

EDC-4 Pavement Preservation When/Where Peer Exchange Report

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FOREWORD

This report summarizes the proceedings of the *Every Day Counts (EDC) 4 Pavement Preservation When/Where Peer Exchanges* hosted by the Federal Highway Administration (FHWA). The Peer Exchanges were held in Denver, Colorado on April 3-4, 2018; Atlanta, Georgia on April 11-12, 2018; and Rocky Hill, Connecticut on April 17-18, 2018. The Peer Exchanges provided an opportunity for State Departments of Transportation (DOT's) and Eastern Federal Lands Highway Division (EFLHD) to provide valuable lessons learned to other agencies on the topic of *Pavement Preservation When/Where*. The outcomes of the three Peer Exchanges resulted in the following:

- Familiarized with how other agencies are practicing Pavement Preservation When/Where and learn what works and what does not.
- Learned strategies to include pavement preservation at a strategic level.
- Explored ways a Pavement Management System (PMS) can be used to select pavement preservation treatments. In addition to detailed approaches for using and identifying pavement preservation to inform the asset management process.
- Provided input for a next generation tool to quantify the long-term effectiveness of pavement preservation strategies.
- Discussed metrics used for gauging the effectiveness of pavement preservation treatments.
- Provided input into how the outputs from the project should be presented to practitioners.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

TABLE OF CONTENTS

CHAPTER 1. OVERVIEW	1
PEER EXCHANGE PURPOSE	1
PEER EXCHANGE AGENDA	1
PEER EXCHANGE PARTICIPANTS.....	3
FORMAT OF THIS REPORT	4
CHAPTER 2. WELCOME, INTRODUCTIONS, AND OVERVIEW.....	5
CHAPTER 3. EXPERIENCE WITH PAVEMENT PRESERVATION WHEN/WHERE....	7
CHAPTER 4. STRATEGIC LEVEL SELECTION AND EVALUATION.....	13
PRESENTATIONS.....	13
DISCUSSION.....	15
CHAPTER 5. PMS ROLE IN PAVEMENT PRESERVATION	19
PRESENTATIONS.....	19
DISCUSSION.....	21
CHAPTER 6. PAVEMENT PRESERVATION FROM AN ASSET MANAGEMENT PERSPECTIVE.....	23
PRESENTATIONS.....	23
DISCUSSION.....	25
CHAPTER 7. PAVEMENT PRESERVATION EVALUATION/DECISION TOOLS	27
REVIEW OF EXISTING TOOLS.....	27
DEVELOPMENT OF A NEW TOOL	27
CHAPTER 8. HOW TO MEASURE SUCCESS.....	29
PRESENTATIONS.....	29
DISCUSSION.....	31
CHAPTER 9. USING THE PRODUCTS OF THE PROJECT	33
PRODUCTS DISCUSSION	33
AUDIENCE DISCUSSION.....	34
FORMAT DISCUSSION	34
ADDITONAL DISCUSSIONS	34

LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ADOT	Arizona Department of Transportation
ALDOT	Alabama Department of Transportation
ASR	Asset Sustainability Ratio
CCI	Critical Condition Index
CDOT	Colorado Department of Transportation
ConnDOT	Connecticut Department of Transportation
CRS	Condition Rating Survey
DOT	Department of Transportation
EAMS	Enterprise Asset Management System
EDC	Every Day Counts
EFLHD	Eastern Federal Lands Highway Division
EUAC	Equivalent Uniform Annual Cost
FAST	Florida’s Analysis System for Targets
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FWD	Falling Weight Deflectometer
GDOT	Georgia Department of Transportation
HMA	Hot-mix asphalt
HPMA	Highway Pavement Management Application
HPMS	Highway Performance Monitoring System
IDOT	Illinois Department of Transportation
IRI	International Roughness Index
KDOT	Kansas Department of Transportation
KYTC	Kentucky Transportation Cabinet
LCC	Life-cycle costs
LCP	Life-cycle planning
MSDOT	Mississippi Department of Transportation
MDOT-SHA	Maryland Department of Transportation – State Highway Administration

MoDOT	Missouri Department of Transportation
NCAT	National Center for Asphalt Technology
NCHRP	National Cooperative Highway Research Program
NDOT	Nevada Department of Transportation
NHS	National Highway System
NMDOT	New Mexico Department of Transportation
NPS	National Park Service
NYSDOT	New York Department of Transportation
PACES	Pavement Condition Evaluation Survey
PASER	Pavement Surface Evaluation and Rating
PCR	Pavement Condition Rating
PMS	Pavement Management System
PQI	Pavement Quality Index
PRS	Priority Ranking Score
PSI	Pavement Serviceability Index
PSR	Pavement Serviceability Rating
RIDOT	Rhode Island Department of Transportation
RQI	Ride Quality Index
RSL	Remaining Service Life
SAS	Statistical Analysis System
SCDOT	South Carolina Department of Transportation
SHRP	Strategic Highway Research Program
SR	Surface Rating
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TIP	Transportation Improvement Program
TRB	Transportation Research Board
TxDOT	Texas Department of Transportation
VDOT	Virginia Department of Transportation
WSDOT	Washington State Department of Transportation
WVDOT	West Virginia Department of Transportation

CHAPTER 1. OVERVIEW

This report summarizes the proceedings of the Every Day Counts (EDC) 4 Pavement Preservation When/Where Peer Exchanges hosted by the Federal Highway Administration (FHWA). The Peer Exchanges were held in Denver, Colorado on April 3-4, 2018; Atlanta, Georgia on April 11-12, 2018; and Rocky Hill, Connecticut on April 17-18, 2018.

PEER EXCHANGE PURPOSE

The Peer Exchanges were a chance for State DOT's and Eastern Federal Lands Highway Division (EFLHD) to provide valuable lessons learned to other States on the topic of *Pavement Preservation* by applying the right preservation treatment (i.e., "the what") for the right road (i.e., "the where") at the right time (i.e., "the when"). In addition, the participants were provided the opportunity to share input with the project team conducting *Pavement Preservation When/Where* support to FHWA. Each Peer Exchange meeting focused on the following topics.

- A brief overview of the *State of the Practice of Pavement Preservation When/Where* in each participating agency.
- Establishing a good program delivery process for selection and evaluation of pavement preservation projects as a strategic investment for pavements.
- Good practice for using a Pavement Management System (PMS) that includes decision trees to aid the selection process of pavement preservation treatments.
- Linking pavement preservation to a strategic, Transportation Asset Management Plan (TAMP), perspective.
- A discussion of what a tool can do or should consider for analyzing the long-term effectiveness of preservation strategies as investment program alternatives.
- Metrics for gauging the effectiveness of pavement preservation for the overall asset to the agency's program.
- Input for how the results of the project should be communicated and delivered for maximum usefulness.

PEER EXCHANGE AGENDA

Each Peer Exchange had identical agendas. The agenda for each was as follows:

Day One Agenda

1. **Welcome, Introductions, and Overview** **8:00 – 8:45a.m.**
 - *Welcome from DOT*
 - *Welcome from FHWA*
 - *Introductions*
 - *Peer Exchange Scope and Objectives*

2. **Experience with Pavement Preservation When/Where (State DOTs)** 8:45 – 10:30a.m.
- *What is your States policy on Pavement Preservation?*
 - *What is your States experience with Pavement Preservation (by States forces or contracting out)?*
 - *How long have you been performing Pavement Preservation?*
 - *What treatments do you use and their life expectancy?*
 - *What would you say your agency's maturity level (0-5 with 5 being the best) is with Pavement Preservation?*
 - *What is the one thing you could improve about your practices?*
3. **Strategic Level Selection and Evaluation (State DOTs)** 10:45a.m. – 12:00p.m.
- *DOT Presentation (20 min)*
 - *How do you make strategic level decisions—budget, types, split between preservation and rehab, etc.?*
 - *How does your PMS play a role in strategic decisions?*
 - *How do you determine When? How do you determine Where?*
 - *What do you consider as best practices in strategic level decisions?*
 - *Discussion and Input (Group)*
4. **PMS Role in Pavement Preservation (State DOTs)** 1:00 – 2:45p.m.
- *DOT Presentation (20 min)*
 - *How is the PMS used as a tactical tool to select projects? How should it be used?*
 - *What are best practices in using your PMS in tactical level decisions?*
 - *Who makes the decision of When/Where? Why?*
 - *Centralized or decentralized decision making?*
 - *Discussion and Input (Group)*
5. **PP from an Asset Management Perspective (State DOTs)** 3:00 – 4:15p.m.
- *DOT Presentation (20 min)*
 - *How does Pavement Preservation impact your plans to meet the TPM rules?*
 - *How is Pavement Preservation used in your Transportation Asset Management Plan?*
 - *How is Pavement Preservation considered in your risk register? Lifecycle cost analysis? Investment strategies?*
 - *Discussion and Input (Group)*
6. **Summary of Day 1 (FHWA/Contractor)** 4:15 – 4:30p.m.
- *Day 1 Takeaways for Implementation*
 - *Day 2 Preview of Agenda Items*

