniformity
- Consistency
- **Quality**



**Out with the old,
In with the new...**

Raw feed, asphalt



Contractor owns and must manage the material.

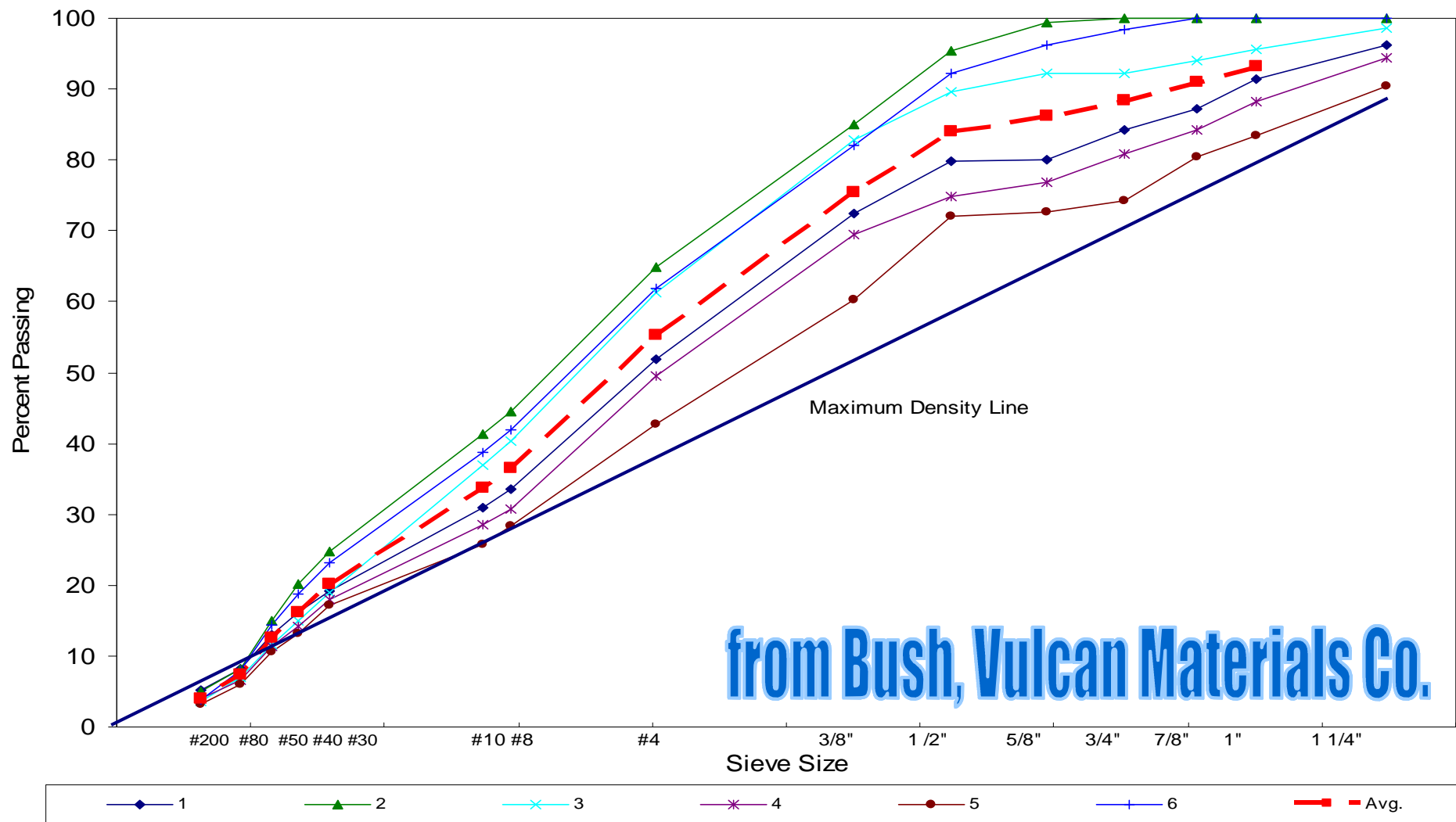
RAP Sampling



Virgin Aggregate Sampling

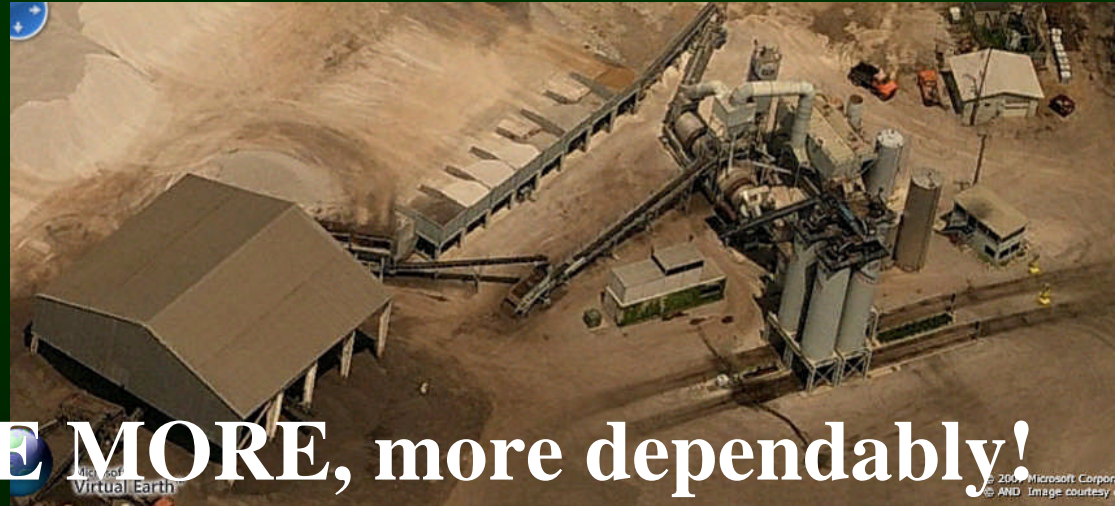


Unprocessed RAP can be Variable



Processed RAP

- Uniform
- Consistent
- **QUALITY**
- **And you can USE MORE, more dependably!**



