

2014 Transportation Asset Management Peer Exchange – Preparing for MAP-21 Implementation

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1 Overview

This report summarizes the proceedings of the 2014 Transportation Asset Management Peer Exchange hosted by the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO). The peer exchange was held in Miami, Florida on May 1st, 2014.

1.1 Peer Exchange Purpose

The purpose of this peer exchange was to provide participants from State Departments of Transportation (DOTs) an opportunity to share information on the best and current practices in transportation asset management (TAM) and the preparation for implementing the TAM-related requirements in the transportation reauthorization legislation Moving Ahead for Progress in the 21st Century Act (MAP-21). The peer exchange was organized around three primary themes: developing a MAP-21-compliant TAMP; making TAM performance measures work; and TAMP development and risk – climate change and extreme weather events. Each of these is described further below.

Developing a MAP-21 Compliant Transportation Asset Management Plan (TAMP)

MAP-21 requires State DOTs to produce a risk-based asset management plan. FHWA is completing three pilot TAMP projects that meet current understanding of MAP-21 requirements. Several additional states are completing their TAMPs consistent with the requirements of the legislation. Each presenter in this session provided a brief overview of their TAMP and shared their experience of TAMP development. Specific questions addressed included:

- What is included in your TAMP – did you go beyond the minimum requirements?
- What were the constraints and opportunities that you considered in the development of your TAMP?
- What are lessons learned that you can pass on to other states who are starting their TAMP development?

Making TAM Performance Measures Work

An important aspect of developing a TAMP is the inclusion of performance measures. MAP-21 requires state DOTs to report data on bridge and pavement condition using measures being defined by U.S. DOT. While State DOTs will include the required measures in their TAMPs, they may also include other measures related to bridge and pavement condition, as well as measures related to other transportation asset classes. This session focused on performance measures that State DOTs are using (or plan to use) that go beyond those required in MAP-21, as well as how the asset-based measures are being integrated into the other aspects of the State DOT planning and decision-making process. Specific questions addressed included:

- What performance measures are being used in the DOT's TAMP?
- How are targets being used to assess progress being made?
- How are the asset-based measures being integrated into the overall planning and decision-making process?

TAMP Development and Risk – Climate Change and Extreme Weather Events

MAP-21 requires states to develop a risk-based asset management plan to improve or preserve the condition of their assets and the performance of the system. Climate change—which will vary by region and may include higher sea-levels, more frequent heat waves and higher high temperatures, changes in freeze thaw cycles, wildfires, droughts, heavier precipitation events, localized flooding and permafrost thawing—and extreme weather events present significant risks to the transportation system. This session explored the linkages between asset management and risks associated with the impacts of climate change and extreme weather events. Specific questions addressed included:

- What are states currently doing to integrate these risks into the asset management process?
- What potential approaches could be used that have not been considered?
- What are the challenges and barriers to addressing the risks of climate change and extreme weather events in asset management plans?

1.2 Peer Exchange Format

The peer exchange consisted of three sessions organized around the themes discussed above. Each session was followed by a question and answer (Q&) panel discussion. At the conclusion of the peer exchange, the participants conducted a roundtable discussion. This format was designed to balance structured presentations with open discussions, and to enhance opportunities for the exchange of practical information.

Tim Henkel (Minnesota DOT) and Butch Wlaschin (FHWA) began the peer exchange with introductions and opening remarks. Hyun-A Park (Spy Pond Partners) then outlined the agenda and objectives for the peer exchange. The first series of presentations focused on developing a MAP-21 compliant TAMP. Presenters included Michael Bridges (Louisiana DOTD), Angela Alexander (Georgia DOT), William Johnson (Colorado DOT), and Richard Heineman (Pennsylvania DOT). The presentations were followed by a Q&A panel with Josh Bench-Bresher (South Dakota DOT), Anita Bush (Nevada DOT), and John Priess (Rhode Island DOT). The second round of presentations concentrated on developing successful performance measures for a TAMP. Presenter on this topic were Glenn Davidson (New Hampshire DOT), John Selmer (Iowa DOT), and Jerri Bohard (Oregon DOT). A Q&A panel followed these presentations with Tim Henkel (Minnesota DOT), Martin Kidder (Wyoming DOT), and Mark Lester (South Carolina DOT). The final presentations discussed developing a risk-based asset management plan in the face of climate change and extreme weather events. Presentations were given by Rob Kafaenos (FHWA), Garth Hopkins (Caltrans), Kevin Walsh (Massachusetts DOT), and Dave Wresinki (Michigan DOT). The Q&A panel following the presentations included Jennifer Brandenburg (North Carolina DOT), David Kuhn (New Jersey DOT), and Scott Richrath (Colorado DOT).

After the presentations were completed, all of the peer exchange attendees participated in a roundtable discussion facilitated by Cory Pope (Utah DOT) and Andrew Williams (Ohio DOT). Participants discussed topics pertaining to asset management plans, including: risk, coordinating with Metropolitan Planning Organizations (MPOs) and local governments, determining assets that should be incorporated into the TAMP, life cycle costing, and management systems. At the end of the peer exchange Steve Gaj (FHWA) provided a set of closing remarks.

