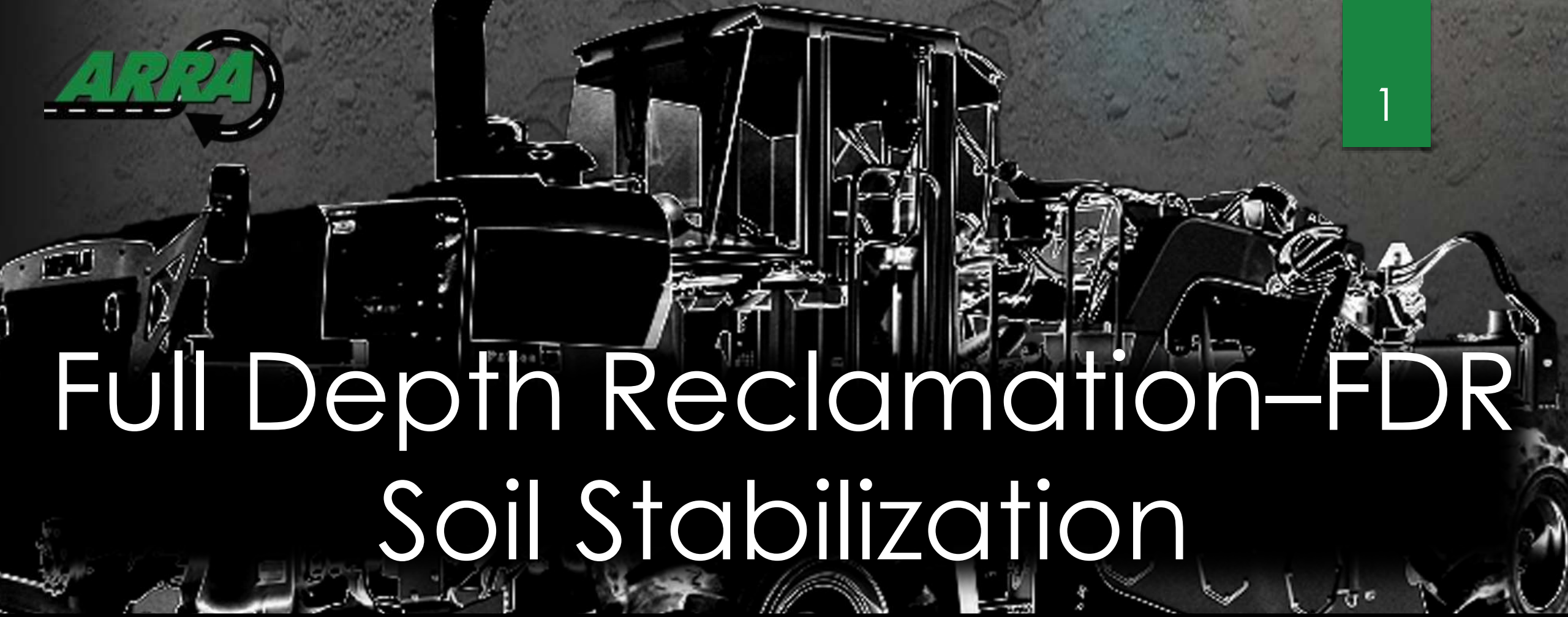


Full Depth Reclamation–FDR Soil Stabilization

JONATHAN PEASE – PRESIDENT

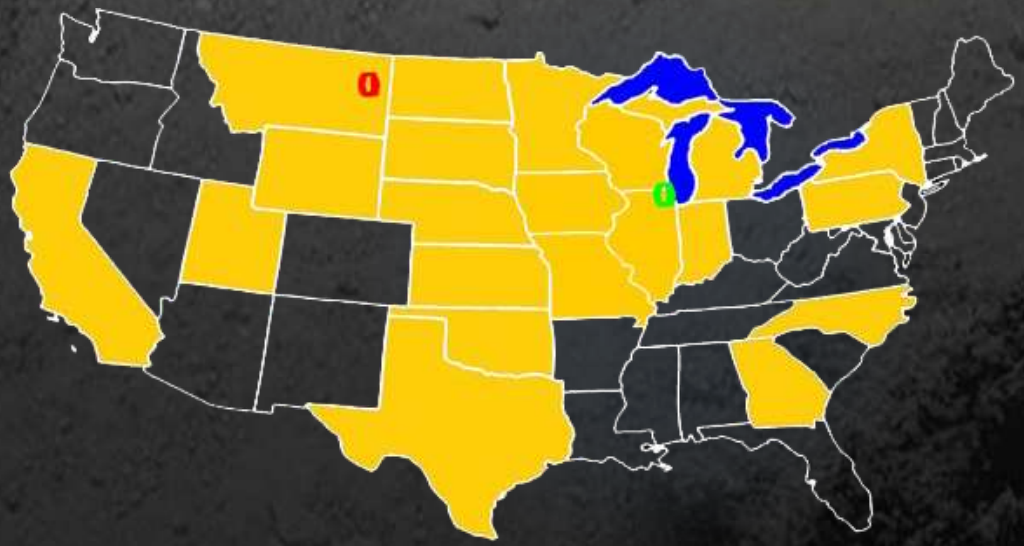
ROCK SOLID STABILIZATION & RECLAMATION, INC.

Jonathan Pease History

- Started in the heavy civil construction industry at 12 yrs. of age
- Performed various tasks throughout my career in the heavy civil road building industry
- Purchased the family road construction business in 2002
- Formed Rock Solid Stabilization in 2007 & joined ARRA
- Joined the Board of Directors of ARRA in 2015
- Been involved in 40million+ SY of soil stabilization & FDR projects

Rock Solid Stabilization & Reclamation, Inc.

- Greater Midwest
- Seasonally 85+ Employees
- Full Service Soil Stabilization And Road Recycling Contractor



Presentation Overview

- Full Depth Reclamation – FDR
- Soil Stabilization
- Cost examples of both processes

