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TRB Webinar: Sustainable and Low-Carbon Solutions for Asphalt Pavements

December 4, 2023

1:00 – 2:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

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Purpose Statement

This webinar will provide an overview of the state of the practice with CIR and CCPR of asphalt mixtures. Presenters will discuss the new draft report of American Association of State Highway and Transportation Officials' (AASHTO) Construction Guide Specifications for CIR and CCPR asphalt mixtures. Presenters will also share the best practices guide and training materials that will be published as a part of this report.

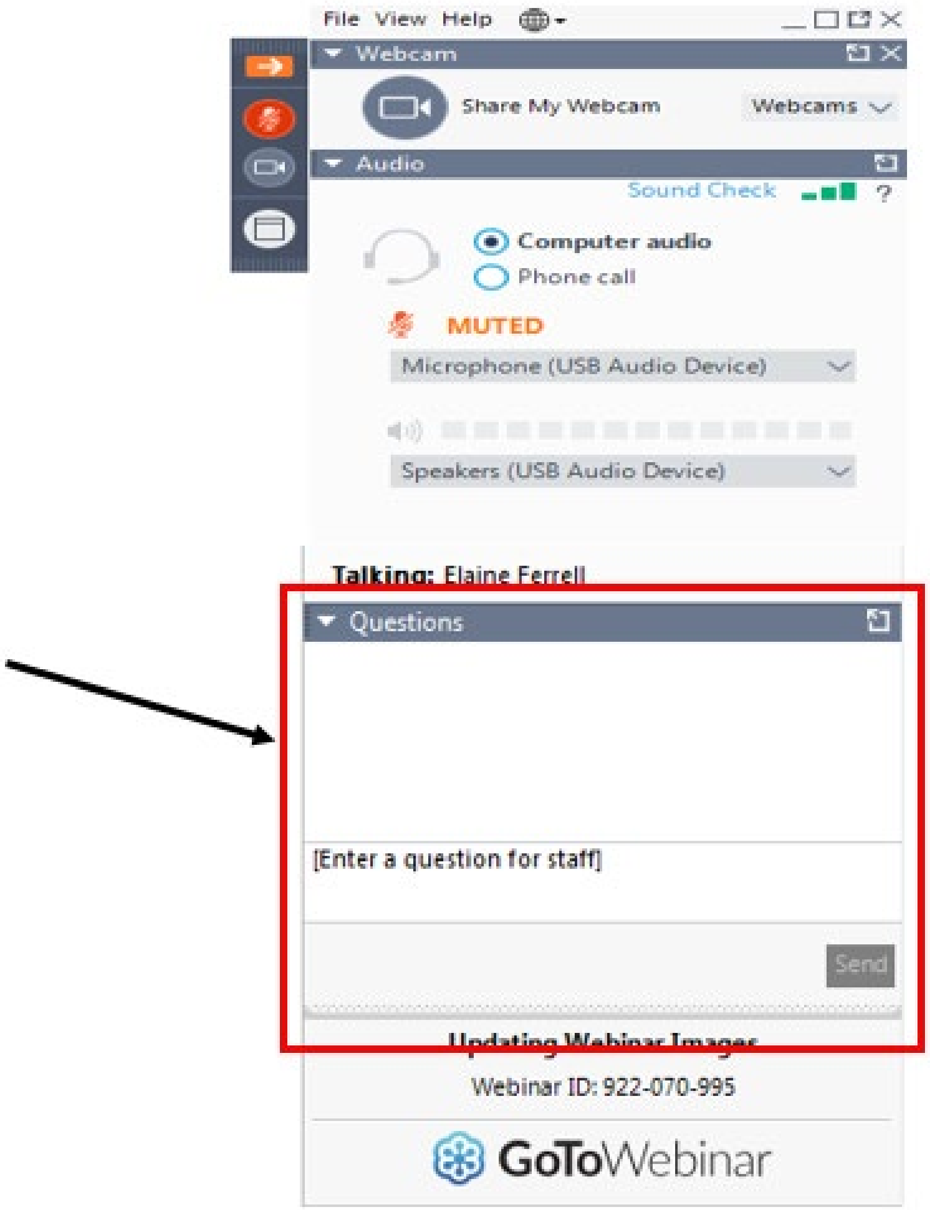
Learning Objectives

At the end of this webinar, you will be able to:

- Differentiate between CIR, CCPR, and typical asphalt mixtures and their applications
- Interpret and apply the draft AASHTO Construction Guide Specification for CIR and CCPR
- Use the best practice guide and training materials to implement CIR and CCPR into standard practice within the agency

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

Brian Diefenderfer
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Virginia Transportation Research Council

Adriana Vargas
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Auburn University, National Center for Asphalt Technology

Benjamin Bowers
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NCHRP Project 14-43
A foundation for today's webinar

Benjamin F. Bowers, PhD, PE
Assistant Professor
Auburn University

Team

- Ben Bowers, PI – Auburn University
- Brian Diefenderfer, Co-PI – Virginia Transportation Research Council
- Steve Cross – S. Cross & Associates, LLC
- Adriana Vargas – National Center for Asphalt Technology
- Fan Gu – Changsha University of Science and Technology

NCHRP 14-43 Objective

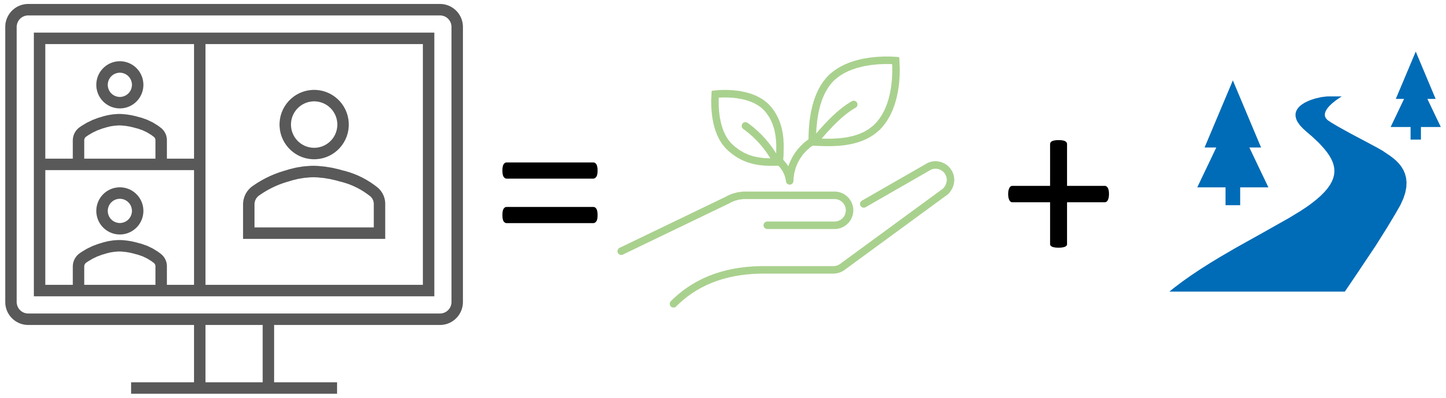
1. Develop and produce a proposed AASHTO Construction Guide Specification for CIR and CCPR
   a. Five-part AASHTO format
   b. Includes commentary
2. Develop Best Practices Guide and additional training materials
   a. Both play a critical role in the implementation of Objective 1

Research Approach – Informing Today!

