

Arizona DOT Black & Green Sustainable Pavement Systems Program



Arizona DOT Sustainable Transportation Program Linkage

ADOT's pavement management contributes to sustainability by enhancing roadway safety, optimizing pavement life cycles to reduce costs, while considering the environmental impacts of construction and material usage.

Sustainable Pavement Defined

FHWA *TechBrief* on Pavement Sustainability (2014)

<http://www.fhwa.dot.gov/pavement/sustainability/hif14012.pdf>

FHWA's *Toward Sustainable Pavement Systems* (2015)

<http://www.fhwa.dot.gov/pavement/sustainability/hif15002/hif15002.pdf>

- FHWA defines a sustainable pavement as one which “achieves its specific engineering goal” (i.e., meeting accepted performance standards) while meeting “basic human needs,” using “resources effectively,” and preserving/restoring ecosystems
- Pavement sustainability is meant to involve every phase of the pavement life cycle, including **1)** materials production, **2)** pavement design, **3)** construction, **4)** use, **5)** preservation, maintenance, and rehabilitation, and **6)** end-of life management

ADOT Application Sustainability Matrix

Treatment	Description	Economic	Social	Environmental
Crack Filling	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Crack Sealing	Placement of adhesive material	Life : Low Cost: Low	Aesthetics/Roughness	Low
Asphalt Patching	Localized structural distress	Life : Medium/Low Cost: Medium/Low	Aesthetics/Roughness	Low Variable
Fog/Seal Rejuvenators	Very light asphalt emulsion application	Life: Low Cost: Low	Improved Aesthetics	Medium Variable
Chip Seal	Sprayed application/subsequent chips	Life : Medium/Low Cost: Medium/Low	Improved Friction/Roughness	Medium High
Slurry Seal	Mix of well-graded aggregate/emulsion	Life : Medium/Low Cost: Medium/Low	Aesthetics/Improved Friction	Medium
Microsurfacing	Crushed, well graded aggregate/emulsion/multiple course	Life: Medium/High Cost: Medium	Aesthetics/Improved Friction	Medium Variable
Hot In-Place Recycling	Heat or mechanically loosening within top 2"	Life: Medium/High Cost: Medium/High	Aesthetics/Ride Quality/Friction	Medium High
Cold In-Place Recycling	Milling and sizing reclaimed asphalt pavement (RAP)	Life: Medium/High Cost: Medium	Aesthetics/Ride Quality/Friction	Medium Variable

2019 ADOT Black & Green Program Goals

- Develop overall working group
- Continue documenting the 5-yr Construction Program Projects, Sub Program Surface Treatment / Pavement Condition activities
- Define the ADOT Materials sustainable program goals
- Begin documenting ADOT BMPs of each of the six (6) lifecycle phases in a single sustainable pavement systems framework
- Pilot a selection of suggested sustainable practices, innovations, and applications identified through the initial BMP process
- Begin formalizing advanced economic analysis and environmental methods CBA, ROI, Life Cycle Assessment (LCA), Life Cycle Cost Analysis (LCCA)
- https://www.environment.fhwa.dot.gov/Pubs_resources_tools/publications/newsletters/sep17nl.aspx
- https://www.fhwa.dot.gov/pavement/sustainability/articles/primer_on_pavement.cfm

2019 ADOT Black & Green Program Goals

Life Cycle Assessment (LCA)

LCA provides a comprehensive approach to evaluating the total environmental burden of a particular product (such as a ton of aggregate) or more complex systems of products or processes (such as a transportation facility or network), examining all the inputs and outputs over its life cycle, from raw material production to the end of the product's life.

Life Cycle Cost Analysis (LCCA)

LCCA evaluates agency expenditures throughout the life of the expenditure, rather than only considering the initial investment. The goal of the LCCA is to promote the efficient use of materials and resources through the informed cost of using a product or implementing a program. LCCA can be viewed as the economic component of both



LCA analysis and the three pillars of sustainability.

Every Day Counts Initiatives (EDC-4)

260 NA 302 F0038 01C Mainline Road – Overgaard

This is an EDC-4 Study Project divided into two sections which will receive two separate treatments. This is a life extension project and will be evaluated as a national and State performance level.

- MP 302.70 to MP 306.00 EB & WB Full Width
Cape Seal: Pre-coated chip seal with TR+ and Type 3 Micro Surfacing
- MP 306.00 to MP 310.05 EB & WB Full Width
Cape Seal: Pre-coated chip seal with TR+ and Type 3 Slurry

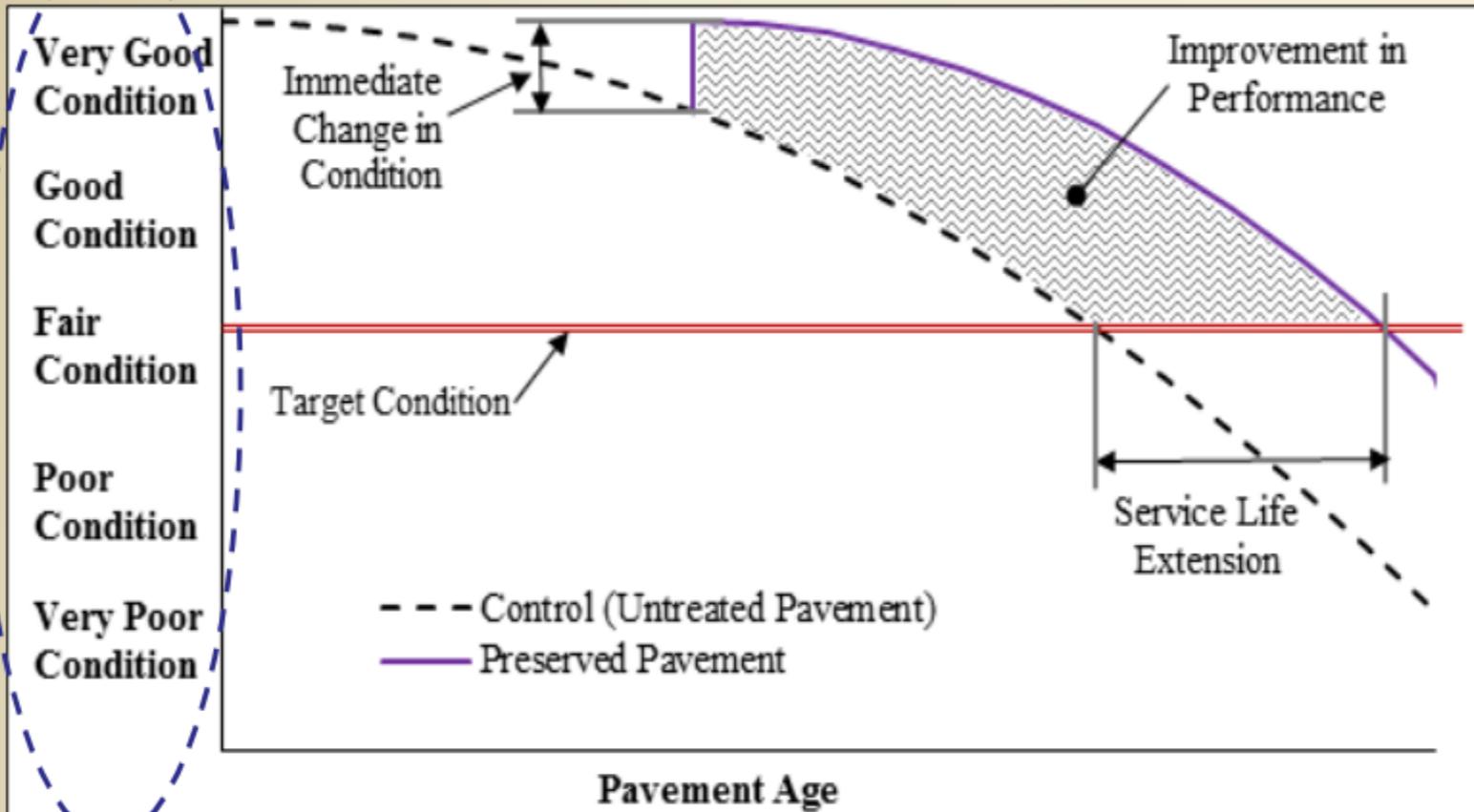
For this pilot it was determined that milling the ½” of AC could damage the existing pavement. The existing roadway surface will be cape seal treated in its “As-Is” condition.

Materials

- Pavements, Materials , and Sustainability:
 - Maximize performance and extend the life of our pavements to the furthest extent economically feasible while minimizing adverse impacts to both society and the environment.
 - Driven by design, materials engineering, and the quality of both materials and construction with consideration for how these factors affect what exists beyond the pavement.
- Making our pavements sustainable (and preserving them) is the right thing to do and it is everyone's responsibility to participate in this effort.
- How do we do it?

Materials

Background, Cont'd



Materials

- Performance Life
 - 20 years for new
 - 10 years for old
 - Might include
- Preservation of I
 - Drainage
 - Crack Fill
 - Fog Coat
 - Surface Treat
- Maintenance Sp
 - Patch potholes
 - Shallow mill