1.3 Peer Exchange Agenda

Introduction

8:00 – 8:30 Welcome, Opening Remarks

Tim Henkel, Minnesota DOT

Butch Wlaschin, FHWA

Peer Exchange Overview and Objectives

Hyun-A Park, Spy Pond Partners

A. Developing a MAP-21 Compliant TAMP

8:30 – 10:30 Louisiana DOTD TAMP Development

Michael Bridges, Louisiana DOTD

Georgia DOT TAMP Development

Angela Alexander, Georgia DOT

Colorado DOT TAMP Development

William Johnson, Colorado DOT

Pennsylvania DOT TAMP Development

Richard Heineman, Pennsylvania DOT

New Jersey DOT TAMP Development

Dave Kuhn, New Jersey DOT

Q&A Panel

Josh Bench-Bresler, South Dakota DOT

Anita Bush, Nevada DOT

John Priess, Rhode Island DOT

10:30 – 10:45 Break

B. Making TAM Performance Measures Work

10:45 – 12:15 Tri-State Performance (ME, NH, and VT)

Glenn Davidson, New Hampshire DOT

Improving Asset Performance at Iowa DOT

John Selmer, Iowa DOT

Asset Management and Transportation Performance at Oregon DOT

Jerri Bohard, Oregon DOT

Q&A Panel

Tim Henkel, Minnesota DOT

Martin Kidner, Wyoming DOT

Mark Lester, South Carolina DOT

12:15 – 1:15 Lunch

C. TAMP Development and Risk – Climate Change and Extreme Weather Events

1:15 – 2:45 **Topic Introduction and Overview**

Rob Kafalenos, FHWA

California Experience

Garth Hopkins, Caltrans

Massachusetts Experience

Kevin Walsh, Massachusetts DOT

Climate Change and Asset Management

Dave Wresinski, Michigan DOT

Q&A Panel

Jennifer Brandenburg, North Carolina DOT

David Kuhn, New Jersey DOT

Scott Richrath, Colorado DOT

D. Roundtable Discussion

2:45 – 4:15 **Discussion**

Cory Pope, Utah DOT (facilitator)

Andrew Williams, Ohio DOT (facilitator)

1.4 Peer Exchange Participants

The following is a list of peer exchange participants.

State DOT Participants (by state)

Name	Agency
Carolyn Morehouse	Alaska Department of Transportation and Public Facilities (DOT&PF)
Andrew Pavey	Alaska DOT&PF
Jean Nehme	Arizona DOT
Scott Omer	Arizona DOT
Jared Wiley	Arkansas State Highway and Transportation Department (SHTD)
Sharon Hawkins	Arkansas SHTD
Garth Hopkins	California DOT (Caltrans)
Coco Briseno	Caltrans
Steve Guenther	Caltrans
William Johnson	Colorado DOT
Scott Richrath	Colorado DOT
Colleen Kissane	Connecticut DOT
Bill Pratt	Connecticut DOT
Jennifer Trio	Connecticut DOT
Shante Hastings	Delaware DOT
Dana Knox	Florida DOT
Tim Lattner	Florida DOT
Angela Alexander	Georgia DOT
Melany Reynolds	Georgia DOT
Jamie Ho	Hawaii DOT

Name	Agency
Ken Tatsuguchi	Hawaii DOT
Scot Urada	Hawaii DOT
Tom Points	Idaho Transportation Department
Matt Haubrich	Iowa DOT
John Selmer	Iowa DOT
Marcia Ferrill	Kansas DOT
Dana Majors	Kansas DOT
Michael Bridges	Louisiana Department of Transportation and Development (DOTD)
Rhonda Fletcher	Maine DOT
Patricia Leavenworth	Massachusetts DOT
Victoria Sheehan	Massachusetts DOT
Kevin Walsh	Massachusetts DOT
Dave Wresinski	Michigan DOT
Tim Henkel	Minnesota DOT
Mark Nelson	Minnesota DOT
Dave Solsrud	Minnesota DOT
Trisha Stefanski	Minnesota DOT
Imad Aleithawe	Mississippi DOT
Brian Reagan	Missouri DOT
Elizabeth Wright	Missouri DOT
Chris DeVerniero	Montana DOT
Paul Johnson	Montana DOT

Name	Agency
Mick Syslo	Nebraska Department of Roads
Anita Bush	Nevada DOT
Tracy Larkin	Nevada DOT
Glenn Davidson	New Hampshire DOT
Dave Kuhn	New Jersey DOT
Tammy Haas	New Mexico DOT
Jennifer Brandenburg	North Carolina DOT
Michael Holder	North Carolina DOT
Lonnie Watkins	North Carolina DOT
Jack Smith	North Dakota DOT
Steph Weigel	North Dakota DOT
Andrew Williams	Ohio DOT
David Ooten	Oklahoma DOT
Jerri Bohard	Oregon DOT
Rich Heineman	Pennsylvania DOT
Joseph Baker	Rhode Island DOT
John Preiss	Rhode Island DOT
Josh Bench-Bresher	South Carolina DOT
Mark Lester	South Carolina DOT
Laurie Schultz	South Carolina DOT
Chris Harris	Tennessee DOT
Jerry Hatcher	Tennessee DOT
James Maxwell	Tennessee DOT
Howard Holland	Texas DOT

Name	Agency
Cory Pope	Utah DOT
Chad Allen	Vermont Agency of Transportation (VTrans)
Tom Adkins	Wyoming DOT
Ed Fritz	Wyoming DOT
Martin Kidner	Wyoming DOT
Tim McDowell	Wyoming DOT

Other Participants (by organization)

Name	Organization
Jen Brickett	AASHTO
Katie Zimmerman	Applied Pavement Technology, Inc.
Paul Thompson	Consultant
Jason Bittner	Cambridge Systematics, Inc.
Andres Alvarez	FHWA
Barbara Bauer	FHWA
William Beatty	FHWA
Scott Bowles	FHWA
Lorenzo Casanova	FHWA
Robert Conway	FHWA
Mike Culp	FHWA
Steve Gaj	FHWA
Domingo Galicinao	FHWA
Tom Goldstein	FHWA