- Phase I
  - Literature review
  - Compilation + analysis of existing specs
  - Stakeholder survey
  - Targeted interviews
- Phase II
  - Assessment of practical similarities and differences
  - Development of draft specifications
  - Summary of best practices
  - Training materials and implementation plan

Webinar Outline

- Introduction
- Literature review, specification review, survey results
- Similarities and differences between CIR and CCPR
- Guide specifications
- Best practices guide
- Summary



Cold Recycling
What is it and what are we doing today?

Brian Diefenderfer, PhD, PE
Principal Scientist
Virginia Transportation Research Council

Cold Recycling

- Reuse of existing or stockpiled asphalt pavement materials to create a new base asphalt layer
  - Millings or stockpiled RAP are not heated
  - Reduced costs and reduced greenhouse gas emissions

- Term covers the processes cold in-place recycling (CIR) and cold central plant recycling (CCPR)
  - Same product, different opportunities

CIR and CCPR Materials

- Materials are semi-bound using either foamed asphalt or emulsified asphalt
  - Typical application rates around 2% (foam) to 3.5% (emulsion)
- May include an active filler such as cement
  - 1% or less

CIR and CCPR Design

- Mixture design
  - Determines recycling agent rate, need for active filler, and field density target
- Pavement design
  - Many agencies using an AASHTO '93-like approach – layer coefficients range from 0.25 to 0.4
  - Information for mechanistic design in NCHRP Report 863

CCPR Construction Process

RAP loaded into CCPR plant hopper

CCPR mixture discharged onto ground or into dump truck

CCPR mix is loaded into asphalt paver hopper

CCPR mix is paved and rolled to specification

Compaction to target density

Photos Courtesy: Brian Diefenderfer, VTRC; ARRA

CIR Construction Process

Dry additive application on pavement ahead of CIR train (if needed)

Single unit train process

Multi-unit CIR train

Compaction to target density

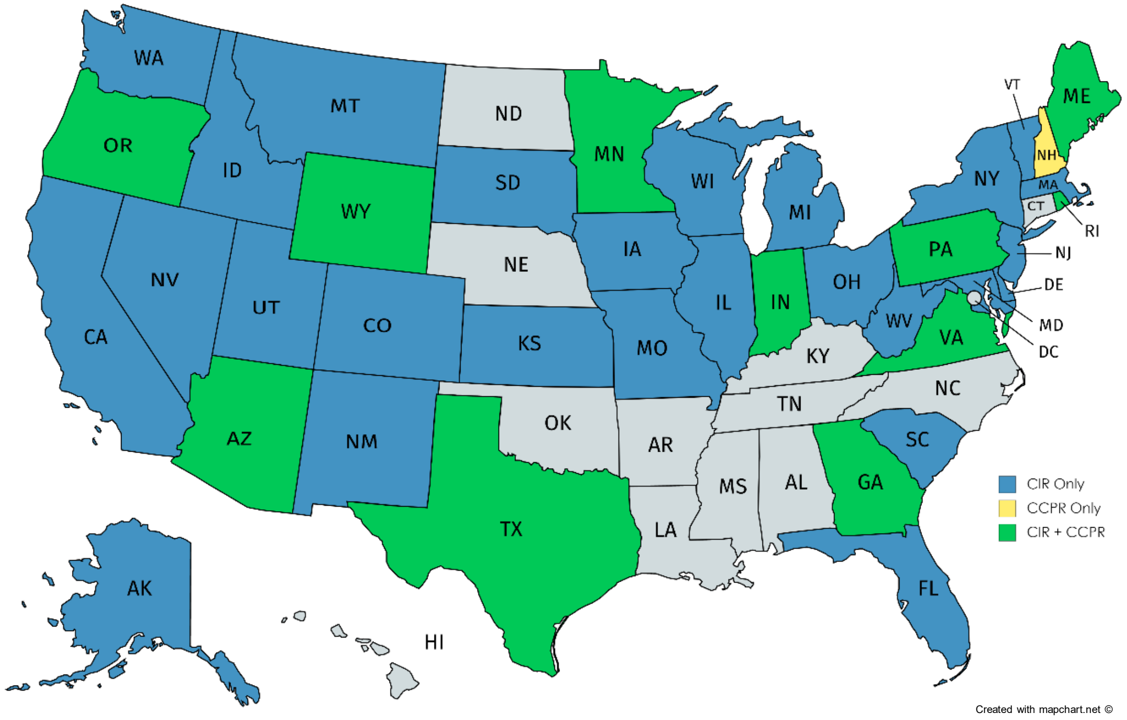
Photos courtesy ARRA

Helpful info

- Additional details can be found in:
  - AASHTO MP 31, MP 38, PP 86, and PP 94
  - Wirtgen Cold Recycling Manual
  - Asphalt Recycling and Reclaiming Association (ARRA) Basic Asphalt Recycling Manual

Specification Review

- Reviewed state agency specifications and special provisions
- Collected specifications from:
  - AASHTO Committees on Maintenance, Materials and Pavements, and Construction
  - National Association of County Engineers

