

# RAP ISSUES AND OPTIONS: BEST PRACTICES

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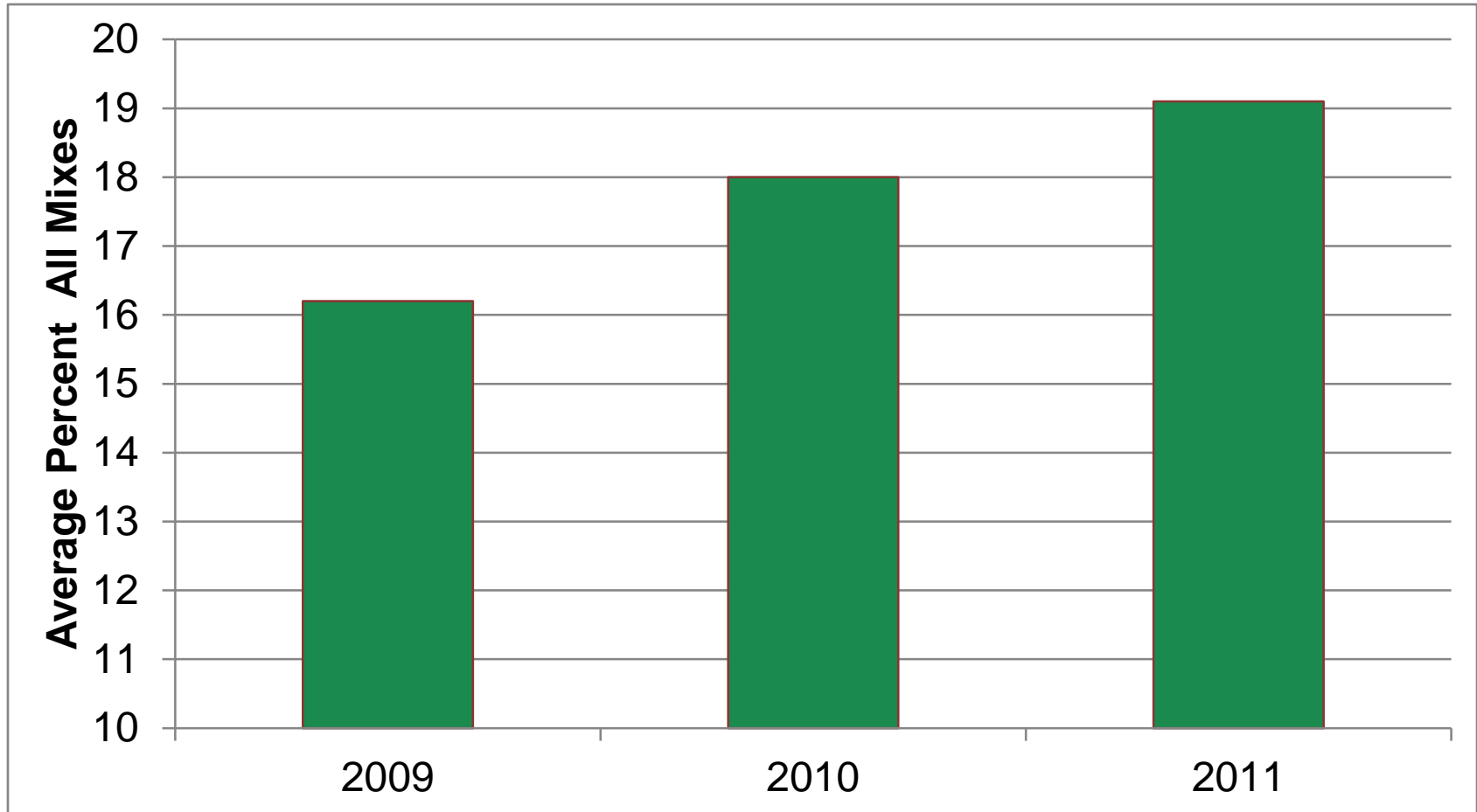
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# RAP ISSUES AND OPTIONS - OUTLINE

