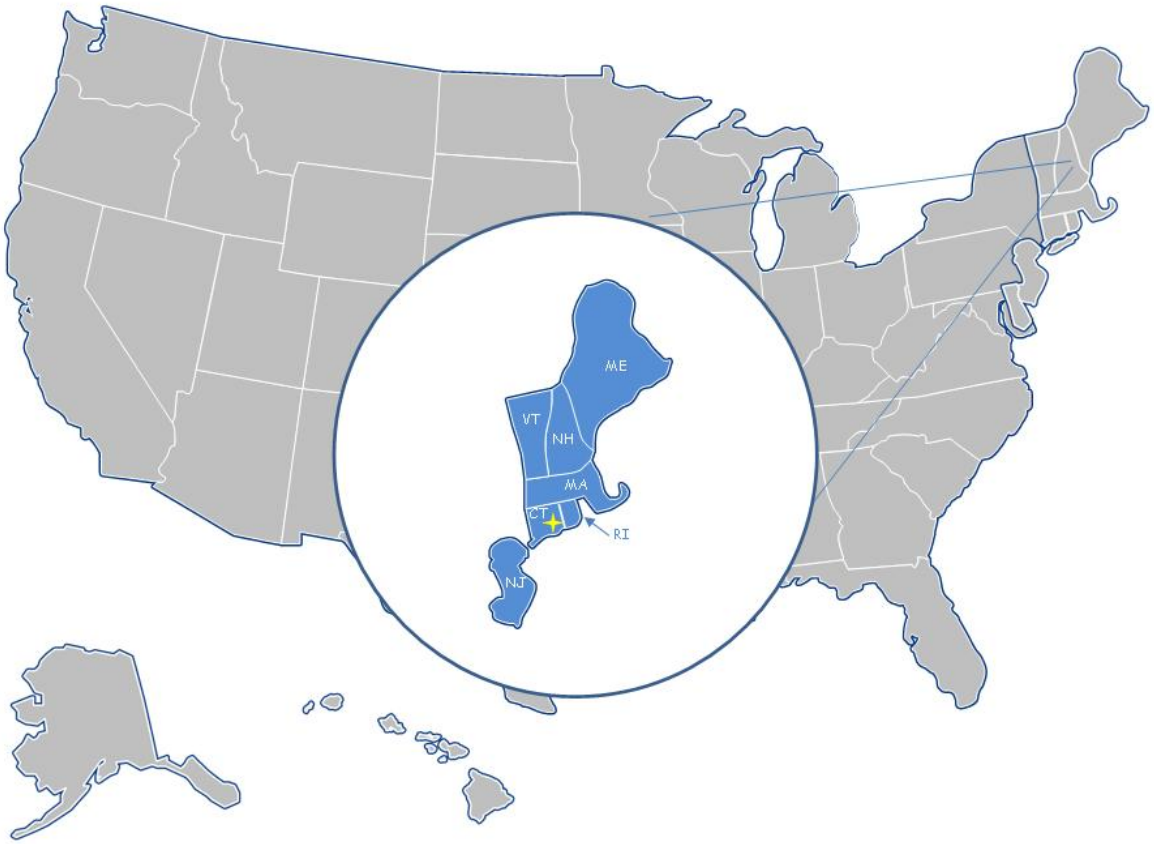
U.S. Department of Transportation
Federal Highway Administration

PEER EXCHANGE PROGRAM

Pavement Management Practices in State Highway Agencies: Newington, Connecticut Peer Exchange Results



Final – January 5, 2011
FHWA-HIF-11-036

U.S. Department of Transportation
Federal Highway Administration

Pavement Management Practices in State Highway Agencies: Newington, Connecticut Peer Exchange Results

Submitted to the Federal Highway Administration
US Department of Transportation

Final – January 5, 2011

FOREWORD

The Federal Highway Administration Office of Asset Management has performed a series of Pavement Management Peer Exchange Workshops. The purpose of these workshops is to provide participating state agencies a forum to discuss issues of mutual interest in the field of pavement management and promote information exchange between participating agencies.

This document reports on the discussions held at the fifth such Peer Exchange held on September 8-9, 2010 in Newington, Connecticut. The peer exchange had representatives from the following agencies:

- Connecticut Department of Transportation (ConnDOT)
- Maine Department of Transportation (MaineDOT)
- Massachusetts Department of Transportation (MassDOT)
- New Hampshire Department of Transportation (NHDOT)
- New Jersey Department of Transportation (NJDOT)
- Rhode Island Department of Transportation (RIDOT)
- Vermont Agency of Transportation (VTrans)
- FHWA Division and Resources Center Staff
- FHWA Office of Asset Management

The report presents a summary of the states' practices in each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short-and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Technical issues related to comparison of performance measures

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16. Abstract

This report summarizes the results of a 2-day Peer Exchange on Pavement Management held in Newington, Connecticut on September 8-9, 2010. The participating states include the following: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island, and Vermont. Representatives from each of the DOTs and their FHWA Division counterpart attended the meeting. The report includes a summary of the states' practices and a discussion on each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short-and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Technical issues related to comparison of performance measures

This report summarizes the discussions at the meeting.

17. Key Words	18. Distribution Statement
Pavement performance, pavement preservation, pavement rehabilitation, pavement maintenance, extended service life, pavement management, hot mix asphalt, and portland cement concrete	No restrictions.

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Unclassified	Unclassified	33	

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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)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		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)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		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)

CHAPTER 1

Introduction

BACKGROUND

In its continuing efforts to provide research and technology transfer activities in support of improving pavement conditions nationwide, the Federal Highway Administration (FHWA) is sponsoring a series of Peer Exchange meetings. These meetings provide pavement management practitioners in state highway agencies (SHAs) throughout the United States with the opportunity to share pavement management practices and exchange ideas for using their tools to support agency decisions in the following areas:

- Data needs and quality
- Short- and long-term planning
- Treatment selection to improve pavement conditions
- Performance modeling and predicting future conditions

The Peer Exchange meetings also provide an opportunity for participants to share information about the cost of collecting and reporting pavement condition data and to identify national initiatives that could result in the development and deployment of innovative materials, processes, and technologies for the effective design, construction, rehabilitation, and maintenance of pavements. The Peer Exchange meetings focus on the use of pavement management tools to support agency decisions regarding the allocation and use of available funding to preserve the highway network.

The first Pavement Management Peer Exchange Meeting was held in February 2008. It included representatives from the New York and California Departments of Transportation and the FHWA. These individuals met with representatives from the Minnesota Department of Transportation in Maplewood, Minnesota on February 4-5, 2008 and then with representatives from the Utah Department of Transportation in Salt Lake City, Utah on February 7-8, 2008.

The second Pavement Management Peer Exchange Meeting was held in Nashville, Tennessee on September 23-24, 2009. Representatives from four SHAs and five FHWA Division offices participated in this meeting in addition to representatives from FHWA Headquarters and the Atlanta Resource Center.

The third Pavement Management Peer Exchange Meeting was held in Golden, Colorado on November 17-18, 2009 while the fourth was held in Madison, Wisconsin on August 24-25, 2010. The SHAs participated in the meeting along with representatives from FHWA Headquarters and Division offices. The meeting built on the framework introduced at the prior Pavement Management Peer Exchange Meetings.

This report documents the results of the fifth Pavement Management Peer Exchange held in Newington, Connecticut on September 8-9, 2010, 2010. Seven SHAs and representatives from the FHWA Division office for each state were represented at the meeting. The format for the meeting was identical to that used for the meetings in Golden, Colorado and Madison, Wisconsin.

At the writing of this report the previous Pavement Management Peer Exchange reports are in various stages of publication. When complete, they can all be accessed through the FHWA website at:

http://www.fhwa.dot.gov/infrastructure/asstmgmt/index.cfm

PARTICIPATING AGENCIES

The participants in the North Atlantic Peer Exchange held in Newington, Connecticut included representatives from the following agencies:

- Connecticut Department of Transportation
- Maine Department of Transportation
- Massachusetts Department of Transportation
- New Hampshire Department of Transportation
- New Jersey Department of Transportation
- Rhode Island Department of Transportation
- Vermont Agency of Transportation
- FHWA Division Offices in each State
- FHWA Resource Center Staff
- FHWA Office of Asset Management.

The names of the participants in the North Atlantic Peer Exchange are listed in Table 1-1.

Table 1-1. Participants in the North Atlantic Peer Exchange Meeting.

