Performance Evaluation of Asphalt Pavement Preservation Activities in Nevada

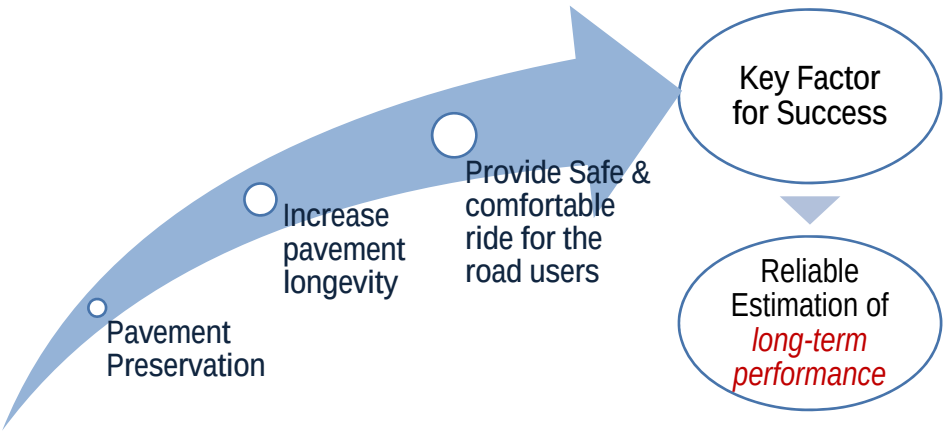
Elie Y. Hajj, Ph.D.

University of Nevada, Reno (UNR)
Western Regional Superpave Center

2013 Utah Asphalt Conference
Salt Lake City
March 27, 2013

Slide No. 1

Introduction



Slide No. 2

Introduction

- Main objective of a preservation activities:
  - Maintain the current condition
  - Slow down the rate of deterioration
- Not intended to increase the structural capacity.

Overall Objective

- In attempt to optimize the use of funds, Nevada DOT sponsored this research study to develop an *effective preservation activities program* for Nevada's flexible pavements.
- Developed program will help in:
  - Selection of consistent, effective & efficient strategies,
  - Provide guidance to ensure uniform and quality maintenance practices.

Identification of Preservation Activities Implemented by NDOT

- Chip seal: asphalt binder overlaid by a layer of embedded aggregate
  - Emulsion: SS-1, SS-1h, CSS-1 or CSS-1h, LMCRS-2 or LMCRS-2h.
- Sand seal: emulsion followed by a sand layer.
  - RS-1, CRS-1, MS-1 or HFMS-1.
- Scrub seal: polymer-modified emulsion, sweeping or squeegee followed by a sand layer.
  - Poly-methyl-phenyl-silane (PMPS) emulsions

Slide No. 5

Identification of Preservation Activities Implemented by NDOT

- Fog seal: application of SS emulsion diluted with water
  - Emulsions: SS-1, SS-1h, CSS-1 or CSS-1h.
- Crack filling: cleaning of cracks and filling them with rubberized asphalt, rejuvenating agent, emulsion, or liquid asphalt (cutback).
  - hot-applied CRAFCO PolyFlex crack filler sealants Type 1, Type 2 and Type 3 were used depending on the climatic zone.

Slide No. 6

Identification of Preservation Activities Implemented by NDOT

- Maintenance overlay cold mix (MO-CM):
  - Small paver
  - small roller compactor.
  - CMS-2S (AC-10 base asphalt)

- Machine patching paver laid plantmix (MP-PLP):
  - Dense graded HMA
  - Small paver
  - small roller compactor.
  - PG64-28NV (northern NV), PG76-22NV (southern NV).

Identification of Preservation Activities Implemented by NDOT

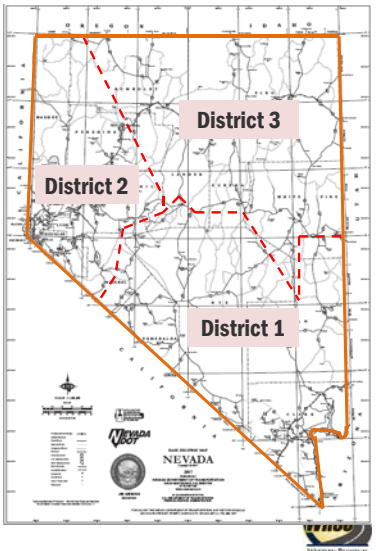
- Machine patching blade laid cold mix (MP-BLC): restore surface lost to raveling → vertical difference > 1" in 10 ft.
  - Max 2" thick
  - < 300 yd^3 or 550 tons in 10 mile section
  - CMS-2S (AC-10 base asphalt)

- Machine patching blade laid plantmix (MP-BLP):
  - Dense graded HMA laid down from the truck
  - Motor-grader
  - PG64-28NV (northern NV), PG76-22NV (southern NV).