Name	Organization
Max Grogg	FHWA
David Harris	FHWA
Nelson Hoffman	FHWA
Randy Jensen	FHWA
LaToya Jones	FHWA
Rob Kafalenos	FHWA
John Lohrey	FHWA
Kelly Lund	FHWA
Karim Naji	FHWA
Jeff Purdy	FHWA
Hassan Raza	FHWA
Kris Riesenber	FHWA
Nastaran Saadatmand	FHWA
Thomas Van	FHWA
Butch Wlaschin	FHWA
Hyun-A Park	Spy Pond Partners, LLC
William Robert	Spy Pond Partners, LLC
Tom Palmerlee	Transportation Research Board (TRB)

2 Peer Exchange Introductions

Tim Henkel, Vice Chair of the AASHTO Asset Management Subcommittee, opened the 2014 Transportation Asset Management Peer Exchange by welcoming the participants and thanking the organizers and participants. Butch Wlachsins, Director of the FHWA Office of Asset Management, Pavements, and Construction provided an introduction to the peer exchange topic: Preparing for MAP-21 Implementation. Butch discussed the timeline for development of rules implementing the MAP-21 requirements for states to develop a TAMP, and explained that regardless of the rulemaking process, there is no “one size fits all” approach for developing a TAMP. FHWA recognizes that each state has slightly different priorities and methodologies that can be blended together to support national goals. The new legislation will help agencies work towards maintaining all assets in a state of good repair, but will not require a single asset management approach. FHWA will also be working on guidance for the acceptance or certification process to be used by states and FHWA divisions. The result will likely feature a checklist including items that may be included in a TAMP such as:

- Elements required in MAP-21;
- Vision for maintaining assets in a state of good repair; and
- Inventory and condition assessment.

FHWA’s goal is to develop a flexible approach that will allow states to adapt their current practices to reflect national requirements. For many states, this will involve taking their asset management approach to the next level by incorporating new asset types and maintaining assets over time – managing for their whole-life. As part of taking this next step, states will be required to develop transportation asset management plans. These plans will build on work that states are already performing. For example, the TAMP will not require a list of projects, but will instead include investment strategies that lead to a “program of projects” that can be compiled and included in their STIP. Butch concluded his remarks by encouraging all of the attendees to actively participate in the peer exchange. He asked that everyone listen, share, and be sure to bring any lessons learned back to their respective agencies.

Hyun-A Park reiterated Butch’s final remarks, reminding everyone that the purpose of the peer exchange is to collaborate and share knowledge. She noted that this year, AASHTO and FHWA made an effort to get every state to participate in the peer exchange. The peer exchange was designed to generate a dialogue. Hyun-A then provided a short summary of the agenda.

3 Developing a MAP-21 Compliant TAMP

The objective of this session was to share the experiences of five state DOTs that completed development of their TAMP before MAP-21 or have recently completed or are nearly complete in the development of their state TAMPs. These TAMPs reflect alignment with the MAP-21 requirements based on the best information available at the time of their development. The final MAP-21 TAMP requirements will not be known until the rules are published and finalized.

3.1 Louisiana DOTD TAMP Development

Michael Bridges, Undersecretary of the Office of Management and Finance of Louisiana DOTD (LADOTD), began his presentation by summarizing the scope and responsibility of LADOTD’s highway system. The state manages 16,655 miles of roadway and 13,095 bridges, in addition to airports, ports, public transit, freight rail, public works, waterways, and facilities. LADOTD has chosen to include the entire state system in the TAMP, the document will focus on pavement and bridges. In the future, LADOTD hopes to include other assets in more detail.

LADOTD subdivides the state system into four categories:

- IHS – Interstate Highway System
- NHS – including all non-IHS roads on the National Highway System
- SHS – Statewide significance highways, non-NHS highways that are Federally eligible
- RHS – Regional significance highways, non-NHS highways that are not Federally eligible

Michael then reviewed the timeline of the TAMP development process at LADOTD. In 2012, the agency formed a Transportation Asset Management (TAM) steering committee with Michael selected as the executive champion. The steering committee included staff in finance, maintenance systems management, data collection, district representatives, IT, engineering, multimodal planning, and strategic planning.

The complete governance framework is outlined in **Figure 3.1.1**. Michael noted that initially the committee faced issues caused by questions concerning the scope of asset management and the relationship of asset management to other LADOTD activities. Having a diverse group of advocates represented in the steering committee, in addition to strong leadership from the executive champion, helped to make transportation asset management a core component of LADOTD functions.

LADOTD TAM Governance

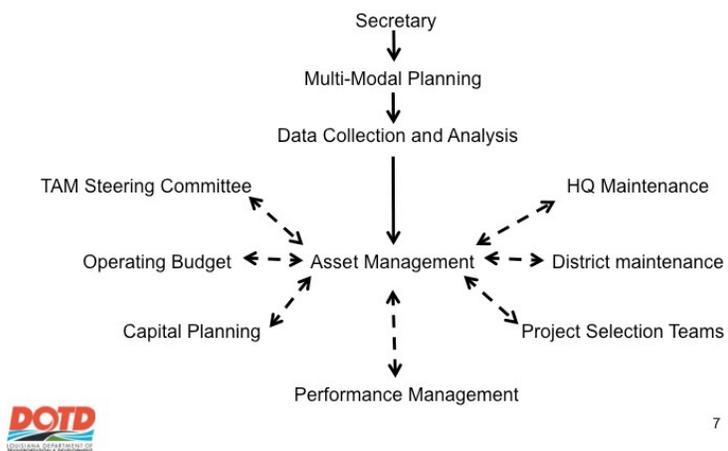


Figure 3.1.1 LADOTD TAM Governance

In 2013 LADOTD participated in a FHWA pilot project that provided assistance in developing their TAMP, they developed a work plan for creating the TAMP, and hired additional outside consultants to assist in TAMP development. LADOTD identified a core working team that included the executive champion, a data collection and analysis engineer, a statewide operations engineer, an asset management engineer, the consultant selected by LADOTD, and an FHWA pilot consultant. During this period, LADOTD identified a new position for an asset management engineer, who was hired to work across business units and use “management by influence” to champion asset management efforts.

