Update on TERRA Survey & ARRA Activities

19th Annual TERRA Pavement Conference

February 12, 2015

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Technical Director
Asphalt Recycling & Reclaiming Association
Surveyed agencies, suppliers and contractors to determine what methods/procedures they use to determine when a CR and FDR mixture has cured sufficiently to allow placement of a surface course.

48 Respondents to survey
Survey Results

Q 2. Does your agency have program or use CIR or FDR?

Q 4. Do you have a criteria for when safe place surface course?
Survey Results

Q 3. Is time/criteria when place overlay an issue or concern?

Q 5. Are you satisfied with your criteria?

Q 3.
- Yes: 60%
- No: 40%

Q 5.
- Yes: 80%
- No: 20%
Questions 6 & 7

► Only 23% were aware of any research in the area (U of Iowa/IDOT, Caltrans, Cal Davis, RMRC.

► Suggested test methods:
  ■ DCP, lightweight deflectometer, proof rolling, Geogauge, Clegg hammer, fracture energy

► Suggested procedures:
  ■ avoid/minimize curing issues by using additives (cement or lime) to improve curing and early strength gain, proper mix design, and secondary compaction prior to placing the surface course.
ARRA’s Recommended Curing Criteria for CIR

The recycled pavement layer should be allowed to cure for a minimum time (typically 3 days) and to a maximum moisture content (typically below 3 percent) before placing the surface course or applying secondary compaction. If the moisture content does not fall below the maximum limit and if the roadway has been free of rain for a specified amount of time (typically anywhere from 2 to 10 days), the contractor should be allowed to place the surface course or perform secondary compaction. Traffic is usually allowed on the mat during this time.
ARRA’s Recommended Curing Criteria for FDR

The surface course may be placed after a minimum cure time (typically 3 days) and when the recycled layer can support the applied loads without deflection and/or the moisture content has dropped to less than 50% of the optimum moisture content determined from a modified Proctor of the recycled material. Traffic is usually allowed on the mat during this time.
ARRA’s Concerns/Position

► Development of test methods/QC procedures allowing evaluation of mix design/mix properties in the field
► Development of test procedure to determine when it is safe to allow traffic on the recycled mix
► Development of criteria when it is safe to place surface course
ARRA Activities

► Best Practice Guidelines
► Pavement Preservation Application Checklist Series
► Transportation Curriculum Coordination Council (TC3) web based courses
► New Basic Asphalt Recycling Manual
ARRA Guidelines

► 100 Series - Recommended Construction Guidelines
► 200 Series - Recommended Mix Design Guidelines
► 300 Series - Recommended Quality Control Sampling and Testing Guidelines
► 400 Series – Recommended Project Selection Guidelines
# Status of ARRA Guidelines

<table>
<thead>
<tr>
<th>Status of ARRA Guidelines</th>
<th>100 Series Const.</th>
<th>200 Series Mix Design</th>
<th>300 Series Quality Control</th>
<th>400 Series Project Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Planing</td>
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<tr>
<td>Milling</td>
<td>X</td>
<td></td>
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<tr>
<td>Micro Milling</td>
<td>X</td>
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<tr>
<td>Cold Recycling</td>
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<tr>
<td>Cold Central Plant</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Cold In-Place</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Full Depth Reclamation</td>
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<tr>
<td>Bituminous</td>
<td>X</td>
<td>X</td>
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<td>Cementitious</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Lime</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

X Available  X Under Development
Education Resources

► Pavement Preservation Application Checklist Series
► www.fhwa.gov
► www.pavementpreservation.org
► www.arr.a.org &
Inspection Training for Cold In-Place Recycling

Module 1: Introduction to Cold In-Place Recycling

The presentation is available as an attachment from the paperclip icon in the bottom right-hand part of the screen.
TC3 Training Resources

- **TCCC Inspector Training for Cold In-Place Recycling (CIR) Web Based**
  FHWA-NHI-134114 – www.tccc.gov

- [http://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=old&typ=3&sf=0&course_no=134114](http://www.nhi.fhwa.dot.gov/training/course_search.aspx?tab=0&key=old&typ=3&sf=0&course_no=134114)

- HIR Class: 3-4 months out.