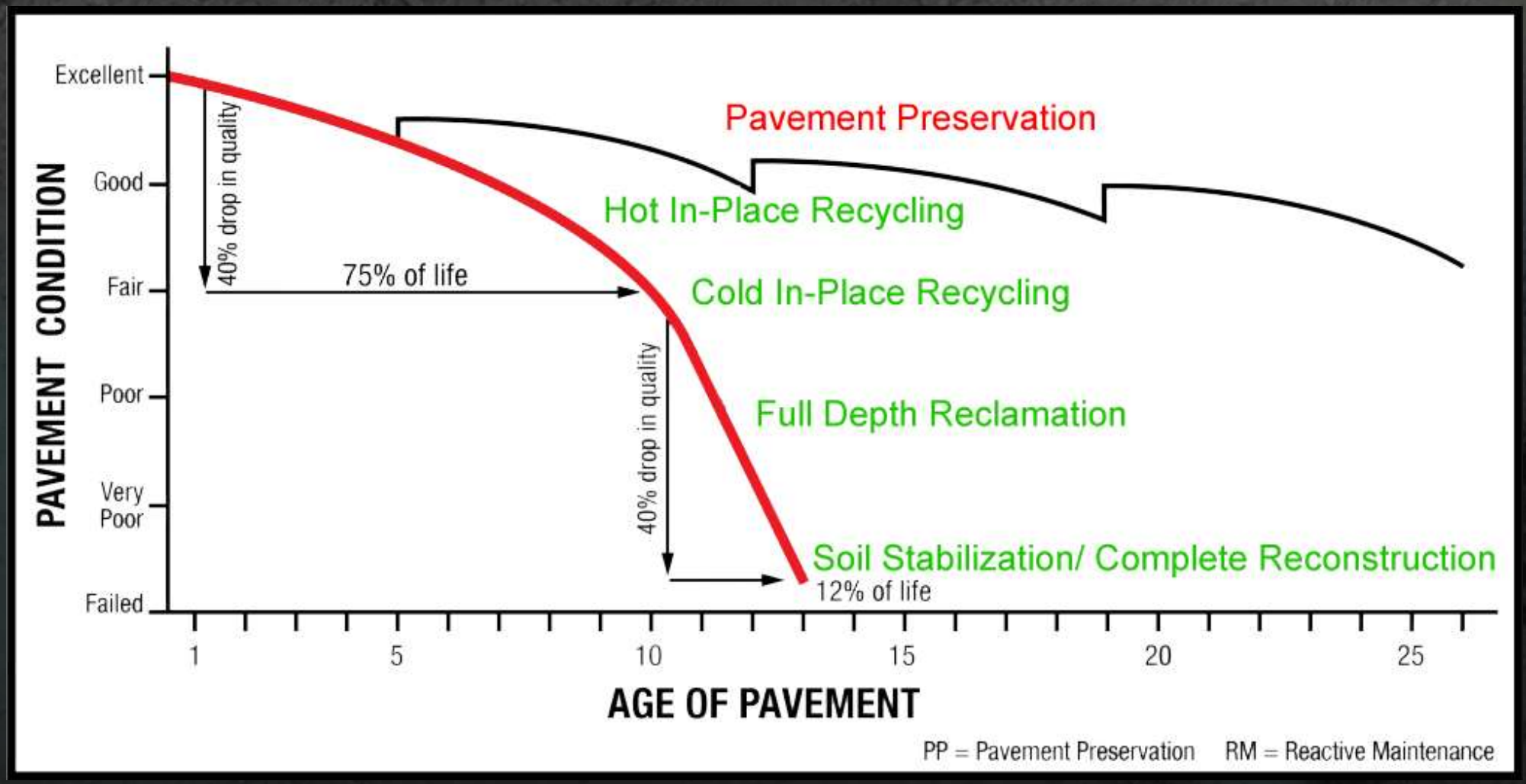
Pulverization

Cold Recycling Mill vs. Reclaimer

- Collects millings into center
- Typically utilized to remove surface materials and place on to trucks

- Grinds/blends all pavements/soils in place, in a linear fashion
- Creates homogenous blend

Pavement Life cycle Curve



Industry Overview

Chose the Right Process @ the Right Time, on the Right Road, For the Right Price

- Visual site investigation
- Subsurface investigation (includes subgrade) "sampling the site"
- Perform a "Mix Design" to find the right mixture to achieve the desired strengths and flexibility desired and which additives will work.
- Cost comparison of available options/additives
- Fix subgrade drainage issues if needed