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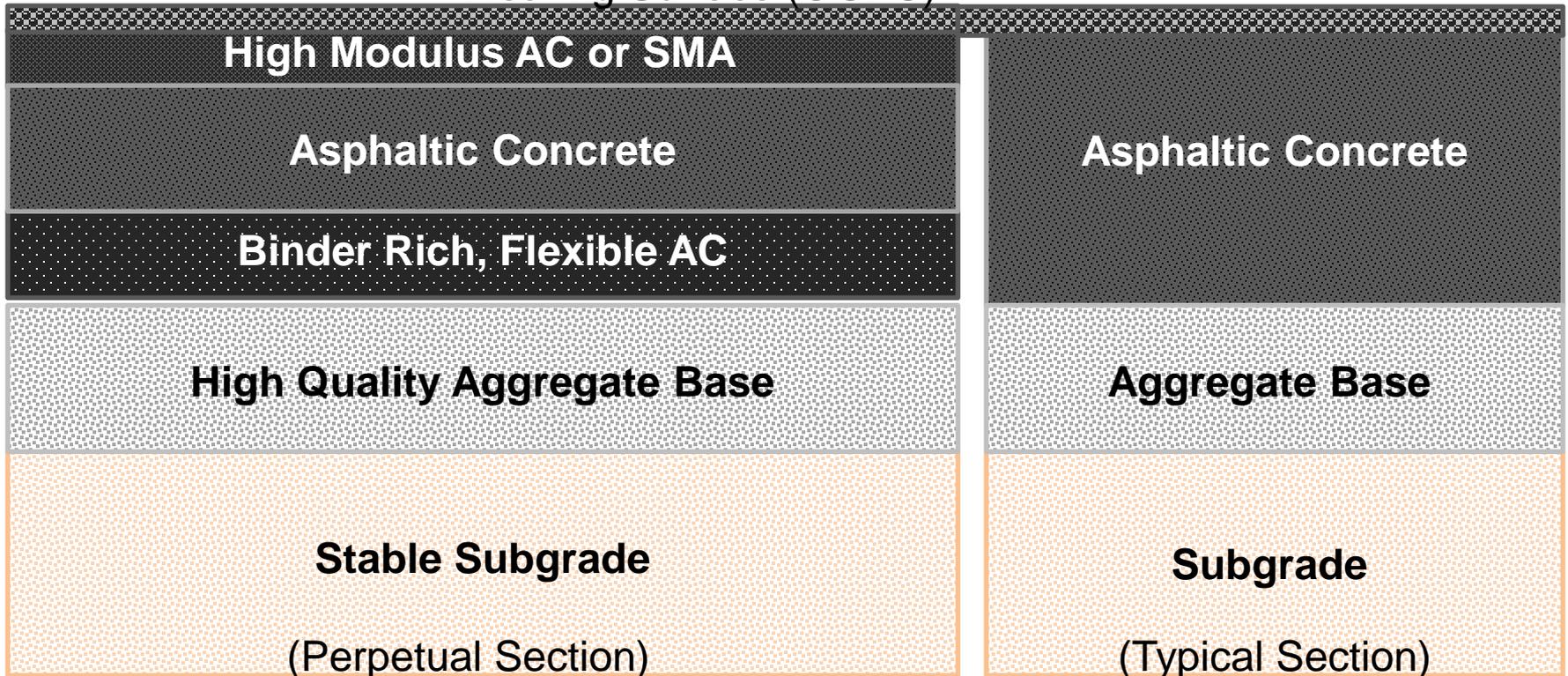
Materials

- Pavements, Materials , and Sustainability:
 - Not discussed in detail in this presentation but worthy of mention:
 - Lower Permeability PCC for Bridge Decks / Fiber Reinforced PCC
 - RAP Chip Seals / Slurry Seals
 - Supplementary Cementitious Materials (Fly Ash, Silica Fume)
 - Recycled Concrete Aggregate
 - Balance Mix Design / Mixture Performance Testing
 - Non Destructive Testing
 - Maximize performance and extend the life of our pavements to the furthest extent economically feasible while minimizing adverse impacts to both society and the environment.

Materials

- Perpetual Pavement: 50+ year design life without significant structural rehab or reconstruction. – [Asphalt Pavement Alliance \(APA\), 2002.](#)

Wearing Surface (OGFC)



Materials

- High Quality Fractured Aggregate
 - Well established within ADOT specifications
 - Materials suppliers produce high quality aggregate
- Binder Selection (PG, PG+, TR+, CRA)
 - Adequately addressing both cold and warm temperatures
 - LTPPBind, PGSelect, local experience, traffic
- Improved Performance (Stability & Durability)
 - Increased Density & Improved Joint Density
 - Polymer / Rubber Modified Asphalt
 - Asphalt Rubber / Crumb Rubber Asphalt
 - Fiber Reinforced Asphalt
 - Reduced Moisture Susceptibility
 - Improved Construction Techniques



Materials

Reclamation, Recycling,
& Re-use of Existing
Materials

Materials

- Pavements, Materials , and Sustainability:
 - Maximize performance and extend the life of our pavements to the furthest extent economically feasible while minimizing adverse impacts to both society and the environment.

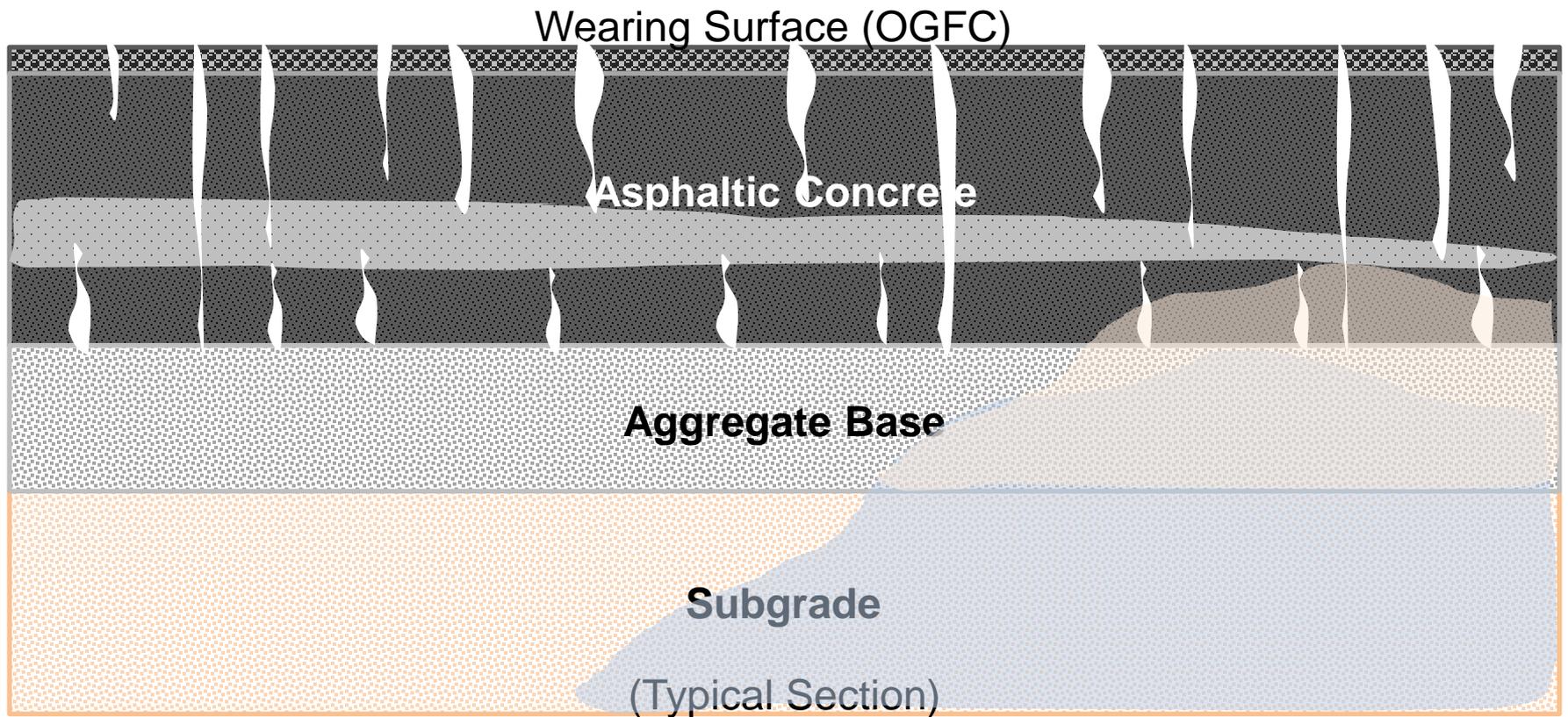
Materials

- Reclaimed Asphalt Pavement (RAP)
 - Approaching 10 Million tons of RAP since 2009 (ADOT)
 - 15%, 20%, 25% (below upper 2 inches of AC)
 - LTPP SPS-10 Test Sections up to 30% (I-40 & I-8)
 - Included Warm Mix Technology
- Full Depth Reclamation
- Cold Recycling
 - Cold in-Place Recycling (CIR) since early '80s
 - 1.5 Million sq.yds. Since 2004 (rural, low volume roads)
 - 2018 - Revised & Updated Specification (includes CIR & CCPR)
 - Solventless Engineered Emulsion, Mix Design, Mineral Admix
- Hot in-Place Recycling
 - Over 1 Million sq.yds since 2004 (Repaving & Remixing)



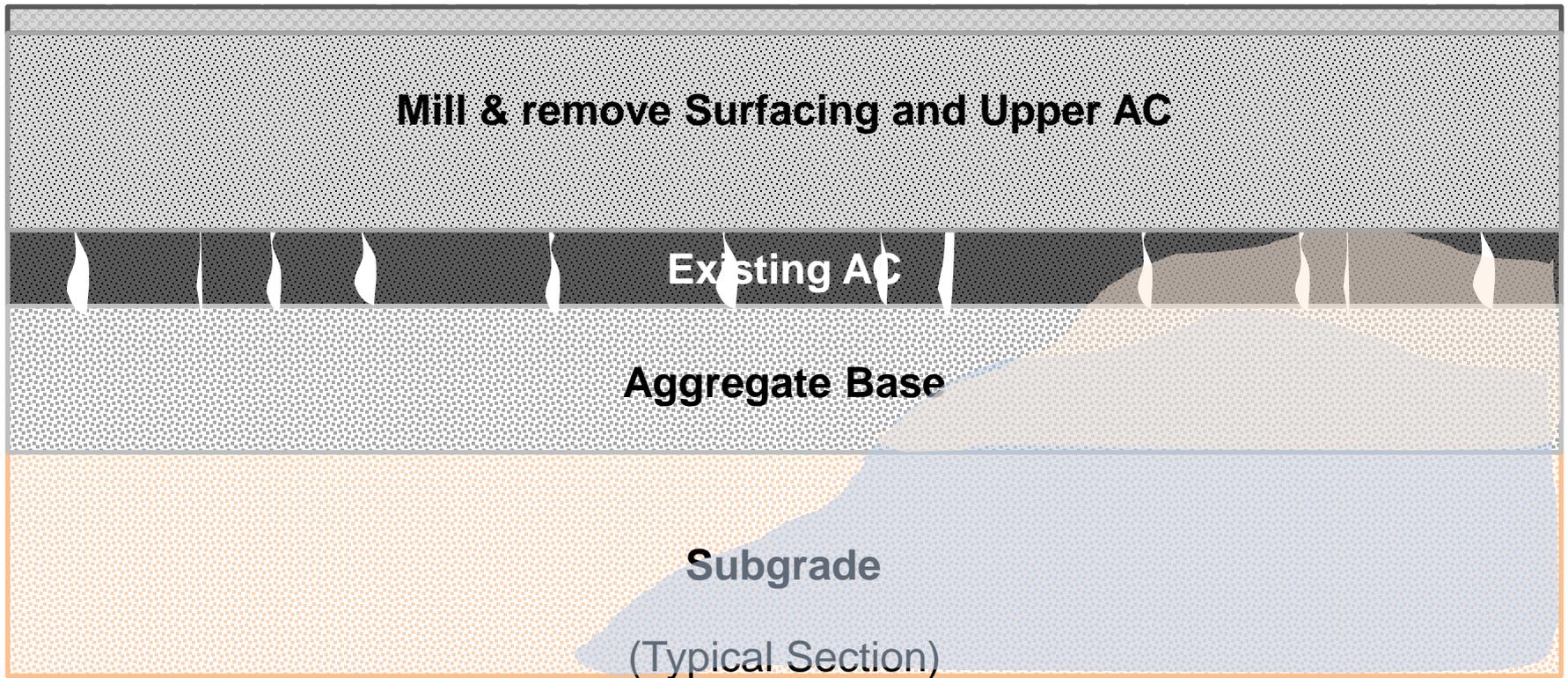
Materials

- Perpetual Pavement: How do we get there from where we are now?