**Out with the old,
In with the new...**

Input to Output

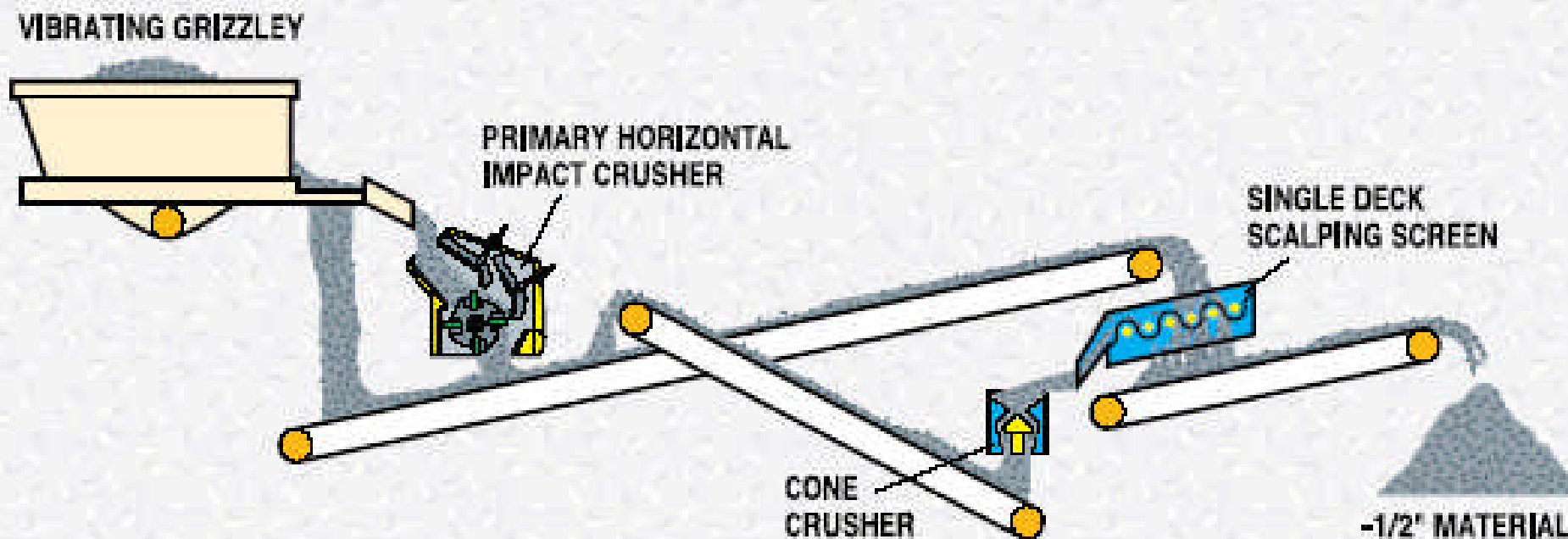
**Unprocessed
stockpile**



**Processed
stockpile**

Crushing and Screening

- Dr. Brock



Two-Stage RAP Crusher Circuit Producing One Product

Portable Crusher



Photo H. Bush, VMC

Contractor Equipment Solution, Asphalt



Fold 'n Go

Photo from Astec

Contractor Equipment Solution, Concrete and C&D



Fold 'n Go

Photo from Astec

High Frequency Screening

If possible, screen RAP first

- Don't crush if not required
- Generates less fines
- Exposes less aggregate for moisture