Day Two Agenda

1. **Day One Recap Discussion (FHWA/Contractor)** **8:00 – 8:15a.m.**
2. **Pavement Preservation Evaluation/Decision Tools (State DOTs)** **8:15 – 9:45a.m.**
 - *DOT Discussion*
 - *Do you use the:*
 - *OPTime tool?*
 - *R-26 tool?*
 - *PPETG Pavement Preservation Benefits Calculator Tool?*
 - *Overview of tool to be developed*
 - *What level of analysis should be undertaken?*
 - *What analysis should be included?*
 - *Format: Excel? Web-based? Stand-alone program? Other?*
3. **How to Measure Success (State DOTs)** **10:00 – 11:00a.m.**
 - *DOT Presentation (20 min)*
 - *What metrics do you use?*
 - *What metrics would you like to see further developed?*
 - *How is cost effectiveness determined?*
 - *Discussion and Input (Group)*
4. **Using the Products of the Project (Contractor)** **11:00 – 11:50a.m.**
 - *Products*
 - *Audience*
 - *Format for easy use*
5. **Closing (FHWA/Contractor)** **11:50a.m. – 12:00p.m.**
 - *Discussion on Takeaways for Implementation*
 - *Next Steps*
6. **Adjourn** **12:00p.m.**

PEER EXCHANGE PARTICIPANTS

Agencies that participated in each of the three Peer Exchanges included:

- Arizona, Colorado, Kansas, Minnesota, Nevada, New Mexico, Texas, Washington
- Alabama, Florida, Georgia, Kentucky, Mississippi, Missouri, South Carolina
- Connecticut, Eastern Federal Lands Highway Division, Illinois, Maryland, New York, Rhode Island, Virginia, West Virginia

FORMAT OF THIS REPORT

All three Peer Exchanges included identical agendas, and the report includes a chapter for each topic. Therefore, each topic is presented as if all three Peer Exchanges occurred at the same time. Individual participant's names are not included in this report, rather the agency they represent.

CHAPTER 2. WELCOME, INTRODUCTIONS, AND OVERVIEW

EDC-4 is a program focused to promote the early adoption of proven technologies in State DOTs. The program identifies project areas with substantial interest to States and other transportation entities where innovative programs are expected to include positive results. The current program identified the *Pavement Preservation When/Where* project as a priority area where substantial improvements could be made in the strategic application of preservation with a focus on long-term performance and whole-life of pavement systems. The vision and mission of the *EDC-4 Pavement Preservation When/Where* project is included below.

Vision

- *Focus the use of preservation to promote effective strategies that reduce the annual cost of managing the pavement network at acceptable performance levels.*

Mission

- *Provide guidance and implementation tools that assist agencies in selecting cost-effective pavement preservation projects that sustain pavement performance programs.*
- *Demonstrate the cost savings and other benefits that can be realized through effective pavement preservation programs.*
- *Facilitate accelerated national deployment of proven practices that support inclusion of pavement preservation as an asset management strategy.*

Pavement preservation programs historically focus on applying specific project treatments at specific locations. These projects demonstrated that the proper application of a treatment could extend the life of pavements at a relatively low cost. The FHWA promoted the mantra, “*Right Road, Right Treatment, at the Right Time,*” from 1995-2005 to address these issues. Extensive training by the asphalt and concrete pavement industries, as well as the FHWA, helped eliminate many of the construction issues and improper uses for temporary fixes. While these practices were valuable to demonstrate the viability of preservation projects, they were project based and did not link to pavement management or other strategic processes. Poor timing is a critical issue due to a pavement preservation project constructed too late is not likely to deliver the expected benefits. Furthermore, when agencies are not able to consistently construct preservation projects, it is unlikely that the preservation industry is incentivized to gain the knowledge, expertise, and corporate capacity to deliver quality projects in a timely manner. Recurring issues with pavement preservation include the absence of metrics, strategic framework, and specialized analysis tools needed to integrate preservation investments into mainline highway pavement programs.

To maintain the performance of an agencies highway system, these studies, along with discussions among the Transportation Research Board (TRB) and American Association of State Highway and Transportation Officials (AASHTO) committees, suggest closing the gaps to use preservation as a valid strategy; resulting in substantial cost containment for State and local agencies.

Pavement preservation is an activity highway agencies employ to maintain and improve a pavement's functional condition at a relatively low cost. Although it is not expected that pavement preservation increases the structural load carrying capacity of the pavement, preservation will lead to improved pavement performance, longer service lives, and reduced life-cycle costs (LCCs). However, many factors can be detrimental to the performance of preservation treatments such as poor timing, inappropriate treatments, substandard materials, and inexperienced construction crews.

The idea focuses on introducing FHWA to these Peer Exchanges.

In all cases, the project team led the discussion concerning the purpose and the intended outcomes of the Peer Exchange. The intended outcomes of each of the three Peer Exchanges were described as follows:

- Become familiar with how agencies are practicing Pavement Preservation When/Where and learn what works and what does not.
- Learn strategies to include pavement preservation at a strategic level.
- Explore ways a PMS can be used to select pavement preservation treatments. In addition to detailed approaches for using and identifying pavement preservation to inform the asset management process.
- Provide input into a next generation tool to quantify the long-term effectiveness of pavement preservation strategies.
- Discuss metrics used for gauging the effectiveness of pavement preservation.
- Provide input for how results from the project should be presented to practitioners.

Following a brief introduction by the host State DOT and each participant, the Peer Exchange commenced.

CHAPTER 3. EXPERIENCE WITH PAVEMENT PRESERVATION WHEN/WHERE

This chapter summarizes the section of the agenda that focused on an open discussion for the agencies to provide their experience with *Pavement Preservation When/Where*. The agencies provided a summary of their experience based on the following questions:

- What is your agency's policy on pavement preservation?
- What is your agency's experience with pavement preservation (by internal forces or contracting out)?
- How long have you been performing pavement preservation?
- What treatments do you use and their life expectancy?
- What would you say your agency's maturity level (0-5 with 5 being the best) is with pavement preservation?
- What is the one thing you could improve about your practices?

The Alabama Department of Transportation (ALDOT) manages 29,578 lane-miles of pavement. ALDOT centrally controls the application of treatments on the interstates and centrally distributes funding. Districts provide recommendations on treatments and the Areas provide the decisions on treatments for local roadways. Since 2012, ALDOT maintains a pavement preservation policy with FHWA. Existing for nearly ten years, the pavement preservation program maturity level is either a one or two. ALDOT received pavement preservation training from the National Center for Asphalt Technology (NCAT) and is working on decision trees. There is a process for treatment selection and decision-making, as well as a need to defend every pavement preservation project due to dismissal from the industry. ALDOT's PMS includes cracking, rutting, age, and the International Roughness Index (IRI).

The Arizona DOT (ADOT) does not have a written policy on pavement preservation, as all preservation activities are contracted. The pavement preservation program is quite mature with many years of experience. The treatments used include thin overlays, surface treatments, cape seals, crack seal, micro surfacing, as well as light mill and fill projects. The maturity level with pavement preservation is over four. Currently, the project turnaround time from identification to placing the treatment is 18 months, but recommend reducing this to 12 months.