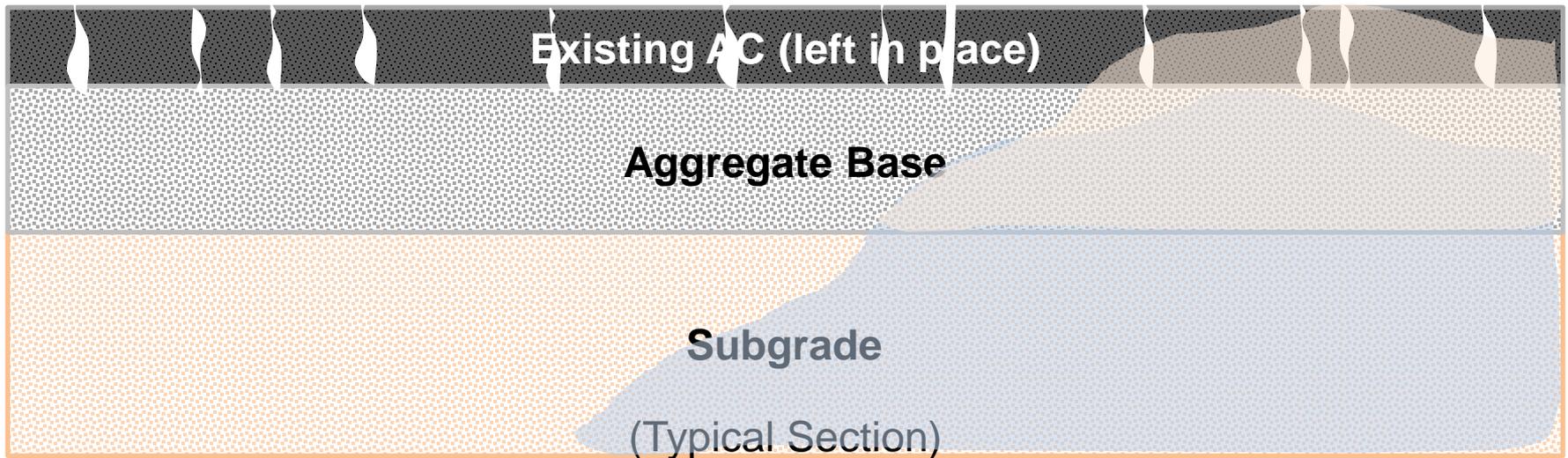
Materials

- Mill and remove surface wearing coarse & upper AC.
- Fractionate and stockpile for use as cold recycled material (CCPR)



Materials

- Fractionate and stockpile for use as cold recycled material (CCPR)
- Full-depth reclaim and stabilize the remaining AC, Base, and Subgrade



Materials

- Fractionate and stockpile for use as cold recycled material (CCPR)
- Full-depth Reclaimate and stabilize the remaining AC, Base, and Subgrade

**Full-Depth Reclaimed & Stabilized Section
(12 to 18 inches thick)**

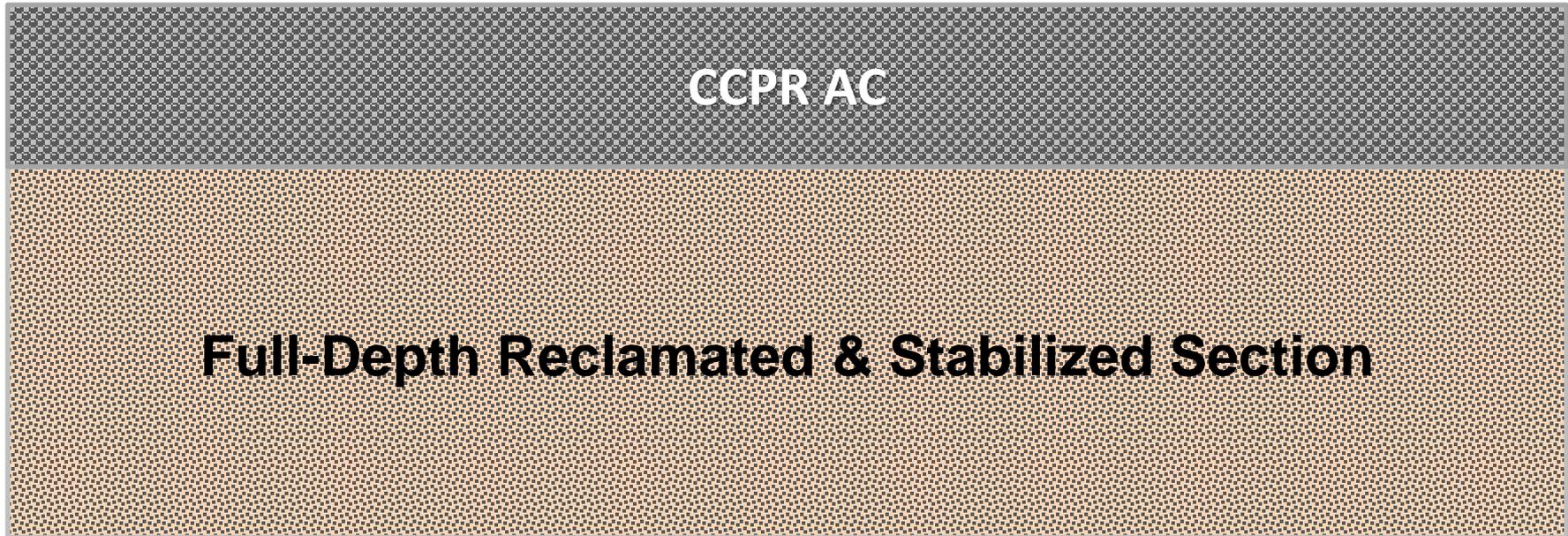
Materials

- Full-depth Reclamate and stabilize the remaining AC, Base, and Subgrade
- Place Cold Central Plant Recycled AC

Full-Depth Reclamated & Stabilized Section

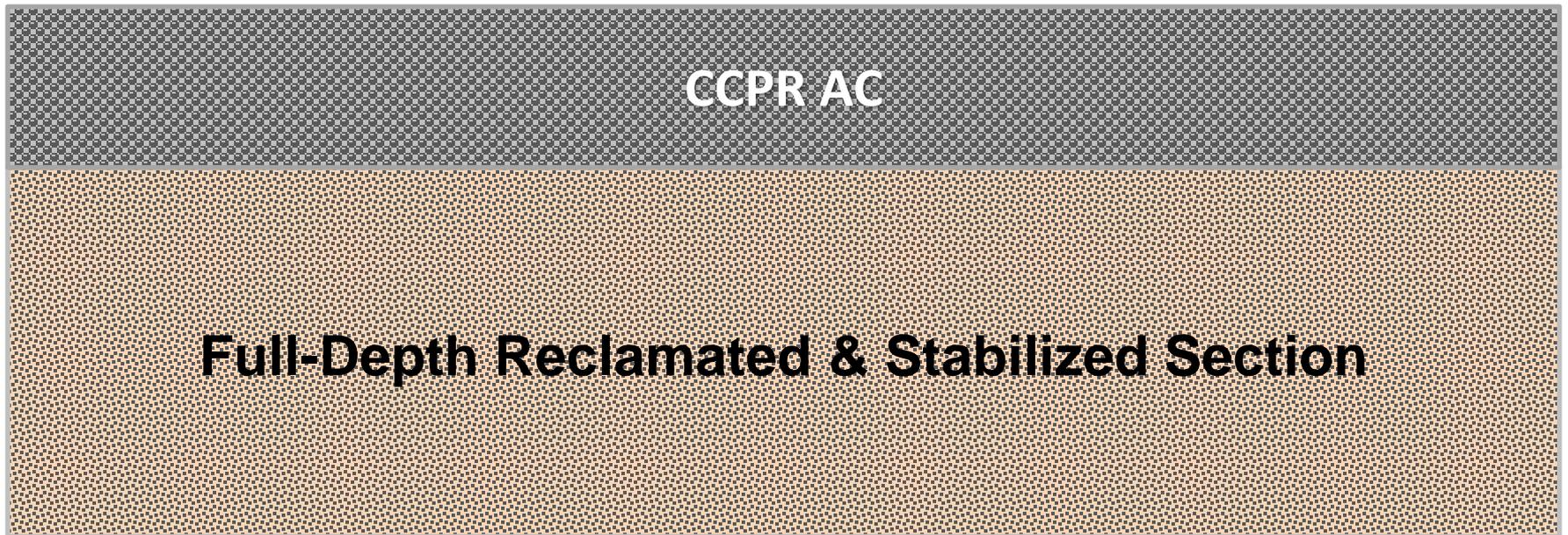
Materials

- Full-depth Reclamate and stabilize the remaining AC, Base, and Subgrade
- Place Cold Central Plant Recycled AC