The final draft of the TAMP is expected to be completed in May 2014. LADOTD will finalize the TAMP once FHWA has established its rules for TAMP development.

Michael discussed lessons learned in TAMP development. He noted that creating a TAMP requires a focus on data, funding, and condition. Additional lessons learned included:

- **Relate funding to targets.** When considering funding, it is important to consider pavement and bridge funding independently to understand how performance relates to the agency targets. For example, LADOTD noted that funding constraints resulted in an increase in IHS projects, in some cases at the expense of NHS projects that would have allowed LADOTD to achieve targets.
- **Develop a cohesive strategy.** Initially, the agency struggled with reconciling conflicting strategies. Ultimately, it was important to LADOTD that the asset management strategy met established performance targets and also matched all federal funds.
- **Leverage existing data systems.** LADOTD also found that having effective data collection and storage processes, particularly a Pavement Management System (PMS) and Bridge Management System (BMS), was crucial to the success of the TAMP. Understanding the PMS and BMS outputs also was necessary and allowed the agency to conduct analysis specific to the goals of the TAMP.

When compiling the TAMP, Michael noted that some sections, including risk management, financial planning, and the asset inventory, required more effort. Often the additional effort was needed to develop the framework for the section. For the financial plan, the working group had to determine the appropriate information to be included despite having created many financial plans in the past. With the inventory, the team had to decide on the best method for measuring and reporting on the inventory, e.g. by lane miles, centerline miles, etc.

Michael concluded the presentation with a set of observations concerning key success factors in developing a TAMP. He noted that it is important to get executive buy-in early in the process, as it facilitates coordination and implementation. He also added that it is important to allocate resources towards the project, both internally and externally. Finally, he encouraged others to start the process of TAMP development now. Developing a TAMP is challenging and beginning the development process early allows DOTs time to adapt and arrive at a strategy that best reflects agency goals.

3.2 Georgia DOT TAMP Development

For the second presentation, Angela Alexander, Chief Engineer of Organizational Performance Management, presented on Georgia DOT’s TAMP. Angela first explained the role of the

Organizational Performance Management Division at Georgia DOT (GDOT). This division serves as a facilitator, responsible for coordinating implementation efforts across GDOT divisions and offices. The division also is responsible for the department's Transportation Asset Management Program, combining strategic planning, performance management, and asset management efforts. The asset management program manager, Melanie Reynolds, is currently responsible for developing the TAMP.

The presentation reviewed how asset management has changed at Georgia DOT over the past five years. GDOT began to focus on asset management in 2009 and appointed a Transportation Asset Management Director to champion future efforts. The following year GDOT created an asset management task force. To determine the current status of asset management at the department GDOT completed a self-assessment and held a peer exchange. At the end of 2011, GDOT completed its first attempt at an asset management plan, the Strategic Direction. The Strategic Direction addressed pavement and bridges, and had limited information on other assets, such as signs. With the initial draft of the Strategic Direction complete, the agency held a series of "lunch and learns" to communicate the objectives and concepts of asset management.

In 2012, Georgia DOT drafted a TAMP, which built on the Strategic Direction and incorporated additional information from MAP-21. The TAMP included an implementation plan with recommended improvements. In 2013, GDOT submitted the plan to FHWA for review and published the final document online. This year, GDOT has continued to improve the TAMP. Georgia is currently executing an implementation plan and developing additional plans for other assets. GDOT has been monitoring the work of other states to find areas for improvement when modifying the plan to comply with upcoming rules for TAMP development to be issued by FHWA.

Angela concluded the presentation with a series of lessons learned. She stressed that the plan should be developed as part of a collaborative effort across the agency and listed a number of key findings that led to the success of the Georgia TAMP:

- **Start with what you know.** GDOT began the TAMP development process with pavement and bridges. These assets were chosen because data were readily available, but the agency expects to add asset types in later versions of the TAMP. Angela urged participants to evaluate the availability and reliability of data before creating performance measures and targets.
- **Have a plan.** GDOT benefited from having an implementation plan in place before beginning to work on the TAMP. An implementation plan should include action steps to follow and targets to measure progress towards the final document.

Finally, Angela urged states not to hope for "immediate perfection." The TAMP is a "living document" that will inevitably change over time. Agencies should be prepared to modify the TAMP as funding, priorities, and requirements shift.

3.3 Colorado DOT TAMP Development

William Johnson, Transportation Performance Branch Manager at Colorado DOT (CDOT), described the Risk-Based (RB) Asset Management Plan development process at CDOT.

Colorado began developing an asset management plan a year before MAP-21 was approved. The initial goal of the program was to leverage existing initiatives at the agency and develop a cohesive vision. William began by reviewing the pavement, bridge, and maintenance management processes. **Figure 3.3.1** highlights pavement management as an example. For each process, CDOT determined a goal and objective. The goal for pavement was to achieve 60% good/fair pavement conditions system-wide.

Using data collection efforts, regional input, and revenue estimates, CDOT developed a pavement management model to determine how CDOT was performing compared to the pavement goals and objectives. Similar initiatives were executed for maintenance and bridge activities. The implementation strategy for these processes included performance and risk based resource allocation, asset inventory and condition, and data management and governance. The processes of setting targets and comparing performance were intended to improve overall level of service, decision-making for project selection, and performance monitoring.