The Colorado DOT (CDOT) currently only uses chip seal and crack seal as pavement preservation treatments. Projects take approximately one to two months to design and then to place the treatment. CDOT's maturity level with pavement preservation is a 3.5. Currently, the Regions must meet eighty percent of what the PMS provides in terms of treatment selection. It is critical for the CDOT to improve their use of data to drive the analysis for the timing of preservation treatments.

The Connecticut DOT (ConnDOT) manages 4,136 centerline miles, of which 3,719 are surveyed annually (i.e., the remainder are State Park roads, State forest roads, federal roads, etc.). There are 5,514 lane-miles with 2,056 lane-miles on the interstate. The pavement network is 70.5

percent flexible, 29 percent composite and 0.5 percent rigid. ConnDOT has had experience with preservation since 2011 and a preservation policy agreement with the FHWA Division office. ConnDOT policy will use the PMS to generate a project list, which includes a centralized project selection for the capital program while the Districts decide on pavement preservation treatments. The maintenance resurfacing program is \$50-75 million using ultra-thin overlays, crack sealing, and chip seals. ConnDOT's preservation program has a maturity of four to five. ConnDOT needs a place for the preservation program to call home. Currently, the preservation program uses a single year but a three-year plan is desired.

The EFLHD manage 5,700 miles of park roadway; most of which are owned by the National Park Service (NPS). The first pavement preservation project was in 2016. EFLHD life expectancy for chip seals is the years. They are in the beginning stages of a pavement preservation program and their current maturity level is a two or three. EFHLD needs deterioration curves for chip seal and micro surfacing.

The Florida DOT (FDOT) has decentralized decision making on pavement treatment selection. The central office manages the interstates and reviews all projects and budgets. FDOT currently does not use pavement preservation, but is beginning to research treatments such as crack seals. The maturity of the pavement preservation program in Florida is one. FDOT's PMS is developed in-house with the use of a Statistical Analysis System (SAS) and includes cracking, rutting and ride. The PMS includes history since the 1970s. Crack rating is conducted with windshield surveys. FDOT manages 44,000 lane-miles and are being careful with implementation of pavement preservation. Currently, they are learning the "when/where" from FHWA.

The Georgia DOT (GDOT) has centralized decision making for the interstates and decentralized decision making for the rest of the State highways. GDOT has been using pavement preservation for a long time. The Pavement Toolkit indicates recommendations for pavement evaluation, which is shifted to the District offices for pavement preservation. Pavement preservation is included in the Transportation Asset Management Plan (TAMP). GDOT uses crack seals, cape seals, surface treatments, and thin overlays. Crack sealing and chip sealing are completed in-house. The interstates use open-graded friction courses. GDOT ranked their pavement preservation maturity at 4.5 out of 5. Improvements needed include a PMS tool to determine the best use of funding. They are currently rewriting, with FHWA, the pavement treatment policy memorandum. GDOT manages 43,000 lane miles.

Since 2004, the Illinois DOT (IDOT) is using pavement preservation and contracts it out. IDOT manages 16,000 centerline miles. IDOT started the use of pavement preservation treatments by using chip seals, slurry seals, micro surfacing, and cape seals. Recently, IDOT expanded the treatment options to include those original treatments, as well as other treatments such as ultra-thin bonded wearing course and other thin hot-mix asphalt (HMA) overlays. The Midwest Pavement Preservation Partnership is an asset and helps the State. IDOT would like to improve their understanding of the longevity of treatments and the cost effectiveness of each treatment.

The Kansas DOT (KDOT) is a lead State for pavement preservation. There is no set pavement preservation policy, but it is codified in their PMS. Currently, the DOT allocates \$10 million to the Districts for reactive preservation treatments. Since the 1980s, the DOT performs preservation and maintains a very mature program. Kansas currently includes 300 or more

options in the PMS for treatments. The maturity level for Kansas, while no specific number was provided, is high. The main opportunity for improvement for the DOT is documentation of where the treatment has been used.

The Kentucky Transportation Cabinet's (KYTC) pavement preservation program is ten years old. They have used 1.5-inch thick overlays. KYTC is learning about scrub seals and chip seals. KYTC uses centralized decision-making for pavement treatment selection, with input from. The preservation program in Kentucky includes a maturity level of three or four. There is strong leadership support for the pavement preservation program. KYTC recommends to improve the PMS program and the decision trees. KYTC manages 64,000 lanes miles.

The Maryland Department of Transportation - State Highway Administration (MDOT-SHA) uses preservation as part of a mix of fixes system that spends \$200 million annually on 17,000 lane miles. Each District should allocate a percentage of their budget to preventive maintenance with the budgets established by the PMS optimization. In this process, preventive maintenance treatments are specifically defined and the optimization provides suggestions; however, the Districts are not bound to them. This policy became effective for FY 2018, but not yet determined whether it is effective or not. MDOT-SHA utilizes pavement preservation since 2010 and developed a guide for determining "when/where" that includes an optimization process. The maturity of MDOT-SHA preservation program is a three. MDOT-SHA evaluates the benefits based on lane mile years extended by the preservation. The challenges faced by MDOT-SHA for preservation are:

- District staff buy-in;
- Improve obtaining more "top of curve" projects (i.e., using the treatments when a pavement is in good condition);
- Utilize open graded friction courses (not used because of failures from 20 years ago);
- Use of fog seals on shoulders;
- Capture accomplishments;
- Educate District personnel; and
- Project selection (i.e., right road, right time, right treatment).

The Mississippi DOT (MDOT) began pavement preservation in the early 2000s. Preservation services are both done by in-house staff and contracted out. Chip seals and scrub seals are used. The maturity of pavement preservation in Mississippi is a four. The MDOT looks to improve the feedback loop. Pavement data (i.e., automated) is collected every two years. A committee decides on the treatments for the interstate system. Districts have latitude in selection for other non-interstate pavements with projects being picked from the list the PMS generates. The MDOT also maintains a pavement preservation manual. The MDOT manages 27,500 lane-miles.

The Missouri DOT (MoDOT) uses the Engineering Policy Guide to assist them with Project Selection using the Pavement Surface Evaluation and Rating (PASE) rating system. The District Pavement Specialist performs project selection with centralized monitoring. The maturity of MoDOT's pavement preservation program is a three. Knowledge within the DOT of the pavement preservation program is widespread, but implementation is lacking. Currently, buy-in is an issue. The key needs are training and centralization of construction and pavement specialists. The MoDOT is working on writing their pavement preservation policy and obtaining agreement with FHWA. The MoDOT manages 33,680 lane-miles. Their pavement data collection is fully automated.

The Nevada DOT (NDOT) has a documented preservation policy. Currently, about fifty percent of the preservation treatment activity is contracted out. The DOT has been performing preservation for a long time and predominantly uses chip seals, cold in place recycling, slurry seals, and micro surfacing. Nevada has a high-level of maturity with pavement preservation practices (i.e., no numerical value).

The New Mexico DOT (NMDOT) manages 30,000 lane-miles of pavement and utilizes all types of pavement preservation. Many of the projects are inlays. The NMDOT's pavement preservation maturity level is 3.5 to four. The NMDOT's program is decentralized. Improvements are needed for better calibration of the prediction models, a benefits model, and better construction history.

The New York State DOT (NYSDOT) manages 39,000 lane-miles. The NYSDOT policy has targets based on funding and lane-miles for each District. Pavement preservation is part of a formal process that has been ongoing for 20 years. There is no specific funding for preservation and is divided by pavement and bridge preservation by region. The NYSDOT's pavement preservation maturity level is a four and includes good project selection.

The Rhode Island DOT (RIDOT) started pavement preservation in 1998. The Project Management Section takes jobs from the Transportation Improvement Program (TIP). Preservation is a line item in their TIP. The PMS is used for capital projects such as mill and fill, reconstruction, etc. and includes a ten-year plan. Pavement preservation is completed through the materials department. The preservation program has a five-year plan and uses the PMS for projections. Surface treatments and rubberized chip seals in rural areas have a life expectancy of eight to nine years. Chip seals are not used in urban areas. The RIDOT also uses thin overlays with a life expectancy of ten to fifteen years. The RIDOT was not successful in using micro surfacing. All preservation work is contracted out. The RIDOT's preservation program indicating a maturity of 4.5 to five. They have a strong link to the PMS, good specifications, and good quality control. The RIDOT requested to improve the practice of workmanship, contractor performance, and concentrating on the process (i.e., "the ho" of pavement preservation).