Agency or Affiliation	Participant Name
Connecticut DOT	Edgardo Block Marcelle Zeitoun Dean Dickinson Craig Babowicz Leo Fontaine Donald Larsen Mike Derewianka Joseph Obara
Maine DOT	Anne Emidy
Massachusetts DOT	Edmund Naras Jonathan Smith
New Hampshire DOT	Eric Thibodeau Deirdre Nash
New Jersey DOT	Susan Gresavage Phil Bertucci
Rhode Island DOT	Paul Petsching Michael Byrne
Vermont AOT	Reid Kiniry Kevin Marshia
FHWA Division Offices/Resource Center	CT: Stephen Cooper NH: Christopher Tilley NJ: Hadi Pezeshki RI: Anthony Palombo VT: Mark Richter Res. Ctr: Joe Huerta
FHWA Office of Asset Management	Nastaran Saadatmand Thomas Van

REPORT ORGANIZATION

The report includes the following chapters:

- Chapter 1: Introduction.
- Chapter 2: Using pavement management data to support decision making.
- Chapter 3: Using pavement management for short- and long-term planning.
- Chapter 4: Establishing links with pavement preservation and maintenance and operations.
- Chapter 5: Developing performance models and performance measures using pavement condition information.
- Chapter 6: The economics of pavement management: cost-effectiveness and cost savings.
- Chapter 7: Technical issues related to comparison of performance measures.
- Chapter 8: Summary.

Chapters 2 through 7 address the six topics discussed during the meeting. The first five topics were selected by FHWA. The sixth topic, technical issues related to comparison of performance measures, was selected by the participants.

For chapters 2 through 7, the following topics were addressed for each issue:

- Topic Summary
- Current Practice Among Participating Agencies
- Issues Identified
- Needs to Enhance the Use of Pavement Management
- Highlighted Practices

An appendix providing background information about each of the participating SHAs is included in Appendix A.

CHAPTER 2

The Use of Pavement Management Data To Support Decision Making

TOPIC SUMMARY

The final measure of a successful pavement management system is the degree to which an agency's decisions are influenced by the output of the system. Pavement management systems are designed to assist agencies with planning and programming functions over the short- and long-term. As a result, most pavement management systems are designed to help in the following ways:

- Identify and prioritize maintenance and rehabilitation needs,
- Evaluate the cost effectiveness of various strategies, and
- Recommend projects and treatments under various budget scenarios.

In recent years, advancements in technology have allowed decision makers to extend pavement management's reach in other areas such as:

- Evaluation of pavement preservation needs,
- Determination of the cost effectiveness of preservation treatments, and
- Selection of optimal timing for preservation treatments.

This is leading to stronger and more effective pavement management systems in highway agencies.

During this session of the peer exchange, each agency had the opportunity to explain their current use of pavement management information to support agency decisions, the factors influencing the use of the pavement management output, and the future changes they hope to implement.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After introducing the topic to the participating agencies, each agency was provided an opportunity to explain their current use of pavement management information to support the agency's decision process.

Summary of Practice

A summary of data collection techniques, pavement management software, and the organizational location for the pavement management office for each of the agencies is summarized in Table 2-1. More detailed information about the practices being used in these areas is given in Appendix A. As shown in Table 2-1 and discussed in Appendix A, the participants use a variety of different approaches to data collection with some agencies contracting out the services and others collecting the pavement condition data in-house.

In all cases, the current pavement management software was developed by Deighton (dTIMS software). The organizational location of the Pavement Management group varies widely within the focus agencies as shown in Table 2-1.

Most agencies indicated that the success of their system is due to top management support and the strength of their central office pavement management activities.

The following sections summarize the current practices of each agency with respect to the use of pavement management data to support decision making. Following this discussion, the group identified issues concerning use of pavement condition data for decision making. Then they identified needs to address the cited issues, followed by identification of the good practices for the agencies.

Table 2-1. *Summary of practices in participating state highway agencies.*

State Highway Agency	Data Collection Approach and Vendor	Pavement Management Software Vendor	Organizational Location for Pavement Management
Connecticut Department of Transportation	Two state-owned Roadware (ARAN) vehicles	Deighton	Engineering and Construction
Maine Department of Transportation	State-owned ARAN vehicle	Deighton	Asset Services Division
Massachusetts Department of Transportation	State-owned ARAN vehicle	Deighton	Highway Division, Project Development
New Hampshire Department of Transportation	State-owned Pathways vehicle	Deighton	Division of Project Development, Materials and Research
New Jersey Department of Transportation	State-owned ICC vehicle	Deighton (recent change from in-house system)	Design Services Division
Rhode Island Department of Transportation	Vendor supplied ARAN vehicle	Deighton	Traffic Management
Vermont Agency of Transportation	Vendor supplied ARAN vehicle	Deighton	Highway Safety and Design

How Pavement Management Is Currently Being Used

All of the participants in the Peer Exchange use the pavement management system to develop project and treatment recommendations. In addition, the information is used to meet reporting requirements for both internal and external stakeholders. Following is a summary of each state's response with respect to this topic.

Connecticut

In Connecticut, the pavement management system provides a list of candidate projects. The deadline for this document is in February each year. This is the primary output from dTIMS and the list of projects is reviewed by maintenance. Final projects are "tweaked" based on engineering judgment and other factors. The time period between the survey and final project list is almost 2 years. The state noted that this time lag is not acceptable for preservation projects. ConnDOT also used the PMS to select American Recovery and Reinvestment Act (ARRA) projects (shovel ready).

It was noted that the ConnDOT pavement history database is not well populated and it is difficult to track where treatments have been placed. The key is to capture maintenance, rehabilitation and permit project data as part of normal work flow to reduce data collection problems.

Maine

MaineDOT makes condition data available through their intranet data warehouse for agency-wide consumption. This is used to develop project lists. After internal review, the list is sent to each region for review and tweaking. Once this is completed, the region and headquarters goes on a field review together to prioritize and negotiate the final project list. The final product is the dollars needed to affect performance.

The project development process has been effective to drive additional funding. It is used to allocate funding between regions and has been considered to be an effective tool to allocate budget based on needs rather than politics or "the way it always has been."

The state noted that it is difficult to program light treatments two or three years ahead of time. It is also difficult to obtain all the necessary project history (section and M&R history). The process is improving, but is still an issue.

Massachusetts

MassDOT has performed a pavement structure survey and they find it very useful although hard to keep current. It is difficult to get districts to provide maintenance information consistently and with the same amount of information. The condition data developed by the PMS is presented to other personnel in the DOT, but pavement management personnel are not sure if it is used.

The PMS provides multi-year forecasts to determine funding needs. It is used as part of the "agency scorecard". They break down the regional condition and provide it to the districts which use it to justify additional funding.

Project level PMS is used to initiate all Interstate (IS) and National Highway System (NHS) projects and is used to identify all potential projects. It is also used to initiate safety projects based on rutting. Engineering judgment is used to determine the final project lists.

The state pointed out that the pavement management system is used for many different inputs to the decision making process, but it does not have the final say. Engineering judgment and other factors are used to make final decisions.

New Hampshire

Condition data and maps are generated to assist with developing a ten year plan, and are provided to the district engineers so they know how they are doing. They help the district engineers develop their resurfacing program. The central office does not provide a list of projects to districts. The central office uses the list of district selected projects and maps the projects in a geographic information system (GIS) for use as the first cut in project selection.

Next year, the central office will provide a potential project list to the districts and discuss project selection with them. In the longer term, the state is working on a graph of long-term performance given various budget scenarios. Right now it is an educated guess. The state is striving to further develop the PMS to provide input to the long-term planning process. The state suggests that a major challenge is maintaining the system over the long-term. Also, in the future, NHDOT will use the PMS to determine how the budget is divided among the districts. Currently, the districts obtain their budget on a relatively equal basis.

New Jersey

NJDOT performs network level condition forecasting over a ten year analysis period for various funding scenarios to determine the level of funding needed. They also develop potential project lists which are used by the Capital Program Management Division to develop the capital improvement program and by the Operations Division for maintenance resurfacing and pavement preservation treatments in each of the three regions. All recommended projects are reviewed in the field. The following project lists are generated:

- Crack seal list
- Micro-surfacing and Thin Overlay list
- Resurfacing and Rehabilitation/Reconstruction list

The unit is becoming a "one stop shop" for all pavement information. They are also trying to capture accurate pavement history. The state acknowledged that there is still work to do in this area.

The state is working to improve communication between the central and regional offices.

Rhode Island

RIDOT uses PMS data to select projects and engineering judgment to refine the project list. Other factors include legislatively selected projects, costs, and the like.

The list is sent to the district managers and they select final projects and list on the Transportation Improvement Program (TIP). The 2009 data drives the 2011 program.