High Frequency Screenings with Crushing



Radial Stackers



Photo H. Bush, VMC

Black Gold



Crusher and stockpiles of RAP and Concrete



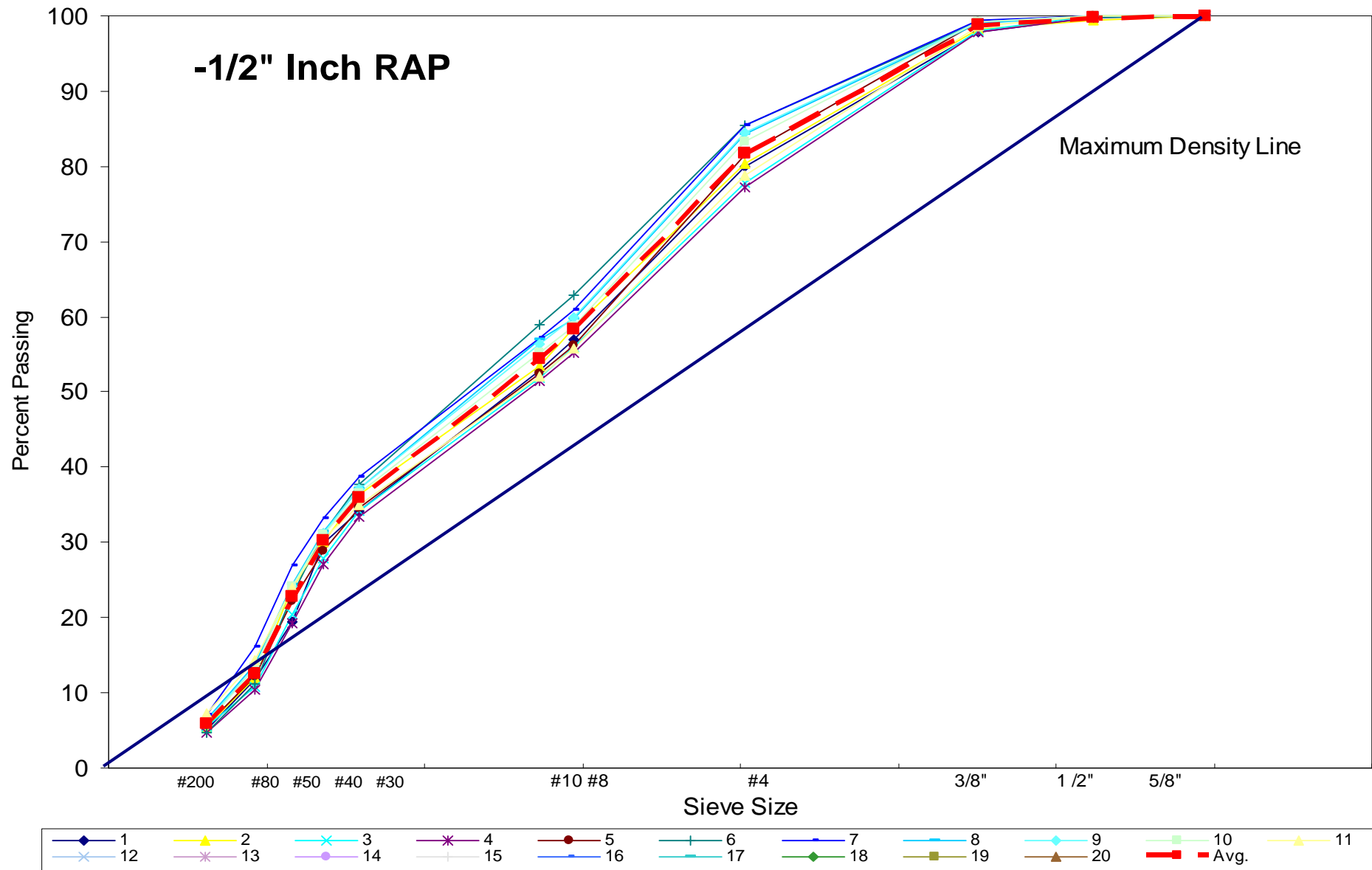
From raw feed to finished product

Raw Feed



Finished Product

-1/2" RAP Uniform & Consistent



In 1990's we saw fractionating RAP
as the future



Multiple RAP Feeders





Calibrate RAP Belt



In-Line Scalper Before Drum



At the beginning this is what occurred

- Assembled an interdisciplinary project team
- Characterized the waste
- Classified the waste components
- Identified constraints
- Identified funding sources