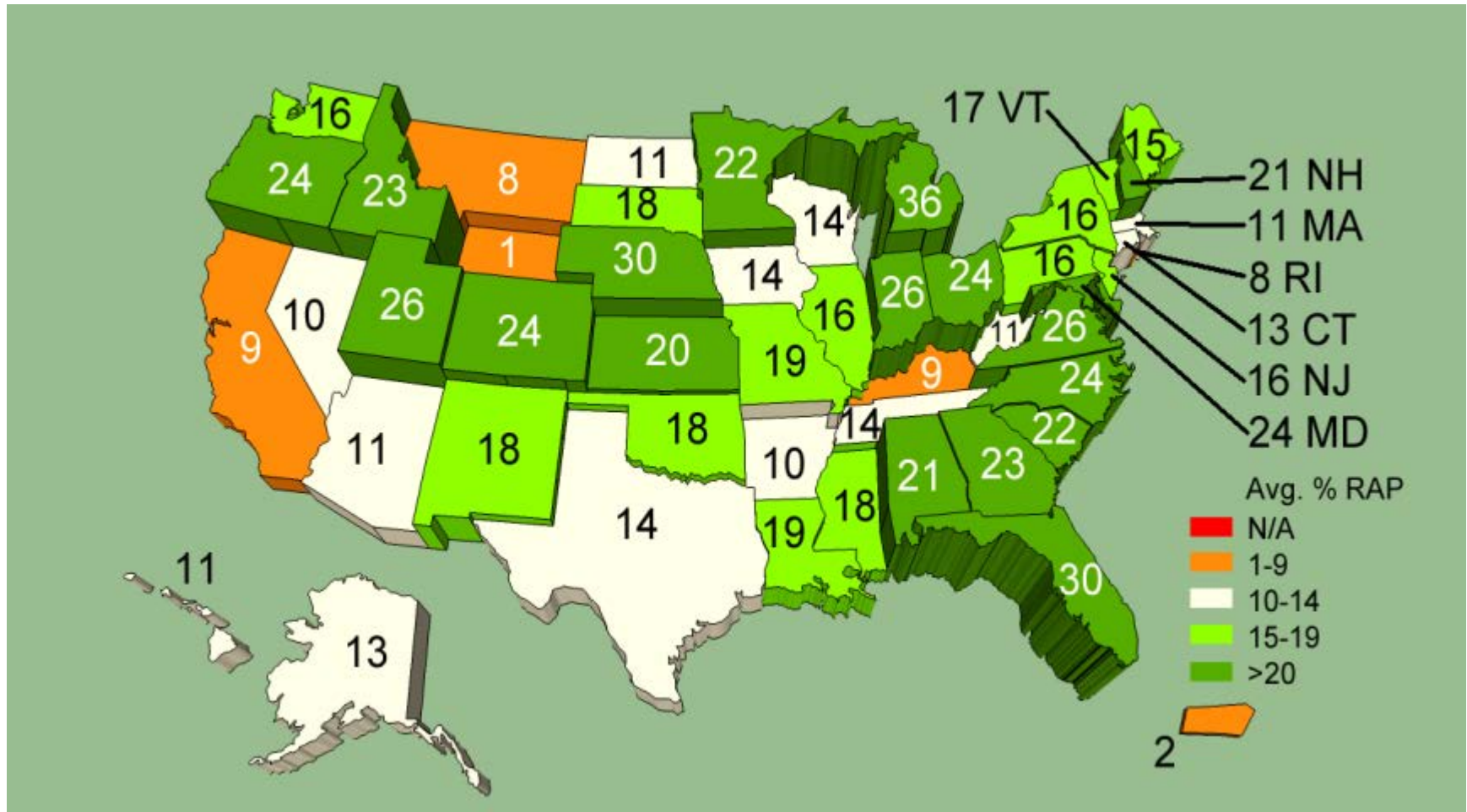
- **Variations in RAP Specs and Usage**
- **Barriers to RAP Use**
- **Lowering the Barriers**
- **Best Practices**