- Utilizing a competent "team" of civil & geotechnical engineer, contractor, equipment manu. & additive supplier all with experience.
- Realize and inform customer that there can be field changes due to unforeseen circumstances at times
- Infield QC/QA when possible

What is FDR?

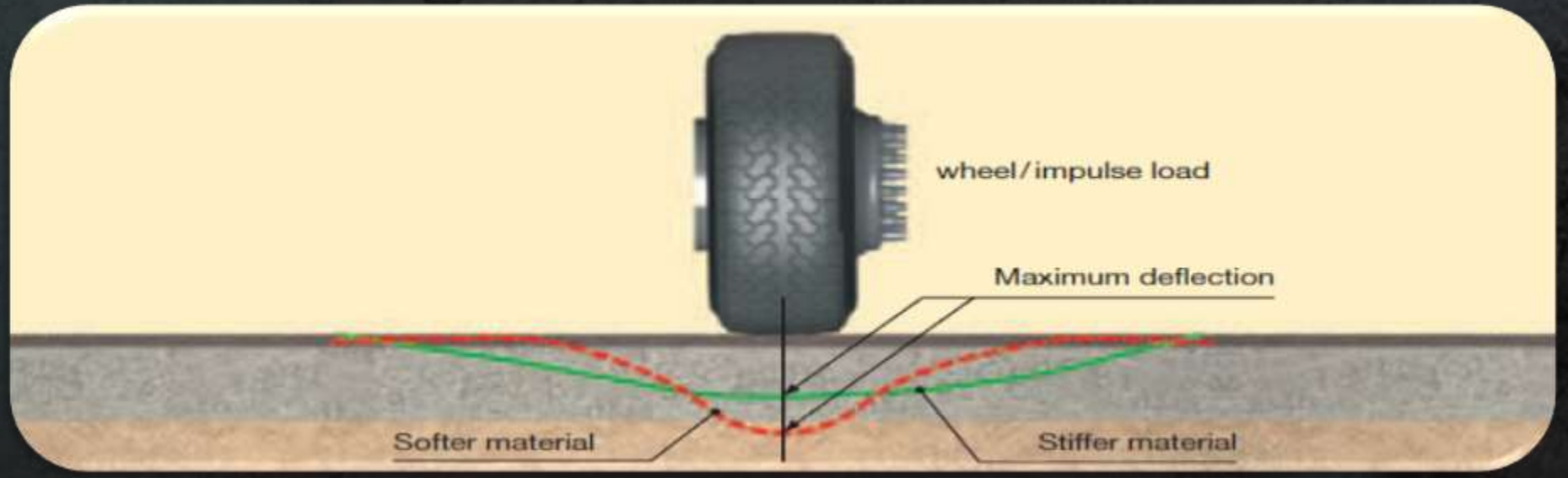
Per ARRA, Full Depth Reclamation is a technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly crushed, pulverized, or blended, resulting in a stabilized base course; further stabilization may be obtained through the use of available additives. By addressing the entire pavement section, full depth reclamation is able to correct delinquent cross sections, increase the load-bearing strength of the base, and utilize 100% of the existing materials. (ARRA)