CDOT developed an asset management structure within the agency to support the development of the TAMP. This consisted of a Transportation Commission and Transportation Commission Asset Management Committee. These entities formed the TAM Oversight Committee, which includes representatives from staff services, engineering, transportation development, finance, and district representatives. Having strong leadership turned out to be a crucial aspect for successful

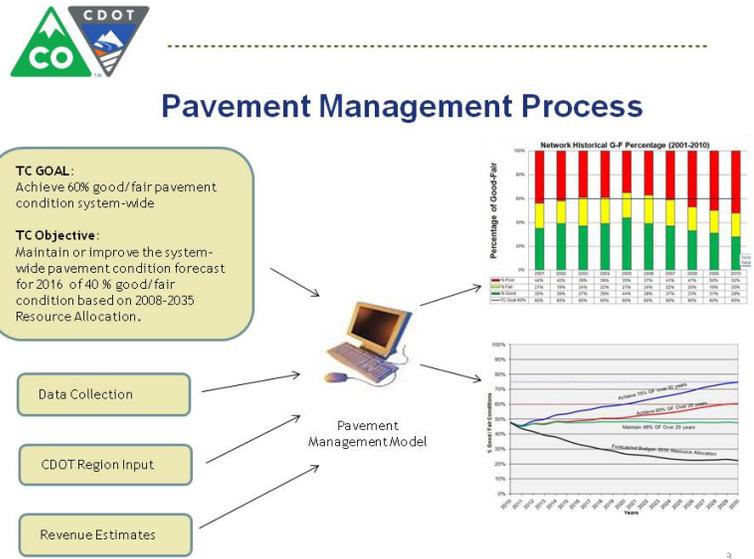


Figure 3.3.1 Pavement Management Process

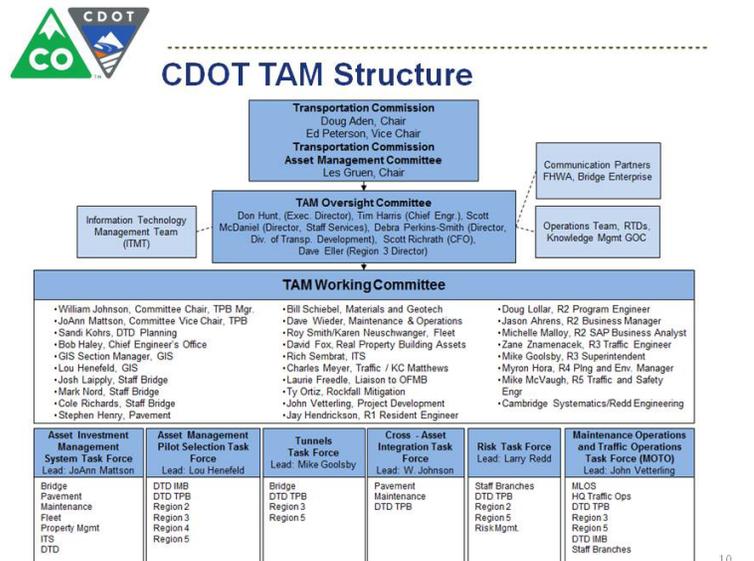


Figure 3.3.2 CDOT TAM Structure

development of the TAMP success and ensuring buy-in across the agency.

CDOT also developed a TAM Working Committee, incorporating members from an even larger and more diverse range of staff throughout the agency. The complete TAM structure is shown in **Figure 3.3.2**. The working committee met monthly in order to ensure consistent and timely input from representatives of multiple districts and departments. Amongst the working committee, additional task forces were also formed to gain professional insight from specialists in the areas of asset investment management, tunnels, cross-asset integration, risk, and maintenance/traffic operations (MOTO). The working committee also sponsored an AM Pilot Selection Task force, formed to rapidly encourage the research of new approaches to asset management. Ultimately, the task forces were successful at reviewing asset management practice at the agency. For example, the MOTO group identified traffic signals as a \$500 million dollar asset where CDOT needed a cohesive asset management strategy.

With processes in place for measuring Colorado's achievement towards their goals, CDOT embarked on the TAMP development process in 2013. The document was recently completed and is available online at http://www.tamtemplate.org/wp-content/uploads/tamps/022_coloradodot.pdf. The proposed vision for transportation asset management at CDOT was defined early and is as follows:

“CDOT’s Transportation Asset Management program optimizes for CDOT’s customers the service levels of the department’s infrastructure through strategic decision making that relies upon accurate and timely asset-related information.”

William also reviewed the proposed mission statement, which stressed that the TAMP would be used to support strategic planning and decision-making at the agency through a better understanding of asset condition and levels of service. The presentation also included a list of sections for the TAMP. The final document will include:

- Executive Summary
- Value to Citizens
- Asset Inventory and Condition
- Asset Management Performance Measures and Targets
- Current Asset Management Processes
- Life-Cycle Cost Considerations
- Incorporating Risk into the Asset Management Program
- Financial Plan
- Investment Strategies
- Asset Management Gap Assessment
- Asset Management Implementation Plan
- RB AMP Governance Appendices

The assets that will be included and reviewed in the TAMP are:

- Pavement
- Structures
- Culverts
- Maintenance Levels of Service (MLOS)

- Buildings
- Intelligent Transportation Systems (ITS) Equipment
- Roadway Equipment
- Tunnels
- Rockfall Mitigation Sites

When considering what sections and assets should be included in the TAMP, Colorado compared the document to other CDOT plans to determine areas that needed to be addressed. During this process, CDOT mapped out the completion of existing plans and determined what elements could be leveraged and incorporated into the TAMP document. This process is summarized in **Figure 3.3.3**.