The South Carolina DOT (SCDOT) does not have a specific pavement policy, but maintain guidelines on pavement treatment selection. The pavement preservation program is favorable and is contracted out. The agency is decentralized but the National Highway System (NHS) is done centrally. Budgets are set centrally. The maturity of SCDOT's preservation program is a two. SCDOT needs more training and pavement preservation certification. Their current PMS is the

Highway Pavement Management Application (HPMA) and use a Pathways van purchased for their data collection. The SCDOT manages 90,000 lane-miles.

The Texas DOT (TxDOT) policy is a four-year plan. TxDOT is decentralized and the Districts receive the funding and determine how it is spent. Districts are provided with the outputs from the PMS to help them decide on pavement treatments. The maturity of TxDOT's pavement preservation program is a four. TxDOT recommends improving the chip seal design procedure.

The Virginia DOT (VDOT) maintains a preservation agreement with the FHWA Division office and uses chip seals, slurry seals, micro surfacing, and 1.5-inch overlays. The preservation treatments are contracted out. The pavement preservation program is mature and began more than 15 or years ago. VDOT does not use ages for treatment selection because it creates problems, instead optimization is used to select projects. Project treatment selection is completed at the Districts. The central office distributes a list with a target for treatment types. The VDOT's preservation program maturity is a four to 4.5. The VDOT manages 128,000 lane miles. The Districts are provided lane-mile targets for each type of treatment. The VDOT recommends improving preservation being placed at the right time.

The Washington DOT (WSDOT) manages an internal policy report that guides their pavement preservation program, with content of these guides previously published as various TRB papers. The central office chooses every pavement treatment project and the District is charged with programming the project. The WSDOT maintains a policy, as well as favorable PMS and communication between the central office and the Districts, and execution. The pavement preservation system maturity is a four to 4.5.

The West Virginia DOT's (WVDOT) current policy is primarily rehabilitation. The central office provides a list of projects and the Districts implement, but a wide discretion concerning implementation. Nine out of 10 Districts are interested in pavement preservation and every District utilizing preservation. The agency is using pavement preservation for decades, but in the last six years, they began a modern program. The VDOT uses micro surfacing, thin lays, chip seals, cape seals, crack sealing, concrete pavement restoration, and scrub seals. The maturity of WVDOT's preservation program is a two. The WVDOT does not currently maintain a preservation policy or decision trees. The WVDOT needs more training and improvements to selection of projects at the District level.

CHAPTER 4. STRATEGIC LEVEL SELECTION AND EVALUATION

This chapter provides agency experience with strategic level selection and evaluation. Specifically, the following questions were discussed:

- How do you make strategic level decisions (i.e., budget, types, split between preservation and rehab, etc.)?
- How does your PMS play a role in strategic decisions?
- How do you determine when? How do you determine where?
- What do you consider as best practices in strategic level decisions?

The session included a brief introductory presentation by an agency followed by discussion.

PRESENTATIONS

Arizona DOT

Pavement preservation is one of the ADOT's major programs at their five-year transportation facility construction program. The ADOT's pavement preservation program is divided into two sub-programs: (1) a Statewide Rehabilitation 111 Sub-Program with a \$160 million baseline budget and nearly 90 percent of the budget; and (2) the Statewide Minor and Preventative 112 Sub-Program with \$16 million continual budget, or approximately ten percent of the budget. The ADOT's main factors to determine the sub-program are based on cracking percent and IRI for the 111 sub-program and cracking percent, rutting, and raveling for the 112 sub-program with different thresholds for the interstate and non-interstate. It is recommended for the ADOT to complete a new PMS by the end of 2018. The new PMS is expected to generate a list of strategies, cost (i.e., materials, mobilization, etc.), and benefits. A "category" of treatment is recommended rather than a specific treatment. The specific treatment is determined by a scoping process and field data.

The ADOT uses several optimization methodologies such as benefit cost analysis, lowest cost, minimization of risk, and level of service/performance-based analysis. The optimization process produces a multi-year set of project level treatment strategy recommendations for rehabilitation and maintenance. The five-year Transportation Facilities Construction Program – Statewide Rehabilitation includes a three-year plan with year one and two focused on identifying specific projects and new projects being added for the third year. No specific projects are listed for years four and five, but includes lump sum funding. Project prioritization is based on IRI, traffic, cracking, last project, and highway functional classification. The five-year Transportation Facilities Construction Program – Minor and Preventative, includes specific projects amended yearly into the program. Project prioritization is based on cracking, rutting, raveling, and highway functional classification.

ADOT best practices include:

- Improving data collection is critical – the true condition of the pavement assets should be known.
- Be proactive, not reactive – maintenance and preservation of the pavement assets are critical.
- Target setting (i.e., two points rather than a single point). A minimum level below which the pavement assets would be failing.
- Use trend analysis to determine areas that are not performing (i.e., reconstruction may be required).
- Do not take the results from the PMS blindly. Use the results to assist in the decision, not make the decision.

Florida DOT

A DOT representative presented the FDOT's strategic level selection and evaluation. The Florida Statute 334.046.1 requires that 80 percent of the pavement on the State Highway System meets Department standards. Please note, this is not a Federal requirement.

The FDOT is a decentralized agency with seven geographic Districts. The central office establishes Departmental policies, rules, procedures, and standards. Budget and strategic decisions are made at the central office. The FDOT network includes 44,180 lane miles with 97.5 percent being flexible and 2.5 percent being rigid. The FDOT almost exclusively uses milling and thin HMA overlays. The FDOT measures cracking, rutting, ride, and IRI to form the Pavement Condition Rating (PCR) index. A PCR value of 6.5 is deficient. Since 2006, the Department surpassed the 80 percent performance standard per the Florida Statute. Currently, 92 percent of roadways meet the standards.

PMS data is used to maintain accountability of the Department's assets. It assists in determining when and where to resurface, performs forecasts, tracks District and statewide deterioration; in addition to the development of a resurfacing program that meets a pavement performance goal and system behavioral analysis. The FDOT uses Florida's Analysis System for Targets (FAST) to:

- Perform impact analysis for different funding scenarios and policy decisions;
- Calculate future resurfacing allocations based on forecasted conditions, based on the historical performance of pavements; and
- Prepare a prioritized list of candidates resurfacing projects.

Maryland DOT – State Highway Administration

The MDOT-SHA provides strategic level direction on budgets based on a range of vehicle miles and lane miles. In addition, the contracts should be feasible and have sufficient quantity to be “contract worthy.” Budgets are divided between rehabilitation and preventative maintenance based on the optimization. There are no pre-determined preventative maintenance requirements, but there is an innovation bonus starting in fiscal year 2020.

The MDOT-SHA PMS combines condition data, historical PMS data, performance models, and business plan goals to feed the optimization process. The system preservation objectives by engineering District consider total cost and benefit to the network. Pavement condition is measured using five metrics – ride quality, rutting, friction, functional cracking density, and structural cracking density. The overall pavement condition is the lowest individual condition measure.

The MDOT-SHA optimization process considers all pavement sections with data. The life extension for each of the five metrics is calculated along with the cost of feasible treatments. The most cost-effective treatments are chosen for each pavement section. The most cost-effective projects rise to the top of the list based on lane-mile/vehicle-miles-traveled constraints.

The MDOT-SHA’s final project site selection is based on input the Districts receive from the optimization recommendations, public complaints, maintenance shop recommendations, elected officials, and coordination with other activities (e.g., utilities, adjacent roadway projects and developers).

Beginning in fiscal year 2018, each District should achieve targets for preventative maintenance and are expected to develop and deliver a program that meets budget targets for preventative maintenance.

DISCUSSION

The ALDOT’s budget is based on the number of lane miles in a District. The ALDOT’s pavement preservation policy includes surface treatment, mill and fill, and minor rehabilitation. The District is asked to develop a preservation program which typically leads to one or two preservation projects a year.