Research Approach
Assessing Performance

- Review of NDOT maintenance records
  - 15 years
  - 17,000 preservation activities
  - Construction date, location, costs (labor, equipment and materials)…
- Criteria for treatment selection
  - Road classification (SR, US or IR)
  - Location (Districts 1,2 and 3 / Counties)
  - Project length: ≥ 1 mile

Results:
847 sections were identified for evaluation



Slide No. 9

Research Approach
Assessing Performance

- Analysis of NDOT Pavement Management System (PMS)
  - Distress data
    - Rutting, fatigue cracking, thermal cracking and smoothness.
  - Present Serviceability Index (PSI)
- Analysis of NDOT Maintenance Management System (MMS)

INTEGRATE MMS and PMS Databases

Slide No. 10

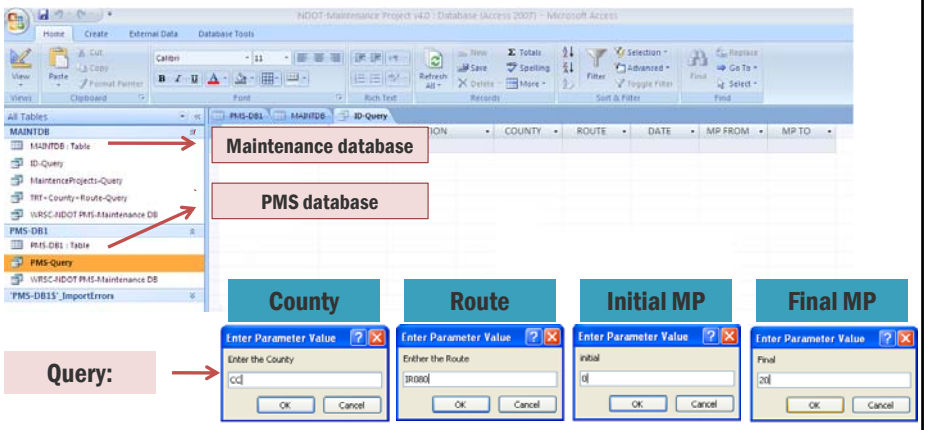
Research Approach
Assessing Performance

- Match exact location of field sections from PMS with MMS.

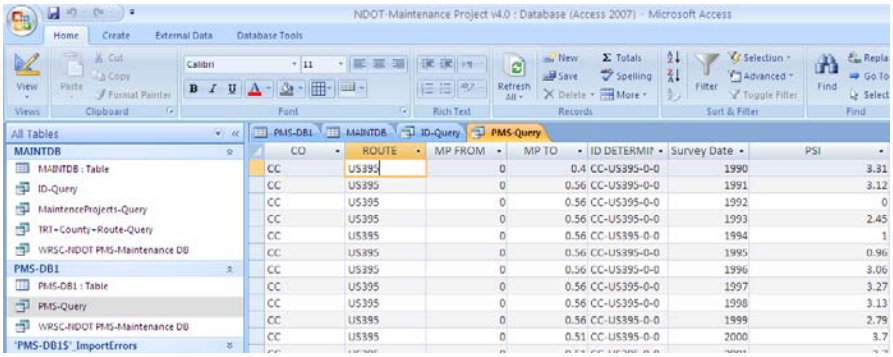
Two different and separate database
Different codes assigned for same routes.

Microsoft Access database was developed

Research Approach
MS Access Database

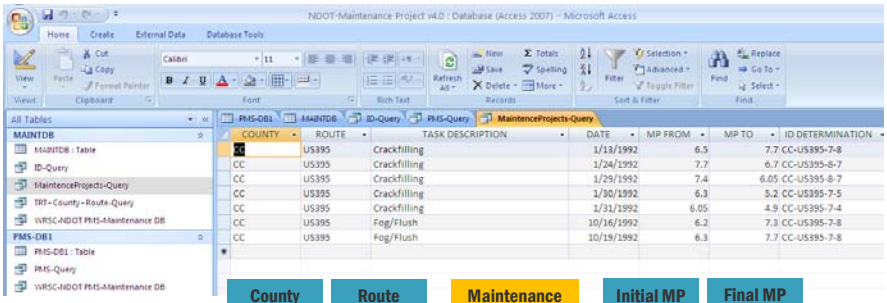


Research Approach
MS Access Database



County **Route** **Initial MP** **Final MP** **Survey date** **PSI**

Research Approach
MS Access Database



County **Route** **Maintenance Technique** **Initial MP** **Final MP**

Present serviceability index (PSI)

- The PSI is correlated to various pavement measurements (i.e. roughness, rutting, cracking, and patching) and provides an indication of the overall pavement condition.