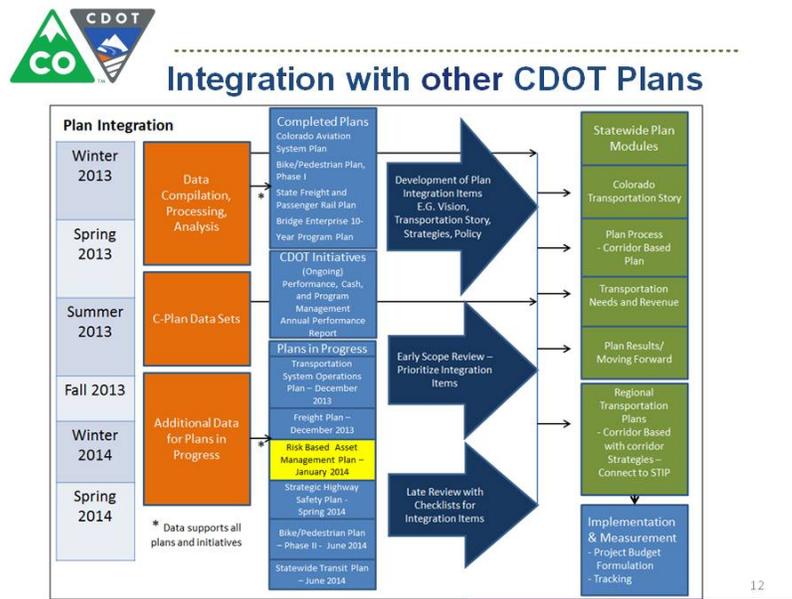


Figure 3.3.3 Integration with other CDOT Plans

When developing the TAMP, Colorado faced a series of challenges including:

- **Incorporating existing models.** CDOT uses its Asset Management Investment System (AMIS) to support TAMP development. While leveraging an existing asset management system was beneficial, CDOT found that existing models had to be modified in order to adhere to the goals and objectives of the TAMP.
- **Ensuring the flexibility of the plan.** During the TAMP development process, CDOT shifted from measuring remaining service life of pavements to drivability life. While this change did not require additional data collection, it did require changing the models and weighting measures differently.
- **Accelerated learning.** CDOT completed the TAMP over a short period, and therefore had to adjust quickly to ensure that asset management principles were thoroughly understood within the agency. Having a strong leadership and dedicated working groups helped CDOT to overcome this challenge.
- **Portfolio management.** CDOT is transitioning to programming on a cash basis. This will change how the state manages their portfolio and this will have to be addressed in later versions of the TAMP.

The next steps for the Colorado TAMP will be to address items stemming from the rulemaking process as the new rules for TAMP development are promulgated. Colorado will also have to address asset management gaps identified in the first TAMP. While the plan identifies 30 gaps, the state will begin by focusing on the first 10:

- Develop and document the budget distribution, project selection, and project tracking process
- Integrate risk analysis into planning and programming processes
- Develop strategies to manage project and program delivery risks
- Establish a risk framework to evaluate alternative strategies
- Analyze budget tradeoffs across programs
- Improve project scoping and optimization
- Incorporate life-cycle analysis into decision-making
- Clarify the role of target-setting
- Implement a strategic management framework to reflect on progress
- Communicate the benefits of transportation asset management

While many of these gaps can be easily addressed for pavement and bridges, it is less clear how projects are selected for other assets and CDOT will work towards refining this process.

3.4 Pennsylvania DOT TAMP Development

Richard Heineman, Supervisor for the Asset Management and Performance Metrics Group at the Pennsylvania DOT (PennDOT), presented on the Pennsylvania TAMP. PennDOT began its asset management initiative by performing a self-assessment and interviewing executives to determine the current state of asset management at the agency. This assessment was followed by a gap analysis. Using these two sources, PennDOT developed an implementation plan, creating a roadmap for achieving a successful asset management program. With this plan in place, the agency shifted towards a prime objective of the plan, developing a TAMP.

Richard reviewed the timeline for the TAMP project. For the first six months, PennDOT worked on developing the initial TAMP draft, including first round pavement and bridge performance forecasts. The TAMP development approach was to create a “starting point” that was flexible enough to incorporate new elements based on changing requirements and the release of new rulemaking. The next step was to refine the TAMP based on new information from MAP-21 while improving the bridge and pavement forecasting models.

In 2014 PennDOT began to incorporate stakeholder comments and add new content to the TAMP. Engaging planning partners in the TAMP development process was a challenge, but sharing their experience provided valuable feedback for later versions of the TAMP. Currently, the agency is communicating the results of the TAMP to a wider group of stakeholders in order to receive additional feedback and enhance the TAMP accordingly. The goal is to complete a final draft of the document for Fiscal Year (FY) 2015. One of the goals for the TAMP is to use the document as a transparent communication tool for communicating with other agencies. For example, using the finalized TAMP to communicate with the Department of Environmental Protection could help PennDOT convey the size of the program for their planning efforts. Other potential stakeholders that could benefit from the TAMP include FHWA and other public agencies, districts, legislators, the governor, planning partners, and the traveling public.

The PennDOT TAMP is organized by asset type, with an initial focus on pavement and bridge assets. The TAMP will include the following information for each asset type:

- Data Overview
 - Data sources
 - Data rules, detailing how the data has been used
 - Identified data gaps
- Asset Condition/Assessment
 - Estimated asset life and remaining useful life
 - Identified risks, including the consequence of failure and the likelihood of failure
 - Intervention strategies, such as preservation, rehabilitation, and/or replacement
- Analysis
 - Needs, including the life cycle costs and the needs by year for each action type (rehabilitation, replacement, etc.)
 - Risk profiles over time
- Scenarios
 - Impact of funding on conditions

After providing the outline, Richard expanded on PennDOT’s approach for quantifying risk in the TAMP. PennDOT measured the likelihood of failure of pavement based on International Roughness Index (IRI) and consequence of failure by average daily traffic (ADT). This resulted in a risk assessment matrix, shown in **Figure 3.4.1**, comparing the likelihood of failure and the consequence of failure over time. In the figure risk scores are calculated by multiplying likelihood scores and consequence scores.