- FDR class: just started work.
Training Overview

Intro
- Training Introduction

Module 1
- Introduction to Cold In-Place Recycling (CIR)

Module 2
- Cold In-Place Recycling Full Production

Module 4
- Cold In-Place Recycling Post Production Activities
BARM II will be sent to the printer in February
Basic Asphalt Recycling Manual

1st Edition

► Served industry well over past 13 years
► Numerous innovations and improvements in
  ▪ Equipment
  ▪ Materials
  ▪ Methods
► Time for a complete rewrite of the original document
BARM II

► True to the original concept of 1st edition
► Completely rewritten
► Same basic format
► Chapters reorganized
► All photos (117) updated (in color)

FHWA – HIF-14-001
Divided 6 Parts
- Introduction
- Cold Planing
- Hot In-place Recycling
- Cold Recycling
- Full Depth Reclamation
- Appendix

Each Part Color Coded
CHAPTER 2: ASPHALT RECYCLING AND RECLAIMING STRATEGIES IN PAVEMENT MANAGEMENT

The rapid expansion of roadway networks through new construction has peaked. The ability of roadway infrastructure has grown and the majority of roadways are nearing the end of their useful service life. Limited funding and demands on existing resources have shifted the emphasis away from new construction to preservation and extending the service life of existing roadways.

Pavement management is an analysis and decision process used by owner agencies to select and plan maintenance and rehabilitation activities within the constraints of often insufficient annual capital improvement budgets. When implemented correctly, pavement management allows owner agencies to wisely use their funds and do more with less. When implemented correctly, pavement management allows owner agencies to wisely use their funds and do more with less. When implemented correctly, pavement management allows owner agencies to wisely use their funds and do more with less.

While pavement management has proven to be an effective approach to maintain or improve the overall condition of pavement networks, most owner agencies only plan the few they are familiar with, for example:

- Preventive maintenance treatments such as surface treatments for pavements in good condition
- Crack and blown asphalt (HMA/VIM) overlays for pavements in need of rehabilitation
- Reconstruction for pavements in poor condition

This classic approach is shown in Figure 2.1. The solid line in Figure 2.1 represents the decrease in pavement condition with time, deterioration caused by the combined effects of traffic loading and environmental conditions. Different pavements will deteriorate at different rates, as dictated by:

- Original construction quality
- Type and thickness of individual layers
- Skewness of the various layers
- Subgrade soil type and moisture content
- Environmental factors
- Traffic volume and loadings

When implemented correctly, pavement management allows owner agencies to wisely use their funds and do more with less.
PART 2: COLD PLANING

CHAPTER 4: COLD PLANING CONSTRUCTION

Cold Planing (CP), commonly referred to as milling, is the controlled removal of the surface of an existing pavement to the desired depth with specially designed equipment capable of removing portions of the pavement surface to the specified grade and cross-slope.

Development of the cold planer or milling machine began in the late 1970’s when a grade trimmer was upgraded to mill asphalt pavements. Since that time significant advancements in size, horsepower, milling width, milling depth, production and cost-efficiency have been made. CP has become commonplace in construction and is now the preferred method of removing and/or reclaiming pavement materials.

CP can be used to remove part or all of the existing pavement layers and, in addition, can be used to excavate base and subgrade materials. It can be used as a temporary driving surface provided that the appropriate milling pattern is used and the resulting pavement is stable and will not delaminates or reveal.

CP can be used for a wide variety of applications including:
- As a means of improving ride quality prior to an asphalt overlay (hot or warm mix) or other surface treatment, as evidenced by the common use of cold in-place recycling (CIR), Cold Recycling (CR), Full Depth Reclamation (FDR), or asphalt overlays
- As a method to re-establish desired grades and profiles to existing pavements
- As a surface preparation or grade preparation for other maintenance/ rehabilitation techniques such as Hot In Place Recycling (HIP), Cold Recycling (CR), Full Depth Reclamation (FDR), or asphalt overlays.