# HOW MUCH RAP IS IN AN AVERAGE MIX?



2012 NAPA/FHWA Survey – 2011 Usage

# 2011 AVERAGE RAP CONTENT BY STATE



2012 NAPA/FHWA Survey

# WHY AREN'T CONTRACTORS AND AGENCIES USING ALL THE RAP THEY CAN?

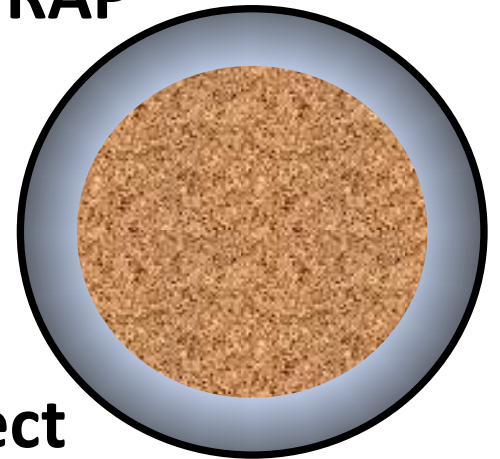
- **Guidelines require use of softer binder for high RAP contents.**
  - May not be readily available
  - May be more expensive
  - May be harder to compact
- **There are RAP surpluses in some areas and shortages in other areas.**
- **Lingering concerns about performance effects.**

# ONGOING ISSUES/CONCERNS

- **Is RAP a “black rock” or does it blend?**
  - When is binder grade change needed?
  - What effects do softer binders have?
  - Will RAP mixes crack more than virgin?
- **What about the RAP aggregates?**
  - What specific gravity should be used?
  - Friction of unknown aggregates? (See previous presentation on RAP Materials)
- **Is RAP more variable than virgin?**
  - How can I control production?

# BLENDING VS BLACK ROCK

- **There is evidence that, *in most cases*, RAP binder and virgin binder do blend**
  - Complete blending highly unlikely
- **RAP is not a black rock**
- **Low RAP contents → insignificant effect**
- **Higher RAP contents → RAP binder becomes significant**



# OPTIONS TO ADDRESS BLENDING

- **Know your materials**

- Assess materials regionally or statewide (virgin and RAP)
- Test stockpiles regularly

- **Test for blending**

- Compare virgin and recycled mixes
- Bonaquist approach



# Average RAP Binder Properties

	High Temperature	Low Temperature
Mean	90.2	-11.1
Std. Deviation	5.02	3.11
Minimum	83.0	-21.3
Maximum	104.0	-0.8

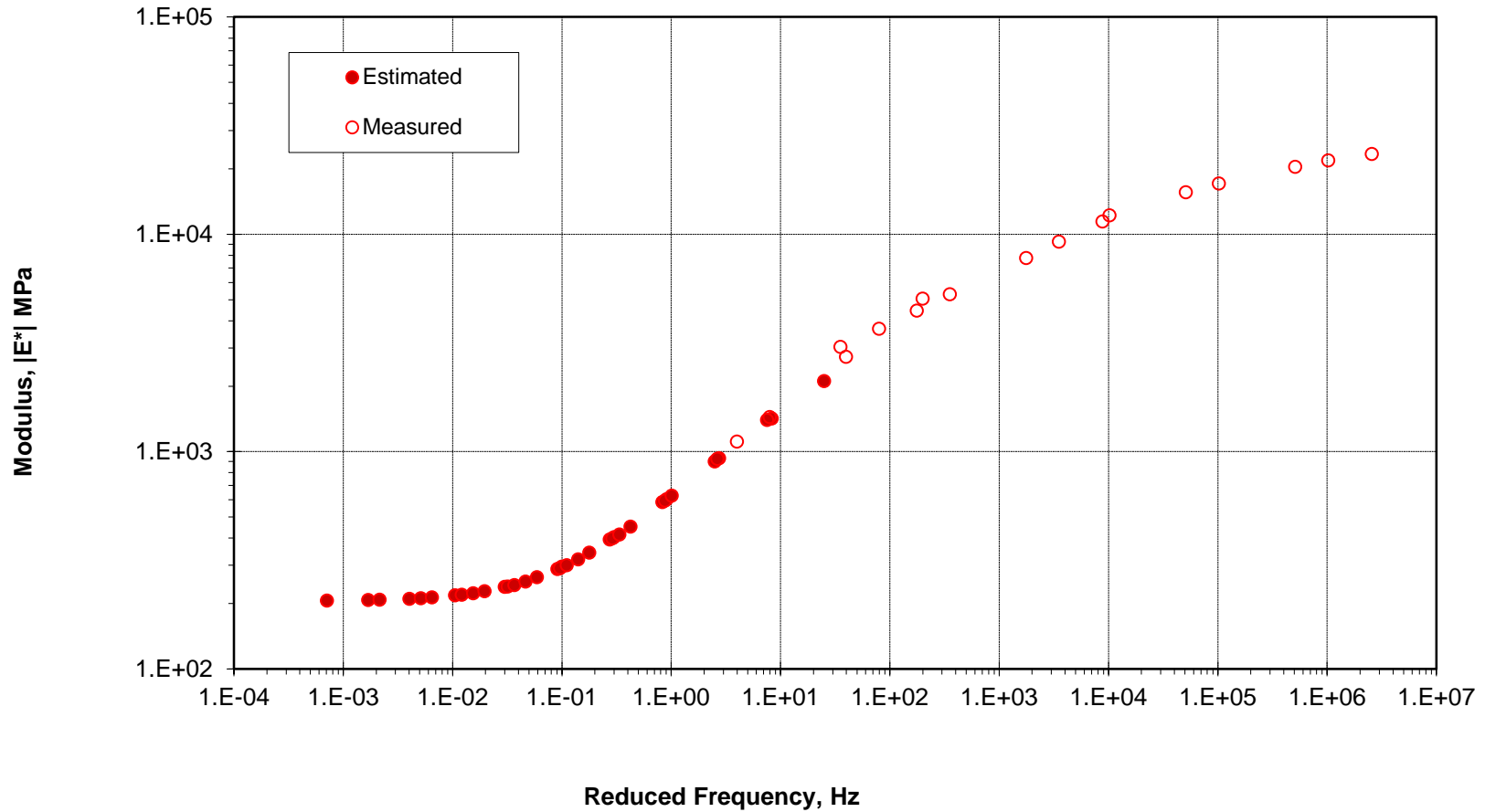
- PG 90-11
- No statistical difference found between different regions of Indiana
- 33 stockpiles tested