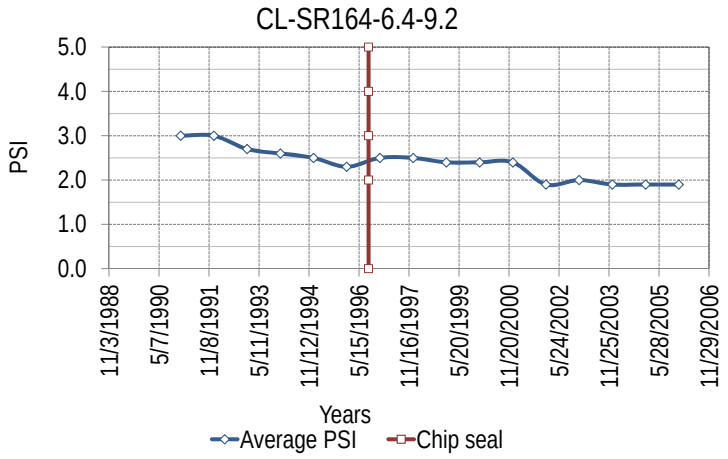
$$PSI = 5 \times e^{(-0.0041 \times IRI)} - 1.38 \times RD^2 - 0.03 \times \sqrt{C + P}$$

where, IRI = international roughness index (in/mile), RD = rut depth (in), C = cracking ($ft^2/1000ft^2$), and P = patching ($ft^2/1000ft^2$).

Present serviceability index (PSI)

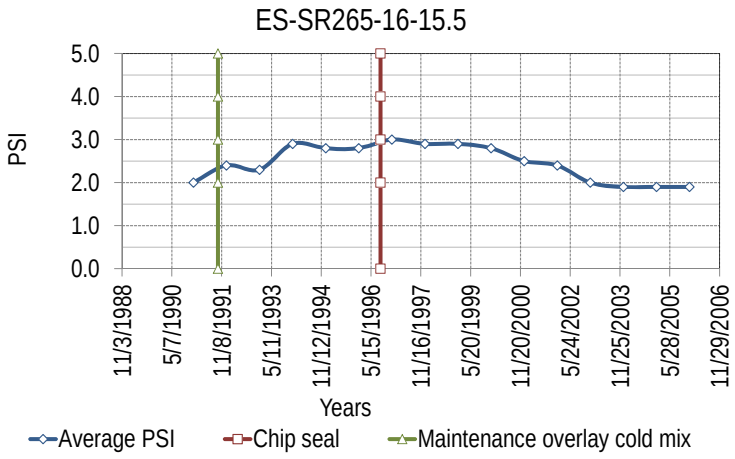
- The PSI values range from 5 for a pavement with a very good condition to a value of 0 at the extreme low end for a pavement with a very poor condition.
- The terminal (or failure) serviceability (PSI) is the minimum level of serviceability the agency allows in design.
- NDOT pavements:
  - U.S. Routes (US) and Interstates (IR) designed for a minimum PSI (terminal serviceability) of 2.5.
  - State Routes designed for a minimum terminal serviceability of 2.0.