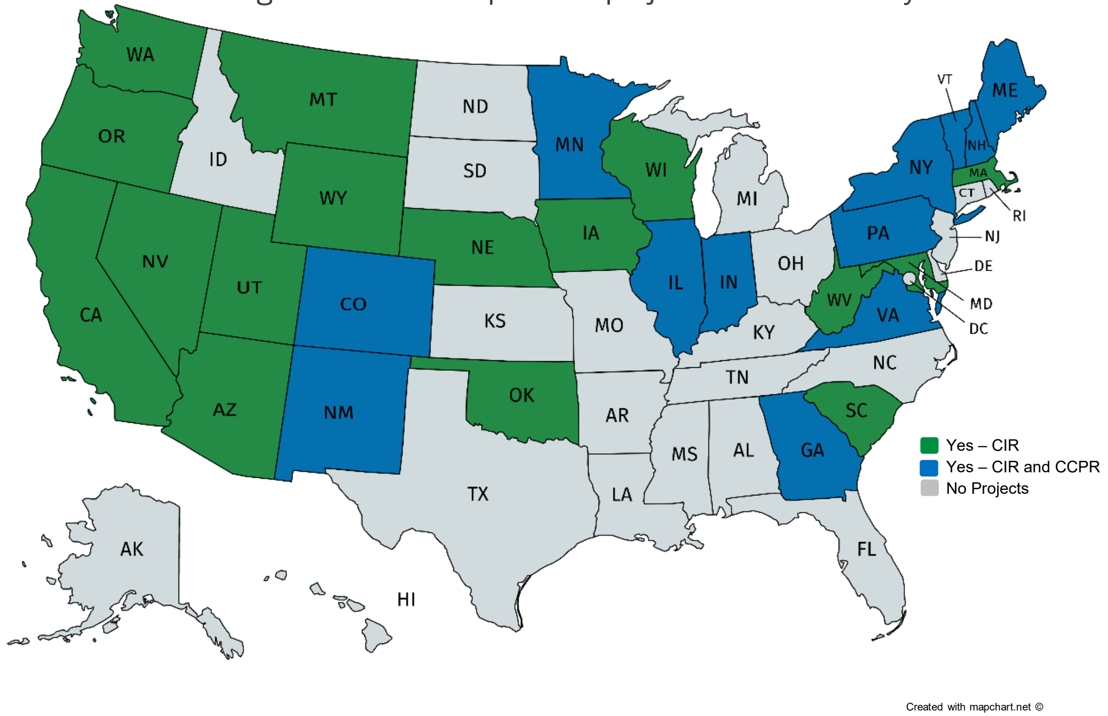


2019 Map of State Agencies Adopting Cold Recycling Specifications (Searchable)

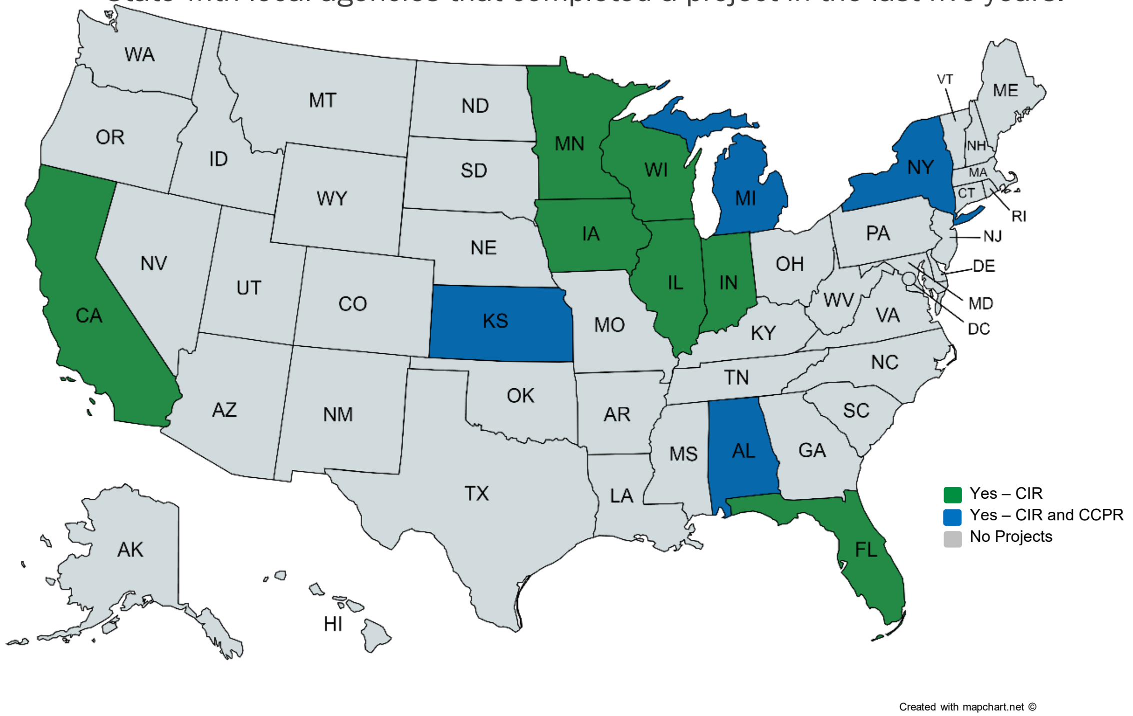
Specification Review

- Ninety-four individual survey responses:
  - 44 state/provincial agencies (43 U.S. DOTs and 1 Canadian province)
  - 33 local agencies (31 U.S. counties and 2 U.S. cities).

State agencies that completed a project in the last five years.



State with local agencies that completed a project in the last five years.



Focused Survey

- 10 Agency and 6 Industry members were interviewed
- Selected based on location and level of experience
- What works? What doesn’t? What is missing?



Focused Survey General Takeaways

- Specification components to achieving good performance
  - Pre-construction quality control plan and just-in-time training were noted most often

- Specification components that may be *unnecessary*
  - Some requirements may not be adding significant value and may be surrogates for desired properties that are hard to measure
  - Examples include: gradation with many sieves, cracking tests, laboratory testing of field materials, and curing

Focused Survey General Takeaways

- Specification components that are *missing*
  - Guidance documents
  - Field acceptance tests and balanced mix design concepts

- Test strip timing
  - Consider mobilization costs especially when the test strip is required to be performed and accepted prior to actual production

Focused Survey General Takeaways

- Measuring moisture in the field
  - Low is good, high is bad. But what about in between?
  - Does a certain moisture content guarantee good performance?

- Establishing the production density target
  - Specifications cover many ways to establish target density
  - Commentary is needed on challenges with each method and when to establish a new target

Focused Survey General Takeaways

- Mixture verification tests
  - Many of these tests have value, but provide challenges (time to results) that cause them to typically not be used for acceptance and/or pay
- Test requirements and test frequency
  - Consider adjusting based on traffic level or roadway type
  - Do interstates and subdivisions have the same risk?

Focused Survey General Takeaways

- Achieving good smoothness/surface tolerance
  - Various methods to measure along with their benefits/drawbacks are discussed in best practices document
- Should smoothness/surface tolerance be measured on the recycled layer or the final surface?
  - Most often final surface
  - May have implications if recycling is performed by a subcontractor

Construction Guide Specifications

How do we use these materials?

Benjamin F. Bowers, PhD, PE
Assistant Professor
Auburn University

Specification Organization and Details

1. DESCRIPTION
2. REFERENCED DOCUMENTS
    a. AASHTO Standards
    b. Other Published Standards
3. TERMINOLOGY

4. MATERIALS
    a. Materials
        i. Reclaimed Asphalt Pavement (RAP)
        ii. Asphalt Recycling Agent
    b. Mixture Design
        i. Referenced AASHTO Specifications for Mix Design

Specification Organization and Details

5. CONSTRUCTION.
   a. Equipment Requirements
      i. Self-propelled milling machine
      ii. Sizing Equipment
      iii. Additive (Dry or Slurry)
      iv. Cold Central Plant Recycling Equipment
      v. Water Supply
      vi. Hauling Equipment
      vii. Laydown Equipment
      viii. Compaction Equipment
      ix. Optional Fog Sealing and Fine Aggregate Spreading Equipment
   b. Equipment Calibration

Specification Organization and Details

5. CONSTRUCTION (continued)
    - c. Preconstruction Meeting
        - i. Just-in-Time Training / Preconstruction Personnel Training
    - d. Roadway Preparation
    - e. Weather Limitations
    - f. Processing and Mix Operation
    - g. Paving Operation
        - i. Placement
        - ii. Compaction
    - h. Opening to Traffic
    - i. Maintenance
    - j. Pavement Smoothness / Surface Tolerance
    - k. Surfacing
    - l. Quality Assurance (QA) Program
        - i. Calibration of Equipment
        - ii. Quality Control (QC) Plan
        - iii. Acceptance Testing
        - iv. Independent Assurance (IA)