FDR Candidates

- Deteriorated Asphalt and/or Aggregate Base (Reconstruction)
  - Parking Lots
  - Industrial Storage Lots
  - Secondary Roads
  - City Streets
  - Interstate Highways
  - Airport Runways

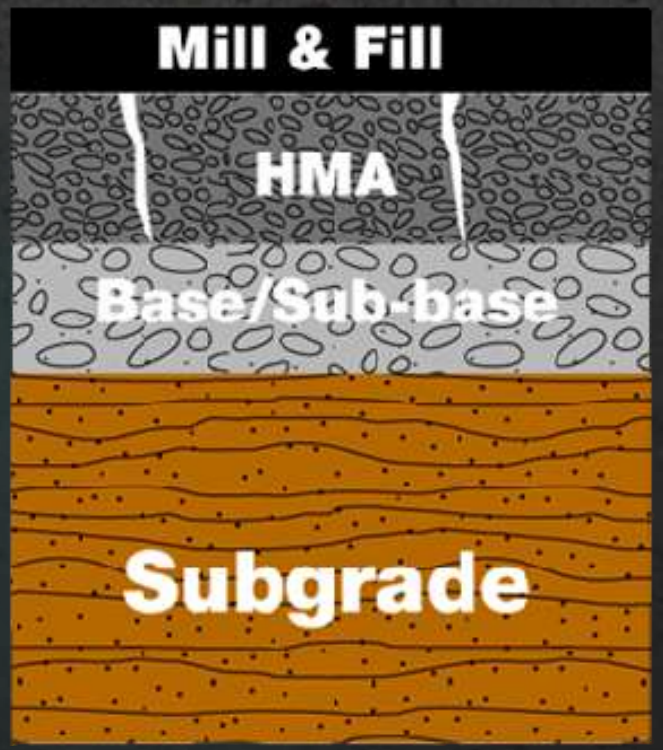
When to Utilize FDR

- Spec'd or Value Engineered on Asphalt Pavements in Need of Replacement
  - Frequent Deep Cracking
  - Reflective Cracking
  - Heavy Pothole Patching
  - Severe Rutting/ Shoveling
  - Frost Heaves (may require drainage corrections)
  - Insufficient Base Strength