Performance Data Analysis



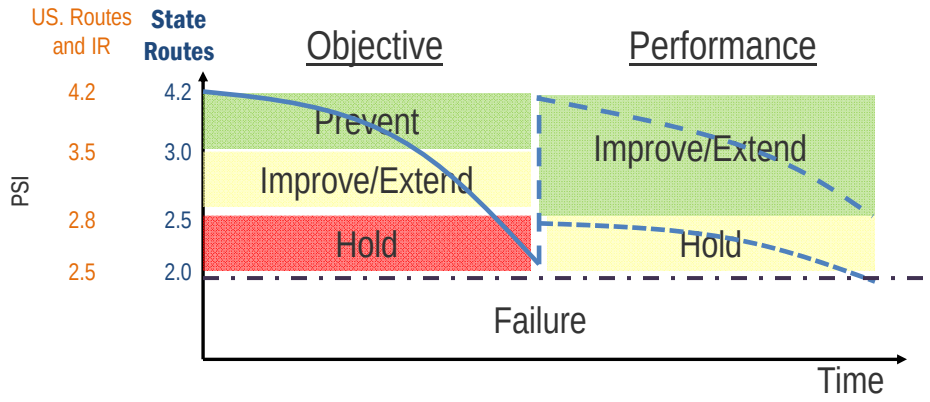
Slide No. 17

Performance Data Analysis



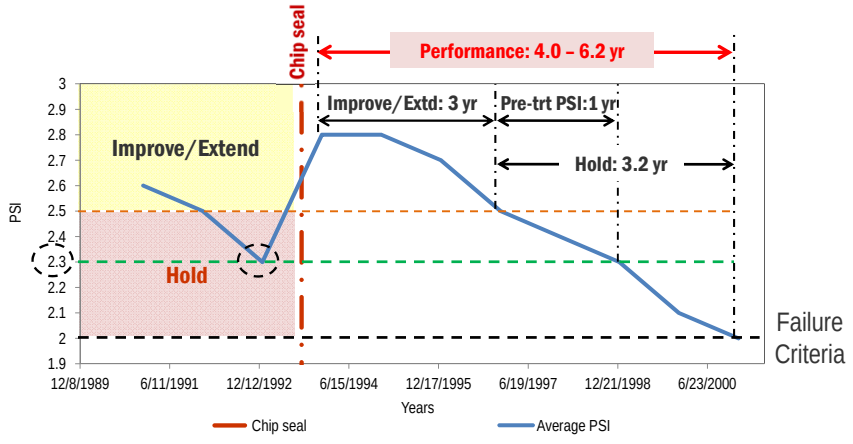
Slide No. 18

Performance Data Analysis



Slide No. 19

Analysis Approach
Example: State Route



Slide No. 20

Analysis Approach Example

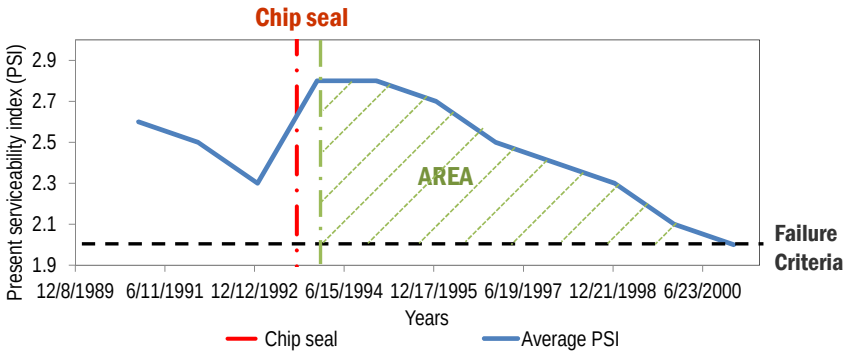
- Project level analysis: Example table – State Route

Section ID	PSI	Trt. Obj.	Treatment performance					Years to reach the pre-trt PSI	Perf. Range (years)	Benefit (B)
			PSI	Improve/ Extend, years (PSI > 2.5)	PSI	Hold, years (PSI ≤ 2.5)	PSI			
ES-SR266-25-29.3	2.3	Hold	2.6	3.0	2.5	3.0	2.1	3.8	3.8-6.0	3.5
CL-SR168-4.7-8 A	2.6	Improve /Extend	2.9	2.1	2.5	2.0	2.0	2.0	2.0-4.1	4.2

Slide No. 21

Analysis Approach Example

- Project level analysis: Benefit
  - Area under the performance curve.



Slide No. 22

Analysis Approach Example

- Benefit-cost Ratio is a good indication of treatment effectiveness.
  - Cost per lane-mile includes:
    - > Labor
    - > Materials
    - > Equipment

$$B/C = 100 \times \frac{PSI \times years}{1000\$/lane-mile}$$

Slide No. 23

Detailed Results for Chip Seal Performance

Slide No. 24

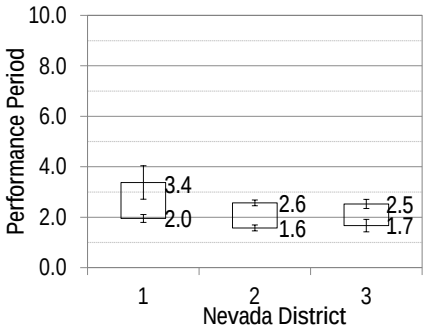
Overall Performance of Chip Seal

Treatment objective	Total number of sections	Treatment performance, number of sections (percent of total)	
		Improve/Extend	Hold/Maintain
Hold	65	38 (58%)	27 (42%)
Improve/Extend	33	22 (67%)	11 (33%)
Prevent	24	24 (100%)	0 (0%)