Specification Organization and Details

6. MEASUREMENT
    a. CCPR Mixture
    b. Recycling Agent
    c. Active Filler
    d. Corrective Aggregate
    e. Fog Seal and Fine Aggregate
    f. Tack Coat
    g. Subgrade Repair

6. PAYMENT

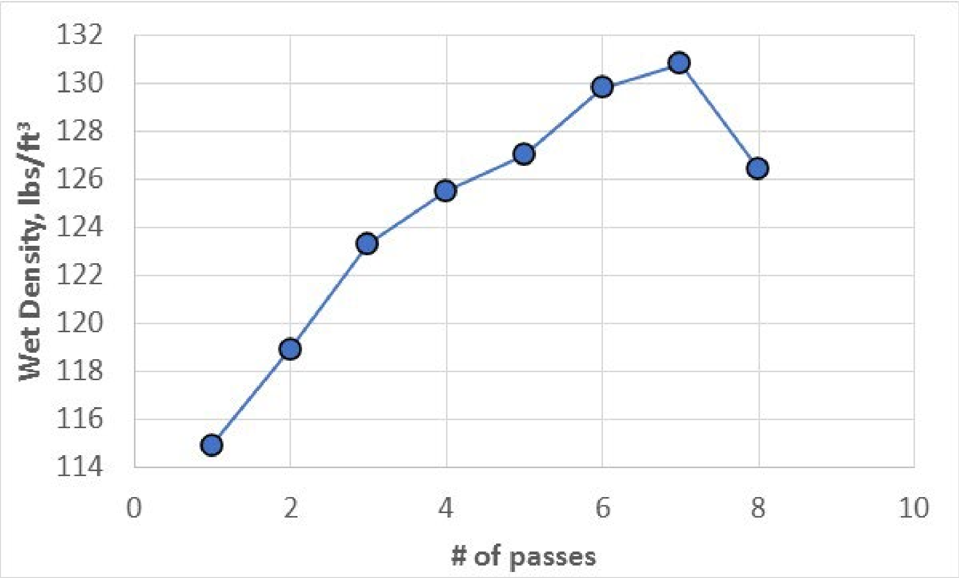
Best Practice Guide and Training Materials

- A Best Practice Guide
  - Summarize best practices to produce a quality CR material
  - Identify areas where more research is needed to improve current practices
- Training Materials
  - Overview of CIR and CCPR construction
  - Linkage between Guide Specifications and Best Practice Guide

...a few frequently asked questions

Construction: Test Strip

- Construct a test strip on the project at an approved location
  - Process a minimum 500-foot-long test strip with testing in the last 200 feet
- Provide the Engineer with…
  - Maximum in-place density achieved
  - Percent passing maximum sieve size
  - Application rates of recycling agent, water, and other additives used on the accepted test strip



Construction: Trafficking

- Do not allow traffic on the recycled layer until
  1. The moisture content of the layer is reduced to 3.0 percent or less, *or*
  2. Passing values using AASHTO XXXX (NCHRP 9-62 Short-Pin Raveling Test) are obtained, *or*
  3. The Engineer approves

Photo courtesy Brian Diefenderfer

Acceptance Table

Property	Method	Minimum Frequency	Criteria
Density	AASHTO T 310 or T 355	Once per 100 ft	97-103% of target density
Gradation	AASHTO T 27	At least once in the first 250 ft of each day and then once per 2500 ft thereafter	100% passing max particle size
Cross Slope	Agency Method	At least once in the first 250 ft of each day and then once per 500 ft thereafter	±0.1% of planned percent cross slope
Surface Tolerance			Less than 3/8 inch using a 10-ft straight edge
Recycling Agent	Read Meter	At least once in the first 250 ft of each day and then once per 1000 ft thereafter	±0.25% of planned percent rate
Active Filler			±0.1% of planned percent rate
Corrective Aggregate			±0.1% of planned percent

Report and Specification Timeline

- NCHRP Web-Only Document 363
- AASHTO specifications are in being voted on in next AASHTO Ballot

Section XXX

Construction Guide Specification for Cold Central Plant Recycling

XXX.1. DESCRIPTION

This guide specification is intended to provide information needed for agencies and contractors for the construction of cold central plant recycling (CCPR). CCPR consists of mixing an asphalt recycling agent, water, and additives with the reclaimed asphalt

Section XXX

Construction Guide Specification for Cold In-Place Recycling

XXX.1. DESCRIPTION

This guide specification is intended to provide information needed for, agencies and contractors for the construction of cold in-place recycling (CIR). CIR consists of milling and pulverizing existing asphalt layers to a specified depth; mixing an asphalt recycling

What’s next?

How will we move forward?

Benjamin F. Bowers, PhD, PE
Assistant Professor
Auburn University

What's next?

- The goal is to *increase use* of these techniques
  - They are not new!
  - Have been proven on low and high-volume routes
- The Construction Guide Specifications for CIR and CCPR should allow for this
  - Designed to be flexible for agencies while also achieving a quality product
- These mixes promote a good performing, low carbon alternative
  - See example GHG emissions reductions in implementation example

Where do we need to go?

- There is a need to further develop structural design criteria
  - AASHTO ’93 structural layer coefficient ~0.35 (VDOT)
  - Mechanistic properties can be used (NCHRP Report 863), but transfer functions, etc. may not (are likely not) applicable
    - Pavement-ME to *underpredict* performance