For CDOT, the PMS is only useful for the overall strategic distribution, and not project level selection. It is recommended for the regions to select projects that are 80 percent based on PMS output. With this list, the final selection of projects is based on judgement. At a tactical level, the PMS is not relevant for pavement preservation project selection. It is used for determining general classifications of treatment, but less so on specific treatments. The PMS is also used to do a first cut at the dollar amount and general locations for pavement preservation, but detailed investigations assist with final project selection. The ConnDOT’s strategic level pavement preservation process consists of three major components:

- A system to regularly collect highway condition data.
- A computer database to process, sort, and store the collected data.

- An analysis program to evaluate repair or preservation strategies and suggest cost-effective projects to maintain highway conditions.

The analysis (i.e., optimization) process selects the best paving program against available funds in the budget scenario. This system seeks:

- Pavements in good condition for mill and overlay.
- Pavements in good condition for ultra-thin polymer modified asphalts.
- Low-volume roadways for rubberized chip seals.

The DOT then reviews scheduled construction projects in vicinity of candidate locations and perform field reviews to refine the list and develop scopes for selected projects.

The FHWA EFLHD's ten-year program treats all parks and utilizes a cost effectiveness score to select projects.

The KYTC pavement preservation program splits are largely driven by Pavement Sustainability Ratio (PSR) with a goal to maintain existing conditions. They also include fleet of vans collecting cracking, rutting, and ride data. The PMS data is used to drive selection of preservation treatments and a formula is used to determine District funding. The District provides a list of potential projects that are vetted centrally.

The MoDOT maintains a pavement planning tool to assist with decisions. The MoDOT does not have a matrix of treatments. After an overlay, they generally place a seal in six or seven years. The PMS helps them select when and where.

It is recommended for the Mississippi Department of Transportation (MSDOT) Districts to spend ten percent of the budget on pavement preservation activities. There is a pavement preservation manual that assists with the selection. The MSDOT uses PMS data to select when and where and predict the resultant network conditions.

The SCDOT funding is driven by Transportation Asset Management (TAM) targets and PMS data is used in the development of the TAMP. The Districts make the final project level decisions, but it is a data driven selection process with a cutoff score used for different types of treatments.

The VDOT makes strategic decisions about the network using their PMS. There is no dedicated funding for preservation. Districts are provided an overall funding and should meet lane-mile targets. The PMS is used to make these decisions and recommend treatment types. The VDOT uses the area under the deterioration curve for the benefit. VDOT's best practices in strategic decisions is to use deterioration curves to make tactical decisions. The PMS solely is not used to select projects. Apart from the PMS recommendations, the projects are selected based on field visits, project evaluation, and additional testing such as falling weight deflectometer (FWD), coring, etc.

The WVDOT uses surplus money for pavement preservation using the PMS and five-year scenarios. The when and where decisions can be validated using the video log. It takes WVDOT four to six months to install pavement. The WVDOT requested for best practices to select when and where, in addition to a tool to help with using the PMS to select when and where.

A common theme from this discussion is that the agencies all use a different method for strategic selection of pavement preservation treatments. There was general consensus for a standard terminology for what pavement preservation is and what it is not.

CHAPTER 5. PMS ROLE IN PAVEMENT PRESERVATION

This chapter summarizes the PMS role in pavement preservation. The discussion focused on the following questions:

- How is the PMS used as a tactical tool to select projects? How should it be used?
- What are best practices in using your PMS in tactical level decisions?
- Who makes the decision of “When/Where”? Why?
- Should there be centralized or decentralized decision-making?

PRESENTATIONS

Kansas DOT

The KDOT has a long history with PMS and pavement preservation and uses a tiered approach: (1) worst scenario is first (based on prioritization); (2) 1R/substantial maintenance/pavement preservation that is optimized; and (3) reactive routine maintenance.

The KDOT’s best practices used in their PMS are:

- Systematic with human overrides - allow flexibility but follow the system.
- Reduce the number of poor pavements but keep good pavement.
- Group actions to allow choices.
- Let people be the project optimization system.

Many parties are involved in making the “when/where” decisions at KDOT including:

- PMS selects candidate locations and preliminary scopes and District mileage.
- District selects specific locations and scopes.
- Headquarters and District field review locations and scopes.
- Headquarters provides final approval on locations and scopes.

This allows a system to review the entire network; local reviewers to add value beyond the system knowledge, and those monitoring funding to make sure they stay within budget.

The KDOT decision-making is both centralized and decentralized. Headquarters provides mileage allotments for each of the six Districts and candidate project locations are designed around network goals and starting scopes. The Districts select specific locations within the

mileage allotment and selects the preferred scope. Headquarters will finalize the list following a field review with the District.

Rhode Island DOT

The PMS is used for 85 to 90 percent of the tactical decisions. The treatment decisions are made at the District level. The PMS selects a treatment category, not an exact treatment. The DOT leaves the tactical decisions to the field personnel who know their roads best. The key is well-defined training and treatment selection process.

South Carolina DOT

South Carolina passed the Act 114 in 2007, which required SCDOT to establish a project prioritization process. This State mandated process is not a Federal requirement, however, consists of two components: (1) initial priority ranking score (PRS) from PMS and (2) an additional field ranking component. The PRS uses weighted criteria that results in 1,000 maximum points. Threshold PRS scores established for eligibility are greater than or equal to 550 and 450 for primary and secondary roads, respectively. Routes with PRS scores less than 450 could be preservation candidates. Once eligible candidates are identified, field engineers can add (or deduct) points for relative condition, corridor continuity, connectivity, and contractibility to complete the ranking process. The SCDOT also uses a Pavement Quality Index (PQI) expressed on a scale of zero to five. A PQI greater than 3.2 is eligible for preservation. PQI is measured using specialized van instruments with lasers, cameras, and distance measuring devices. The data collected from the PMS undergoes a rigorous quality control check before it is loaded into the system. From there, county or District level maintenance engineers can run a Pavement Improvement and Pavement Preservation Candidate List to aid in selecting rehabilitation and preservation treatment routes. Packaged projects are reviewed by the State Maintenance Contract staff for proper treatment selection, historical documentation and quality control. The route selection methodology varies across Districts, but the common goal is to select the appropriate treatment. The route selection process is a cycle between the local knowledge of routes and treatment selection, preservation candidate list and State maintenance contract staff. The end goal is to preserve roads that are in good condition.

Texas DOT

The objective of TxDOT's project selection development process is to develop a comprehensive and uniform pavement management plan which is roadway specific to the greatest extent possible and is fiscally constrained. The TxDOT requested to generate pavement condition projections based on a financially constrained plan, which can be used to assess the impact of the appropriated funding. The three primary goals are to:

- Assure maintenance resources are directed towards pavement operations and roadway related work.
- Provide a reporting mechanism for District engineers, administration, and commission to utilize in briefing elected officials.

- Allow Districts and Regions to appropriately allocate resources through long-term planning to accomplish the plan.

The first two years of the plan are project specific while the second two years are placeholders. The plans use a wide variety of treatments. The plans result in:

- Construction: four-year plan.
- Maintenance: four-year plan.
- Routine maintenance: zero to one-year plan.

These project plans are incorporated into the system to determine the performance of the system. The Districts will provide the final recommendations for when and where treatments are placed.

DISCUSSION

The ALDOT uses PMS recommendations for pavement preservation and resurfacing. This creates an initial discussion of what is needed. The Districts recommend their proposed preservation and resurfacing program to the Area. An Area is typically composed of three to five Districts. Each Area in turn narrows the program to their allotted funding and makes a program recommendation to the Region. Each Region is composed of two Areas. In the end, the Region makes the final decision on treatment type and timing.

The CDOT has a performance based system, within reason. The system is balanced to account for workload and contracting capacity. There are other factors that should be considered besides the PMS such as construction costs and pricing. This was a common theme in this session. The PMS can help in making decisions, but there are a multitude of other project factors that come into play in addition to the condition of a roadway.