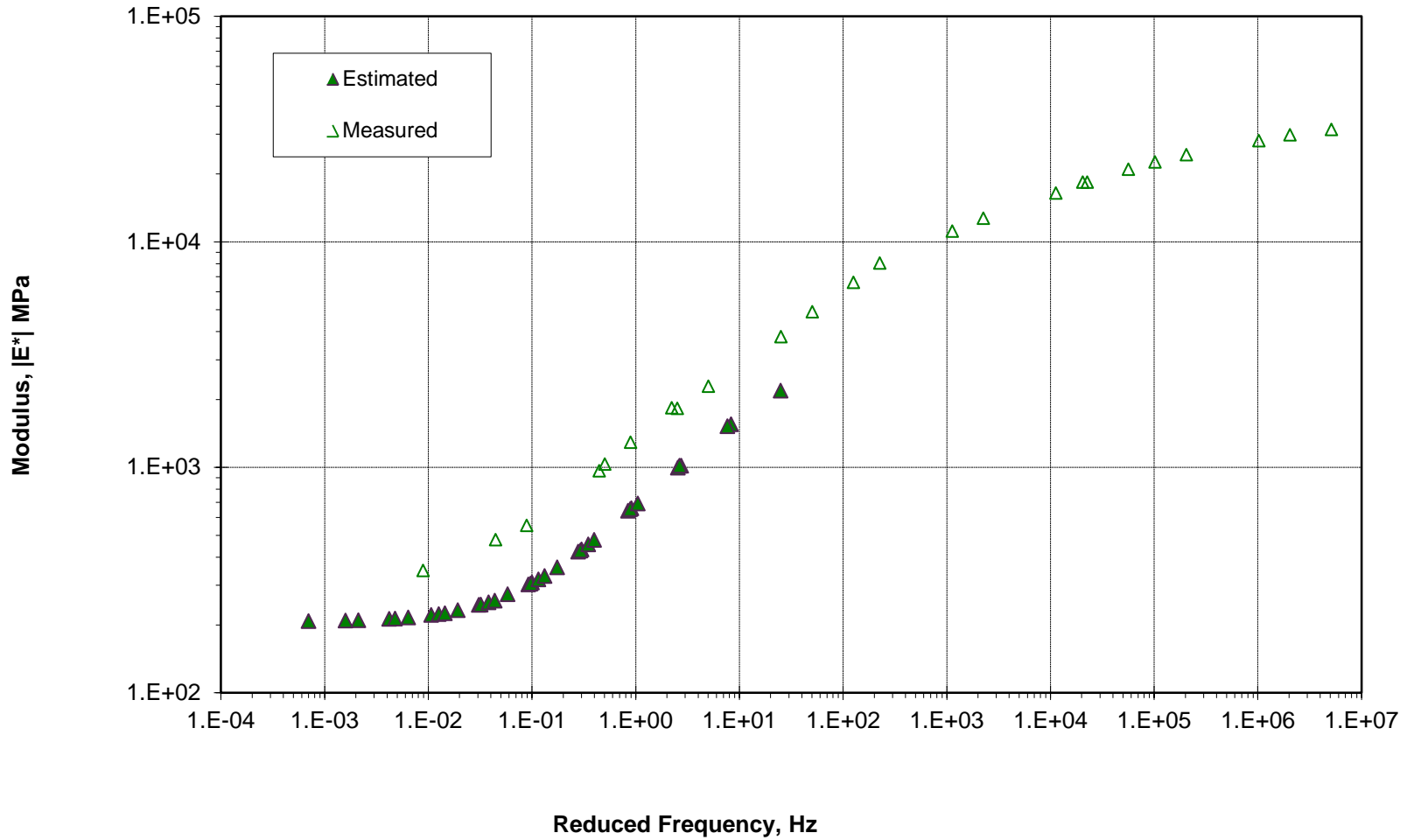
# BONAQUIST ANALYSIS

- **Compare measured mix modulus to estimated modulus**
  - Hirsch model using recovered binder (blended) and mix volumetrics
- **Suggests how the combination of binders is behaving in the mix**
  - Does the mix act as if the binders mixed or not?

# THOROUGH MIXING



# POOR MIXING



# BINDER GRADE CHANGE

- **Needed to counteract stiffness of RAP binder**
  - More critical as RAP content increases
  - Helps to reduce cracking issues (thermal and fatigue)
- **But softer binders may be less readily available, more difficult to work with.**
- **So, it is important to change the grade at appropriate RAP contents.**