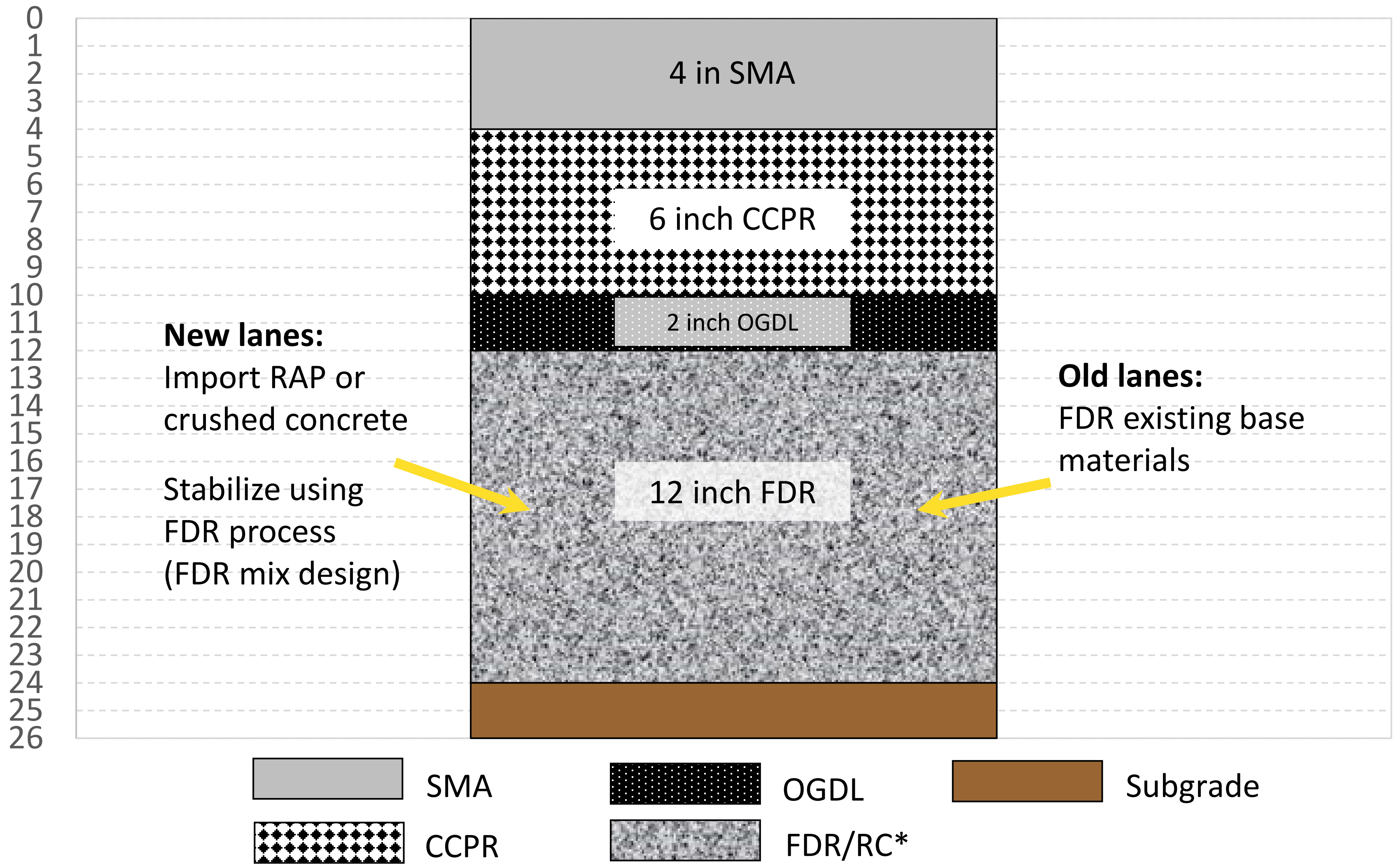
Implementation

Cost Example: VA Interstate-64 Widening

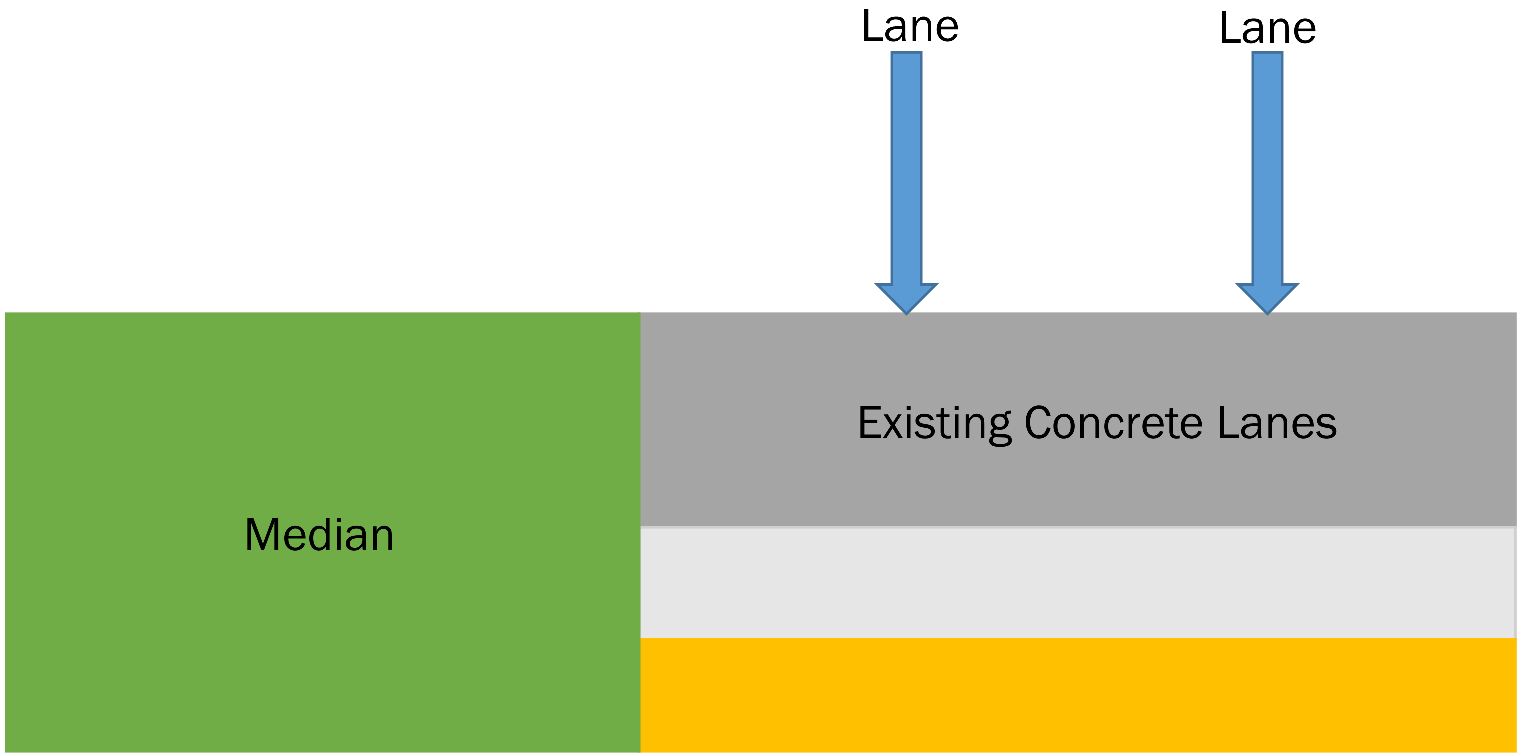
Interstate 64 Widening

- Segment II (2019) and Segment III (2021)
  - Total 15.4 miles
  - New lane + full width shoulder
  - Reconstruct existing lanes