CP can aid in the mitigation/treatment of the following distresses:
- Raveling
- Bleeding
- Should drop off
- Rutting
- Compressions
- Shoving
- Removal of deteriorated, stripped or aged asphalt
- Poor ride quality caused by swells, bumps, sags and depressions
- Diminished curb reveal heights

The product of a CP operation in asphalt layers is a pulverized material referred to as milled asphalt pavement (RAP). RAP can be used in a number of applications including hot recycling, cold recycling or as a granular aggregate.
BARM II

► Parts 3-5
► Hot In-place Recycling
► Cold Recycling
► Full Depth Reclamation
► Four Chapters for Each Part (Discipline)
BARM II

For Each Part - Chapters on:

- Detailed Project Analysis
- Mix Design
- Construction
- Project Specifications and Inspection
Part 3: Hot In-place Recycling

Chapters 6-9

CHAPTER 6:

HOT IN-PLACE RECYCLING DETAILED PROJECT ANALYSIS

Hot In-place Recycling (HIR) is an on-site, in-place maintenance/rehabilitation method which consists of heating, softening, scarifying, mixing, placing and compacting the existing pavement. Rejuvenating agents (rejuvenating oil, rejuvenating emulsion or in some cases a soft binder) and additives such as admixtures, consisting of new plant-mixed hot or warm mix asphalt (HMA/WMA), or new aggregates can be integrated into HIR mixtures to improve the characteristics of the recycled pavement. There are three sub-disciplines of HIR: Surface Recycling, Remilling and Repaving. There are many variations within the sub-disciplines of HIR based on heating and mixing methods, admixture addition and use of integral overlays but they all fall within one of these three HIR sub-disciplines:

Surface Recycling is the HIR process in which softening of the asphalt pavement surface is achieved with heat from a series of pre-heating units. The heated and softened surface layer is then further heated and scarified to the desired treatment depth with either a series of spring activated teeth or "tines," a small diameter rotary milling head or an auger and moldboard. As the surface is scarified a rejuvenating agent is added, if required, and the loose recycled mixture is thoroughly mixed in-place and then sprayed with a paving sealer. No admixtures or new aggregates are added during the Surface Recycling process so the overall pavement thickness remains essentially the same. A surface course (surface treatment or asphalt overlay) is generally placed in a subsequent operation for most functional classes, although the HIR Surface Recycling mixture has been left as the surface course on some low volume roads.

Remilling is the HIR sub-discipline where the existing asphalt pavement is heated, softened, augered, scarified or milled, and remixed in a mixing drum or pugmill, typically with a rejuvenating agent. Admixtures or new aggregates may be added as required for recycled mixture needs and/or grade control. In many cases admixtures are not required. In all cases, the result is a thoroughly mixed, homogenous layer. This recycled mixture is often left as the surface course; but it could be overlaid with HMA/WMA or a surface treatment such as a chip seal, slurry or micro surfacing depending on pavement needs.

Repaving combines Surface Recycling or Remilling with the placement of an integral asphalt overlay. The recycled mixture and asphalt overlay are then compacted together. In the Repaving process, the recycled mixture functions as a base or leveling course while the new asphalt overlay is the final surface course. Overall pavement thickness can be increased in the HIR Repaving process. The thickness of the asphalt overlay can be less than a conventional thin lift overlay since there is a thermal bond between the two layers and they are compacted as one lift. In addition, the asphalt overlay can include larger nominal aggregates since it will be embedded into the overall structure. The use of tack coat is eliminated due to the thermal bond between layers.
Table 6-1 describes which HIR sub-discipline addresses which pavement distresses.