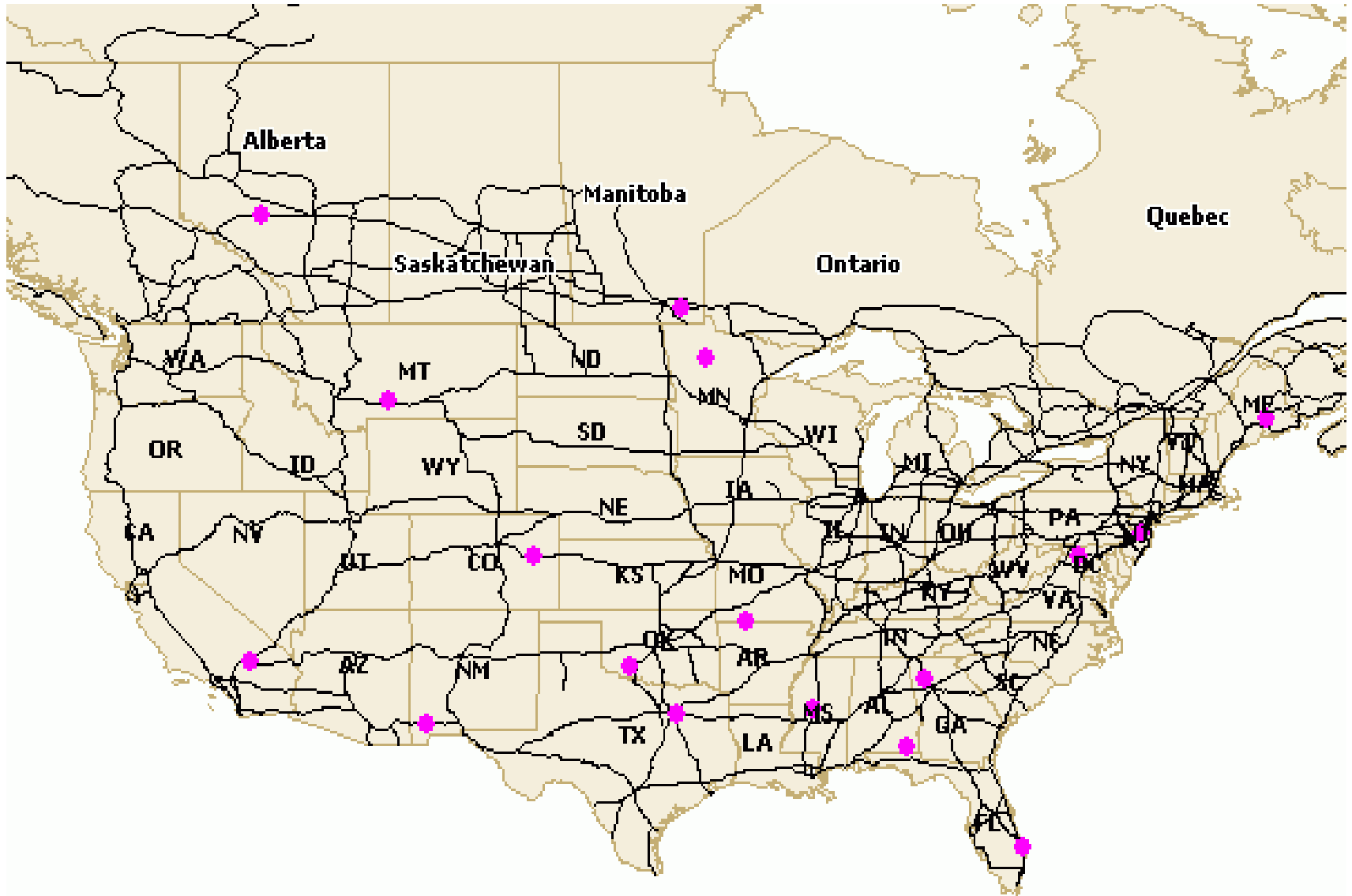
# BINDER GRADE CHANGE

- **AASHTO specifications call for grade change (one grade drop) at 15% RAP**
  - May be too conservative.
- **Again, need to know *your* materials**
  - From INDOT example, based on their testing and other research, they determined they could allow up to 25% RAP without a grade change and up to 40% with a one grade drop.
  - Not true for all states/areas

# DO RAP MIXES CRACK MORE?

- **They can, if RAP is not properly accounted for.**
- **Randy West, at NCAT, studied projects from 18 states/provinces in LTPP program**
  - At least 30% RAP
  - Compared to virgin mixes on same projects
  - Compared cracking, smoothness, rutting
  - Projects were 6 to 17 years in age
  - Compared 2 overlay thicknesses ( 2" and 5")

# SPS-5 PROJECT LOCATIONS





# PERFORMANCE OF RAP MIXES

- Pavements using  $\geq 30\%$  RAP performed equal to or better than virgin pavements in *most* cases