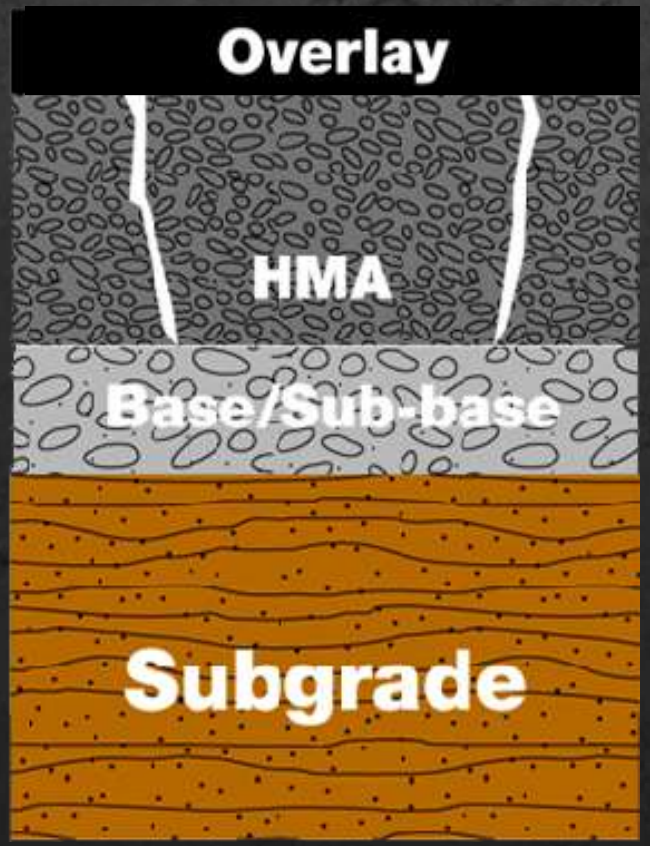


Typical vs. fdr Cross Sections

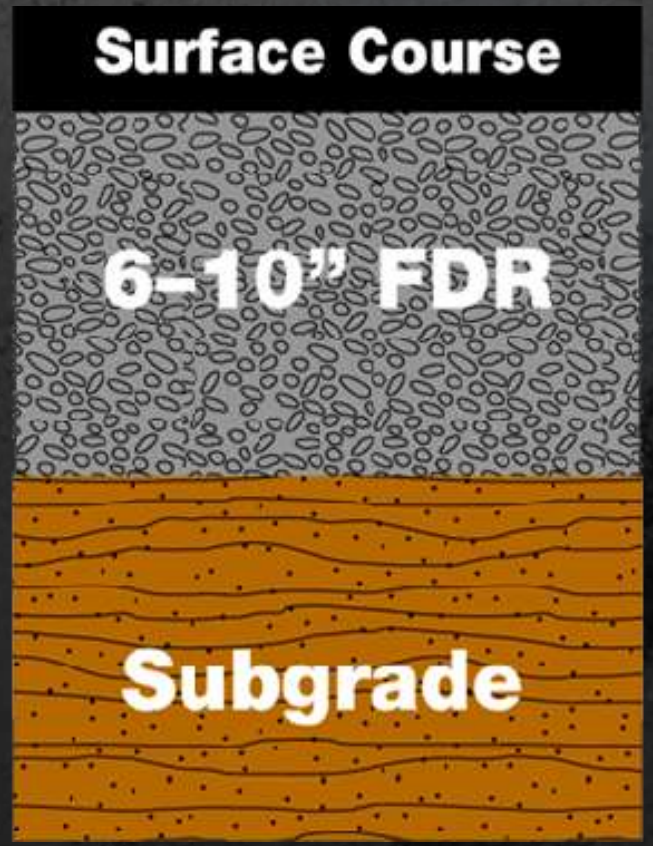
Mill & Fill



Overlay



Full Depth Reclamation



FDR Methods

- Mechanical
- Chemical
- Bituminous

Mechanical stabilization

- Pulverizing deteriorated asphalt and/or aggregate surface
- May incorporate the addition of supplemental aggregate
- No stabilizer or binder are incorporated into the blend

Chemical stabilization

- Includes the addition of chemical stabilizers such as:
  - Portland Cement
    - Dry or Slurry
  - Quicklime or Hydrated Lime
    - Dry or Slurry
  - Lime Kiln Dust
  - Cement Kiln Dust
  - Class "C" Fly Ash
    - Or blends of the above
  - Other Polymers or Enzymes

Bituminous stabilization

- Includes the addition of bituminous binders
  - Emulsified Asphalt
  - Expanded Foam
  - **FDR Video Next Slide**