There is a two year lag between condition data collection and construction.

Vermont

VTrans uses dTIMS to develop annual budget levels. It is used to develop a first cut multi-year capital program based on benefit-cost analysis. Then engineering judgment is employed to break down the list into projects. Also the regions and MPOs prioritize projects and that is taken into consideration during final project development. This helps to reduce legislative "input" into project selection by justifying selections based on community input.

They are currently using the system to develop a "worst of the worst" list of pavement conditions for potential special funding.

ISSUES BEING FACED

The various state participants identified the major issues facing them with respect to this topic. These included items such as:

- Project history is a difficult issue. The agencies need a dedicated person and a process for districts to report work performed to the pavement management group.
- It is difficult with current staffing to maintain the pavement management databases.
- The agencies need "silo smashers" to coordinate activities between groups (for example maintenance and pavement management group). Everyone needs to be on same page and using the same play book.
- Educating people (users) is vital to develop confidence in the output of the pavement management system.
- There is a significant lag time between data collection and when the project actually is constructed. Project programming is not an exact science, but there is a need for better coordination to speed up the process.
- There is a need for a fast track process to get Federal funds for pavement preservation. The states can't afford to wait for more than a year. Pavement preservation projects need to be programmed and executed in short order.
- Pavement preservation requires a change in project funding procedures. There is a need for dedicated funding for preventative maintenance.
- There is a need for better communication with finance people to show how preservation can help save money.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

Several needs were identified to address the issues raised above. These include:

- More time and staff (funding) dedicated to establishing project history.
- Education to assist personnel better understand the importance of the pavement management system.
- Better communication with the various stakeholders to show the importance of preserving our infrastructure.
- Need to address all the assets, not just pavements. Most states use Pontis for bridge management. The pavement and bridge systems need to be integrated better.
- Need for better quality condition data.
- Need integration among asset classes so everyone knows what is being programmed.
- As we move to a preservation philosophy, there is a need to establish some method to hold together the very worst roads.

HIGHLIGHTED PRACTICES

Each agency was asked to highlight their best practices in this area. Following are the responses:

Connecticut

- An objective pavement condition index is used (helps with defending data).

- ConnDOT is using a legacy index and sectioning for buy-in.
- ConnDOT puts data together for agency-wide performance measures (IRI).
- Participation (active) on cross-functional teams for pavement preservation and performance measures raises visibility.

Maine

- Have developed panoramic color images (tied into the data warehouse) and making them available department-wide through a user-friendly intranet application.
- Using dTIMS results to justify allocating pavement preservation dollars among regions based on need and expected benefits.
- Improving the quality of pavement condition data to the point that most people at Maine DOT have confidence in the data.

Massachusetts

- Emphasizing the decline in the network condition given current funding to secure more money.
- Using condition driven NHS preservation processes.
- Funding condition driven Interstate projects.
- Providing results of the short- and long-term funding reports.

New Hampshire

- Creative advertising allows the state to advertise contracts in short order.
- Proposal only format and Pavement Management advertising contract allows this to happen.

New Jersey

- PMS generates all pavement projects including capital projects and operations programmed work.
- Maintains a project tracking system to ensure more accurate project generation.
- Pavement management and pavement design are in the same unit under design and work closely with materials.
- Maintains close contact with FHWA.
- Have close relationships and support with Pavement Resource Center at Rutgers University.
- Participate in pooled fund study on pavement management.
- Coordinates federal funding for all pavement related activities and advancing new technologies.

Rhode Island

- Have worked to improve data collection frequency.
- RIDOT does a thorough job selecting recommended projects.
- There is a lot of room for improvement to educate and communicate pavement management practices and results to appropriate groups such as legislature, governor, and others.
- RIDOT takes an aggressive pavement preservation approach.

Vermont

- Preventative maintenance concept has been well vetted, accepted by management, legislature, and public.
- Decisions are data driven.

CHAPTER 3

Using Pavement Management for Short- and Long-Term Planning

TOPIC SUMMARY

This topic covers the methods used for short- and long-term planning. The participants defined short-term planning as less than five years and long-term planning as greater than five years. The agencies first discussed their current practices then covered some of the issues and needs associated with the topic. A list of good practices was also developed.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

The current practices among the various states are briefly summarized below.

Connecticut

ConnDOT provides current and future pavement condition information to help determine the short- and long-term effects of funding levels. This allows the pavement management people to discuss policy with upper management. The pavement management group is the only group in ConnDOT that can provide this type of information. All of the prediction models are currently expert based and not data based.

Maine

MaineDOT uses dTIMS to track the performance of the various corridors and plan their maintenance and rehabilitation activities using these corridors. This is a new concept in the state and appears to be a more realistic approach to planning. The PMS will allow the agency to make these projections and thus make decisions.

For long-term planning, the highway corridor improvement concept is a new process gaining traction in the state. MaineDOT prioritizes corridors within the state. The top priority is preserving high priority roads. The second priority is the use of less expensive treatments on less important roads. The lower priority roads receive surface maintenance projects to keep them serviceable.

Massachusetts

Short-term planning is working very well. The state is trying to get the Metropolitan Planning Organizations (MPOs) involved with this effort.

Long range planning has been done in the past, but recent reporting is based on a five year forecast. A ten year forecast is considered a “pipe dream.” One benefit of long range planning is the recent identification of a large number of roads that would require rehabilitation all about the same time. The pavement management system was able to identify this “bulge” in projects early and thus the state was able to identify and target these roads for proactive rehabilitation.

New Hampshire

Short-term planning is working well but it is still a struggle to convince people of the need for long-term planning. The pavement management system is the only program that can help with these long-term decisions.

New Jersey

Currently, NJDOT forecasts network system conditions over a ten year analysis period based upon various funding scenarios. They currently produce year-to-year project recommendations due to budget issues and pavement management system constraints, but are transitioning from the current pavement management system to the Deighton dTIMS.

Rhode Island

RIDOT has used a two-year planning horizon for communicating pavement management’s project recommendations, but it has the ability in Deighton’s dTIMS CT software to plan for longer periods. Due to a lapse of pavement condition data collection, the state

waited for any previously recommended projects to be implemented until a new survey could be completed. Pavement preservation projects were selected solely by windshield surveys during this automated data collection lapse.

Vermont

VTrans can provide short- and long-term analysis (usually 10 years into the future is the maximum for planning purposes). They started out with expert based performance models, but recently rebuilt data models based on actual condition data.

ISSUES

The issues raised by the various states on this topic included the following:

- There is a problem with long-term planning in that budgets are fluid and sometimes what is planned is not funded or, in some cases, more money becomes available unexpectedly.
- Sometimes people don't listen, particularly in terms of the long-term analysis. This is a communication issue which needs to be improved.
- There is a lack of commitment to long-term planning, partly because the terms of most legislators is considerably shorter than the long-term planning time frames.
- Pavement budgets are lumped together in one big number, which is easy to cut. Safety and other programs are a number of smaller budgets. It is much easier to cut the relatively large pavement number.
- The one year plan is not much of a problem to develop, but the multi-year plans are an issue because of constant changes in budgets and focus.
- Some stakeholders are skeptical of the results of long- term planning.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

What do we need to make improvements in the short- and long-term planning process? The following items were mentioned by the attendees:

- Education K-12. We need to begin to educate students on the importance of maintaining the infrastructure.
- Commit to performance measures. The various agencies need to define performance measures and adhere to them.
- Stakeholders need feedback on impacts of funding on pavement performance.
- Dedicated federal funding is required for preservation. Without a commitment to preservation, there is no way to catch up with all of the pavement needs.
- A united front between agencies and industry is necessary for gaining the funding needed.

HIGHLIGHTED PRACTICES

Each of the participating agencies was asked to provide a summary of their best practices. The best practices are summarized as follows:

Connecticut

They like their process. The performance models are robust and the PMS' capability to perform long-term analysis is functional. The major challenge is getting people to understand the results. A major challenge is how do you communicate the result in a meaningful way to various stakeholders?

Maine

Holistic highway corridor planning and key performance indicators are two of the best practices identified by Maine.

Massachusetts

Prediction models are capable of a five to ten year analysis, but they still are not used widely for the longer term predictions.

New Hampshire

Short-term planning is robust, but there is more work to do on long-term planning.

New Jersey

They have established long-term performance goals adopted by the Department. The Department's focus on asset management is a step in the right direction.

Rhode Island

RIDOT believes implementation of the PMS has been a best practice but they are in need of improved communication and education on the importance of short- and long-term planning to make the effects of the PMS analysis more useful.