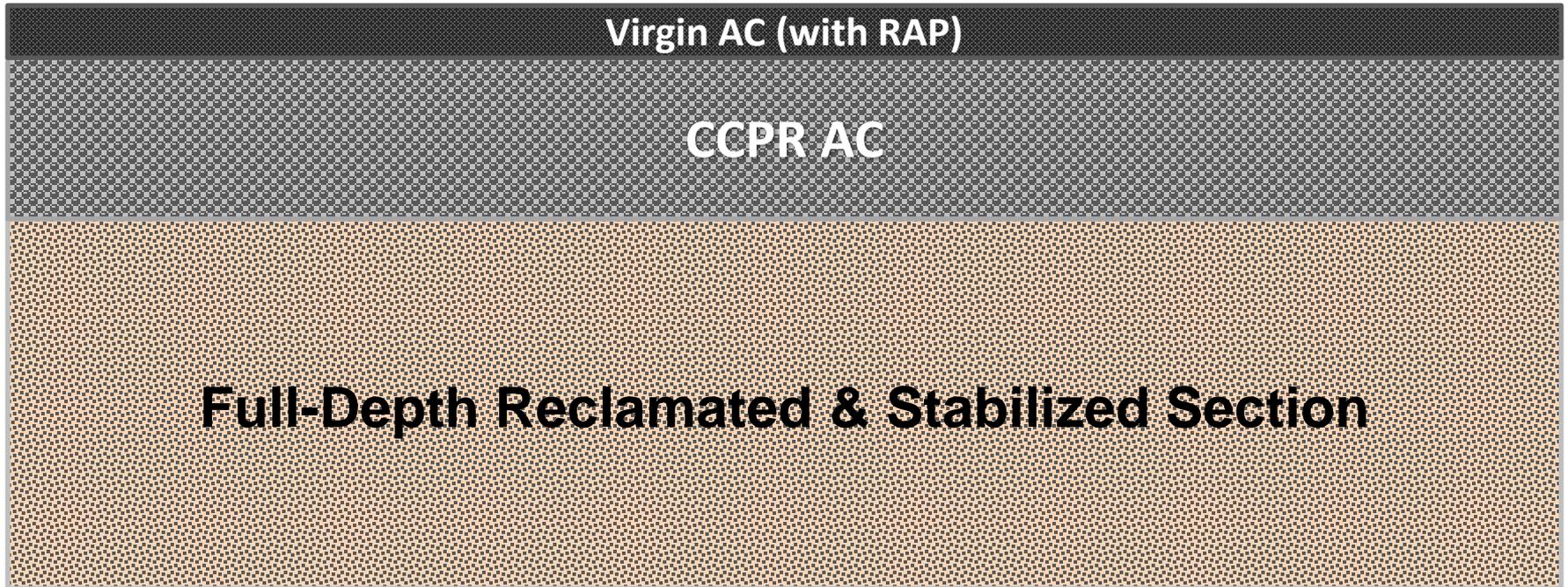
Materials

- Place Cold Central Plant Recycled AC
- Place 2 to 3 inches of Virgin AC mix (with RAP)



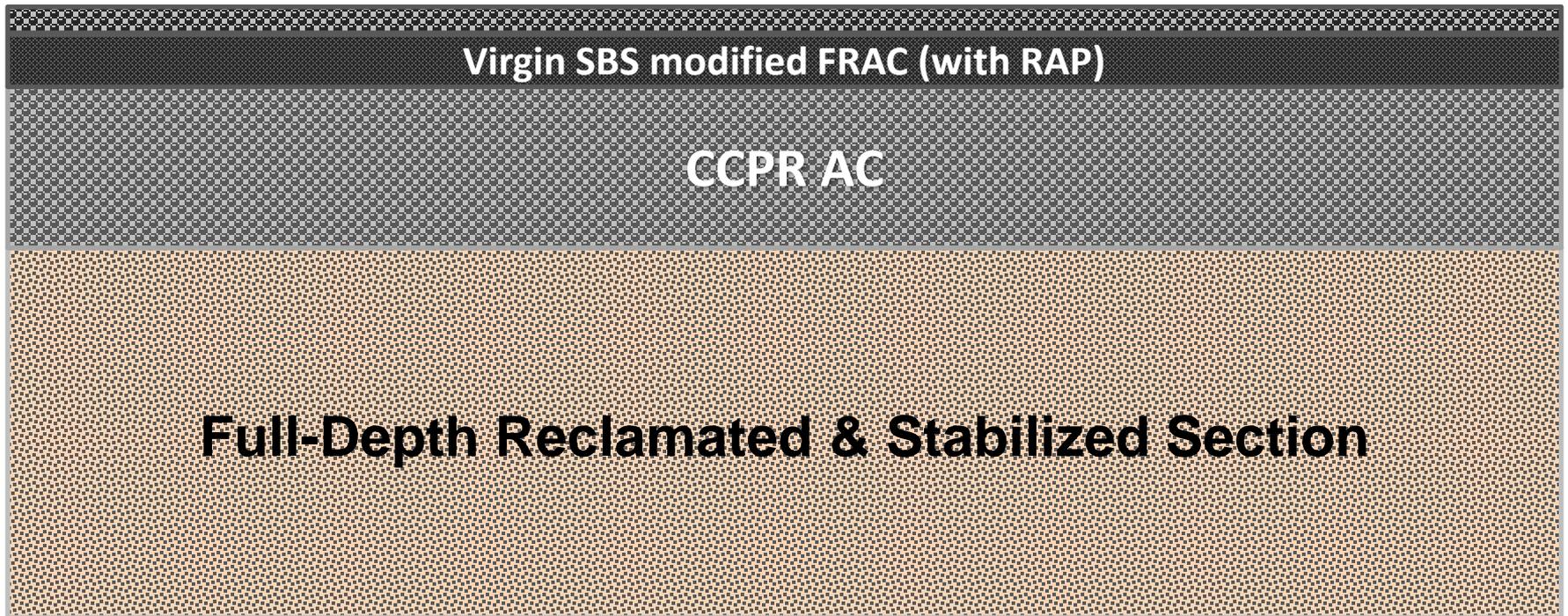
Materials

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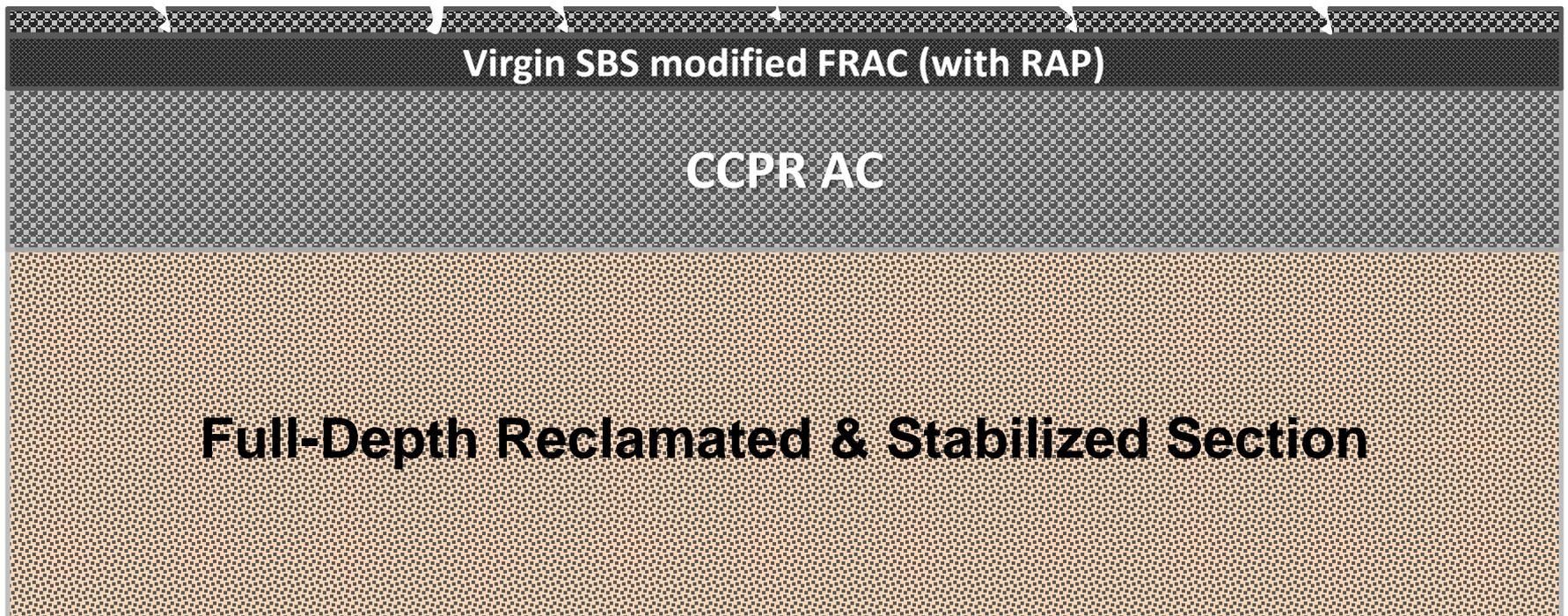
Materials

- Place 2 to 3 inches of Virgin AC mix (with RAP)
- Place Surface Wearing Course (ACFC, AR-ACFC, Chip Seal, Microsurfacing)



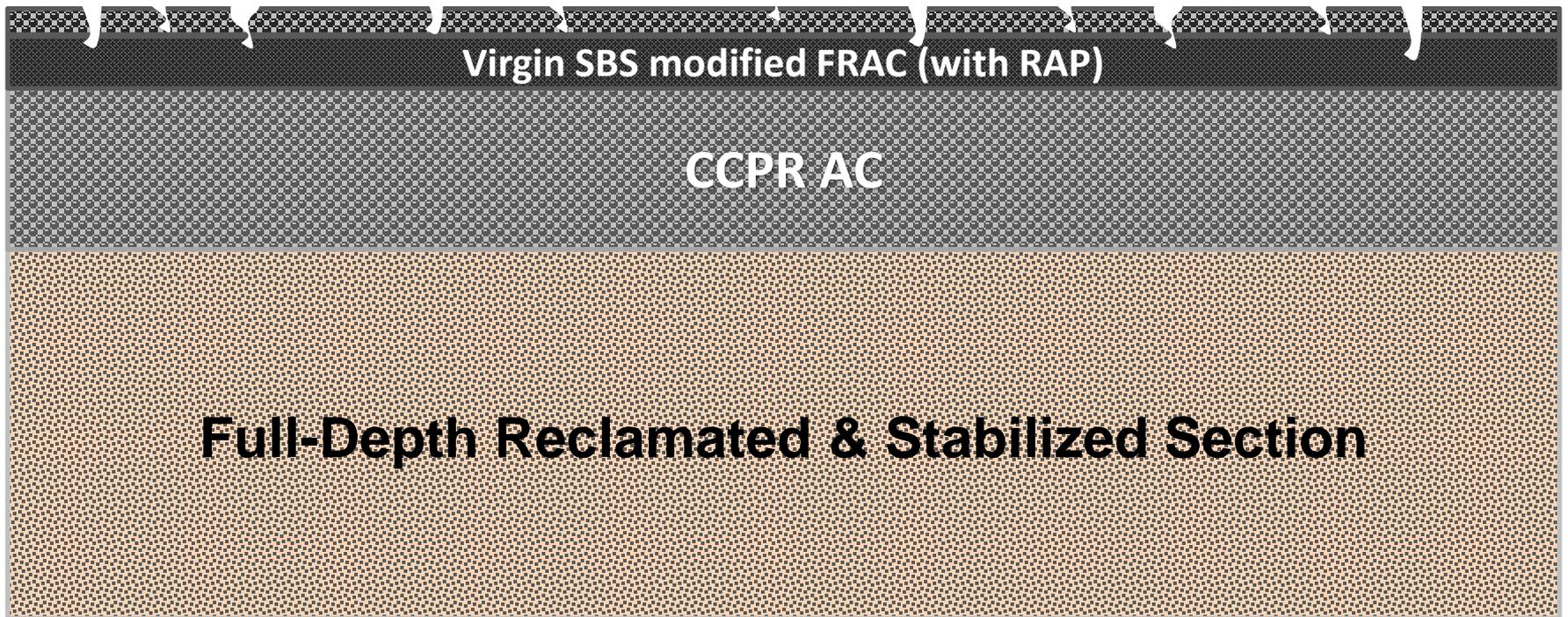
Materials

- Now that it's built, how do we maintain it?
 - Minor pavement preservation (drainage, crack fill, fog seal)