- Performed economic analysis
- Provided project planning
- Supplied contract administration
- Oversaw project operation.

We must continue...

Pack Your Board with Industry Experts [The Doers]



©Oliver Brunskill/Getty Images

The Doers Charge

- Retain quality & performance
- Strive for highest value use
- Create policies that have economic sustainability
- Protect the environment
- Identify short and long term issues
 - Specification changes
 - Research topics (Binder, Volumetric's, LCCA)

The US Approach

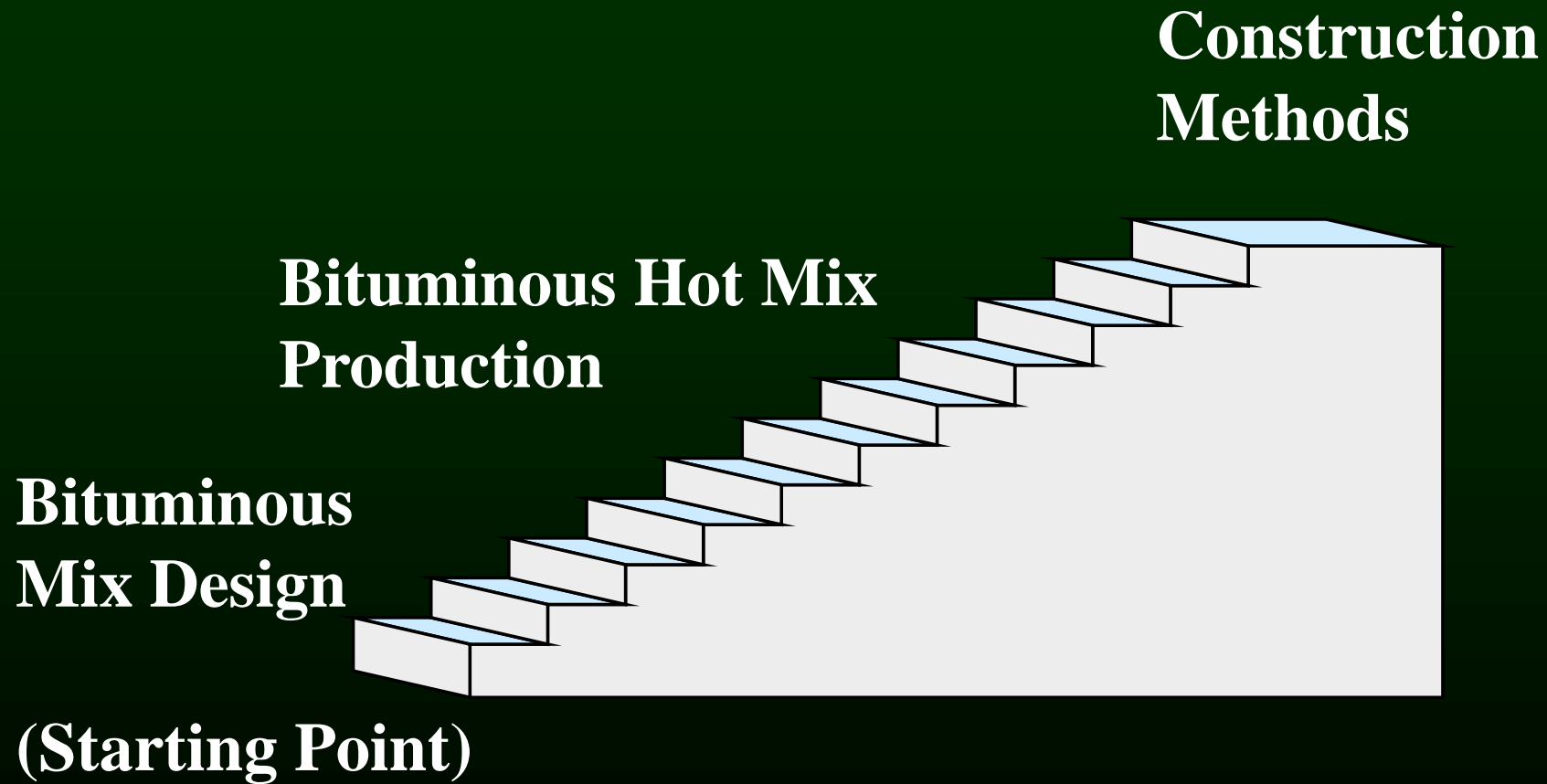
[Today, Tomorrow, and The Future]