Vermont

Vermont does a good job of long-term planning and uses the planning tools effectively.

CHAPTER 4

Establishing Links with Pavement Preservation and Maintenance Operations

TOPIC SUMMARY

This chapter summarizes the discussion from the Peer Exchange on links between pavement management, pavement preservation, and maintenance and operations.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After introducing the topic to the participating agencies, each agency was provided the opportunity to present information on the links between the various programs and to indicate areas that may need improvement.

Connecticut

There is a strong link between pavement management and pavement preservation. The pavement management group is involved in the pavement preservation initiative. There has historically been a rivalry between the maintenance and pavement management groups, but this relationship has improved significantly recently. The pavement preservation group is making great strides and having condition data and the pavement management system in place has been very beneficial to the state.

When planning pavement preservation projects, the pavement management system picks the treatment and the design section puts it on the street. The state is trying a number of different treatments. In 2010, the DOT spent $20M in pavement preservation and crack sealing. The system does output the pavement preservation treatments, but crack sealing is not in the PMS yet. At one time, pavement preservation funds were hard to come by. Now, upper management is starting to think about preservation. Pavement preservation still does not have a dedicated funding source.

The state still has some work to do to fully connect pavement management, pavement preservation and operations. The maintenance pavement program consists almost exclusively of hot-mix asphalt (HMA) treatments. Pavement preservation concepts are now gaining acceptance. One strategy the state has implemented to strengthen the preservation philosophy is to invite maintenance personnel to a series of NHI courses on pavement preservation along with the pavement management group and others. This strategy is helping to “turn the tide”. District managers are receptive to pavement preservation principles.

Massachusetts

Pavement preservation is a part of the pavement management section. Therefore there is a strong link between these groups. Pavement design is also part of the pavement management section so there is a strong link between pavement management and rehabilitation.

The link between pavement management and maintenance and operations varies among districts (regions perform maintenance). All districts are provided condition data, but the data is used in an inconsistent manner between districts. The districts use data to justify some projects … some times.

New Hampshire

NHDOT has a strong link between pavement management and pavement preservation. Pavement preservation and rehabilitation projects are advertised out of the pavement management section. The pavement management section selects limits, develops and maintains specifications and advertises the projects. Therefore, pavement preservation projects get out the door quickly.

The link between pavement preservation and operations is not as strong. The pavement management group provides condition data maps, Ride Comfort Index (RCI) maps, maximum rut depth map, and summary tables to operations. The pavement management group wants to work with the districts to develop performance goals and to advertise the district resurfacing program. The PMS group works with the districts to get as-built data.

As far as future activities, the pavement management group will work with the districts to improve the effectiveness of the PMS. A key to this coordination is teaching the districts what the "black box" does. One long-term goal is to set performance goals for each district (percent in good, fair, poor). Also, pavement preservation training is necessary for districts so they are less resistant when trying to implement new treatments. The lines of communication are open between the districts and the pavement management group. The districts have trust in the recommendations of the pavement management group.

New Jersey

Pavement management originated in the operations unit, so there is a close relationship with this group. The state is starting its pavement preservation efforts with crack sealing, microsurfacing, and thin overlay treatments. The pavement management group is not involved with reactive maintenance.

The state is making advances with pavement preservation but it is a slow process. Feedback from operations and coordination of projects has improved and advances in this area will be a key goal moving forward.

The state has an excellent situation because all major players in the design and construction areas look to the pavement management group for approval to do work. All changes to paving projects are approved by the pavement management group.

The state has major fiscal challenges and this hinders execution of plans. The state has a good system to collect as-built information from projects and the pavement management group is involved in the planning process, but it is difficult to affect changes related to pavement funding.

Rhode Island

There is a strong link between pavement management and pavement preservation. Pavement management provides pavement preservation a list of projects. They also interact with other parts of the agency to decide which projects are to be included in the annual program. The state has been hampered by lack of condition data but with a new data collection program, this will improve. A small subset of the roadway system has no condition data. The state has begun to manually survey these roads and have included them into the PMS.

There is not much of a link between pavement management and maintenance. Their main functions are cutting grass and fixing potholes.

Vermont

There is a strong link between pavement management and pavement preservation. The pavement management staff and the highway designers are in the same group. This means there are strong ties to pavement preservation and the rehabilitation programs.

The relationship between pavement management and operations has improved substantially. Maintenance is getting more attuned to treat longer sections rather than in pieces. The link is pretty good and coordination is improving. It is still a challenge to determine exactly where the treatments are placed.

Pavement management is communicating the program two to three years in advance. The districts are using this plan to get out in front of paving by performing maintenance on other assets prior to applying the pavement treatment. The state has come a long way improving coordination between pavement management and the districts. Vermont contracts out most of their maintenance.

ISSUES BEING FACED

As a group, the states identified issues which they face related to the link between PMS and preventative maintenance. The following is the list of issues identified (not listed in order of importance):

- The inability to identify distresses that trigger pavement preservation such as raveling or joint

condition (since this type of data is not collected as part of the automated surveys).

- The integration of the pavement management group and maintenance is a problem, especially in terms of funding. For one state, forty percent of the funding does not get optimized through a PMS analysis.

- For pavement preservation projects, an issue many states face is scope creep. The agency is not allowed to do limited scope pavement preservation work and is expected to manage all the costs without inputs for other required work (drainage, storm water management, sound barriers, other work). Resurfacing costs can vary from $88,000 per lane-mile to over $550,000 per lane-mile. Other states have separate budgets to fix assets other than pavements and in these cases the pavement money goes to pavements and not other work.

- The states need dedicated funding for preservation.

- There is a need to increase the frequency and completeness of pavement condition surveys and to incorporate pavement preservation into the pavement management system. The lack of a formally organized program linking the pavement management system to pavement preservation and maintenance/operations is a need to insure further success. Just linking them on the department organization chart would be a good first start.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

To address the issues noted above, the Peer Exchange participants identified a number of needs in this area, including the following:

- Condition data collection needs to be improved to identify distresses that trigger preservation.

- There is room for improvement on communication and training so that people understand the importance and cost-effectiveness of pavement preservation.

- There is a need for changes in policy to fund pavement preservation “off-the-top” and to have dedicated funding sources for pavement preservation.

- Pavement preservation funding should be exempted from federal regulations (ADA, stormwater, etc.). These requirements extend the time it takes to put treatments down and increase the cost of preservation treatments.

- There is a need for research and materials support for preservation treatments. There is effort needed to revise specifications so that they deliver long lasting, cost-effective preservation treatments.

HIGHLIGHTED PRACTICES

Each of the participating agencies was asked to identify best practices for their state. Here is a summary of the best practices identified.

Connecticut

Pavement preservation is integrated to a significant degree into the PMS so it is feasible to integrate preservation into the project selection process.

Massachusetts

There is a good relationship between preservation personnel and pavement management personnel.

New Hampshire

There is a multiplicity of talent in the agency. The DOT is a small enough agency so colleagues can interact easily, and coordinate often.

New Jersey

All programmed pavement preservation and operations/maintenance activities are generated and coordinated within the pavement management system

Rhode Island

The state has identified deficiencies in its pavement preservation integration effort and improvement strategies have been identified. As part of this improvement strategy, a multi-disciplined committee was established which consists of two levels - an executive level and a technical expert level including representatives from each section. This committee works very well in advancing the

specification process which is critical to implementation of pavement preservation.

Vermont

The pavement management group is involved in decision making across the board. The state has a well integrated decision making process.

CHAPTER 5

Developing Performance Models and Performance Measures Using Pavement Condition Information

TOPIC SUMMARY

One of the most difficult tasks in a pavement management system is to develop reasonable performance curves for individual treatments or families of treatments. Most agencies use either deterministic or probabilistic models to predict pavement deterioration. Probabilistic models predict the likelihood that a certain level of performance will be achieved and rely on probability matrices to quantify the probability of each possible result. More commonly, agencies are using deterministic models to predict the condition as a function of time or age of the pavement. Some agencies use a family modeling approach in which various treatments are grouped into one family and a prediction curve developed for the family.

Performance measures, such as a minimum ride score or distress index, were also covered. Most agencies have a minimum score that they would like to maintain for the network ride or condition.

This chapter addresses the issues of developing performance models and performance measures using pavement condition data. The various states provided an overview of their current practices in this effort. Afterward, they discussed some of the important issues and needs, followed by a short presentation on best practices.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

This section describes current practices in each state related to establishing performance models and performance measures.