Recycled Design



Minimize traffic impacts, enhance safety



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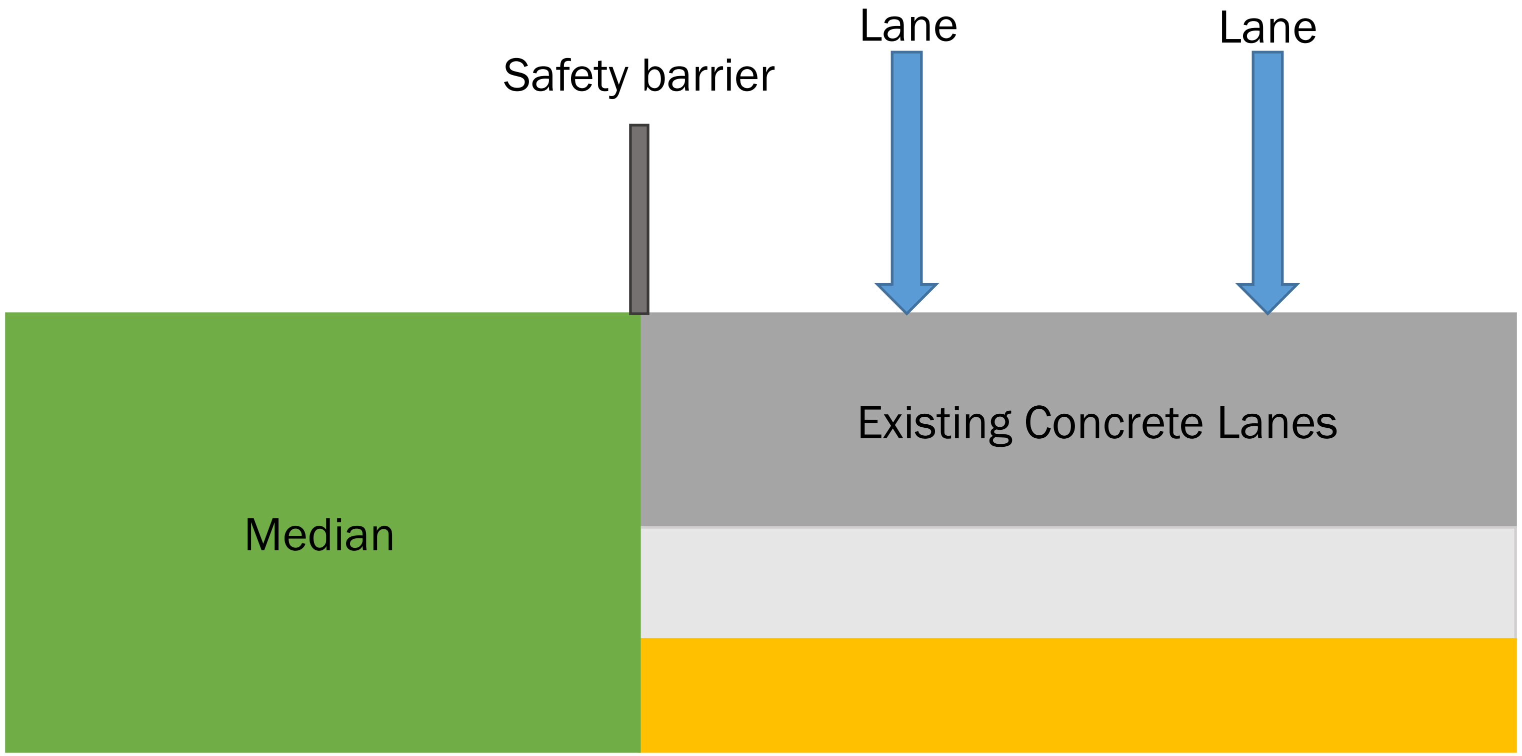

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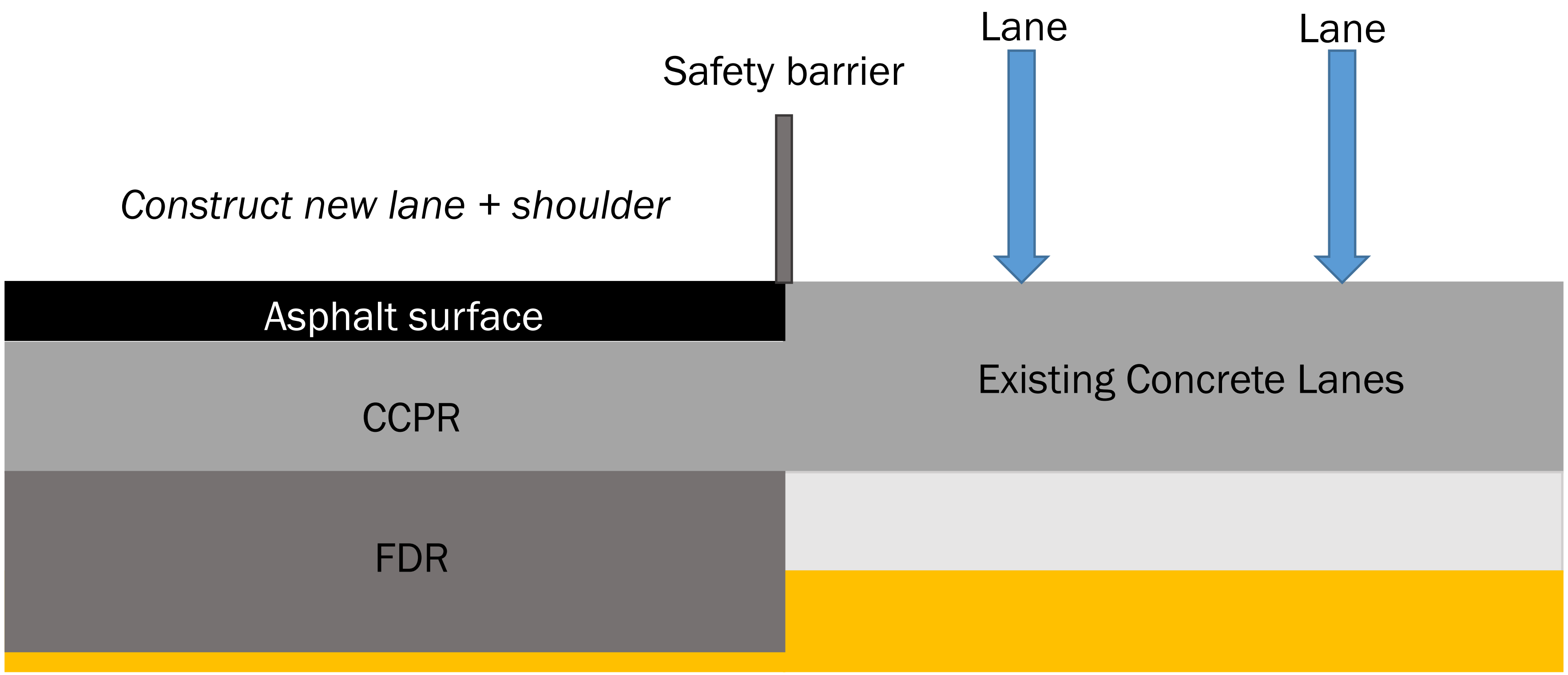