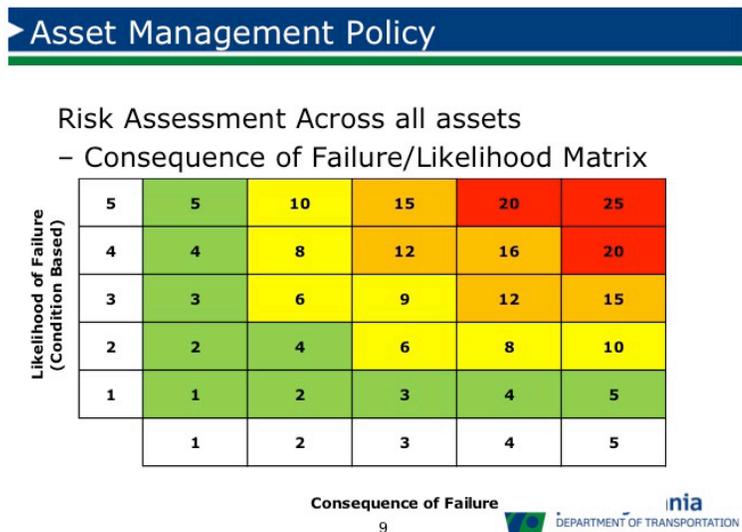


Figure 3.4.1 PennDOT Pavement Risk Matrix

The presentation concluded with a number of insights gained and challenges identified during the TAMP development process. First and foremost, developing a TAMP takes time and the document will require a number of iterations. The document should be flexible to accommodate for these inevitable changes over time. Additional challenges included:

- **Identify data gaps.** As part of the planning process, PennDOT found it beneficial to identify data gaps. This provided an opportunity to address these concerns during the TAMP development process.
- **Relate the TAMP to existing documents.** PennDOT determined that the TAMP should be structured to compliment other documents. In some cases, this was achieved by leveraging or referencing existing documents when developing the TAMP. Specifically, Richard noted overlap with the Long Range Transportation Plan (LRTP) and added that finding the right balance between the LRTP and TAMP was a challenge.

- **Validate the process.** To ensure the success of the final document, PennDOT made every effort to validate the models used in the TAMP. Richard also stressed finding opportunities for validation during the TAMP development process, as the document is constantly changing and it is important that the final plan accurately reflects current conditions at the agency.
- **Develop strategies to address funding.** Many of the other challenges that PennDOT faced related to modeling and funding requirements, including finalizing spreadsheet models, determining the optimal techniques for modeling funding at each level, and relating funding to assets rather than projects or programs. When determining funding, staff had to determine what budgets to use in the TAMP for analysis. After a funding increase, the models needed to be re-run.
- **Frame the story.** PennDOT found that it was important provide information about both the NHS and non-NHS systems in the TAMP to help “tell a complete story.” This allowed PennDOT to examine the whole network and distribute funds based on a system-wide approach.
- **Include all assets in the TAMP.** PennDOT initially included all assets in the TAMP, although some of the sections were relatively short due to limited data. Richard added that it is important to have a starting point for each asset type, which can be built on as the TAMP develops and becomes more comprehensive.

Finally, Richard stressed that having someone dedicated to the day-to-day management of the TAMP development process was important to completing the document. The document will take time to review and will likely be revised multiple times. Therefore, close monitoring of the final document is crucial. He also reiterated that using the TAMP as a DOT communication tool was an important outcome of the asset management effort and all agencies should consider the audience when completing their TAMP.

3.5 New Jersey DOT TAMP Development

Dave Kuhn, Assistant Commissioner of Capital Investment, Planning and Grant Administration at the New Jersey DOT (NJDOT), presented on the lessons learned during the NJDOT TAMP development process.

NJDOT developed its first TAMP in 2009 and updated the document in 2010. After MAP-21 became law, the state reviewed its existing TAMP and compared it to the requirements of MAP-21. New Jersey found that their analysis of pavement and bridge assets went beyond the scope of the new requirements. The existing plan also included the necessary information on asset management objectives, measures, and performance gaps. However, the TAMP did not cover lifecycle costing, risk management, financial planning, or investment strategies.

Because the state had already developed a TAMP, NJDOT was prepared to address the additional requirements of MAP-21. The agency already has identified a high-level owner to champion asset management and established an asset management policy. The state also has an established senior-level steering committee. These institutional changes have helped in championing asset management efforts at the agency, and the longevity of the program has ensured that asset management is a crucial consideration in agency functions. NJDOT also performed a self-

assessment while developing the first TAMP; therefore the agency has a clear understanding of existing gaps in the asset management program.

Lessons learned from NJDOT's first TAMP effort include:

- **Establish strong leadership.** The Commissioner championed asset management at NJDOT and having the initiative supported from top leadership ensured that the process was recognized agency-wide.
- **Promote asset management at all levels.** When developing the TAMP, NJDOT focused on establishing buy-in from all areas of the agency. Senior staff members participated in meetings to set performance measures and targets, while staff members at all levels were encouraged to consider asset management practices through an internal newsletter.
- **Include subject matter experts (SMEs).** During the planning process, SMEs met with senior leadership to help develop performance measures and targets. NJDOT also found that providing a clear outline for SMEs to clarify their roles and outcomes added efficiency to the development process.
- **Make the document inviting.** For the final TAMP, a non-technical staff member was responsible for writing the summary overview in plain language. Meanwhile, the technical documents were included as appendices in the final TAMP. This made the document readable and accessible, making it a successful communication tool.
- **Plan to update the TAMP.** As part of the document, NJDOT laid out an annual update cycle to ensure that the final TAMP would be updated regularly and reflect the current condition of the system.