Connecticut

Performance models. Four performance models have been developed using input from an expert panel. Models were developed for International Roughness Index (IRI), maximum rut depth, structural cracking, and environmental cracking. They are currently being used, but need to be refined as pavement condition data is collected. ConnDOT uses a composite score for optimization, and the four condition indicators to trigger treatments. Each index is reset individually after a particular treatment has been placed.

Performance measures. The pavement management group comes up with internal performance measures, but does not have control over system performance. They use the performance measures to determine limitations of the system and to estimate treatment life. The state also uses IRI as a performance measure and these values are reported. IRI is not considered by the state to be a really good performance measure, but it is the best data that is currently available. One limitation of using IRI as a performance measure is IRI can easily and cheaply be improved in the short-term but you may give up structural capacity in the pavement system and create a large structurally deficient pavement system backlog for later years.

Massachusetts

Performance models. MassDOT uses expert opinion for cracking, raveling, ride, and rutting for both the Interstate and non-Interstate systems. The state has models for each index alone as well as a combined index.

Performance measures. MassDOT has established condition goals for the NHS (70 percent acceptable for overall condition and IRI).

New Hampshire

Performance models. The state has models for ride, cracking, and rutting condition indicators and a composite index value. Performance models are based on expert knowledge.

The state recently obtained a new data collection vehicle and it is likely the models will change based on data from the new vehicle. Currently the state is borrowing Vermont's models and applying factors to make them applicable to New Hampshire. When the state has collected sufficient data with their new vehicle, they will revise their expert opinion performance models using real condition data.
Performance measures. RCI is used for the system performance measure (based on IRI only). Performance measures are a work in progress.

New Jersey

Performance models. Development of performance models is in its infancy, but the state is making progress. The goal is to model using distress indices, including a non-load related distress index (NDI) and a load related distress (LDI), and roughness using IRI. Performance models are being developed for each of these three indices for different classes of roadway. Families are divided by truck traffic and type of pavement. They use mathematical functions (sigmoidal) supplemented by expert opinion to tweak end points and control points.

Performance measures. Individual performance measures have been established in terms of surface distress and roughness. The state does not like to use IRI alone as a trigger to select treatments.

Rhode Island

Performance models. The state has performance curves with varying traffic levels, age, and location (inland and coastal) taken into consideration. The models need to be revised to add pavement preservation treatments. The state has performed pavement preservation for a long enough time that models can be developed for these treatments.

Performance measures. The state does not currently have performance measures for its pavement system.

Vermont

Performance models. The state has models for all treatments. Originally these were expert based models, but they have transitioned to data based models (15 years of data).

Performance measures. The state uses two measures. Measure 1 is the travel average weighted network condition. Measure 2 is the percent of the network in very poor condition. Both of these measures are a combination of four indices.

ISSUES BEING FACED

As a group, the state identified issues which they face concerning performance models and performance measures. The following is the list of issues identified (not listed in order of importance).

Performance Models

- Some states use expert opinion versus data based models. Most of the states are moving to data based models, however generating these models takes a great deal of time.
- There is a lack of national standards for data collection. It would be desirable if every state collects data in a consistent format so that data can be shared among the states. This is especially true of distress data.
- Most states do not have good information on the bearing capacity (structural aspects) of their roadways.

Performance Measures

- The performance measure outputs are affected by funding levels. There is a tendency to think PMS is bad because the system condition does not improve (i.e. shooting the messenger). The PMS group has very little control over funding and thus very little control to influence the performance measures.
- There is a need to be able to make a comparison of PMS driven program versus non-PMS programs. In other words, what are the benefits of managing the

system using PMS versus managing the system on an ad hoc basis.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

To address the issues noted above, the Peer Exchange participants identified a number of needs in this area, some of which would make good research projects.

Performance Models

- There is a need for guidance on developing performance models. The states need guidance to determine what should be measured and predicted.
- The PMS needs to be continually updated with new models. This is a time consuming process. Methods to make this process more efficient are needed.
- There is a need for condition data on the upper half of the pavement condition curve to provide input on candidate pavement preservation sections before these candidate sections exhibit major distresses.

Performance Measures

- A standard is needed for determining remaining service life (RSL). It was mentioned that FHWA has developed the Pavement Health Track Analysis tool which helps calculate RSL.
- Each state can generate and use their performance measures pretty well. A problem arises when you start comparing states because the condition data collection and models used by the different states are not the same.

HIGHLIGHTED PRACTICES

Each of the participated agencies was asked to identify best practices for the entire group. Here is a summary of the best practices identified.

Performance Models

Connecticut

They have synchronized individual distresses with models so when they apply a treatment it only adjusts the indexes that are really affected by the treatment.

Massachusetts

The state has performance models and uses performance measures. This system is well received and accepted in the state.

New Hampshire

Similar to Massachusetts, New Hampshire has performance models that they are comfortable with. They will be incrementally developed over the coming years.

New Jersey

New Jersey's performance models are still in development using the new PMS. However, the best practices used by other states at the peer exchange will assist them in their future efforts.

Rhode Island

The state uses performance curves from their condition data which they continue to update. The state includes pavement preservation in their performance models.

Vermont

A best practice for Vermont is the continuous evaluation and update of their performance models so that the models improve over time.

Performance Measures

Connecticut

The state's performance measure is IRI. The pavement management group is expected to explain performance and measure results - which they believe is a healthy practice.

Massachusetts

The state is very comfortable with their accepted and robust performance measures.

New Hampshire

The agency understands the limitations of the current performance measures. There is buy in and they are working in a cooperative spirit to refine the measures to make more sense.

New Jersey

The state is comfortable with its ability to predict treatments for appropriate roadway sections. The pavement management group has established substantial credibility and good validation of the treatment recommendations.

Rhode Island

The state does not employ performance measures.

Vermont

Their performance measures provide a good picture of overall network health. The Tri-state Commission (Maine, Vermont, and New Hampshire) is tasked with developing consistent measures between the three states.

CHAPTER 6

The Economics of Pavement Management: Cost-Effectiveness and Cost Savings

TOPIC SUMMARY

Over the years, pavement management practioners have identified a number of benefits associated with use of a pavement management system. These include items such as:

- Ability to document the network condition,
- Ability to predict future conditions given a variable budget, and
- Increased credibility among stakeholders.

For the most part, benefits have been difficult to quantify because they are primarily subjective improvements in agency practice. Due to the current economic climate, it is becoming more and more important to quantify these benefits. The benefits have to offset the costs of data collection, software development and updates, analysis and reporting.

This chapter discusses the results of the agencies' discussion on the cost effectiveness of pavement management systems and identifies costs savings associated with the use of the PMS.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

Connecticut

Cost. The cost to maintain the pavement management system is difficult to quantify accurately because the costs are spread throughout the agency. The cost to run the system includes a staff of five, data collection costs, and equipment depreciation; the cost is inclusive of all data collected with the data-collection vehicle. It is estimated it costs about $90-100/mile for data collection. This number, however, should not be used for comparison with any other agency unless all costs are included.

Benefits. One method the state uses to measure benefits is through field trips saved by using photo-log data. The state calculated that the cost saved by use of photo-log use versus field trips was at least $1.5M a year. The state can also toggle off treatments in the pavement management system so the benefits of pavement preservation (PP versus no PP) can be determined. Due to these improvements, discussion in the state is changing from status quo (invest what we usually invest) to "what is it that we really need to obtain the desired system performance."

Massachusetts

Costs. The costs include data collection which is performed in-house (2 Full Time Equivalents - FTE), QC profilers (2 FTEs), analysis (3 FTEs), and the annual software license and technical support contracts. The cost is estimated to be over $1M per year. The state considered outsourcing data collection and determined that they would not be able to react quickly to data collection needs as they arose so they decided to collect data in-house.

Benefits. Reporting the pavement condition annually is legislated. These reports provide the ammunition needed to justify additional funding - $22M to $75M for Interstate funding. The state can also quantify the environmental benefits of using pavement preservation treatments. Benefits can also be shown by performing trade-off analysis to show how much it costs to fix a pavement now versus waiting until the condition has deteriorated.

New Hampshire

Costs. The only cost analysis performed by the state has been analysis of in-house data collection versus outsourcing. Based on this analysis, the state decided to purchase the vehicle and perform data collection in-house. The pavement management staff has three

engineers (includes pavement designers), developers and analyzers of PMS data. There are five technicians to collect network level and project level data and to QC the profile and retro-reflectivity testing for construction projects. The state supplements agency employees with winter and intern hires.

Benefits. Using the PMS, the state has been able to quantify the benefits of pavement preservation.

New Jersey

Costs. The state collects data in-house (5 FTE data collection, 4 FTE data analysis). The state has conducted an analysis between consultants versus in-house data collection and decided to continue using in-house forces.