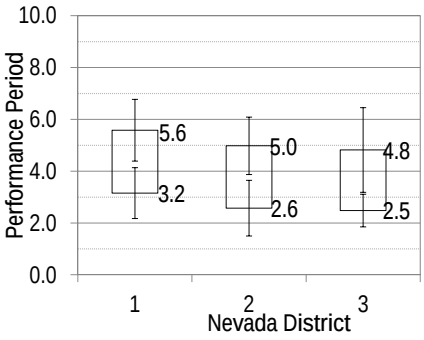
Slide No. 25

Performance Periods for Chip Seal

DISTRICT



HOLD/MAINTAIN

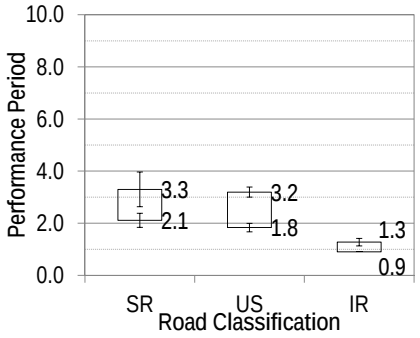


IMPROVE/EXTEND

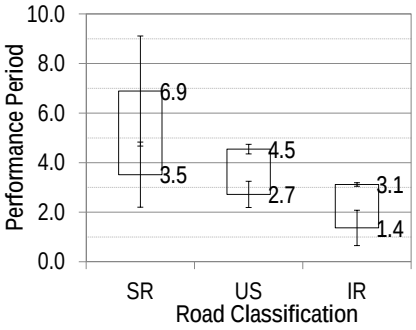
Slide No. 26

Performance Periods for Chip Seal

ROUTE



HOLD/MANTAIN

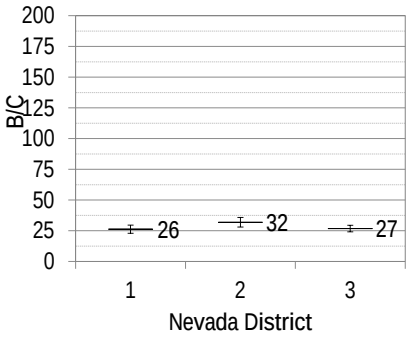


IMPROVE/EXTEND

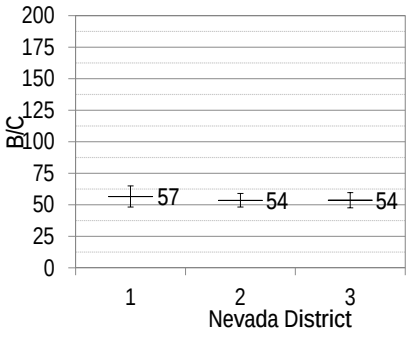
Slide No. 27

Benefit-Cost Ratio (B/C) for Chip Seal

DISTRICT



HOLD/MANTAIN

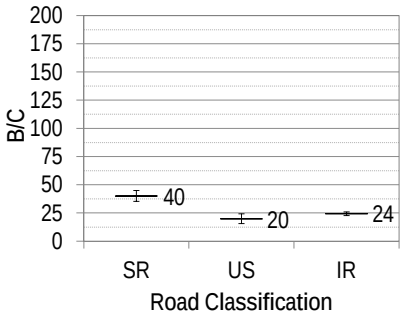


IMPROVE/EXTEND

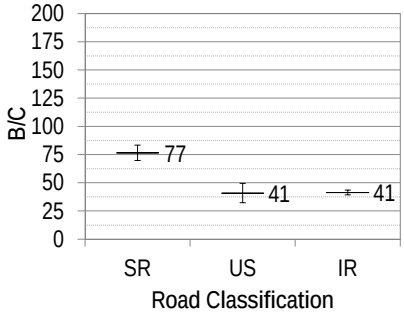
Slide No. 28

B/C for Chip Seal

ROUTE



HOLD/MANTAIN



IMPROVE/EXTEND

Slide No. 29

Existing Pavement Distresses

Treatment	Treatment Objective	Treatment Performance	Pre-Treatment Condition									
			Fatigue Cracking (ft^2)		Transverse Cracking (ft)		Block Cracking (ft^2)		Rut Depths (inch)		IRI (inch/mile)	
			Ave	SD	Ave	SD	Ave	SD	Ave	SD	Ave	SD
State Routes												
Chip Seal	H/M	62% chance of I/E	537	48	46	2	269	15	0.16	0.01	181	10
	I/E	91% chance of I/E	456	24	37	2	218	13	0.13	0.01	147	9

H/M Denotes Hold/Maintain
I/E Denotes Improve/Extend

Slide No. 30

Overall Performance

- Chip seals were effective on
  - SR regardless of pre-treatment PSI
  - on US/IR routes with a pre-treatment PSI > 2.8.
  - Higher benefit on SR roads
- Sand seals :
  - more effective on SR with a pre-treatment PSI > 2.5.
  - effectiveness on SR with a pre-treatment PSI < 2.5 was similar to its effectiveness on US with a pre-treatment PSI < 2.8.
  - Sand seals were not applied on IR.

Slide No. 31

Overall Performance

- Scrub seals:
  - effectiveness on SR with a pre-treatment PSI > 2.5 was similar to its effectiveness on US with a pre-treatment PSI > 2.8.
  - A low benefit was found for the scrub seal when applied to SR and US roads with a pre-treatment PSI < 2.5 and 2.8, respectively.
  - Scrub seals were not applied on IR.

Slide No. 32

Overall Performance

- Fog seals
  - Low benefit on SR and US/IR.
  - Most benefit of fog seals when pre-treatment PSI > 2.5 and 2.8 for SR and US/IR roads.
- Crack fillings
  - More effective when applied to SR when compared to US/IR roads specifically when the pre-treatment PSI > 2.5.