Notes clarify if address, mitigate other actions required.
Part 4: Cold Recycling
Chapters 10-13

CHAPTER 12: COLD RECYCLING—CONSTRUCTION

Cold Central Plant (CCPR)

Cold In-place (CIR)
CR Applicability

Table 10-1: CR Applicability

<table>
<thead>
<tr>
<th>Condition</th>
<th>CR Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Defects</td>
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<tr>
<td>Raveling</td>
<td>Yes</td>
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<tr>
<td>Pot Holes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bleeding</td>
<td>Yes</td>
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<tr>
<td>Skid Resistance</td>
<td>Yes</td>
</tr>
<tr>
<td>Deformations</td>
<td></td>
</tr>
<tr>
<td>Shoulder Drop Off</td>
<td>No</td>
</tr>
<tr>
<td>Rutting - Wear</td>
<td>Yes</td>
</tr>
<tr>
<td>Rutting - Mix Instability</td>
<td>Possible, see note a</td>
</tr>
<tr>
<td>Rutting - Deep Structural</td>
<td>Possible, see note b</td>
</tr>
<tr>
<td>Corrugations</td>
<td>Yes</td>
</tr>
<tr>
<td>Shoving</td>
<td>Possible, see note a</td>
</tr>
<tr>
<td>Fatigue - Bottom Up</td>
<td>Possible, see note c</td>
</tr>
<tr>
<td>Fatigue - Top Down</td>
<td>Possible, see note c</td>
</tr>
<tr>
<td>Edge</td>
<td>Possible, see note d</td>
</tr>
<tr>
<td>Slippage</td>
<td>Possible, see note e</td>
</tr>
<tr>
<td>Load Associated Cracking</td>
<td></td>
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<tr>
<td>Non-load Associated Cracking</td>
<td></td>
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<tr>
<td>Block</td>
<td>Yes</td>
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<tr>
<td>Longitudinal</td>
<td>Yes</td>
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<tr>
<td>Transverse</td>
<td>Yes</td>
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<tr>
<td>Reflective</td>
<td>Yes</td>
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<tr>
<td>Combined Cracking</td>
<td></td>
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<tr>
<td>Joint Reflective</td>
<td>Possible, see note f</td>
</tr>
<tr>
<td>Discontinuity</td>
<td>Yes</td>
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<tr>
<td>Base/Subgrade Deficiencies</td>
<td></td>
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<tr>
<td>Swells, Bumps, Sags</td>
<td>Possible, see note g</td>
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<tr>
<td>Depressions</td>
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<tr>
<td>Roughness</td>
<td></td>
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<tr>
<td>Ride Quality</td>
<td>Yes</td>
</tr>
<tr>
<td>Other Criteria</td>
<td></td>
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<tr>
<td>All Levels of Traffic</td>
<td>Yes, see note h</td>
</tr>
<tr>
<td>Rural</td>
<td>Yes</td>
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<tr>
<td>Urban</td>
<td>Yes, see note i</td>
</tr>
<tr>
<td>Stripping</td>
<td>Possible, see note a</td>
</tr>
<tr>
<td>Poor Drainage</td>
<td>No, see note j</td>
</tr>
</tbody>
</table>

Notes:  
- a) Can be corrected with additives such as cement, lime and new aggregate. Needs to be verified by a mix design.  
- b) Not with CIR but can be addressed with CCPR and correction of the underlying materials.  
- c) Ensure that structural requirements can be met. CR in conjunction with an asphalt overlay may be needed.  
- d) Need to provide shoulder confinement after CR.  
- e) As long as treatment depth exceeds the slippage plane.  
- f) May not correct but will mitigate.  
- g) Can be addressed with CCPR and correction of the underlying materials. CIR may not correct but may mitigate.  
- h) As long as proper pavement structural design is undertaken as part of the process to ensure that the effects of future traffic are taken into account and if the CR mixture is designed to have sufficient early and long term strength. Additives (cement or lime) may be necessary to improve early strength gain.  
- i) Geometric constraints may influence the type of recycling units used or whether CIR or CCPR is used.  
- j) Poor drainage must be improved for CR, or any other pavement treatment, to ensure adequate performance.
Chapter 17: Full Depth Reclamation Project Specifications and Inspection

As with all roadway construction processes, two key steps are required to ensure satisfactory construction and performance of a Full Depth Reclamation (FDR) project. First is the development of an adequate and equitable set of specifications and second is inspection of the FDR project during construction to ensure that the intent of the specifications has been achieved.