The ConnDOT's PMS provides a preliminary list of candidate projects. The roads are then driven and make a treatment decision. The ConnDOT would like to use PMS to select projects, but do not trust this fully yet. The ConnDOT relies on experienced staff and uses PMS in cooperation with maintenance and construction staff to provide expert opinion. The decision making is centralized. For the maintenance and resurfacing program, some projects are selected by the Districts.

The FHWA EFLHD recommends ground truthing as a best practice. Eighty to ninety percent of projects line up with the PMS recommendations. The project selection process is very decentralized. The funding for projects derives from the NPS, while the engineering expertise comes from the FHWA.

The IDOT does not have a formal PMS. The IDOT uses a roadway inventory system for the current year. The IDOT is working on an Enterprise Asset Management System (EAMS). They utilize a centralized pavement preservation program. A pavement preservation oversight committee was established that approves all preservation projects and contains all interested parties. There is a pavement preservation decision matrix that is being reviewed and modified

through a separate working committee, which will eventually be approved for use by Department staff.

The KDOT uses a performance-based system and provides a good example of PMS selecting when and where.

The KYTC has pavement preservation decision trees to decide on the treatment. The central office makes the final decision. The Districts provide a candidate list of projects and the central office then reviews and responds. The final decisions are made shortly after. There is a year between project scoping and placement of the resultant treatment.

The MDOT-SHA uses thirty percent of projects recommended from the PMS optimization. The central office is working to increase this percentage. Projects are selected by the District. Pavement designers use PMS data extensively.

The MoDOT uses PMS to help determine frequency and timing of treatments. There is a year between project scoping and placement.

The MSDOT PMS uses a decision tree to recommend the project lists for a three-year plan. There is training for the District staff on selecting treatments.

The NMDOT stated that some Districts use the project lists from PMS but others do not. The NMDOT allocates funds equally to the Districts. However, tracking District progress against goals is an issue.

The WSDOT uses a performance-based system. All projects are reviewed and approved by the central office.

The WVDOT PMS provides a list of projects using simple decision trees. Higher level roads (NHS, etc.) use 75 percent of the PMS recommendations. The Districts make decisions on lower-level roads.

Many of the DOTs commented that there does not seem to be any training on when and where pavement preservation treatments should be placed.

CHAPTER 6. PAVEMENT PRESERVATION FROM AN ASSET MANAGEMENT PERSPECTIVE

This chapter summarizes how pavement preservation is viewed from an asset management perspective. Issues discussed during the session included the following:

- How does pavement preservation impact your plans to meet the TPM rules?
- How is pavement preservation used in your TAMP?
- How is pavement preservation considered in your risk register? Lifecycle cost analysis? Investment strategies?

PRESENTATIONS

Washington DOT

The WSDOT pavement preservation can range from crack sealing to reconstruction. With 18,500 lane-miles, there is an approximately \$15 billion pavement replacement cost. Asphalt or chip seal pavements are managed in cycles with an emphasis to limit the scope of work to only resurfacing. Concrete pavements are managed as long-term structures and must eventually be reconstructed.

The WSDOT uses pavement condition data to forecast the time of next rehabilitation. The principal objective of WSDOT's pavement management program is to deliver acceptable performance at the lowest LCC. Cost-effectiveness evaluates the cost of strategies to deliver this acceptable performance (i.e., cost per lane-mile per year, or annual cost). Equivalent Uniform Annual Cost (EUAC) is a simple value that can be directly compared with the annual cost of a different project, or an alternative treatment. EUAC is easier to calculate, since the time periods comparing alternatives can be different.

Priority of capital projects at WSDOT considers categories to designate special circumstances (i.e., higher risk of structure failure, etc.) and dollar per lane-mile, per year, per truck. Reliable cost-effectiveness analysis requires reliable inputs. Therefore, success at WSDOT is driven by annual condition assessment, robust construction history, and good cost records. The agency also uses a risk register for pavement that is presented in their TAMP.

Kentucky Transportation Cabinet

The goals of the KYTC goals are as follows:

- Provide a safe and secure movement of people and freight;
- Provide for the improvement and maintenance of the existing transportation infrastructure;
- Deliver a dependable transportation system that effectively and efficiently moves people and freight;

- Offer reliable connectivity and access – locally, regionally, and globally – for people and freight; and
- Ensure that the process which develops and maintains a transportation system adequately considers dependable access to markets, jobs, and resources.

To achieve these goals, asset management and preservation of existing infrastructure is a key component. Pavement preservation is necessary to achieve pavement performance targets established by the Cabinet. An asset management goal is to increase resources targeted toward preservation activities. The TAMP demonstrates cost effectiveness of planned pavement management programs and establishing performance targets that are linked to available funding. The Strategic Highway Investment Formula for Tomorrow program guides development of the six-year highway plan and prioritizes preservation of system over capital construction projects.

Life-cycle planning (LCP) reduces the rate of deterioration through the appropriate use of low cost preventative maintenance treatments that lead to longer asset service lives than traditional strategies. LCP requires the ability to forecast impacts of different treatment strategies using the same total budget for each strategy. The KYTC is moving to a fully functioning PMS. The KYTC is also developing decision trees and deterioration models.

The KYTC includes the following risks in their TAMP and appropriate mitigation strategies:

- If we lack State legislative approval for asset management projects, our program of projects is changed and there may be greater deterioration.
- If we have few projects on the shelf to utilize funds from unspent capital projects, we may not be able to fully capitalize on additional funds.
- If we do not receive stable and adequate funding we may not achieve our goal.
- If funding is unpredictable, we may not be able to optimize our paving treatment.
- If we cannot afford to sustain our target, systems may deteriorate.
- Loss of public support.

Illinois DOT

The IDOT collects pavement condition data (i.e., roughness, rutting and faulting) over a two-year cycle for the entire network. Interstates are collected annually. The Condition Rating Survey (CRS) models directly input sensor data and raters select up to five predominant distresses. Manual overrides are possible if there are more than five predominant distresses or the model inaccurately presents the section. The IDOT develops an annual and multi-year program to provide a list of the programmed projects. The Central Bureau of Programming is responsible for developing these programs. Based on projected funding levels, the Bureau of Programming provides funding targets to the Districts. The total funding is divided with a significant portion going to District 1 (i.e., Chicago). The remainder of the funding is divided over the remaining

eight Districts. The Districts develop the list of projects and the scope of work which are submitted to the Bureau of Programming.

Previously, IDOT's asset management policy included worst case scenarios first and then pavements with the lowest CRS values being the highest priority. Backlog was used as a performance measure. In 2005, the executive staff committed to the initial pavement preservation program. This program included three projects per District with a limit of \$100,000 per project and limited treatment options. Over the years, funding levels increased to \$7.5 million for 2015.

The IDOT is moving from a worst-case scenario first, to an asset management philosophy. Backlog is no longer used as the network indicator and the network is monitored according to the amount of the network is in acceptable condition. Along with changing the terminology, the Department uses a consistent value for determining what is acceptable (i.e., CRS of 5.5 for interstates and 5.0 for non-interstates). The State programs work to maintain various percentages of each type of roadway at acceptable condition. These are ninety percent for interstates and NHS routes, seventy-five percent non-NHS routes and fifty percent for unmarked routes.

Moving forward, it is recommended for each District to program a percentage of unrestricted funds in preservation projects for both pavements and structures. Treatments are selected based on distress type (i.e., functional versus structural) and deterioration rate using decision trees developed by a pavement working group. Projects are monitored to improve strategy selection including condition at time of placement, construction costs, and performance over time. The IDOT is working on an EAMS.

The IDOT is using pavement preservation to show how it is better than worst first. The TAMP discusses how pavement preservation affects the network.

DISCUSSION

For MDOT-SHA, pavement preservation is already integrated within the decision-making process. The MDOT-SHA uses ten-year budgets. The Districts choose the treatments and the resultant performance remains. It is very hard to force the Districts to do anything and some are better than others in following a preservation strategy. The MDOT-SHA is focused on maintaining their condition which is currently at a fairly high-level.

The MSDOT, MoDOT and ALDOT did not explicitly include pavement preservation in their TAMPs.