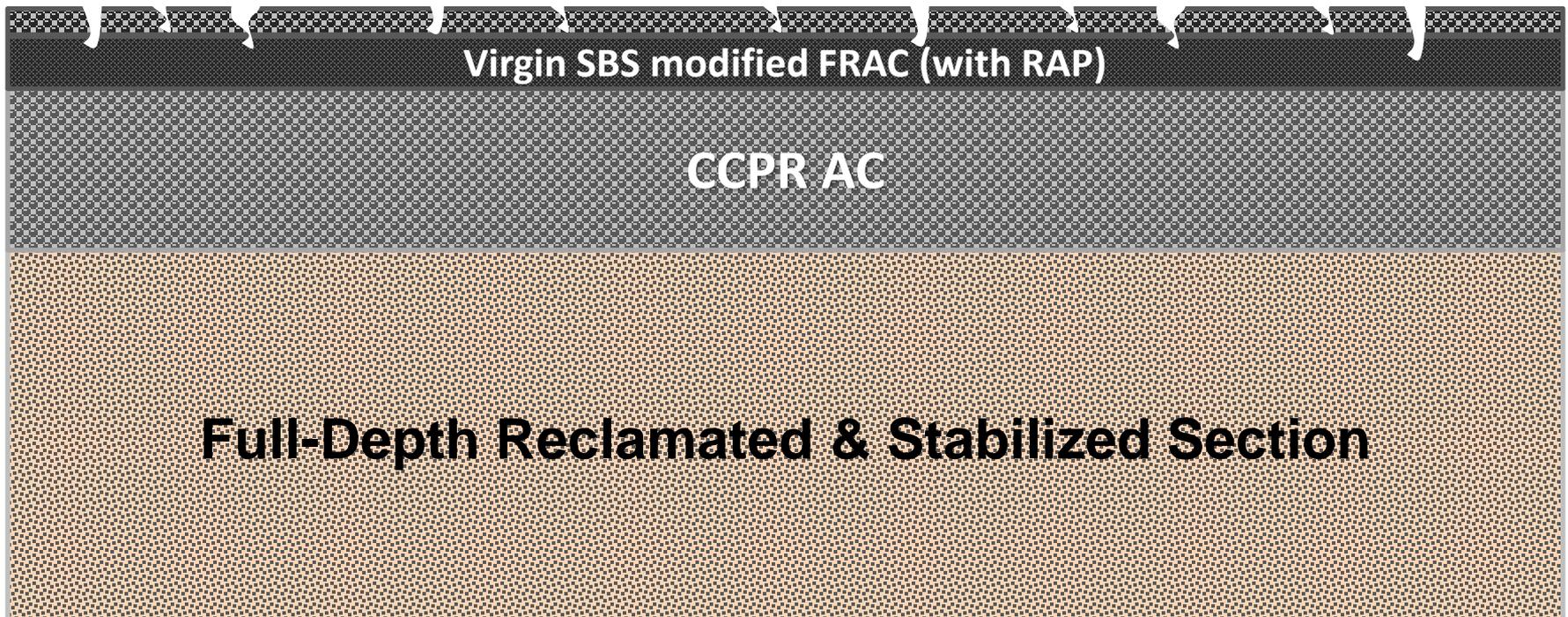
Materials

- Minor pavement preservation activities
- Remove surface wearing coarse (if necessary)



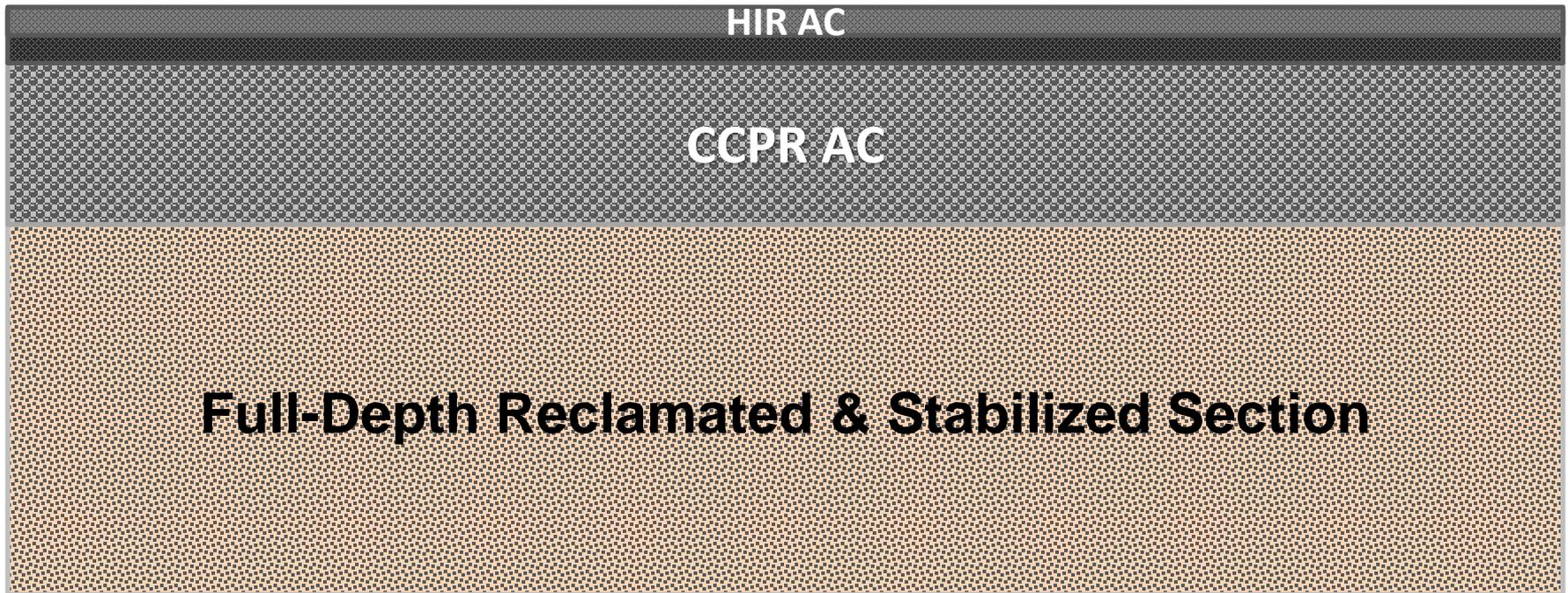
Materials

- Minor pavement preservation activities
- Remove surface wearing coarse (if necessary)
- Hot in-Place Recycle the upper 1.5 to 2 inches of pavement



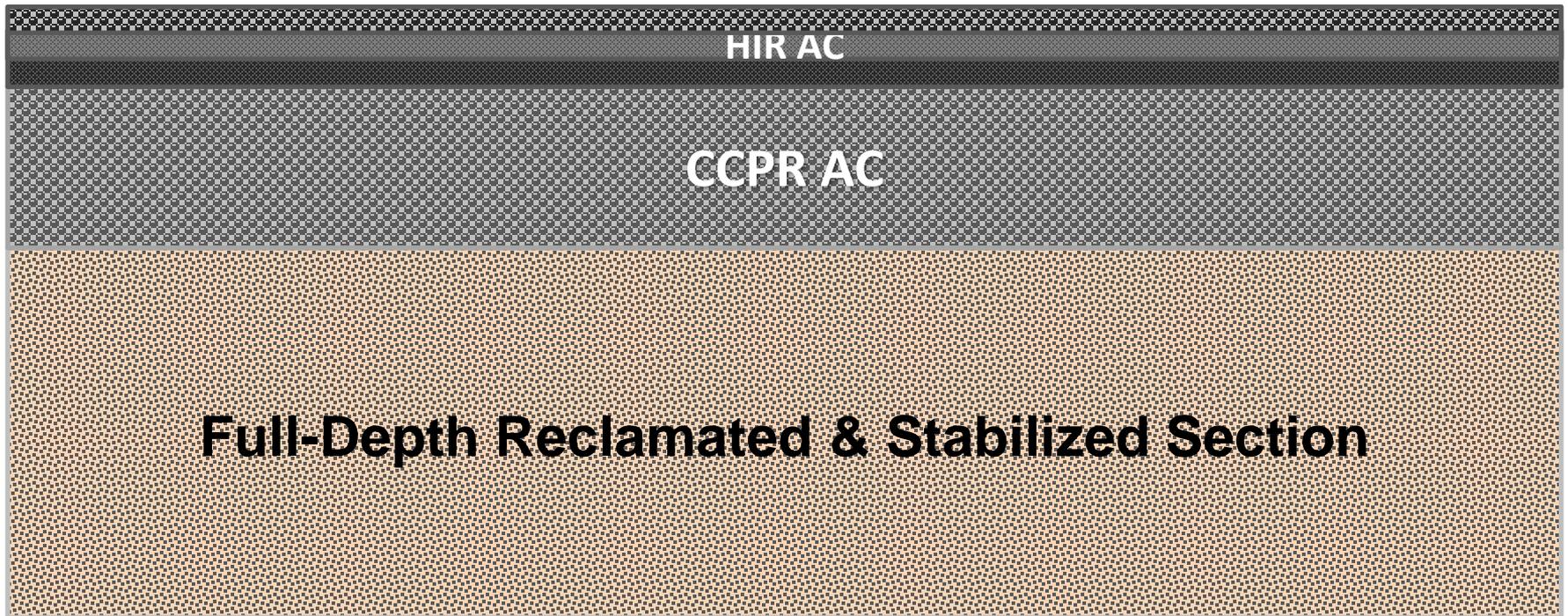
Materials

- Remove surface wearing coarse (if necessary)
- Hot in-Place Recycle upper 1.5 to 2 inches of pavement