Benefits. Because of the PMS, pavement funding is being utilized in a cost effective manner. Efforts will be made in the future to quantify this benefit.

Rhode Island

Costs. The PMS staff consists of 0.5 FTE and data collection is outsourced.

Benefits. The state can quantify the benefit of treatment selection using the highest incremental cost-benefit ratio.

Vermont

Costs. The pavement management staff consists of 1 full time person plus four people that perform pavement designs and two people that do ride testing for project level purposes. A consultant performs all of the data collection at an estimated cost of about $100/mile.

Benefits. VTrans does not have cost-benefit information; however they stressed they would be in the “worst-first” mode if they did not have a PMS.

ISSUES BEING FACED

Following the presentations, the group identified the issues associated with identifying the costs of the pavement management activities, identifying the benefits of the system, and methods used to justify the system to upper management or the legislature. A summary of the issues raised are as follows:

- Changing data collection technology makes it difficult to maintain continuity. Whenever a new and better data collection technology is implemented, the condition data seems to change. This has a cost effect on maintaining the PMS because data needs to be interpreted, models changed, and new reports developed.

- Connecticut mentioned that the pavement technology equipment they use is on about a five year replacement cycle.

- Quantifying the benefits of using new treatment strategies versus old strategies is a continuing challenge for states.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

In order to address the issues identified by the participants, the following needs were suggested:

- It would be useful to have guidelines to quantify the cost effectiveness of pavement management systems.

- There is a need to develop a more robust methodology for quantifying benefits such as the GASB 34 modified approach.

- There is a need to quantify benefits in terms of dollars. Right now, the benefits are fairly anecdotal in nature.

HIGHLIGHTED PRACTICES

Each of the participating agencies was provided the opportunity to provide information on the costs and benefits of their pavement management activities. Most of them had some idea of the costs of the activities, but few had done anything to document the benefits of the system, primarily because upper management and the legislature get the information they need on the network condition and that the “what if “ questions could be answered. Some are able to identify the benefits of treatments.

CHAPTER 7

Technical Issues Related to Comparison of Performance Measures

TOPIC SUMMARY

A technical issue related to comparison of performance measures between states was the topic selected by the participating agencies. This includes data collection, performance measures, and others.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After discussing the topic for a few minutes, each agency was asked to describe their practices on this topic.

Connecticut

Currently, ConnDOT is using IRI as the performance measure to compare within the state and between the states. This is because it is available and easy to compare. They understand there are issues with this performance measure, but it is the best that they have. The state is currently looking for other measures such as RSL, and distress.

ConnDOT has 29 performance measures used by DOT upper management, but IRI is the only pavement related measure. The important issue is still the need for data consistency.

Massachusetts

Ride is the easiest measure to use to compare states, but they pointed out the need for data consistency if we are to compare between states. Even using IRI, it is difficult to compare across states due to equipment differences, data collection inconsistencies, and use of different technologies and data processing algorithms.

New Hampshire

IRI is a pretty consistent performance measure. They have adopted Vermont's system and protocol for automated distress therefore it would be easy to compare between Vermont and New Hampshire.

New Jersey

If there is a move toward performance measure standardization, some consideration should be given to how the data is collected, processed and used. State-to-state performance measure comparisons are meaningless unless identical data are being compared. Having standardized distress data collection, processing, and reporting processes are key. This is important so states can share information and develop better models.

Rhode Island

RIDOT echoed comments made by the other states concerning this topic.

Vermont

Consistency in processing cracking data with automated vehicles is very important. This should be a high priority at the national level.

ISSUES BEING FACED

The following issues or challenges were raised:

- You can standardize data collection and you can compare the data, but it will be a difficult process.
- Need standardized condition data for IRI, distress, and rutting.
- One issue with moving to a standardized distress protocol is continuity issues. How do you deal with historical data? Can it be salvaged?

- 3-D pavement images are coming and technology is changing fast. How will these new technologies be incorporated into the pavement management systems?

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

In order to address the issues identified by the participants, the following needs were suggested:

- National standard protocols need to be able to be correlated to the states' old data collection system – need to be able to correlate old and new data.

- A methodology to cope with technology change is needed (correlate old data to new). This is going to be a major issue.

- Need to set-up a pooled fund study to address the issue of standardizing distress data collection. Set up two-levels of measures: one for public consumption (summarized) and more detailed info for engineering use.

HIGHLIGHTED PRACTICES

Each of the participating agencies was given the opportunity to provide information on the technical issues related to comparing performance measures. The participants identified two best practices.

- The tri-state coalition is a best practice to try and coordinate and correlate data between states.

- Peer exchanges are an excellent method to bring states together to discuss the challenges and methods associated with developing a national standard everyone can live with.

CHAPTER 8

Summary

The FHWA sponsored Pavement Management Peer Exchange Workshop provided an excellent forum for pavement management practitioners from seven states to share ideas and to learn from the experiences of others. This document summarizes the discussions held at the fifth such Peer Exchange held on September 8-9, 2010 in Newington, Connecticut. The peer exchange had representatives from the following agencies:

- Connecticut Department of Transportation (ConnDOT)
- Maine Department of Transportation (MaineDOT)
- Massachusetts Department of Transportation (MassDOT)
- New Hampshire Department of Transportation (NHDOT)
- New Jersey Department of Transportation(NJDOT)
- Rhode Island Department of Transportation (RIDOT)
- Vermont Agency of Transportation (VTrans)
- FHWA Division Offices
- FHWA Office of Asset Management

Maine DOT was able to participant in the PEER Exchange only for the first day.

The report presented a summary of the states' practices in each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short-and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Comparison of performance measures between states

The discussion indicated that the various states have similar approaches in developing and using their pavement management systems. All of the peer exchange participants are using the Deighton software, dTIMS. They all use the pavement management system in decision making and to communicate their needs to upper management and/or the legislature. Most of the states are using their systems for short- and long-term planning and for answering the "what if" questions asked by their management.

Most of the states (6 of 7) have strong links with pavement preservation and rehabilitation groups, but the links with maintenance are not as good. These links need to be strengthened.

Most of the participating states (6 of 7) have performance models for predicting the future condition of the pavement system. Most of them have not been in existence long enough to have data supported models. Most states have defined performance measures such as ride or condition index and goals for each of these measures. The states are doing a reasonably good job of maintaining their targets, despite the decline in funding. This is, in part, due to the heavy reliance on pavement preservation treatments.

The states do not have as good a handle on the costs of operating their pavement management system nor the benefits derived. More work is needed to document clear benefits and to determine the cost effectiveness of the system.

The states were fairly unanimous in their belief that standardizing data collection and reporting would be a beneficial outcome at the national level. However, there are numerous hurdles to overcome to get to a point where states can compare "apples to apples" from a pavement condition standpoint.

Finally, all of the States had positive comments on the two day Peer Exchange. They felt it was an excellent learning opportunity and they appreciated the opportunity to interact and share information among their peers. They also mentioned that having additional peer exchanges in the future would be welcomed by the States.

States were asked how this peer exchange compares to other opportunities for interaction with their peers. Here are some of their comments:

- Very useful to get the time to think about these things and nice to hear about other states. Also it was nice to be able to speak freely among the states.

- It is good to know what other states are doing - similarities and differences are both informative. The discussion made this state begin to think about performance measures. The discussions on equipment were interesting.

- The peer exchange facilitated a good exchange of information. It was nice to be able to talk within a state and was also useful to have a forthright conversation with peers without the pressure of outside influences. The peer exchange provided the states with new ideas to improve their system.

- It was very beneficial to match faces with expertise and there is a hope to contact others that they met at the peer exchange to gain technical expertise. There was a shared camaraderie and it is nice to know others face the same problems.

- The peer exchange was useful to benchmark one state's progress against another state. This creates the opportunity for leading states to educate other states in their practices.

In summary, most of the participants felt the overall strength of the peer exchange was to facilitate one-to-one interaction instead of just listening to talking heads at a conference.

APPENDIX A

Background Summaries of Participating State Highway Agencies

CONNECTICUT DEPARTMENT OF TRANSPORTATION

Summary Statistics

The Connecticut Department of Transportation is responsible for the maintenance and operation of about 3750 centerline miles of road, or 9900 lane-miles. The state is in a wet-freeze environment and the overall highway pavement condition is rated fair to good.

Pavement Management Background Information

The pavement management group fits under engineering and construction bureau/engineering/design services. It is responsible for pavement management and pavement design. The unit was formed in 1986.