FDR
The process

Pre-pulverization

FDR
The process

Shape & Compact

Pre-pulverization

FDR
The process

Transportation

Pre-pulverization

Shape & Compact

FDR
The process

Spreading

Pre-pulverization

Shape & Compact

Transportation

FDR
The process

Spreading

Mixing Powder

Pre-pulverization

Shape & Compact

Transportation

FDR
The process
Mixing Emulsion/Foam

Pre-pulverization

Shape & Compact

Transportation

Spreading

Mixing

FDR
The process

Compacting

Pre-pulverization

Shape & Compact

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Mixing

FDR
The process

Grading

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Shape & Compact

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Spreading

Mixing

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FDR
The process

Finish Static Roll

Pre-pulverization

Shape & Compact

Transportation

Spreading

Mixing

Compacting

Grading

FDR
108th Ave. Structural Numbers

STRUCTURAL EQUIVALENT FDR VS. R&R			
PROPOSED FDR SECTION			
MATERIAL	**Sn/ Inch**	**DEPTH (INCHES)**	**IBR**
Full Depth Reclamation	0.25	10.00	2.50
TOTAL STRUCTURAL NUMBER:			**2.50**
REPLACEMENT SECTION with Aggregate (structural equivalent)			
MATERIAL	**Sn/ Inch**	**DEPTH (INCHES)**	**IBR**
AGGREGATE BASE	0.14	18.00	2.52
BITUMINOUS BAM	0.30		0.00
BITUMINOUS BINDER	0.30		0.00
BITUMINOUS SURFACE	0.33		0.00
4000 PSI (UN-REINFORCED) PCC PAVEMENT	0.50		0.00
TOTAL STRUCTURAL NUMBER:			**2.52**
Mill and Remove 18" of Existing and Replace with 18" of CA-6			
REPLACEMENT SECTION with BAM (structural equivalent)			
MATERIAL	**Sn/ Inch**	**DEPTH (INCHES)**	**IBR**
AGGREGATE BASE	0.14		0.00
BITUMINOUS BAM	0.30	8.50	2.55
BITUMINOUS BINDER	0.30		0.00
BITUMINOUS SURFACE	0.33		0.00
4000 PSI (UN-REINFORCED) PCC PAVEMENT	0.50		0.00
TOTAL STRUCTURAL NUMBER:			**2.55**
Mill and Remove 8.5" of Existing and Replace with 8.5" of BAM			

FDR
108th Ave. Cost Comparison

STRUCTURAL EQUIVALENT FDR VS. R&R			
108th Comparison			
Description	**Unit**	**Unit $**	**Total**
Bit. Materials (GAL)	74,231.00	2.55	189,289.05
FDR Base Course 10" (SY)	27,415.00	7.15	196,017.25
		Total FDR:	**$ 385,306.30**
Description	**Unit**	**Unit $**	**Total**
Mill & Remove 18" Existing HMA, AGG BASE, CLAY (SY)	27,415.00	11.52	315,820.80
18" CA-6 Agg Base (SY)	27,415.00	13.86	379,971.90
		Total R&R Agg Base:	**$ 695,792.70**
Description	**Unit**	**Unit $**	**Total**
Mill & Remove 8.5" Existing HMA, AGG BASE, CLAY (SY)	27,415.00	5.44	149,137.60
8.5" CA-6 BAM (SY)	27,415.00	24.23	664,265.45
		Total R&R Agg Base:	**$ 813,403.05**

- Cost savings between $310,486 and $428,096 – depending on design
- 18” Aggregate Base = Requires R&R of 53,294 Tons or 2,538 Semi Loads
- 8.5” BAM = Requires R&R of 25,167 Tons or 1,198 Semi Loads
- FDR required only 17 semi loads of Asphalt Emulsion
- FDR required only 4 days to complete
- Alternative Designs would have taken 8-12 Days

Soil Stabilization/Modification DEFINITION

Soil Modification, sometimes referred to as "mud drying". Soil Modification is primarily intended to reduce moisture content and the plasticity in order to expedite construction, whereas stabilization can substantially increase the shear strength of a material such that it can be incorporated into the projects structural design. (ARRA)

Soil Stabilization, is the long-term physical and chemical alteration of soils to enhance their physical and engineering properties. Stabilization of in-place soils by incorporating available additives can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a subgrade to support pavements and foundations. (ARRA)

Soil Stabilization/Modification CROSS SECTION

Unstable Wet Subgrade

Stabilized Subgrade

Soil Stabilization/Modification CANDIDATES

- **Soil Modification**
  - Up to 20'+
  - Dry wet/ unstable soil that cannot be properly compacted due to high moisture
    - High groundwater
    - Previous rain events
    - Unstable soil
  - Reduce moisture/ strengthen subgrade
- **Soil Stabilization**
  - Spec'd to add strength to the top 8" – 14" of subgrade
  - Spec'd to reduce moisture and stabilize soil characteristics of swelling and/or shrinkage