Active promotion of recycling technology by providing:

1. Needed specifications,
2. Best practices,
3. Design guidance, and
4. Continuing research;

to overcome barriers.

Well Designed Asphalt Mixtures



Coarse Aggregate Quality

Nothing has changed!

Volumetrics 100

$$V_a = \left(\frac{G_{mm} - G_{mb}}{G_{mm}} \right) \times 100$$

$$VMA = 100 - \left(\frac{G_{mb} \times P_s}{G_{sb}} \right)$$

$$VFA = \left(\frac{VMA - V_a}{VMA} \right) \times 100$$

$$\text{Effective Volume of Asphalt} = VMA - V_a$$

When will we 'build onto' the program?

I believe this is just the beginning of increased recycling applications; we are trying to engineer in a changing environment.



When will we 'build onto' the program?

You can do it once you have your VMA house in order:

- Aggregate gravity
- Field VMA
- Dust / AC
- AC grading



7. CALCULATIONS

- A. Calculate the “adjusted P_b ” of the RAP to account for the addition of the 1 percent virgin asphalt binder as follows:

1. Calculate “mass of RAP Asphalt Cement (AC)”:

$$\text{Mass of RAP AC} = \text{Dry RAP mass} \times P_b$$

2. Calculate “mass of virgin AC added”:

$$\text{Mass of virgin AC added} = 0.01 \times \text{Dry RAP mass}$$

3. Determine “New RAP mass”:

$$\text{New RAP mass} = \text{Dry RAP mass} + \text{Mass of virgin AC added}$$

4. Calculate “Adjusted P_b ”:

$$\text{Adjusted } P_b = \frac{\text{Mass of RAP AC} + \text{Mass of virgin AC added}}{\text{New RAP Mass}} \times 100$$

- B. Calculate the effective specific gravity (G_{se}) of the RAP:

$$G_{se}(\text{RAP}) = \frac{(100 - \text{Adjusted } P_b)}{\left(\frac{100}{G_{mm}} - \frac{\text{Adjusted } P_b}{1.040} \right)}$$

- C. Calculate the stone bulk gravity (G_{sb}) of the RAP:

$$G_{sb}(\text{RAP}) = G_{se}(\text{RAP}) - 0.100$$

Liquid Binder

The method for determining the binder grade adjustment in HMA mixtures incorporating RAP is divided into three categories:

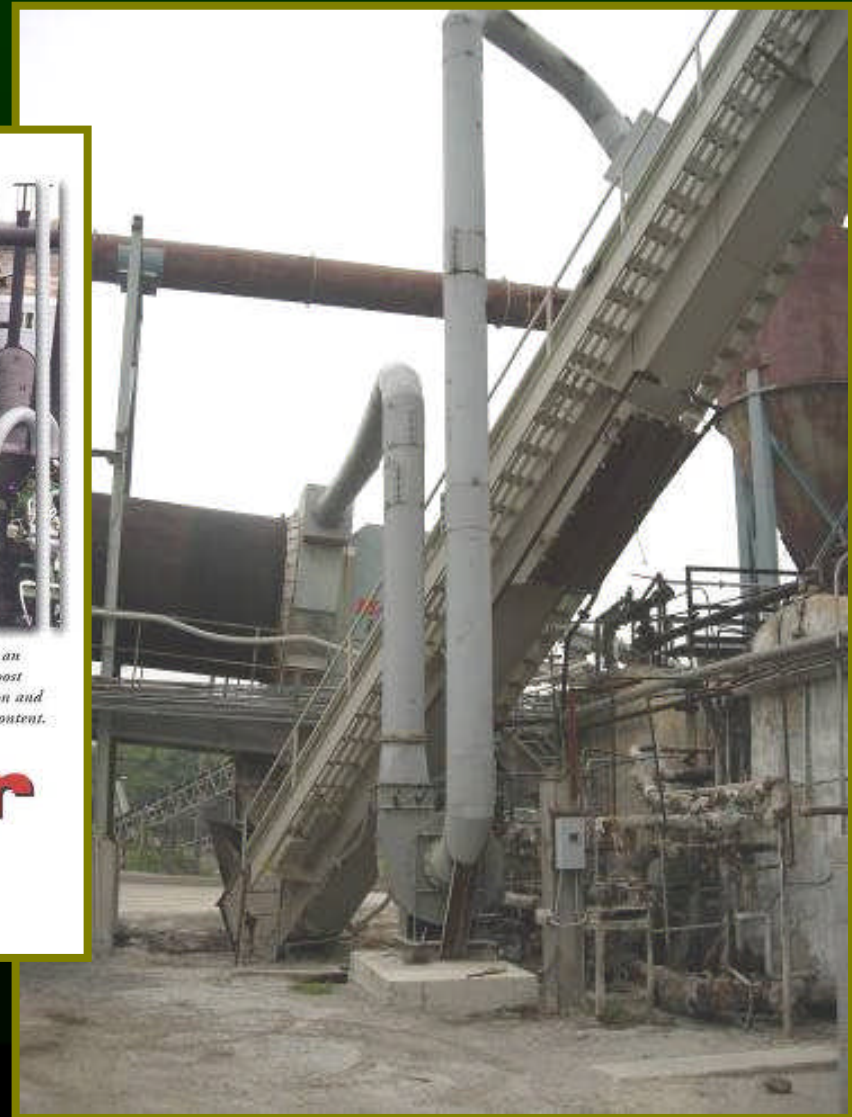
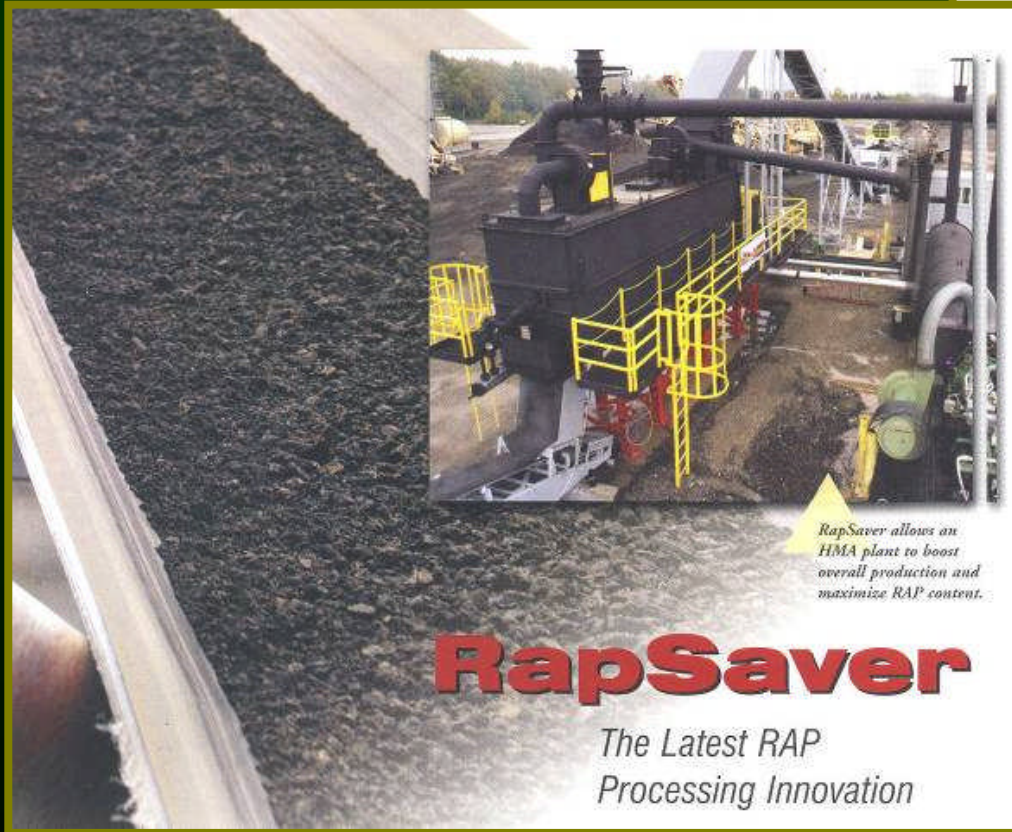
- Level 1; $< 17\%$ RAP AC / Total AC,
- Level 2; $> 17\% - 30\%$ RAP AC / Total AC, and
- Level 3; $> 30\%$ RAP AC / Total AC.