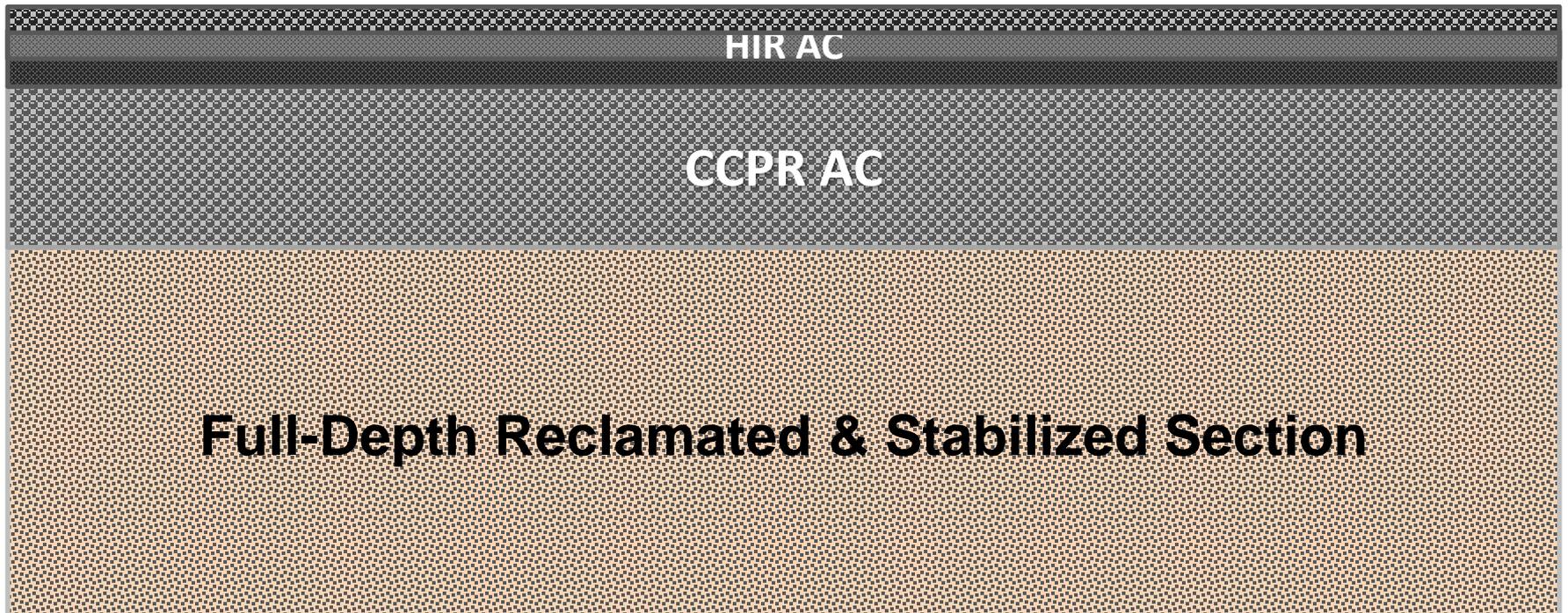
Materials

- Hot in-Place Recycle upper 1.5 to 2 inches of existing AC
- Place additional Virgin AC if necessary (Repaving) and replace surface wearing coarse



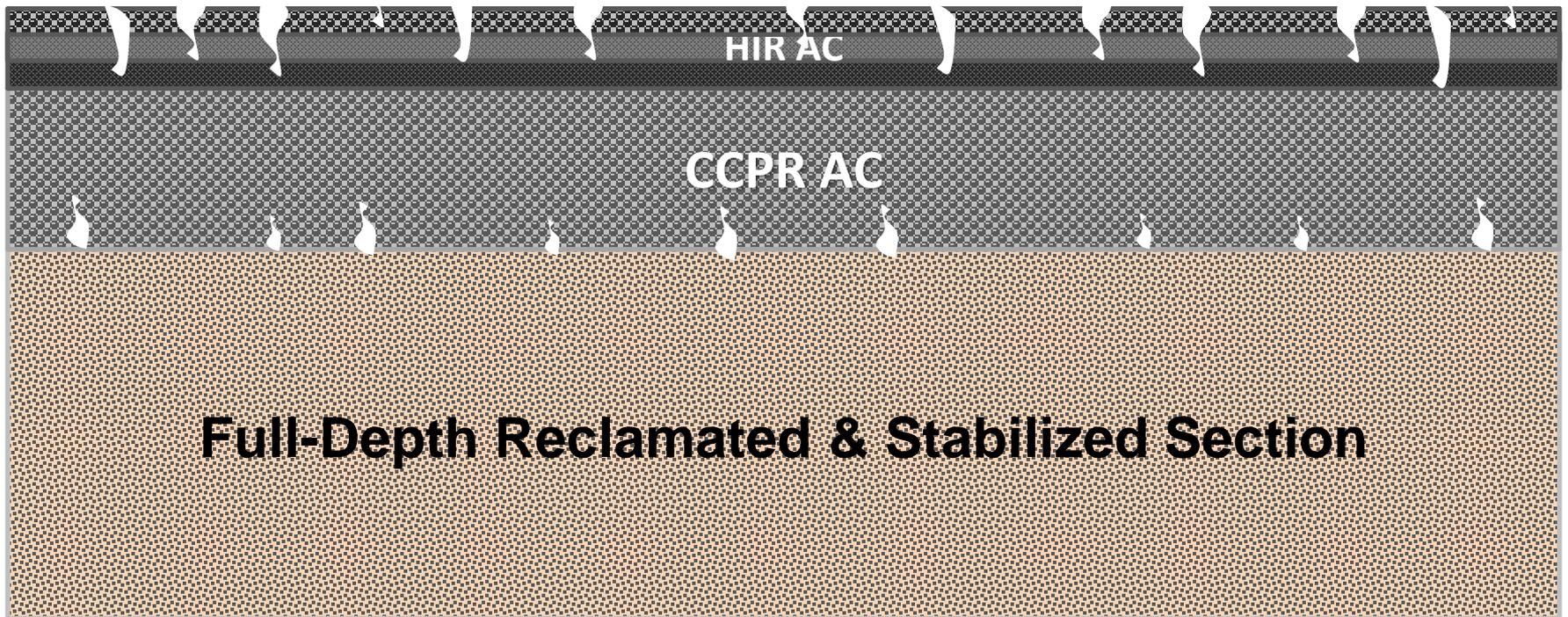
Materials

- Repeat HIR process 1 to 2 additional times
 - May require addition of virgin materials/rejuvenators
 - 8-12 year life expectancy



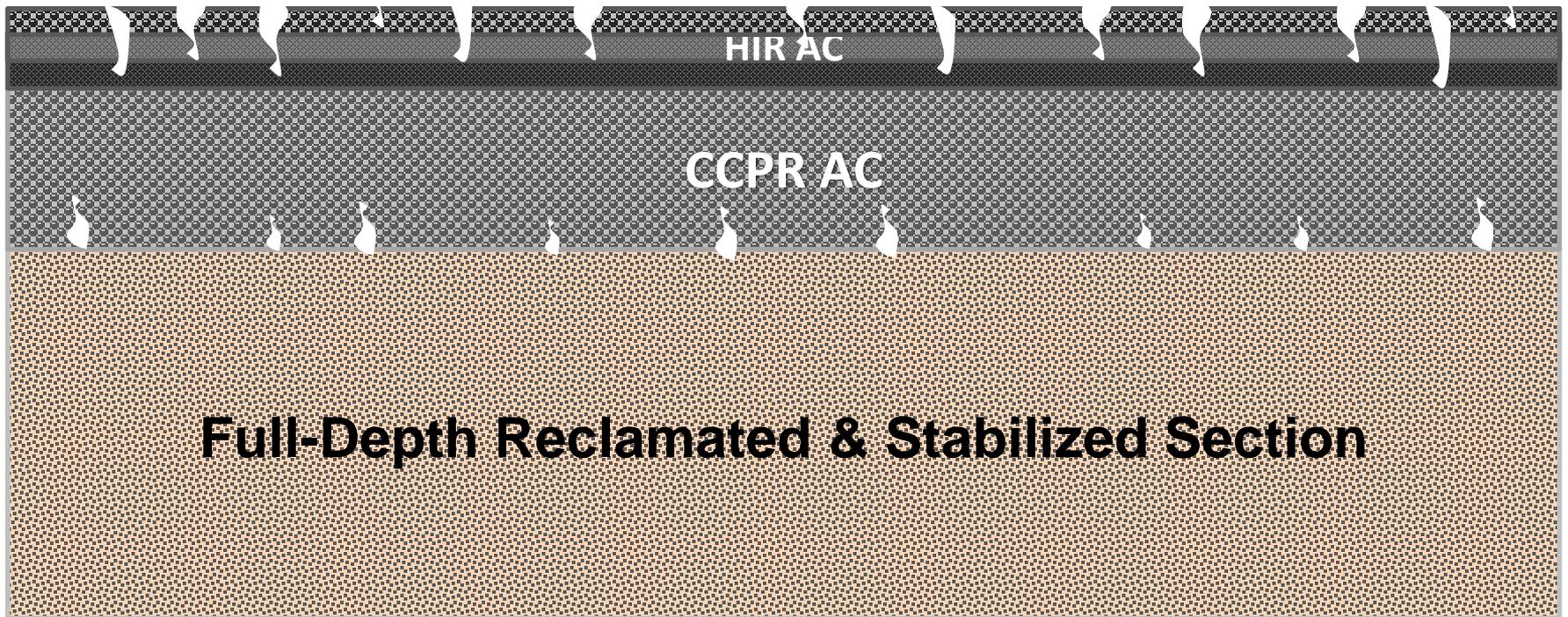
Materials

- What is the treatment after HIR is no longer effective?