- Somewhat more transverse and fatigue cracking in some pavements with RAP compared to pavements with all virgin materials
- Differences in cracking for several locations may have been due to lower asphalt contents and/or higher dust contents (poor mix design)
- Some projects did not have binder grade change

**WITH APPROPRIATE MIX  
DESIGN AND MATERIAL  
SELECTION, THESE ISSUES  
CAN BE ADDRESSED.**



# AGGREGATE ISSUES

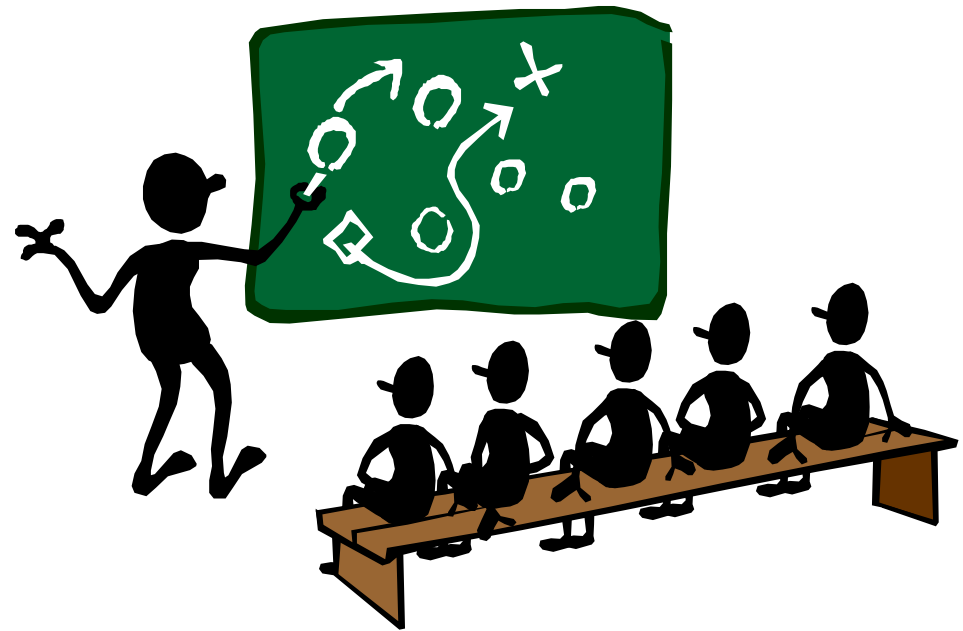
- **What is specific gravity of RAP aggregates?**
  - Some states use effective specific gravity (and adjust VMA requirement)
  - Others backcalculate RAP aggregate gravity using an assumed absorption value
    - Works if you have confidence in absorption
  - Others specify a value to use
  - Can test extracted aggregates if you know your agg properties do not change during ignition oven testing or extraction