The NMDOT recommended to enact a policy for pavement preservation. For NMDOT, preservation principles are included in the TAMP with worst-first scenarios versus preservation analysis to show the impact on condition. The two scenarios – worst-first versus optimization are clearly displayed in the TAMP to indicate the positive impact of preservation. The NMDOT mentioned that risk is difficult to incorporate into modern PMS.

The NYSDOT's PMS uses 0.1-mile segments. The NYSDOT is dealing with three main risks – loss of one third of the work force over five years, new data stream, and funding issues such as long-term underfunding. The lifecycle demonstrates that pavement preservation provides the only way to maintain the system.

The SCDOT's TAMP quantifies pavement preservation, but work history is needed. It is included in the risk register of the TAMP.

The VDOT preservation is imbedded within the analysis and indicated no change in recent tactics. The VDOT does not have anything specific in the TAMP regarding preservation.

The WVDOT stated that their preservation is similar to MDOT-SHA with preservation built into the decision trees. Dust in chip seals and lack of inspection is a risk. Life-cycle analyses shows that preservation is the best option.

CHAPTER 7. PAVEMENT PRESERVATION EVALUATION/DECISION TOOLS

In this discussion, the project team led the participants through a facilitated exercise to determine if the agencies used one of the current pavement preservation evaluation/decision tools. The discussion also focused on the functionality of a tool desired by the agencies with the existing known tools reviewed first.

REVIEW OF EXISTING TOOLS

OPTime Tool

As documented in National Cooperative Highway Research Program (NCHRP) Report 523, a computational tool was developed to evaluate the optimum time to apply a pavement preservation treatment. This tool, referred to as OPTime, is a Microsoft Excel-based program which utilizes macros to progress through the analysis. OPTime allows the engineer to enter input data using a “simple” or “detailed” approach. The methodology provides flexibility in terms of the level of detail that can be used to determine optimal timing.

R-26 Tool

This analytical tool is intended to be used to identify feasible pavement preservation projects on high-traffic volume roads and to select the preferred pavement preservation treatment for each project. It takes into consideration the conditions and characteristics of the project, the cost effectiveness of the treatment, and various selection factors. It complements the suggestions provided in the Strategic Highway Research Program 2 (SHRP 2) R-26 publication, “Guidelines for the Preservation of High Traffic Volume Roadways.” This tool is designed for use by pavement maintenance/preservation engineers, pavement management engineers, and other pavement practitioners responsible for making preservation decisions.

PPETG Pavement Preservation Benefits Calculator Tool

The purpose of this tool is to monetize the benefits of pavement preservation in a simplified, graphical manner for a non-technical audience. The intended audience is anyone who wishes to convey why pavement preservation is worth the investment. Many of the agencies present did not know that these tools existed.

DEVELOPMENT OF A NEW TOOL

As part of the project, the team is contemplating development of a tool that pavement practitioners could use for evaluating the performance and financial benefits realized from alternate management and preservation strategies for pavements. It is envisioned that this effort would entail using theories, algorithms and methodologies from existing programs that were designed for these purposes. The tool should identify parameters and allow easy customization for use by agencies with different sizes, climate, priorities, etc. The requirements for the tool are as follows:

- The tool should calculate economic benefits in terms of a uniform parameter such as EUAC per lane mile.

- The tool should calculate performance in terms of a parameter such as percentage of lane miles in “good” and/or “poor” condition where “good” and “poor” are closely defined.
- Inputs to the tools should be readily available current and historical measurements commonly available to highway agencies.
- Provide simple instructions for use of the tool.
- The tool should not contain any code that is considered proprietary.

The following ideas were offered by the participants for a potential tool:

- A tool that uses Highway Performance Monitoring System (HPMS) data to determine the outcome of using various pavement preservation treatments and budgets, including:
 - Generic models and costs that could be tailored to an agency;
 - Regional or nationwide defaults that could be tailored to an agency;
 - Used generic rehabilitation/pavement preservation activities (i.e., reconstruction, rehab, light rehab, heavy preservation, light preservation, reactive);
 - Use life extension model not specific treatments;
 - Analysis tool to help a state get from one category to another; and
 - Use EUAC as the metric as well as good, fair, and poor.
- A simple tool that helps determine the appropriate mix of structural fixes.
 - There is concern that we are “painting ourselves into a corner” with preservation and we may need large outlays for structural fixes in the future.
- Life-cycle cost analysis tool.
 - Life-cycle curves per agency that compares pavement preservation with rehabilitation, reconstruction, etc.
 - Illustrates cost savings by different types of preservation.
 - Includes depreciation and interest.
- A field application that can be used to enter data to see what their budget can do.
- A training tool for field staff that are selecting treatments.
 - Our experience in the field is lacking; suggest to “Gamify” tool.
- Tool to help develop deterioration curves for different preservation treatments.
 - What are resets?
 - What is the outcome when applying pavement preservation to a certain condition for a treatment?

It was unanimously decided that the tool should not be an excel type tool. Each new version of Excel creates compatibility issues and the macros tend to get outdated. In addition, some agencies cannot run embedded macros due to security concerns. A web-based tool that was based on open source software was the common choice among participants. The source code should be provided to FHWA so that after the contractor is done with the tool, it can be updated.

CHAPTER 8. HOW TO MEASURE SUCCESS

This chapter presents how agencies measure success. The discussion focused on the following questions:

- What metrics do you use?
- What metrics would you like to see further developed?
- How is cost effectiveness determined?

PRESENTATIONS

Minnesota DOT

Ride is the primary metric used by MnDOT. The percent Ride Quality Index (RQI) - a measurement of roughness - in good and poor condition are tracked. This is divided between interstate, NHS and non-NHS and is on a zero to five scale. The Surface Rating (SR) is also measured which combines cracking, rutting, faulting, etc. into an index between zero and four. The PQI is the overall condition of the pavement. The pros and cons of the current metrics are as follows:

- Does not differentiate between rural (low speed) and urban (high speed).
- Does not track an overall trend.
- It focuses on the poor roads.
- There is too much reliance on deterioration curves or the deterioration equations.
- It allows the DOT to review at multiple scenarios quickly.
- Performs well from a system basis, less so a project basis.

The MnDOT requested to review the remaining service life (RSL) and further develop the Asset Sustainability Ratio (ASR).

The pavement management software can run various scenarios with multiple parameters such as funding level and inclusion of preventative maintenance. LCC is required on almost all projects as a State legislative mandate (this is not a Federal requirement). Alternate bid is used between concrete and bituminous if the LCC is close.

Alabama DOT

The ALDOT considers success as follows:

- An established preservation program;

- Successfully training of personnel;
- Pursuing preservation contractors in the State;
- Successful projects are performing well;
- Development of personnel experience; and
- Buy-in.

The ALDOT measures rutting, cracking and rideability with consideration given to crash history. A PCR is used to rate the pavement condition. PCR greater than or equal to seventy is good, PCR between fifty-five and seventy is fair, and PCR less than or equal to fifty-five is marginal. They also track project costs by region of the State. The ALDOT uses a side by side comparison of project application types to determine cost effectiveness as well as reviewing new treatments in new locations.

The PMS is good for making a first cut at pavement preservation projects, but “boots on the ground” are needed to finalize the plan and select the when/where for treatments.

The ALDOT requested for the expected service life based on traffic levels and further develop previous history. In addition, the ALDOT requested for the PMS to account for surface treatments. The ALDOT is determining the reset condition indicator for preservation treatments. The ALDOT also indicated through research, that a simple model can perform as well as or better than a complex model for pavement preservation management.

Virginia DOT

The VDOT uses the critical condition index (CCI) to rate pavement condition. Pavements in fair (i.e., CCI of sixty or greater) or better condition are considered to be in sufficient condition. The VDOT inputs the pavement condition to the decision matrices to develop a list of preliminary treatments. This is combined with traffic level, structural capacity, and construction history in decision trees to determine the final treatment selection. Condition data, pipeline projects, constraints, and advertisement targets are used in the optimization analysis to determine the paving targets (i.e., lane miles).