$$\text{RAP AC} = \% \text{ RAP} \times \% \text{ AC IN RAP}$$

Multiple AC Types Demands Liquid Maintenance



Needs assessment...



HMA Return and Blue Smoke Mitigation



Flighting

- Combustion,
- Dryer flights,
- RAP protection vale.



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Ingenuity

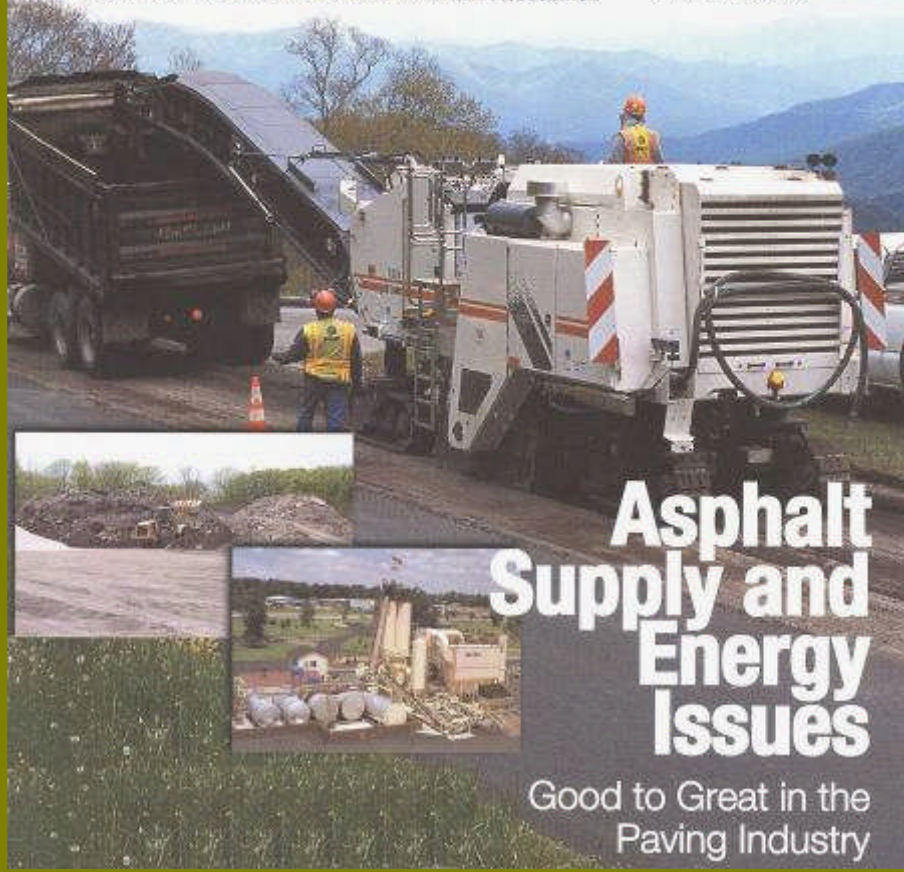
November/December 2006

HMAT

Hot Mix
Asphalt
Technology

PUBLISHED BY THE NATIONAL ASPHALT PAVEMENT ASSOCIATION

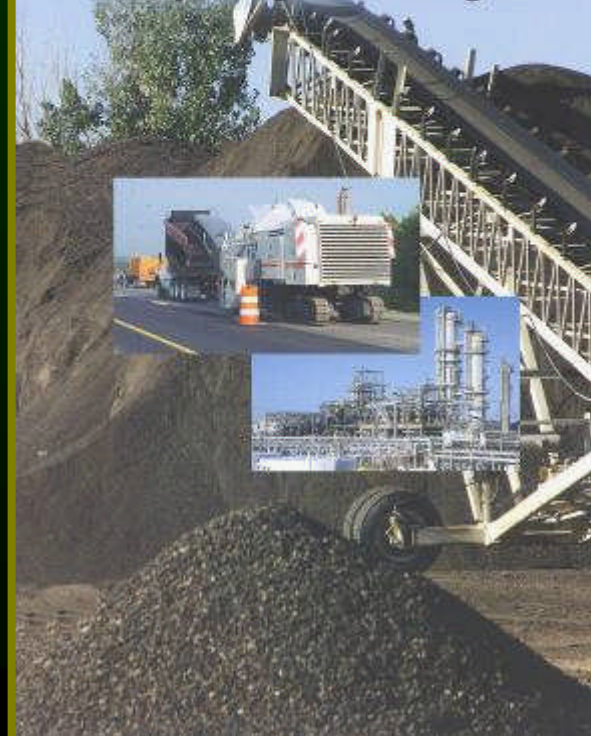
VOLUME 11, NUMBER 6



Special Report 192



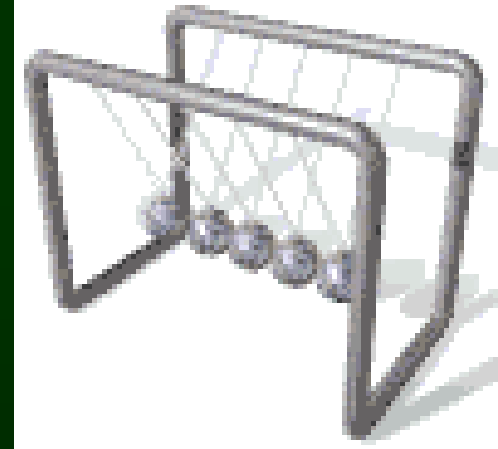
Asphalt Supply and Energy Preparing for Change



What will you *really* remember most about today?





Thoughts?



Thoughts on the future...

Shall we make a list together on how to increase RAP usage or do you want me to pontificate? Use:

- Make 1/4" clear stone to  VMA and  dust.
- Maintain VMA minimums.
- Encourage ingenuity; see DOT's and APA / AGC.



Hot Mix Asphalt is Smooth, Safe, and Long Lasting



N A H G K A O W I E S X Z E E I P T B N U D M H W
Z S L V R I Z L M A N D V C I X C K N O L U N T U