Overall Performance

- Maintenance overlay cold mix (MO-CM):
  - Effective on SR and US roads.
  - Highest benefit on SR with a PSI > 2.5.
- Machine patching paver laid plantmix (MP-PLP)
  - Highly effective on SR and US roads.

Overall Performance

- Machine patching blade laid cold mix (MP-BLC)
  - Low benefit on SR and US roads.
  - Highest benefit when applied to PSI > 2.5 and 2.8 for SR and US.
- Machine patching blade laid plantmix (MP-BLP) were
  - More effective on SR when compared to US/IR roads.
  - Effectiveness on SR was similar to its effectiveness on US/IR roads with a pre-treatment PSI > 2.8.

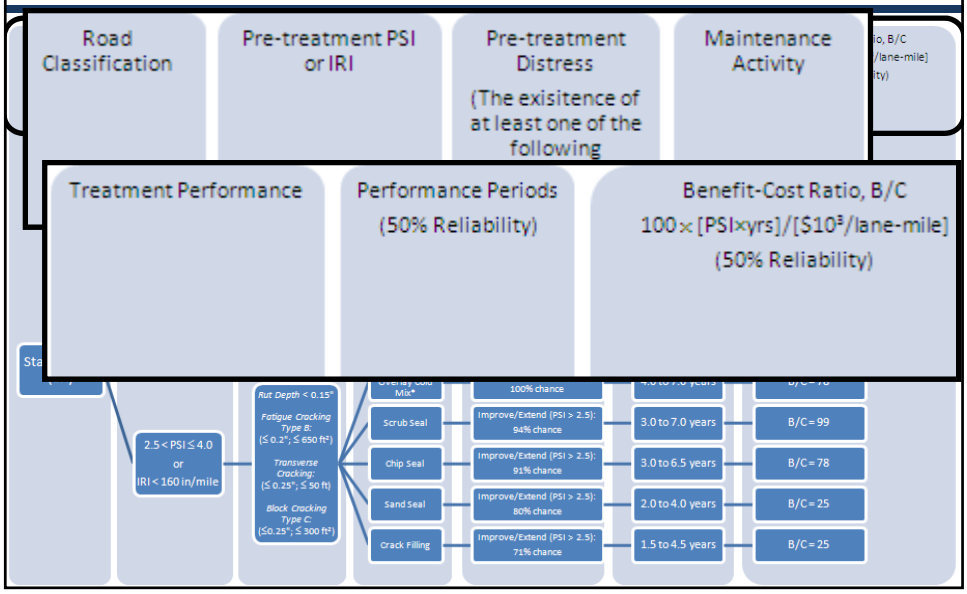
Slide No. 35

Overall Recommendations

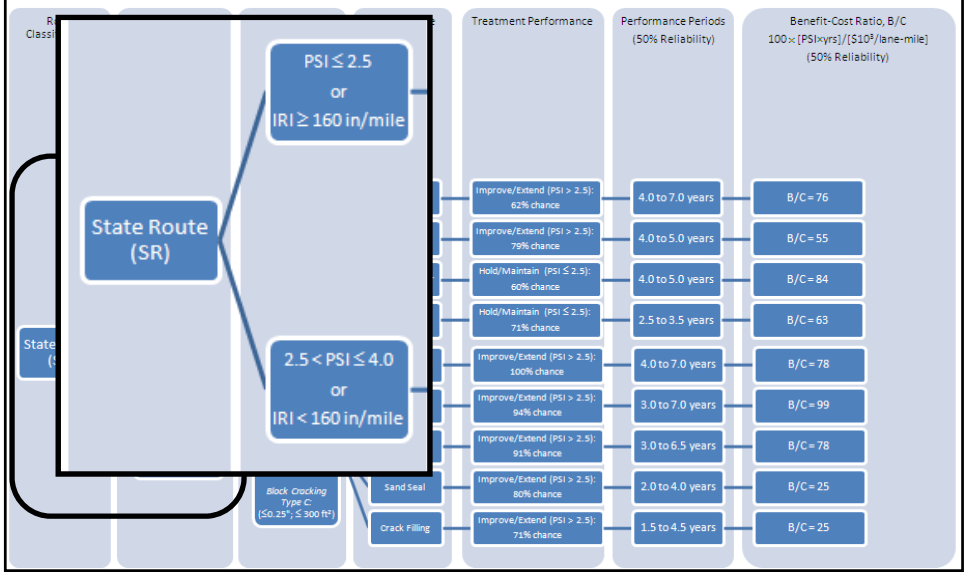
- A pavement preservation program was suggested to NDOT.
- Maintenance activities depends on:
  - PSI
  - Roughness
  - Pavement distresses:
    - Fatigue, block and transverse cracking
    - Rut depths
- Activities recommended if B/C > 25.0