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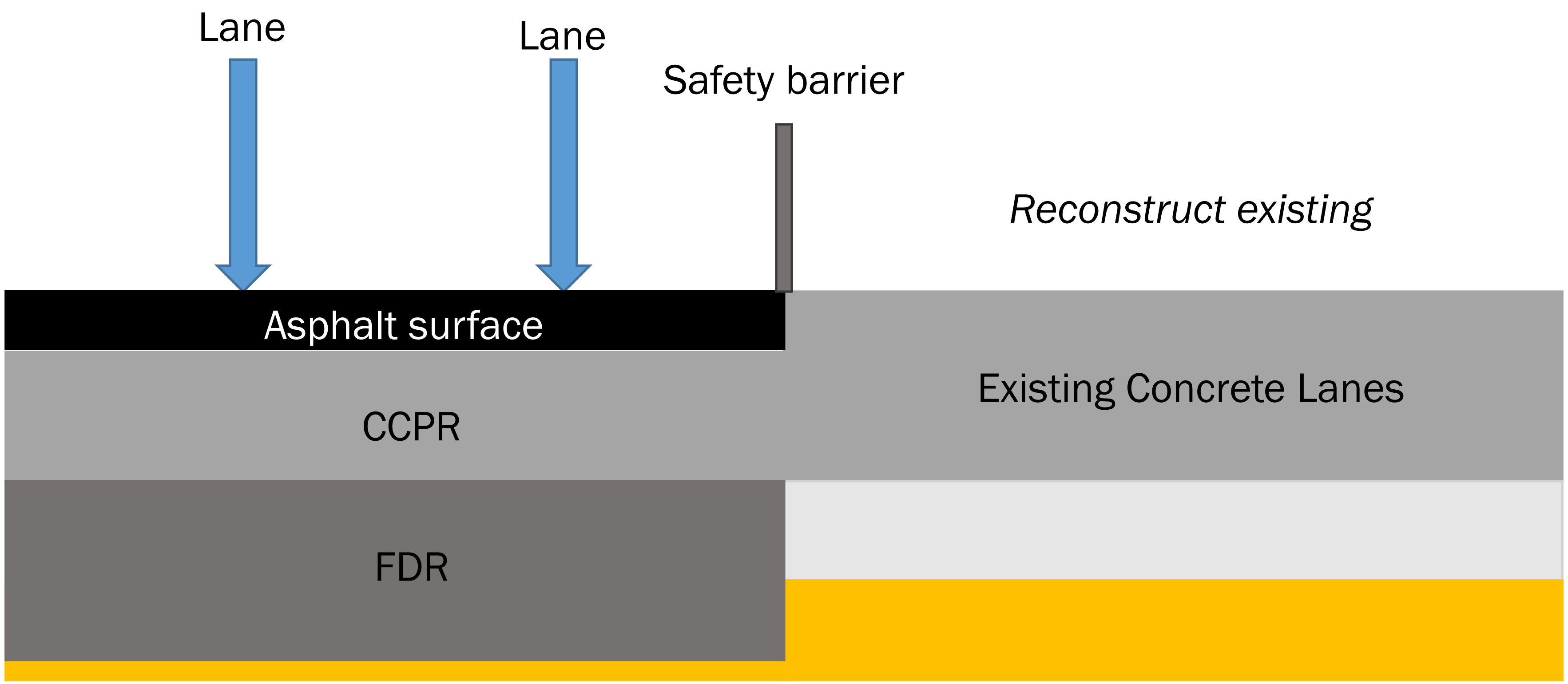
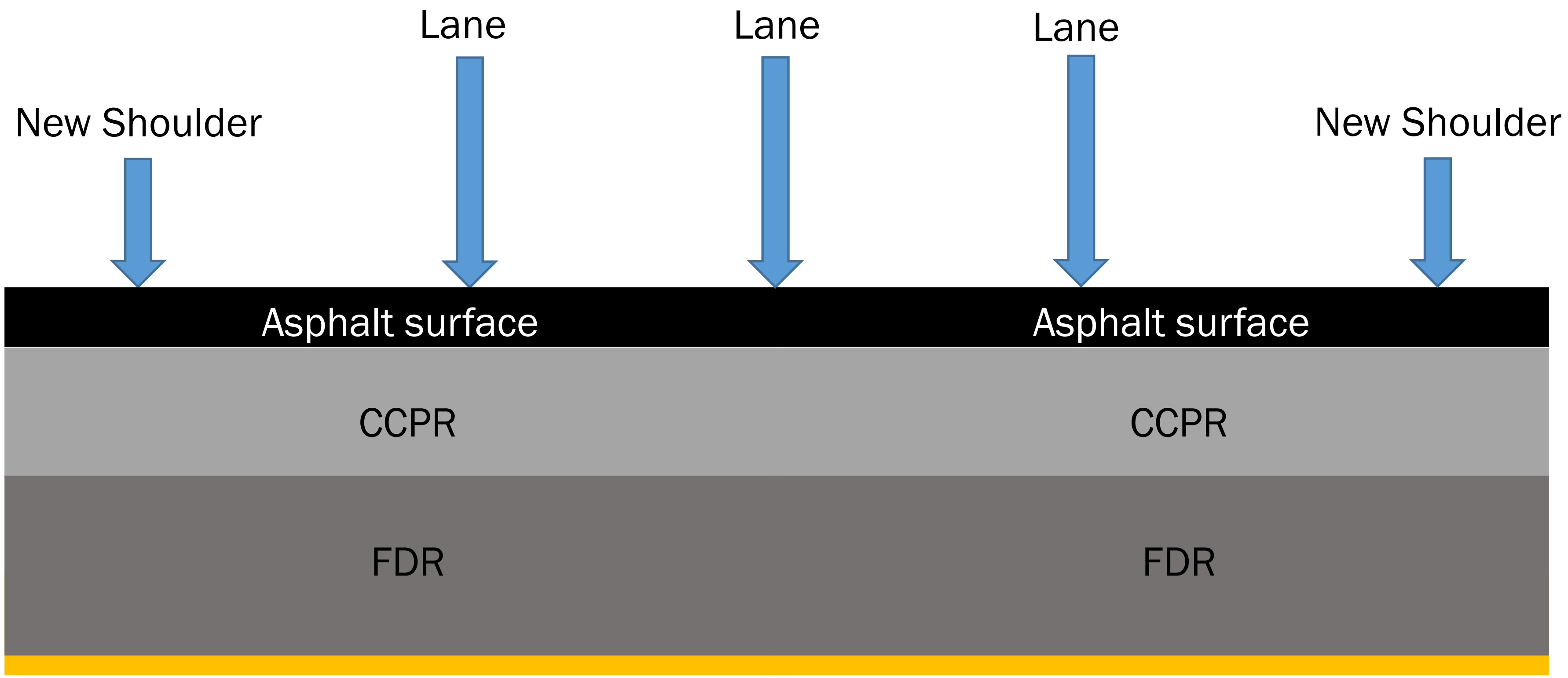


Final Product

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Examples in action…

- Total cost savings are estimated to be $10-15 million
- Energy and Global Warming Potential (Greenhouse gasses) reductions were estimated to be 25-45% and 15-40% respectively[1]
- Total recycled material:

Process	Segment II	Segment III
FDR existing lanes	345,000 SY	229,000 SY
Cement treated concrete/ RAP new lanes	146,000 tons	201,000 tons
CCPR	168,000 tons	196,000 tons