# RAP VARIABILITY

- **Several studies show RAP is no more variable than virgin (if properly stockpiled and handled)**
- **Mixed stockpiles are more problematic – need more attention to detail**
- **Processing the RAP by crushing or fractionating can reduce variability**
- *Remember, you can mess up even with virgin materials – need to follow best practices!*

# BUILDING ON PAST SUCCESS: GAME PLAN FOR INCREASED USE

- Sourcing
- Processing
- Stockpiling
- Reducing moisture
- Control during production



# PROPER PROCESSING OF RAP BEGINS WITH REMOVAL



*When possible:*

Mill layers separately if  
aggs are a concern

- So you can reuse high  
quality aggregates in  
new surface mixes

Keep different projects  
(and layers) separate

# PROCESSING RAP

- **Mixed RAP can be variable**
  - Crushing/Screening to break up clumps
  - Processing can improve uniformity
  - Uniformity is essential to meet specifications



Before



The reprocessed products are very consistent components

After





FRACTIONATED  
RAP =  
CRUSHED AND  
SCREENED INTO  
DIFFERENT SIZES



- **Improves uniformity (remixes)**
- **Allows use of different sizes to meet mix design**
- **Better control of gradation (and binder content)**

# 100% Recycle Plant



# STOCKPILING PRACTICES

- **Avoid segregation**
- **Avoid contamination**
- **Reduce stockpile moisture**
- **Test the RAP stockpiles regularly – *know what is in your stockpiles!***

# SEGREGATION



- **Follow normal stockpiling techniques to minimize segregation**
  - Building the pile
  - Managing the pile
  - Pulling material

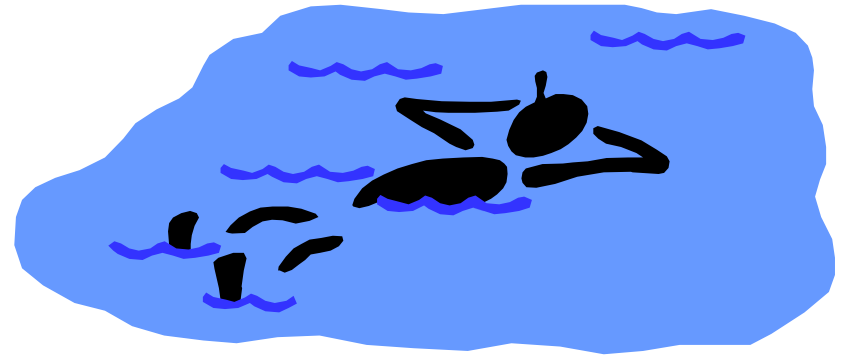
# CAUSES OF CONTAMINATION

- Stockpiles too close together can intermix – keep separated
- Putting wrong material in stockpile – label clearly
- “Dirty” stockpile – pave stockpile area
- Tracking mud into pile – install drainage to help keep area dry, keep mud off loader tires