Slide No. 36

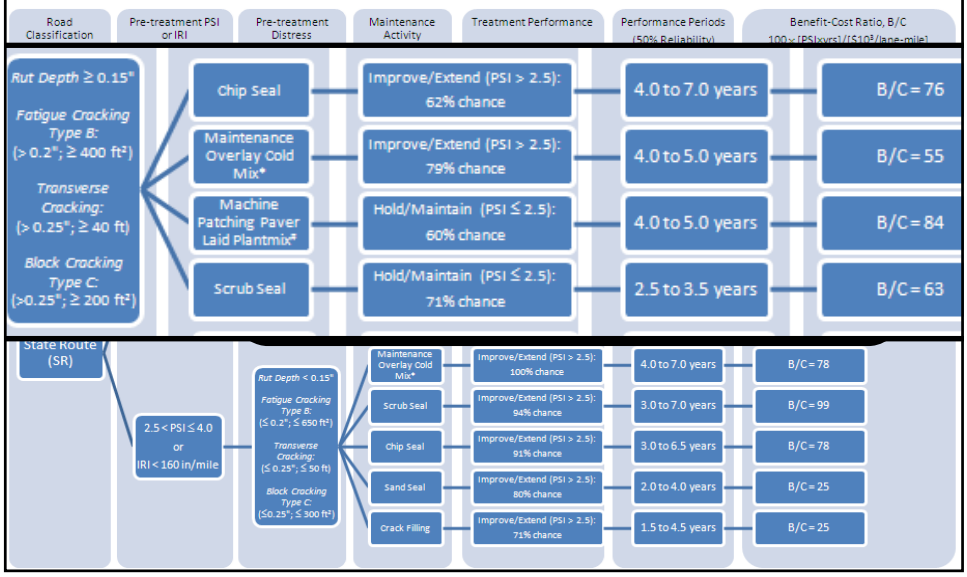
Overall Recommendations – State Routes



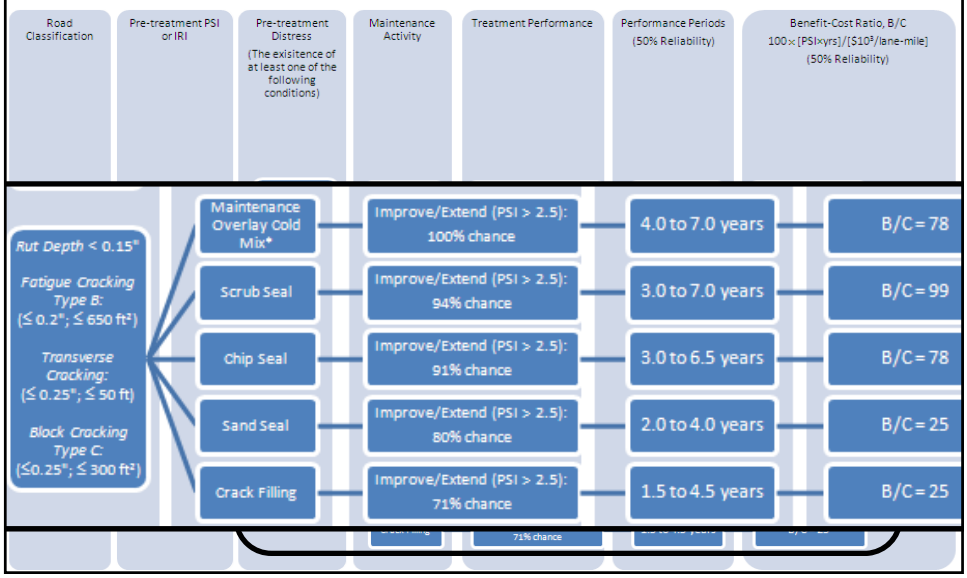
Overall Recommendations – State Routes



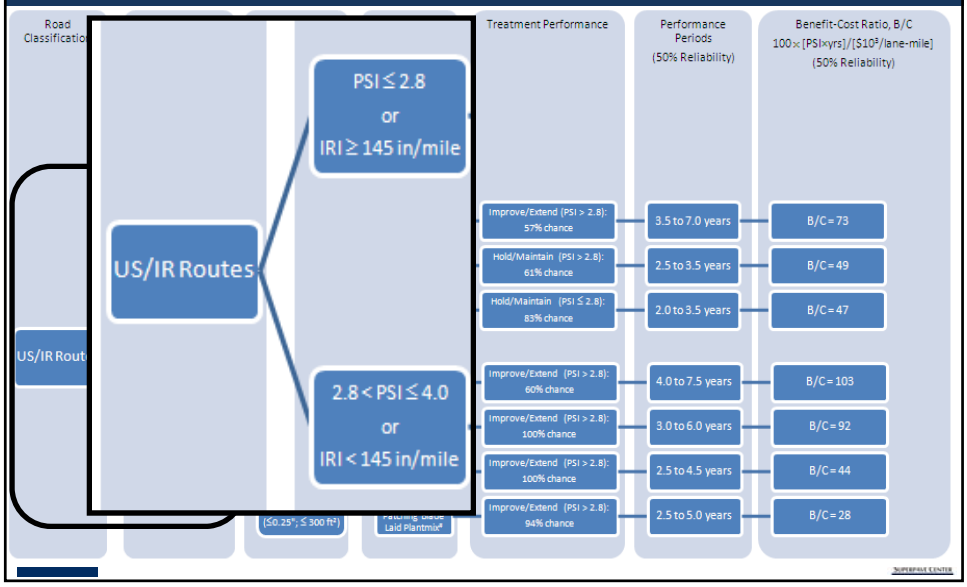
Overall Recommendations – State Routes



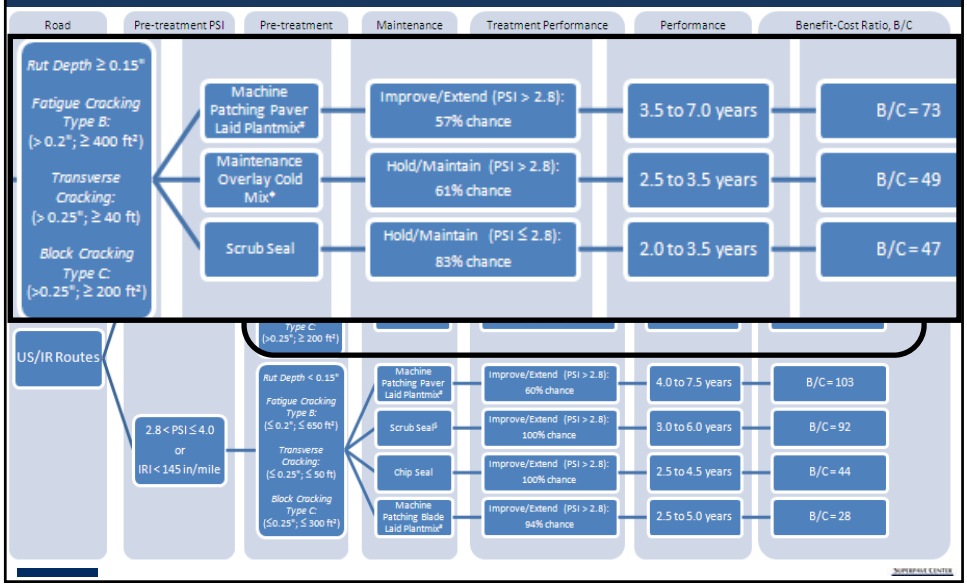
Overall Recommendations – State Routes