Specifications describe to the contractor what they are legally obliged to provide an owner agency. Therefore, it is important that they are specific enough to protect the owner agency and that they lead to the use of standards and practices that will result in a well-constructed project.

When developing effective specifications, it is important that the right type of specification be used for the right project and that the right elements are included in the specification to ensure successful long-term performance of the treatment. The keys to developing effective construction specifications are to select the appropriate type of specification to ensure that the finished project meets expectations.

There are no established criteria for when to use one type of specification (method, and result or quality assurance) over the other. Owner agencies typically use a combination of the specification types by setting some limitations on materials and equipment and then set minimum levels of performance for the project. Combination specifications leave the contractor with the ability to select materials, equipment and construction methods beyond the minimum to achieve the desired results. However, these limitations increase the risk of the contractor not meeting the project requirements.

Method specifications require the owner agency to describe in complete detail all equipment and procedures that must be used to obtain the desired quality of the project. Method specifications require continuous construction monitoring and require that inspectors work closely with contractors to assure compliance. Writing a good set of method specifications requires that the owner agency prepare the specifications be experimented with all phases of the proposed construction.

With end result specifications, the owner agency tells the contractor what level of performance or end result is expected from the project at a particular time interval and how that performance will or and result will be measured. The contractor selects the construction methods and equipment, job mix formula (JMF), stabilizing agents and additives and construction sequence. At the prescribed performance interval, the owner agency performs testing to assure that the minimum contract requirements were obtained. Material and field testing of the quality characteristics determined for the project are usually statistically based and therefore, reasonable construction variation of the quality characteristics must be understood and allowed for in the specifications.
# FDR Stabilizing Agent Selection Guide

## Table 15-1: Stabilizing Agent Selection Guide for FDR Mixtures Including RAP

<table>
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<tr>
<td><strong>USCS</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>GW</td>
<td>GP</td>
<td>GM</td>
<td>GC</td>
<td>SW</td>
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<td>ML</td>
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<td>OL</td>
<td>MH</td>
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<td><strong>AASHTO</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>A-1-a</td>
<td>A-1-b</td>
<td>A-1-b</td>
<td>A-1-b</td>
<td>A-3 or A-1-b</td>
<td>A-2-4 or A-2-5</td>
<td>A-2-6 or A-2-7</td>
<td>A-4 or A-5</td>
<td>A-6</td>
<td>A-4</td>
<td>A-5 or A-7-5</td>
<td>A-7-6</td>
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<td>Emulsified Asphalt</td>
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<tr>
<td>SE &gt; 30 or PI &lt; 6 and P&lt;sub&gt;200&lt;/sub&gt; &lt; 20%</td>
<td>X</td>
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<td>X</td>
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<td>PI &lt; 10 and P&lt;sub&gt;200&lt;/sub&gt; 5 to 20%</td>
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<td>Cement, CKD or Self-Cementing</td>
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<td>Class C Fly Ash</td>
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<td>Pl &lt; 20</td>
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<td>SO₄ &lt; 3000 ppm</td>
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<tr>
<td>Lime/LKD</td>
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<tr>
<td>Pl &gt; 20 and P&lt;sub&gt;200&lt;/sub&gt; &gt; 25%</td>
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<td>SO₃ &lt; 3000 ppm</td>
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<td>X</td>
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Availability

BARM II will be available through ARRA members. Check with your local ARRA Contractor or Supplier Member for more information on how to receive a copy.
Thank You

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