The pavement management group has been subject to six organizational moves since 1986, including stints in Research and Materials, Engineering, and Maintenance. Currently, the group is situated in Engineering and is well supported through a pavement policy statement and has good executive and management support. There are five people in the pavement management unit.

Pavement Management Technical Information

The pavement management system is provided by Deighton Associates and is a dTIMS-CT version.

Data Collection

The state has two Roadware vehicles and collects a 100 percent sample of network condition annually. Planning data is updated yearly (traffic, functional class, lanes, surface area).

The data is summarized every tenth of a mile.
The state uses a composite condition index (1-9 scale from worst to best) to characterize the road condition. This includes distresses such as rutting, cracking and IRI.

Performance Modeling

Connecticut DOT uses a “pavement family” approach to developing performance curves. This includes families for traffic, soil type, climate, pavement type and pavement structural thickness. There are a total of 106 families.

The pavement treatment costs are updated on a yearly basis. About $50 million per year is allocated for pavement treatments.

Perceived Pavement Management Strengths

ConnDOT has been involved with pavement management for a long time, but has reorganized and developed a new system just recently. With the Deighton software they now have many more capabilities, but are still in the beginning stages of using the new system.

Areas of Improvement

The system is in its infancy and ConnDOT will have to develop much more data to ensure the prediction models are appropriate. At the present time, they are using expert opinion as the basis of the prediction models.

MAINE DEPARTMENT OF TRANSPORTATION

Summary Statistics

Maine Department of Transportation is responsible for collecting pavement data on roughly 8900 miles of roads. This includes:

- 740 miles (370 centerline miles) of Interstate highways, 200 miles (100 centerline miles) of which are turnpike
- 2000 centerline miles of minor collectors

The major focus of the pavement management group’s effort is the 6-7 thousand miles of state roads.

Pavement Management Background Information

The pavement management system used by MaineDOT is dTIMS CT provided by Deighton Associates. The pavement management unit consists of four people in the highway management work group including one engineer, one office technician, one ARAN driver and one ARAN operator.

The group used to be located in planning. It is now located in the Asset Services Division, which is responsible for highways, bridges, and multi-modal.

Pavement Management Technical Information

Data Collection

The pavement data is collected using a state owned Roadware ARAN vehicle purchased in 2004. The vehicle collects the following data:

- IRI and rutting every one-hundredth of a mile,
- Black and white pavement images using a strobe light from the back of the van used for pavement distress, and
- Color right of way images from the front of the van.

They collect this information on the entire system every two years, except for the Interstate which is collected every year.

They use WiseCrax software in-house to perform distress analysis. This process is very labor intensive. One technician organizes the data and performs the WiseCrax analysis. The driver and operator of the Roadware ARAN vehicle help in the winter. The WiseCrax analysis is now concentrated on Interstate, NHS, arterials, and major/urban collectors. All WiseCrax data is spot checked as part of QC.

The state computes four index values (0-100) for IRI, rut, functional cracking, and structural cracking. It takes the average of these values minus one standard deviation to compute the pavement condition rating (PCR) on a scale of 0-5, where 0 is the worst and 5 is the best.

All the data is loaded into a statewide data warehouse to share data. The data has been available for over 7 years and is available statewide through the intranet system. The state uses VisiWeb™ (software developed by Fugro-Roadware) to display images tied directly to the data warehouse or to view right-of-way images.

The state used to collect network falling weight deflectometer (FWD) data, but because of a loss in the number of positions, this data is no longer collected on the network.

Performance Modeling

The state is working on pavement performance models. The pavement management system is used to develop a capital work plan every two years. The state has about 8-10 treatments in dTIMS and triggers actions for these treatments based on the index values or the PCR. The pavement management software generates about 400-500 candidate projects for the two year period. The projects are sent to the regions for their review. The pavement management group receives input from the regions and then field reviews of potential projects are performed. They meet with the regions, prioritize, and select final projects.

Perceived Pavement Management Strengths

The pavement management system is being utilized well in the state. It is used for project selection. The ROW images are used as a replacement for trips to the field.

Areas of Improvement

Maine DOT is working on the “Highway Corridor Priority” concept and have instituted key performance indicators in dTIMS to support this effort. They are in the process of upgrading to dTIMS Enterprise which is an Oracle version of the software.

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION

Summary Statistics

Massachusetts DOT is a state about 190 miles long and 50 miles wide. It is comprised of six specific land regions including:

- Coastal lowlands
- Eastern New England upland
- Connecticut valley lowland
- Western New England lowland
- Berkshire Valley
- Taconic mountains

The roadway network includes approximately 72,000 lane-miles of which 9,500 are owned by MassDOT. The remainder is owned by cities and counties. About 13 percent of state lane-miles carry 58 percent of the vehicle miles traveled (VMT). The Interstate system is the backbone of commerce in the Commonwealth and carries about 33 percent of the VMT.

Pavement Management Background Information

MassDOT uses a combined Index (PSI) to represent the overall condition of the roadway network. The index ranges from 0-5 and includes measures of roughness and distress. About 84 percent of the Interstate system is in Excellent or Good condition. For the non-Interstate system, 68.2 percent is in excellent or good condition while 73.7 percent of the entire system is in excellent or good condition.

The pavement management unit has been in existence since the early 1970's. The pavement management unit is comprised of the Pavement Design Section and the Data Collection/Analysis System. The pavement management unit works with the six districts and the GIS planning section to provide the most up to date information on the condition of the roadway network.

MassDOT is continuously improving the manner in which data are collected and analyzed though improved technology or methodologies.

MassDOT has a preservation program and they use open graded friction course (OGFC) on about 60 percent of the roadway system. The first preservation project was constructed in 2003. Other treatments include Novachip, microsurfacing, asphalt rubber gap-graded surfaces, and polymer modified asphalt overlays.

Pavement Management Technical Information

Data Collection

MassDOT measures the condition of the pavements using their own vehicle (Automatic Road Analyzer - ARAN). The ARAN measures pavement roughness as well as indicators of cracking, rutting and raveling and then combines them into a combined index call the Pavement Serviceability Index (PSI). They use lightweight profilers (pickup trucks) for project level roughness and QC.

They use Roadware's software (Visidata/Visiweb) to QA the distresses collected during the network level data collection effort to ensure proper distress identification.

MassDOT uses dTIMS CT Enterprise software to analyze the network data in order to generate potential projects and treatment selections.

Performance Modeling

MassDOT has developed performance models for each of the pavement distresses including roughness and rutting. The curves are based on engineering judgment for now, but as data are collected they will be tweaked using real condition data.

Perceived Pavement Management Strengths

One of the strengths of the pavement management system is the treatment selection process. The state has developed trigger values for each distress which are continuously updated.

Areas of Improvement

The MassDOT pavement management system is still improving. They are adding data to the database to improve the quality of the prediction models.

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION

Summary Statistics

NHDOT is responsible for overseeing 4,559 centerline miles. This is the responsibility of 6 maintenance districts and one turnpike authority.

In 2009, the pavement management system generated 101 projects with a budget of about $58 million for resurfacing and preservation.

Pavement Management Background Information

The pavement management effort in NHDOT dates back to 1995 when they issued a RFP for managing their highway system. This contract was awarded to Deighton Associates. From 1996-1998, the state collected historical data and began providing reports to the districts as early as 1999-2000. In 2001, the state began developing performance curves and received some upgrades to the program from Deighton. They integrated their output with GIS in 2002. In 2003, the Interstate pavement preservation program was established and the champion of the pavement management system retried. System development stopped until a new pavement management section was created in 2005.

Another RFP for a pavement management system was issued in 2006 and Deighton was selected again. After a two year procurement period, the project was up and running. In 2009, a new data collection vehicle was purchased and in 2010 output was sent to the districts again with a new referencing system. It took five years to get the system up and running again after the original champion retired.

Pavement Management Technical Information

The pavement management unit consists of three engineers and five engineering technicians and the data from the system is used by several groups including:

- Pavement management
- Highway design
- Highway maintenance
- Planning

The pavement management unit has been housed in Materials and Research since 2005.

Data Collection

All the pavement condition data is available on the DOT network. The data collection vehicle is a Pathways unit owned by the DOT. It collects the following data:

- IRI
- Rutting
- Cracking (semi-auto line scan)
- Images front, right, rear, 360 degree
- GPS
- Cross slope

Data is collected on a two year cycle. In year 1, data is collected on the intestates, the turnpikes and numbered routes. In year 2, data is collected on the Interstates, the turnpikes and the unnumbered routes. The data is reported to the tenth of a mile.