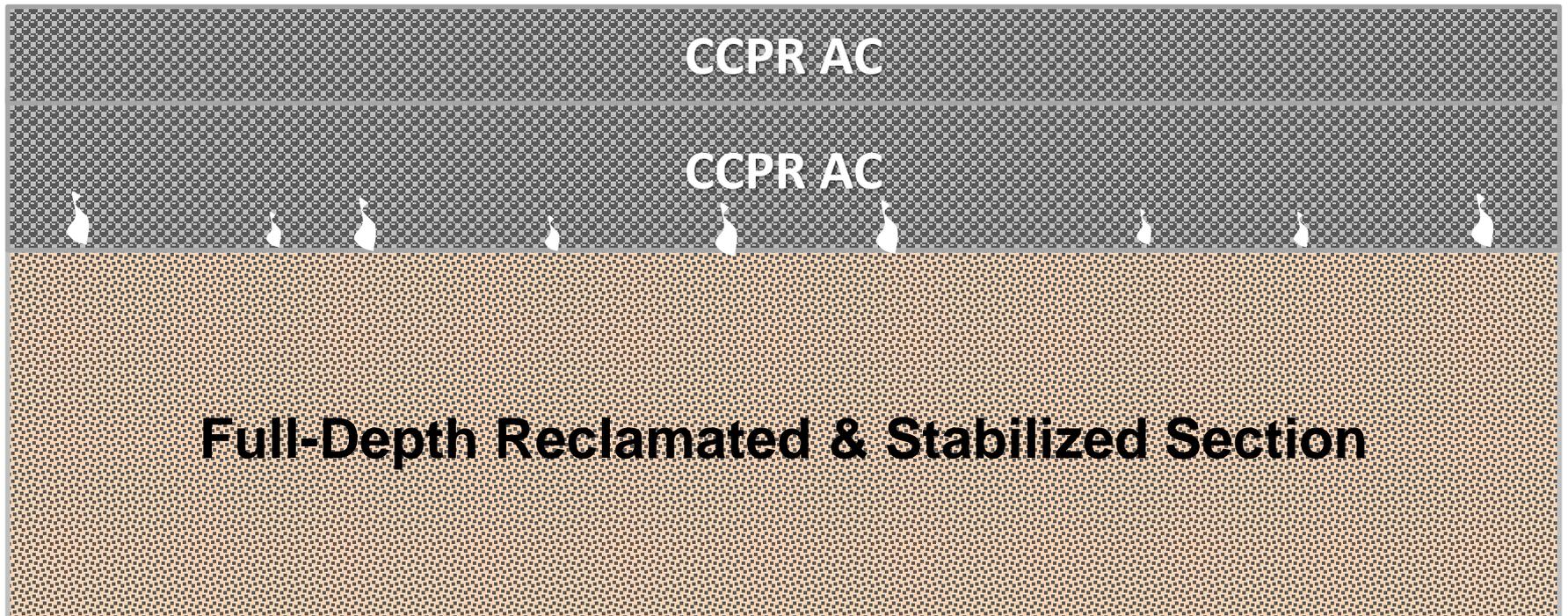
Materials

- Cold in-Place Recycle upper 4 inches



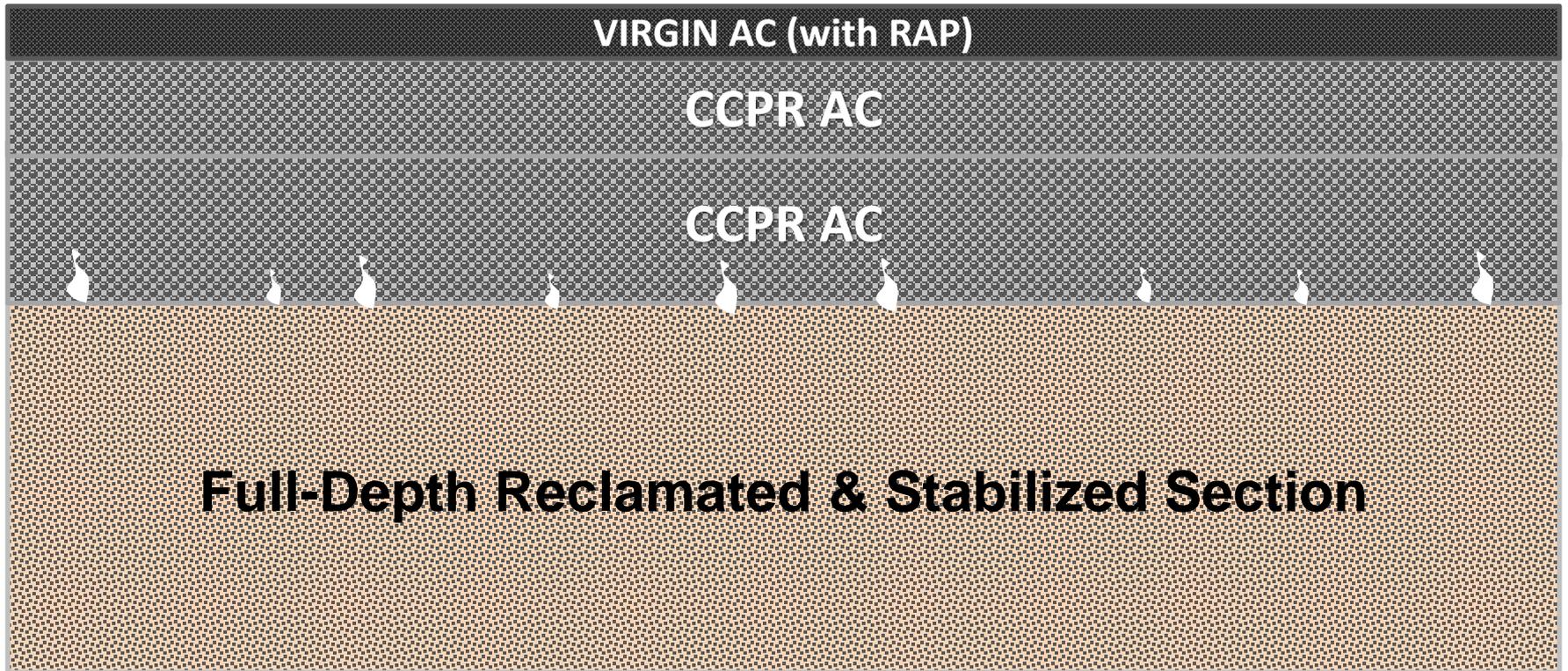
Materials

- Cold in-Place Recycle upper 4 inches
- Place 2-3 inch overlay of Virgin AC (with RAP)



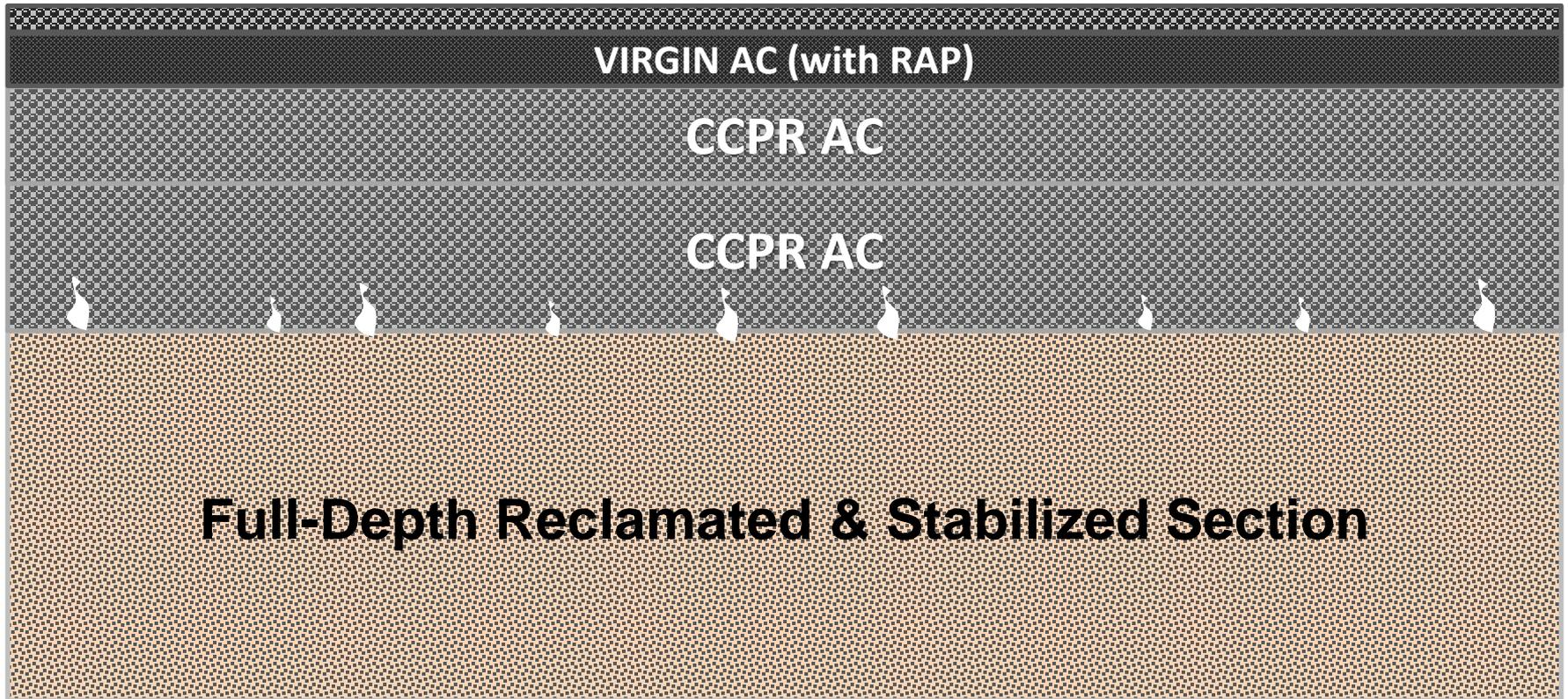
Materials

- Place 2-3 inch overlay of Virgin AC (with RAP)