The goal of the optimization analysis is to determine a set of mix treatments to achieve the desired condition level within multiple constraints. The objective is to maximize benefit and minimize the treatment cost. Constraints include maintain average CCI conditions, meet allowable sufficiency targets, achieve desired mix of treatments, and remain below the budget. The output of the optimization is the optimum combination of different treatment categories and the predicted percent sufficiency.

The VDOT performance-based needs for optimization include the following:

- Collect and apply condition data to management sections;
- Develop pavement condition prediction models;

- Develop criteria for pavement maintenance activity selection;
- Establish performance measures and targets;
- Create planning scenarios and run optimizations; and
- Determine performance-based needs.

The VDOT measures the percent sufficient by functional class and District. This is measured for years and is used routinely by the Districts to adjust work, estimate the needs, and monitor the overall network condition. The VDOT attempts to minimize the number of sections that need reconstruction.

DISCUSSION

The AZDOT does not have metrics for pavement preservation, therefore, is unable to determine the effectiveness of preservation treatments.

The CDOT uses a Drivability Life Index that is similar to RSL. Eighty percent of the PMS recommendations should be implemented by the Regions (i.e., similar to a District in other States). They use metrics such as percent budget going to interstate, non-interstate, etc. by treatment type. The CDOT assumes that the models are wise enough to select the right mix of projects.

The ConnDOT includes an IRI dashboard; moving to rutting, cracking, and faulting as performance indicators. The ConnDOT performance dashboard is online.

The FHWA EFLDH issues a pavement condition report on a yearly basis to report their metrics to the parks.

The GDOT uses Pavement Condition Evaluation Survey (PACES) to determine the good, fair, and poor metrics. There is no way to tie pavement preservation to deterioration curves and default curves are needed. Well performing treatments should be shown to educate officials who fund preservation treatments to illustrate their effectiveness. The GDOT believes that metrics need to have a visual representation. The GDOT uses the lowest LCC as a cost effectiveness metric.

The NMDOT uses a PCR that ranges from 0 – 100. The PCR compares eight different distresses that account for eighty percent of the PCR and IRI is twenty percent. The threshold is 100-65 is good, 65-45 is fair and the remainder are poor. PCRs are developed for each roadway class. Ninety-two percent of the interstate is in good condition. Other metrics NMDOT consider is the cost per lane mile.

The KDOT uses IRI, rutting, and transverse cracking for asphalt concrete pavements. For concrete pavements, KDOT uses IRI, durability--cracking, and faulting. The KDOT combines the metrics to determine a good-fair-poor rating. This results in sixteen combinations of performance level per pavement type.

The KYTC uses performance targets based upon measures to assist in monitoring progress toward goals. These targets help guide decisions through the analysis of options, setting of priorities, program budgeting, and implementation. The performance targets serve as indicators of work performed, results achieved, and network health. The performance targets are:

- Percent of pavement in fair or better health;
- Average years of RSL;
- ASR (i.e., measures how well pavement replenishment is keeping up with pavement wear); and
- Deferred Preservation Liability (i.e., estimate of the funding necessary to address the backlog of deferred pavement rehabilitation).

The MDOT-SHA uses their PMS metrics to define performance.

THE MoDOT uses Pavement Surface Evaluation and Rating and IRI to determine the percent of good pavement. Cost effectiveness is determined by running an LCC analysis.

The MSDOT is working on their PMS. It is recommended to include a rutting index and fatigue index. Cost effectiveness is determined by the LCC analysis.

The NVDOT uses a Pavement Serviceability Index (PSI) similar to the AASHTO PSR that is weighted ninety percent for IRI and ten percent for distress. The roadways are divided into five different categories such as interstate, NHS, etc. Ninety-five percent of the roads are in fair or better condition.

The SCDOT uses lane miles service life as a metric and uses the PMS to determine cost effectiveness.

The TxDOT uses both a condition score that is comprised of a distress score that ranges from 0 to 100 and an IRI ride score that ranges from zero to five. There are seventeen combinations of combined condition score and the statewide goal is ninety percent of the pavement in good or very good condition. The TxDOT also considers structural condition and macrotexture. The TxDOT is working to define the effectiveness of a treatment.

The WSDOT collects data to identify images (i.e., used to identify cracking), roughness, rutting, and faulting.

As described previously, the principal objective of WSDOT's pavement management program is to deliver acceptable performance at the lowest LCC. As a result of their proactive pavement preservation program, \$13 million applied to 3,500 lane miles between 2009 and 2015 resulted in \$15 million annual savings by delaying major resurfacings. Reliable cost-effectiveness analysis requires reliable inputs. Therefore, success at WSDOT is driven by annual condition assessment, robust construction history, and good cost records.

The WVDOT determines performance by the number of complaints.

CHAPTER 9. USING THE PRODUCTS OF THE PROJECT

The Peer Exchanges closed with a discussion focused on the development of the project products. The project team is tasked with the following:

- Developing a Synthesis for selection and evaluation of programs that include preservation as a strategic investment for pavements.
- Developing an effective tool for analyzing the long-term effectiveness of preservation strategies as investment program alternatives.
- Researching the emerging concepts of strategic investment as related to pavement preservation; and preparing fundamental analysis procedures for including pavement preservation concepts in asset management, planning and programming strategies in transportation agencies.
- Developing a synthesis of metrics used to calculate performance of preserved pavements and to determine network-level cost effectiveness of pavement preservation strategic programs.
- Performing Peer Exchanges, workshops, and webinars.

The participants were asked three questions.

1. What products are needed by the pavement preservation community?
2. What is the audience for each product?
3. What format should the products be in to foster use?

PRODUCTS DISCUSSION

The products listed may go a long way for informing executives, technical personnel, and layman in pavement preservation. As part of the outputs it is essential to include:

- Solid terminology as no industry wide consensus exists;
- Definitions of pavement preservation; and
- A list of how an agency defines pavement preservation (i.e., each agency uses a different definition).

In addition, it is recommended to include a policy guide template in the products, as few agencies involved in the Peer Exchanges maintain a policy guide.

The tools should include a beginner, intermediate, and advanced focus so an agency that is just starting can apply the tools and procedures quickly and easily.

An LCC tool is needed in the industry to demonstrate the value of pavement preservation from an economic standpoint; including LCC curves per treatment on a national, regional, and State level. Creation of this tool would allow a comparison of a pavement preservation treatment versus a mill and resurface, etc. The goal of this tool is to illustrate the cost savings of a pavement preservation program. This could be tied to a simpler-than-PMS high-level tool with predictions for HPMS indices (i.e., crack, rut, fault, and roughness) and LCC prediction so personnel could compare what would happen to the national performance measures versus a specific methodology for treating roads.

AUDIENCE DISCUSSION

It is critical to include an executive summary which clearly points out the benefits of pavement preservation. This should be the “why” of preservation. This is critically important so that new and potentially uninformed personnel can immediately acclimate to pavement preservation issues. The audience for the remainder of the documents should be technical in nature.

It is also recommended for project team to consider including a section with the general public as the audience in each report. As an industry, it is important to demonstrate the value of pavement preservation to “John Q. Public” to show them the benefits of pavement preservation.

The best ideas should be placed in the beginning of the documents. It is also recommended to provide ample examples of how a particular idea is used by an agency and provide the benefits of each use.

The documents should include suggestions for local agencies, as well as States. This is critically important as the locals in many States control most of the roads.

FORMAT DISCUSSION

A report format should be followed for each of the report deliverables. Each document should have a five page or less executive summary. Each report should also have a two-page associated technical brief. Agencies should be allowed to review each document prior to it being published. The documents should be written in plain language, as well as with simple and ample graphics.

ADDITIONAL DISCUSSIONS

It is also recommended for agencies to present via webinars, as allowing for an audience peer present is always good practice. These types of Peer Exchanges are very productive. Many of the agencies were very receptive to the idea of a Peer Exchange occurring every year on pavement preservation issues.

A video should also be produced that explains pavement preservation and why it is important for the layman. The ODOT created a similar model that could be used in this regard, which is found here <http://www.dot.state.oh.us/AssetManagement/preservation/Pages/Preservation-Video.aspx>.

Lastly, a communication plan is vital piece of pavement preservation and necessary for each DOT. Additional training is also needed for field staff that are selecting treatments.