All data is reported using condition index values on a 0-5 scales. This includes:

- Ride Comfort Index (RCI)
- Structural Cracking Index (SI)
- Environmental Cracking Index (EI)
- Rut Rate Index (RRI)

The final composite index is essentially a Pavement Serviceability Rating (PSR) which uses the distress indexes above.

Performance Modeling

Performance models are developed for a family of treatments including:

- Crack seals
- Preventive maintenance
- Functional overlays
- Structural overlays
- Reclamation
- Rubblization

NHDOT feels that by using just seven families instead of prediction models for all the treatments used, they get better accuracy from dTIMS prediction models.
The pavement management system is very much a network tool. The data is provided to the districts, but the district selects the final treatment.

Perceived Pavement Management Strengths

NHDOT monitors construction costs, and adds multipliers for "other" work including signs, drainage, etc., broken out by budget category and treatment and by state region. This has proved to be a very used tool.

They also have a pavement review committee which consists of 11 members from a cross section of the agency. This group does the following:

- Review sections
- Review treatments
- Guidance for development of PMS

The asphalt subcommittee which is a partnership between FHWA, DOT, and industry meets once per month in the winter to review and develop specs, review new technologies and deal with challenges. Both these groups have proved useful in getting things done.

Areas of Improvement

The state feels they still have a way to go. The fact that they lost 5 years in pavement management development was not beneficial to the PMS program. They are now trying to make up the lost time and generate useful information to agency stakeholders.

NEW JERSEY DEPARTMENT OF TRANSPORTATION

Summary Statistics

New Jersey has about 39,000 total centerline miles of roadway with 2,300 centerline miles of NJDOT maintained roads. The state maintained portion consists of approximately 8,400 lane miles of mainline pavement.

Pavement Management Background Information

Pavement management activities began in the 1970s with the collection of skid data. The first pavement management system was developed in-house. The state is currently transitioning from the in-house system to dTIMS. They still use two pieces of in-house software including:

- Project-Create software used to develop project candidates
- Project-Analyze software used to develop a first cut on candidate projects for resurfacing and preventative maintenance

An International Cybernetics Corporation (ICC) high speed profiler is used to collect roughness (IRI), rut depth, and surface distress (via a windshield survey and computerized keyboard distress rating).

Currently, NJDOT is in between the in-house system and the Deighton dTIMS system. In the Deighton system, the network is defined, the pavement condition data is in the database, treatment types and costs have been defined, and performance curves and decision trees have been developed. The state is having some problems with network segmentation.

Pavement Management Technical Information

Data Collection

NJDOT currently tests the entire state maintained system every year (except as noted below) for the following:

- Skid (entire system tested over a two year period)
- Profile (IRI)
- Video images
- Rut depth
- Distress based on windshield survey

The data collection is a three step process as follows:

- Collect data
- Process and store data
- Analyze and use data

The distresses are consolidated into a Non-Load Related Distress Index (NDI), a Load Related Distress Index (LDI) and Surface Distress Index (SDI) which is a composite of these two indices. All distress indices are based on a 0 - 5 scale.

NJDOT currently uses PaveView software (developed in-house) to allow users to review pavement data by category or data type.

Performance Modeling

Currently, NJDOT has default performance curves for use in prediction, but they are working on more data based performance curves.

They use a report card to evaluate the network in terms of the percent in poor, fair, and good condition. Using the current criteria, 50 percent of the network is deficient, considering both roughness and surface distress.

Perceived Pavement Management Strengths

Pavement data is available to anyone who requests access to the in-house read only software, PaveView. The pavement management group is moving to an asset management data warehouse for universal DOT access.

NJDOT provides a wealth of pavement related information to users both within and outside the Department, including road data based on ad hoc requests, construction quality assurance evaluations, smoothness reports for the NHS, Capital Investment Strategy Reports, and reports to the Governor and Legislature.

Areas of Improvement

NJDOT has made considerable progress in the development of the new pavement management system. Next, they plan on developing the sectioning for the network, running and refining analyses with different budget scenarios, and phasing in the implementation of the entire system. They have all the pieces in place, but now need to implement the new system.

RHODE ISLAND DEPARTMENT OF TRANSPORTATION

Summary Statistics

Rhode Island is the smallest state in the nation covering about 1,200 square miles. Eastern Rhode Island is dominated by a coastal plain, northeastern Rhode Island is part of the Blackstone River Valley, and Interior Rhode Island is hilly and forested.

Rhode Island has about 1,100 centerline miles of state maintained roadways. Its staff consists of one PMS person (half-time) and is located in the Traffic Management Section

Pavement Management Background Information

RIDOT has been involved with pavement management for several years. It started a formal PMS in 1993 using Deighton's dTIMS. This system provides a pavement condition map and recommended projects as well as pavement condition distribution statistics. It also recommends pavement rehabilitation and preservation projects which are reviewed by a committee including the Pavement Management Unit, Road Design, and Materials.
There was a gap in data collection in the mid to late 2000s (2004-2009). RIDOT awarded a three year contract for data collection in 2009 and are now collecting pavement data yearly. Judging from the results of the 2009 survey, the network condition is deteriorating.

RIDOT has been very aggressive with pavement preservation and has recently begun work with pavement recycling. They try to avoid reconstruction whenever possible because it is very expensive.

Pavement Management Technical Information

Data Collection

Automated pavement surveys have been conducted for the last 15-20 years. This includes all the State Numbered Highways, Principal Arterials, and NHS routes. The remainder of the system is evaluated manually by RIDOT staff.

A three year contract for pavement distress data collection (2009 – 2011) is currently underway. Roadware is providing the data collection vehicle. The data being collected includes:

- Roughness, rutting, patching, bleeding, and cracking (longitudinal, transverse, alligator, block, and edge)
- For manual distress surveys, the state uses the SHRP Distress Identification Manual. RIDOT does not count sealed cracks as cracking unless the crack seal has failed

For calibration purposes, they have five sections of highway where two 100 meter samples are taken in a 1 kilometer stretch of highway. The vendor must be within +/- 30 percent of the values obtained manually on the 100 meter samples. They mentioned they are having difficulty using ProVal to check IRI.

Performance Modeling

Regression equations relating the age of the pavements and individual distress scores and composite scores are developed for modeling purposes. Regression equations are being revised and are being developed for pavement preservation treatments.

Perceived Pavement Management Strengths

The pavement management system recommends preservation and rehabilitation projects which are reviewed by a committee consisting of members from the pavement management unit, road design, and materials so that a final list of projects is developed. Implementation of the plan depends on the funding available and legislative requests.

Areas of Improvement

RIDOT has only one half-time staff member to work on this important effort. It is felt that RIDOT should provide adequate staff to insure the continuity of the system and should make use of the performance modeling capabilities of the system to answer the “what if “questions.

VERMONT AGENCY OF TRANSPORTATION

Summary Statistics

VTrans manages 3200 mile centerline miles of the state system. This consists of 640 miles of Interstate, 840 miles of NHS roads, 140 miles of urban highways and 320 miles of vintage concrete roads. Nearly two-thirds of the system is non-engineered.

Pavement Management Background Information

The pavement management unit was formed in the early 1990’s as part of the maintenance division. An annual vendor contract began in 1988 to collect pavement condition data. The current data collection vendor is Fugro/Roadware.

VTrans began using the Deighton software, dTIMS, in 1994. The Pavement Management Group became part of Highway Safety and Design section in 2008

Pavement Management Technical Information

Data Collection

VTrans currently collects ride, rut, and cracking (both structural and environmental). It collects the data on a two year collection cycle, except for the NHS which they collect data on each year.

The raw data is converted to a Pavement Condition Index (PCI) which is on a 0-100 scale (100=no distress). This index is used in the prediction models and as a performance measure for the network.

Performance Modeling

VTrans uses the prediction models in the dTIMS software. About 50 percent of the network is currently in the poor and very poor category. The prediction models are based on the data collected over time.

From the analysis, reports are generated that include network condition predictions (average, condition distribution). The reports also provide highway section candidates (treatment, location, year, and cost).

The goal for the network is as follows:

- Overall PCI>70 (travel weighted). As of 2009, the PCI equals 60 indicating they are not meeting their goal.
- Percent Very Poor. The goal is < 25 percent in very poor condition. Currently, it is 34 percent, which does not meet their goal.

Perceived Pavement Management Strengths

Recent trends have strongly increased an emphasis on using preventative maintenance. They also see an emphasis on asset management and accountability. ARRA contributed to a 30 percent increase in paving in 2009 and 2010.

Areas of Improvement

The state is working to upgrade to dTIMS Enterprise to share data. They are also working on industry partnerships to improve communication and discuss needs with industry partners.