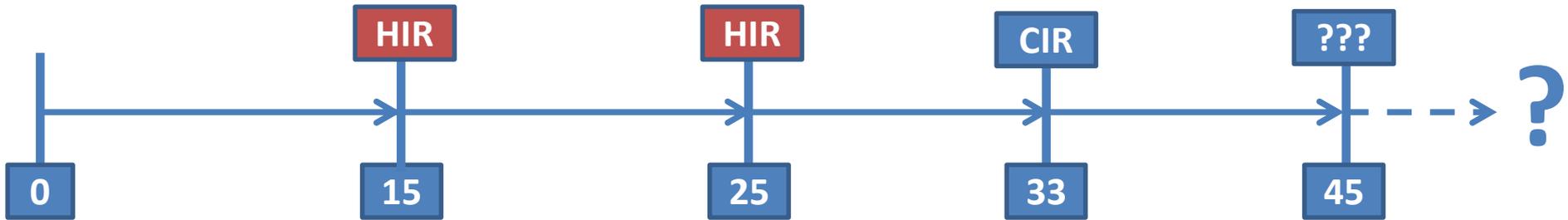


Materials

- Place Surface Wearing Course

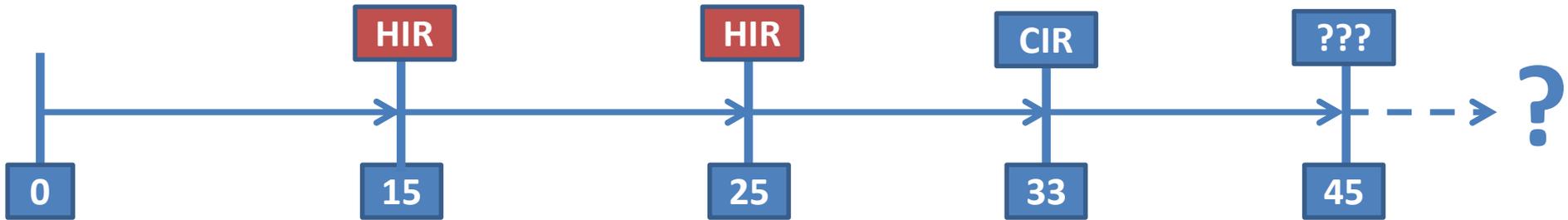


Materials



- Performance Life (initial 15 years before significant surface rehab)
 - HIR after 15 years (year 15)
 - HIR after another 10 years (year 25)
 - CIR after another 8 years (year 33)
 - Significant Recon./Rehab. after another 12 years (year 45)

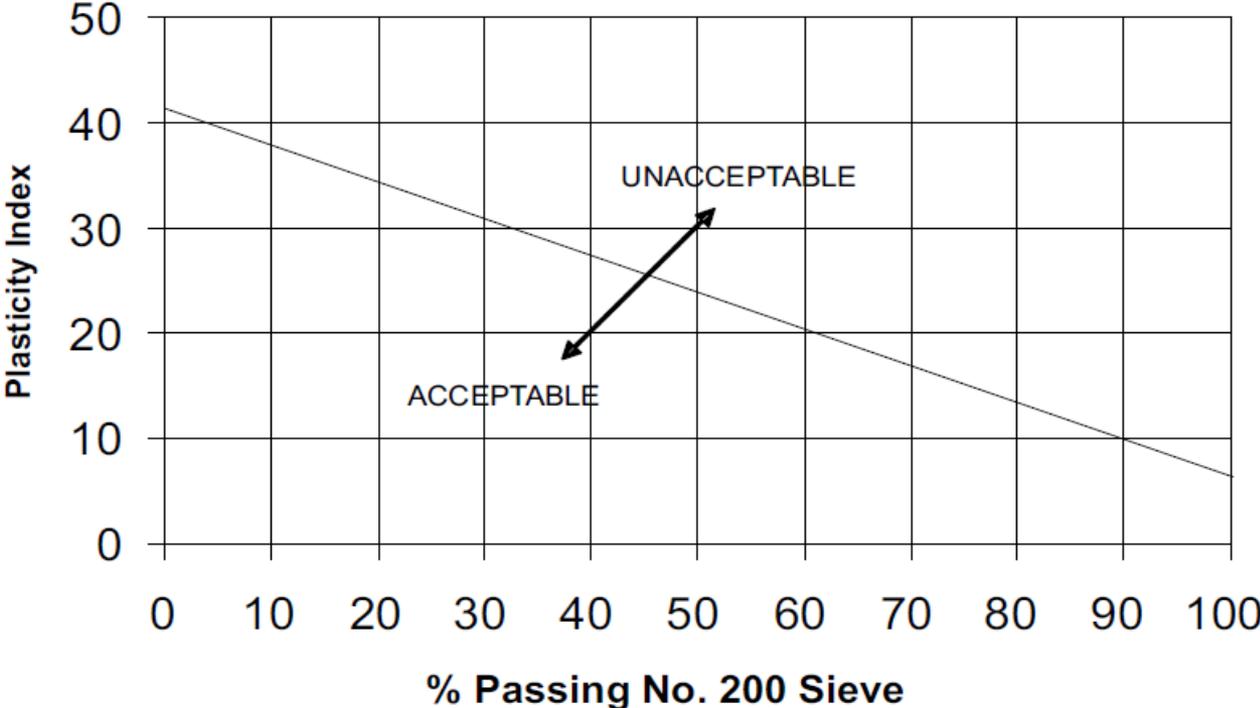
Materials



- Materials Consumed
 - Emulsion / Cement for FDR and CCPR
 - Virgin Aggregate and Binder for High Modulus AC Overlay
 - Virgin Aggregate and Binder for Surface Wearing Course
 - Virgin Binder for HIR (Virgin Aggregate if Repaving)
 - Emulsion with Cement/Lime for CIR
 - Virgin Aggregate and Binder for Overlay and Wearing Courses

Materials

SUBGRADE ACCEPTANCE CHART

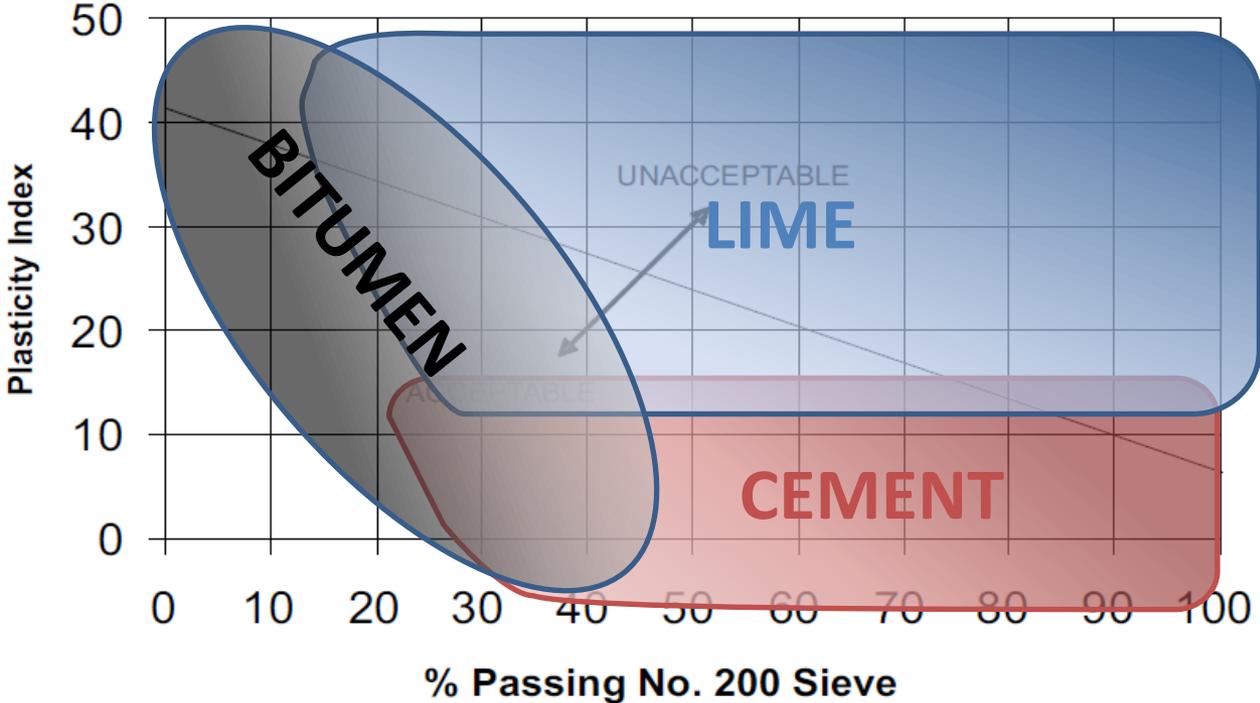


Design R-Value = 20
Construction Control R-Value = 20



Materials

**SUBGRADE ACCEPTANCE CHART
IMPROVEMENT**



Design R-Value = 20
Construction Control R-Value = 20

Materials

- I-40 Devil Dog (PCCP)
 - Geogrid
 - Existing PCCP crushed/re-used for Aggregate Drainage Layer
 - Asphalt Base Mix
- I-40 Cataract Lake (AC)
 - Cement Treated Cinders w/Microcracking
 - RAP (up to 25% in AC) with some WMA
 - Polymer Modified Asphalt in upper 2 inches of AC
 - Intelligent Compaction
- I-17 Coconino County Line (AC)
 - Geogrid Reinforced reclaimed Cinders/RAP Base
 - Intelligent Compaction
- SR89A Cottonwood to Sedona
 - Fiber Reinforced AC

Materials

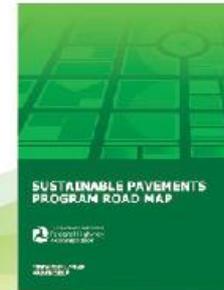
- Pavement Preservation & Recycling Alliance (PPRA)
 - RoadResource.org
- National Center for Pavement Preservation (NCPPI)
 - PavementPreservation.org
- Asphalt Recycling & Reclaiming Association (ARRA)
 - AARA.org
- FHWA, NCAT, Asphalt Institute, State & Local DOTs

Environmental Product Declaration (EPD)

One final area to be aware of – FHWA <https://www.fhwa.dot.gov/pavement/sustainability/hif17029.pdf>



Sustainable Pavements Program Road Map



FHWA project to pilot, begin educating, and develop future guidance for EPDs. In life cycle assessment, an EPD is a standardized way of quantifying the environmental impact of a product or system. In short, is an effort with stakeholders to develop standard product category rules so LCAs between products and system approaches are comparable.

FHWA Environmental Product Declarations And Product Category Rules

<https://www.fhwa.dot.gov/pavement/sustainability/articles/environmental.cfm>

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Sustainable Pavement Systems Program

Thank you

Steven Olmsted

Nye McCarty

Kevin Robertson

Paul Burch