[1]In-Place and Central-Plant Recycling of Asphalt Pavements in Virginia, FHWA Tech Brief, FHWA-HIT-19-078

Cost Comparison

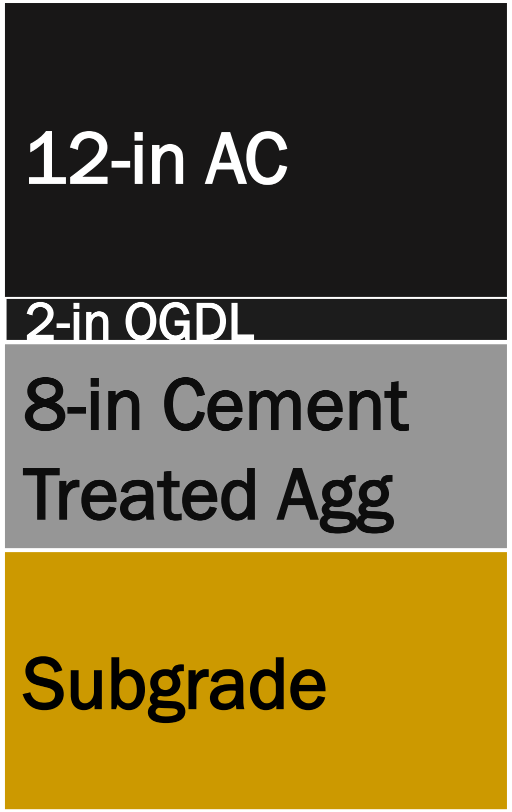
SN = Structural Number

AC = Asphalt concrete

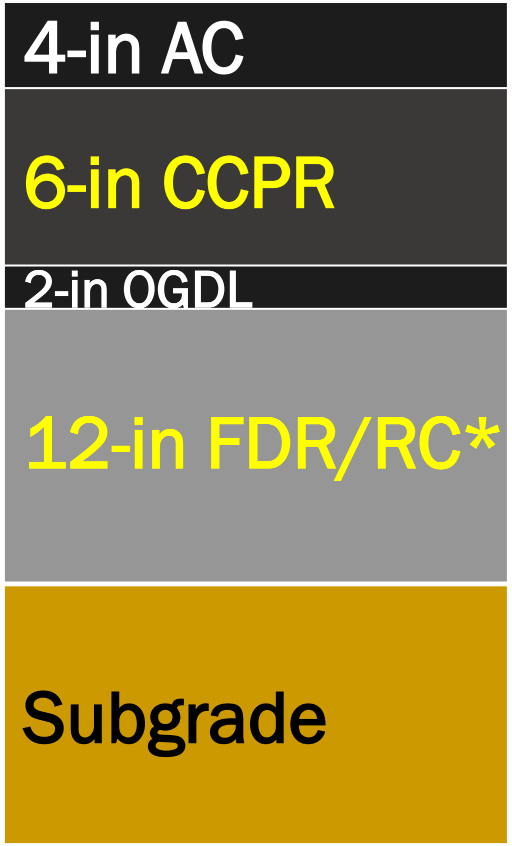
OGDL = Open graded drainage layer

RC = Recycled Concrete

SN = 7.08, $83/SY



SN = 7.06, $40-61*/SY



Questions?

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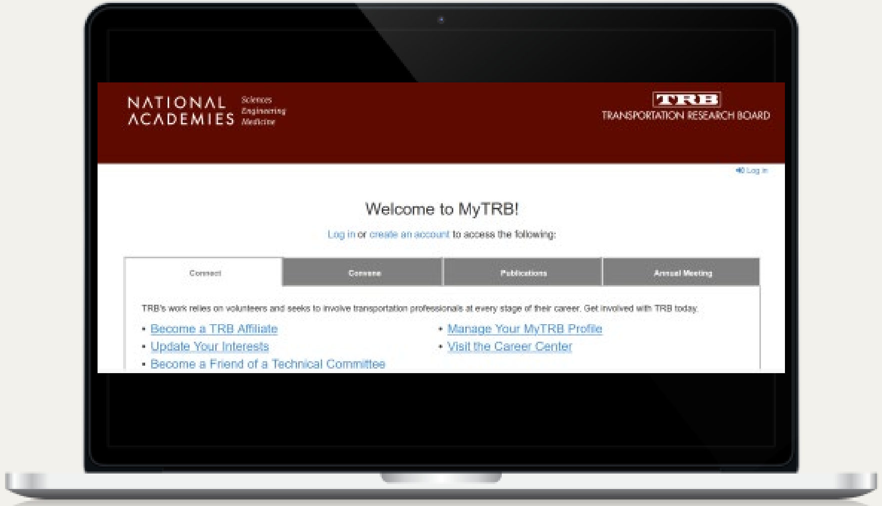

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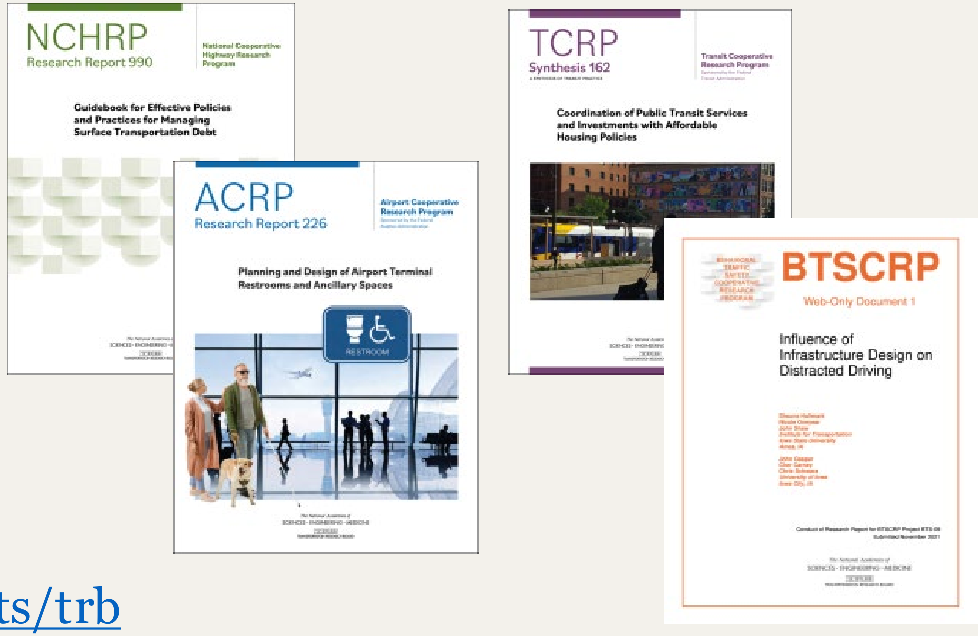

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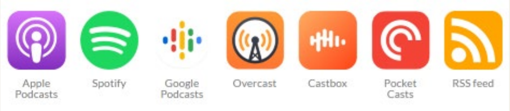

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