V G G O P K E H A R D H A T P I A L Z E R A P O G
S M Z L Q Y D T A M E L P K U O Y U N P M W E O W
V Y A V H P U G U H F D H P Z X L B H G G E V M G
R Y D O K A G I S T V A A O S E H Y F N E T V S O
C C E U W R L I D U I K S T H J U G M R V E S A C
T N E M E V A P L A U T E P R E P W U E S C S V P
N M F G M H O T M I X A S P H A L T T K R H E P X
N B A Y R E B U Z L V Q J N Y A X U C J M N C M V
E T I V L X R U H N P E W V I E L U E A Z O A U F
E W O Z O S D N A S T K Y F T T R T J U Z L F H A
K U T V H I Y L D S U R J E H T L V P W H O D D B
S C E M B T D S E V U R C N V Z J A X L P G E N J
A H A Q I G C S R L F A C D Q N B Q H J A Y R A D
N I T V M M G I X E F D Y S V K G S C P W N U S G
T W A N R G N V K R V R E E N I G N E M S E T B R
I R B O O V V O U U K A I K R E N K F Y A A C U U
G H C W W Z R S H E H F P K O Y D Q Q Z Z E A X Y
E K U S C O A R S E N M W S L H K T F K K Z R I Y
S K J B C V Q X Z M E G K Y L Y S A F W B W F K I
T V Y X Q N W J Z P I Y P B E N X F V S H J Q P X
F J U N V D U Q O G Y X T W R V K U D W W G V Z A
G S Z O I N O B H E B I L D S H U A Y N H Y F Z G
Q W E R L F Y Z X Y L M O V N N W V F I N E F V I