Soil Stabilization/Modification
WHEN TO UTILIZE SOIL STAB/MOD

- **Reactive**
  - To avoid project delays
  - To reduce costs of undercuts
  - To utilize onsite materials
  - To improve subgrade prior to aggregate placement (pass a proof roll)

- **Spec'd**
  - To improve structural integrity of the entire pavement section
  - To reduce thickness of aggregate base or asphalt to achieve overall structural strength determined by the engineer
    - 1" stabilized subgrade = 1" compacted aggregate base (.10 - .14 structural coefficient)

Soil Stabilization/Modification
TYPICAL STABILIZERS/ BINDERS

- **Lime (%)**
  - Lime Kiln Dust (LKD) (3-6%)
  - Quicklime (1-3%)
- **Flyash(%)**
  - Class C (8-12%)
  - Class F, not on its own
- **Portland Cement (3-6%)**
  - Type I/II
- **Slurry**
  - Mostly urban areas
  - More expensive than powders
  - Less dusty
- **Others**
  - Enzymes, polymers, other stabilizers

KEY: GOOD / FAIR / POOR	Fine-Grained: More than 35% Passing No. 200					Coarse-Grained: Less than 35% Passing No. 200	
Type of Stabilizer	Plasticity Index (PI)					Plasticity Index (PI)	
	0	10	20	30	40 +	0	10 +
Portland Cement							
Lime							
Kiln Dust							
Class C Fly Ash							
Bituminous* * Special Applications		Not Applicable					N/A

Soil Stabilization
The process

Transportation

Soil Stabilization
The process

Transportation

Spreading

Soil Stabilization
The process

Transportation

Spreading

Mixing & Water

Soil Stabilization
The process

Transportation

Spreading

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Compaction

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Soil Stabilization
The process

Finish Static Roll

Transportation

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Soil Modification – Soil Stabilization
Parking Lot Undercut vs. Stabilization

12" Average Undercut VS Stabilization			
Description	**Unit /SY**	**Unit Price per SY**	**Total**
Average Cost of Undercut, Remove, & Replace with Agg Base	5,000.00	18.00	90,000.00
		Total FDR:	**$ 90,000.00**
Description	**Unit /SY**	**Unit Price per SY**	**Total**
Average Cost of 12" Cement Stabilization at 5% Treatment Rate	5,000.00	6.25	31,250.00
		Total R&R Agg Base:	**$ 31,250.00**
		Total Savings:	**$ 58,750.00**
			OR OVER 65%

- 5,000 SY or 1,667 CY Undercut will take between 3-5 Days to Complete
- 5,000 SY or 1,667 CY Soil Stabilization will take between .5 – 1 Days to Complete
- Utilizing Stabilization will keep an additional 167 semi's of removal off the road, and an additional 167 semi's of aggregate import off the road as well
- At 5% treatment rate the project would utilize approximately 5 semi's of Portland Cement

Soil Modification – Soil Stabilization
NIMC Change Order

Example:
Road project, 9,000 SY, 80 – 85% failed proof roll

12" UNDERCUTTING
Excavation of 2500 CY at $50.00/CY _____ $125,000.00
(unsuitable soil hauled off site)

SOIL STABILIZATION
9,000 SY stabilized @ 12" depth @ $4.25/ SY _____ $38,250.00

Undercut vs. Stabilization savings of $86,750.00

Modified Pavement Cross Section – Value Engineering
7,900 SY of 2" HMA @ $4.80/ SY _____ $37,920.00
9,000 SY Stabilized @ 12" depth @ $4.25/ SY _____ ($38,250.00)

Change Order Costs after Value Engineering $0!

Soil Modification – Soil Stabilization

Change Order Highlights

- No cost increase
- Uniform subgrade for the entire road
- Maintained overall structural strength per the design
- Eliminated haul off of unsuitable material
- Eliminated import use of virgin aggregate
- Reduced aggregate need by 7,600 SY
- 4900 ton saved aggregate
  - 223 Truck loads of saved import material
  - 223 Truck loads of haul off
  - 40 loads of asphalt import
  - Saved 471 total truck loads
- 15 loads of fly ash used

QUESTIONS?

Jonathan Pease, President

Rock Solid Stabilization & Reclamation, Inc.

jp@rocksolidsr.com

Phone: 815-653-2585

Cell: 262-749-8435