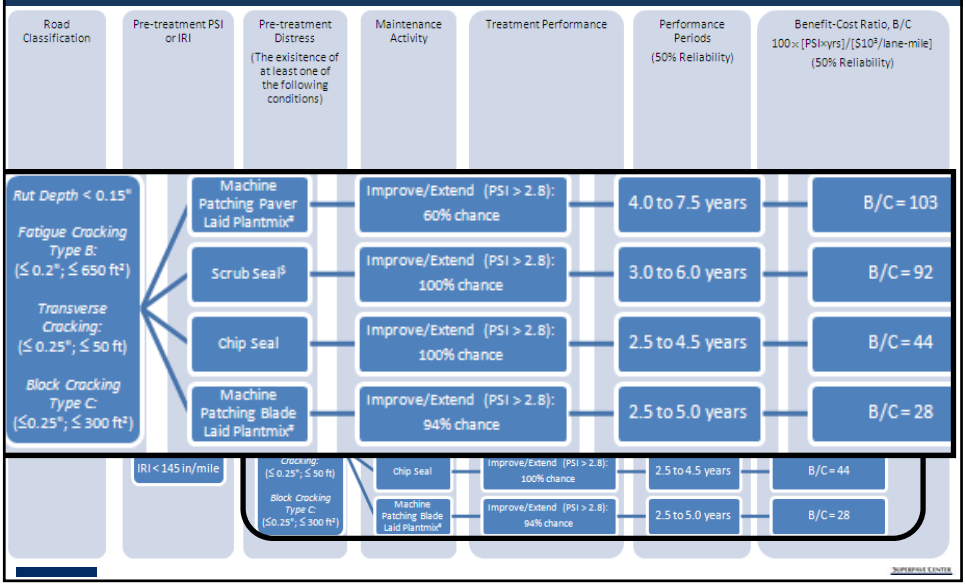
Overall Recommendations – US/IR Routes



Overall Recommendations – US/IR Routes



Overall Recommendations – US/IR Routes



Thank you for your attendance

Visit our websites at:

www.wrsc.unr.edu

www.arc.unr.edu

Contact Information:

Elie Y. Hajj, elieh@unr.edu, 775-784-1180