**Contamination-  
Not Good**

# REDUCE STOCKPILE MOISTURE



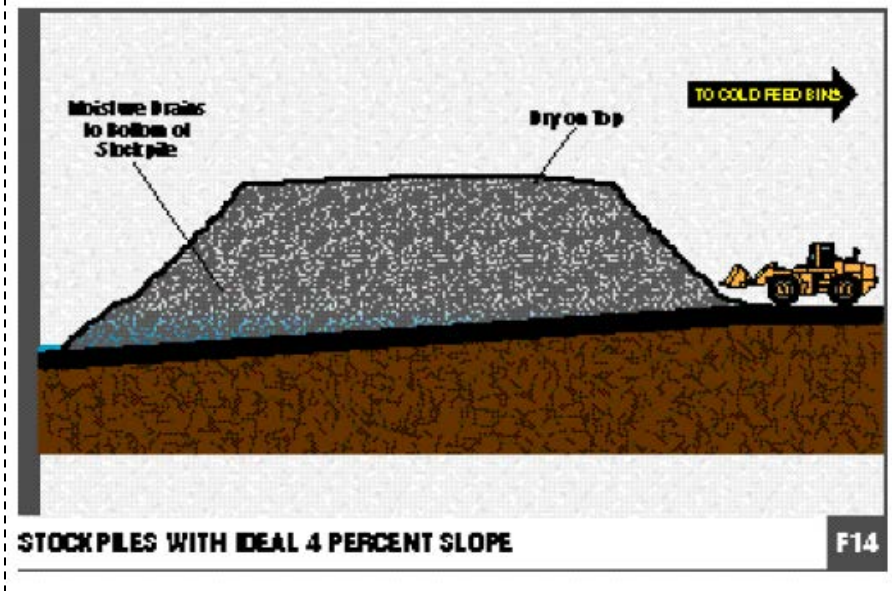
- Expect to lose 12% production capacity for every percent stockpile moisture above 2%
- Reduce fuel consumption and drying costs by keeping your materials dry
- Lower moisture leads to increased production capacity
- Lower maintenance costs
- Lower paving costs

# HOW TO REDUCE MOISTURE

- Paved stockpile area
- Sloped stockpile area
- Covered stockpiles



# BENEFITS OF SLOPED STOCKPILE



- Moisture drains to bottom of pile
- On slope, moisture drains away
- Slope grade 3 to 4°
- Pick off high side of pile
- Face slope towards sun to more drying
- Can reduce moisture 2% overall

# COVERED STOCKPILES

Still rare but useful,  
especially in high  
moisture areas



# Mix Plant Operations

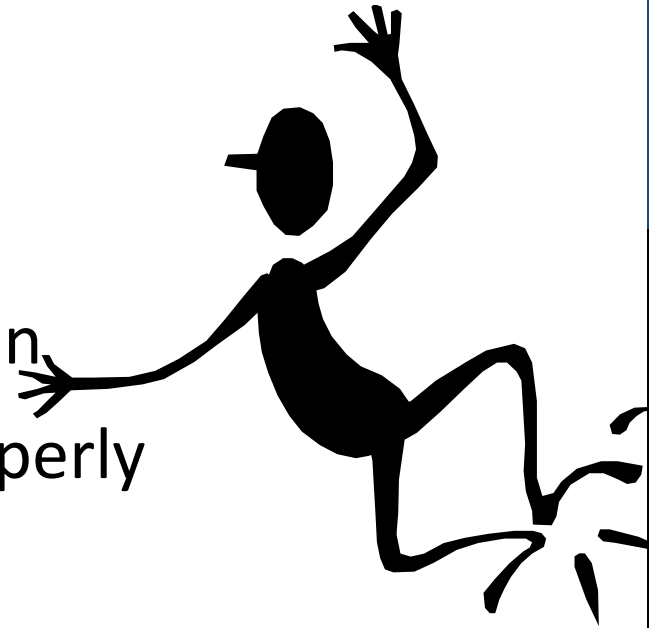


# PLANT CONTROL FOR RAP MIXES

- Control plant inputs (cold feeds)
- Control material variability
- Follow-up Quality Control test results
- Watch drum flighting – maintain protective RAP veil
- Avoid overheating mix
- Normal production care and attention

# BEST PRACTICES

- Mill layers separately when you can
- Process the RAP and stockpile properly
- Consider fractionating the RAP
- Avoid contamination
- Keep the RAP dry –paved and sloped area, covered stockpile
- Test the RAP stockpiles regularly
- Watch plant production



# CONCLUSIONS

*RAP has long history of successful use.*

*But, there are issues and concerns that need to be addressed – can be controlled*

*Asphalt recycling is sustainable.*

*Asphalt recycling is economical.*

*Asphalt recycling works!*



# SORRY I CAN'T BE THERE!



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