Dave also reviewed some of the challenges that NJDOT faced during the TAMP development process. Funding was a key issue, as half of the capital program in New Jersey is federally funded. This had implications for developing the TAMP. Rather than using the TAMP to “tell a story,” the goal of the document was to support prioritization decisions and justify the need for additional funding. The state also had issues with momentum and ensuring that work was done both at an executive and a staff level. Staff turnover also proved to be difficult issue, as key staff working on the plan left the agency. Moving forward, New Jersey will have to address these concerns, ensuring that asset management again becomes an important item of conversation at the agency and new champions are found to replace retired staff members. As part of this initiative, staff will have to be educated on the new components of the plan, namely lifecycle costing and risk management. NJDOT will also have to work to re-engage the Commissioner and other senior leaders at the agency. In order to account for the new requirements in MAP-21, NJDOT will soon establish a cross-organizational project team to develop a new plan for adjusting the TAMP, and this team will be responsible for determining short-term goals that will allow NJDOT to move forward.

3.6 Q&A Panel

Three contributors posed questions to the presenters, and helped facilitate the discussion: Josh Bench-Bresher from South Dakota DOT, Anita Bush from Nevada DOT, and John Priess from Rhode Island DOT. Below is a summary of topics discussed during the panel discussion.

Asset Management Plan Status

One participant asked if any other agencies were close to finishing a TAMP. The panel members noted that Wyoming, Minnesota, and North Dakota were close to completing a TAMP. A number of other states are still early in the development of their TAMP, while others have not yet initiated work.

Communicating the Importance of Asset Management Throughout the Agency

Anita Bush asked how the presenters handled communication. How did champions communicate with their team? How were they able to keep momentum going?

Dave Kuhn noted that this was a problem for NJDOT. Turnover within the agency and a loss of momentum has led to a lack of communication regarding asset management. In the past, a strong leadership structure and an internal newsletter to engage staff members contributed to an agency-wide culture of asset management.

Angela Alexander noted that at GDOT the TAMP had a champion who was responsible for promoting the program. William Johnson explained that CDOT is approaching the problem using three approaches. The first approach is to change the agency network to increase outreach and awareness. This includes producing newsletters and other communications. The second approach is to adjust the organizational structure, creating a working committee and a task force with monthly meetings. The third approach is to host a CDOT workshop on asset management. The workshop will include 300-400 CDOT staff and will help to promote asset management practices throughout the agency.

At PennDOT, Rich Heineman presents on asset management practices throughout the agency. He explained the value of bringing asset management into the conversation whenever possible, even on a small scale. Michael Bridges described his rationale for educating and training LADOTD employees on the value of asset management, pointing out that once the TAMP is released it is not implemented alone and people must understand the importance of the document. Ideally, Michael would have proposed setting up the TAMP development process like a project, with a project manager, working teams, and project schedule. Moving forward, Rich Heineman suggested that PennDOT might implement the approach that Michael described and create a process for setting up and developing the document.

Tim Lattner from Florida DOT added that the communication process should begin even before the TAMP development. He explained that Florida does not yet have a TAMP. However, they currently hold a monthly performance meeting with the Secretary and district staff to review district-level performance.

Challenges Associated with TAMP Development

John Preiss asked which elements of TAMP development were the most difficult to complete, and whether agencies were able to realize benefits of a TAMP right away.

Dave Kuhn explained that starting the conversation about asset management was a benefit in and of itself. It was valuable to establish performance measures and targets even before developing the TAMP. New Jersey is now emphasizing performance measures statewide, but the DOT was

“ahead of the curve.” This was particularly helpful when a new commissioner started at the agency and NJDOT was quickly able to demonstrate how the DOT was performing, resulting in an investment shift to pavement and safety. David urged others to consider that the topics covered in the TAMP are important to consider and should be addressed, even in the absence of a formal TAMP development process.

Angela Alexander explained that the most difficult element of the TAMP for Georgia was the financial plan. Noting similarities to David Kuhn’s story, Angela added that it was important to start a dialogue about financial planning at the beginning of the TAMP development process. Creating a TAMP also helped GDOT to identify a number of financial gaps. This helped to build support for implementing an enterprise asset management system.

William Johnson found that the most important element of the TAMP development process was setting performance targets for non-pavement and non-bridge assets. While pavement and bridge assets had existing asset management programs, other assets at CDOT were not as developed. By requiring those assets in the TAMP, managers were encouraged to change their management approach.

Richard Heineman stated that for PennDOT the risk management section was the most challenging one to develop. Within PennDOT, there was significant discussion on this topic and how it should be measured in the TAMP. Rich also found that the financial element was difficult to articulate, particularly as it pertained to maintenance funding. However, the TAMP was immediately valuable to PennDOT because it required that the asset management program be outlined on paper. This forced staff to consider existing processes and create a unified, formal approach.

Michael Bridges agreed that risk management was the most difficult aspect of the TAMP. LADOTD created risk registers and listed mitigation strategies, but the agency still has to determine exactly how this information should be used. One benefit of developing the TAMP is that it has helped to develop information on projected future funding and work to communicate to agency stakeholders.

Handling of NHS Roads Off of the State System

The next question asked was that of how the presenters were addressing NHS roads not on the state system in their TAMPS.

Michael Bridges explained that this is a small portion of roads in Louisiana, but currently this is a gap that the agency must address. LADOTD’s intent is to include these roads as a new category. Angela Alexander added that GDOT is approaching the issue in a similar manner.

Richard Heineman noted that PennDOT chose to create an “enhanced” NHS, which included other roadways and increased the number of NHS miles by 20%. This method had a significant impact on apparent performance, worsening the overall condition reported for the NHS (given the condition of the roads added to the system as a result of this change).

William Johnson noted that in Colorado, the agency responded to the law immediately and some jurisdictions saw a very large increase in NHS mileage. Subsequently some roads proposed for addition to the NHS were omitted. In any case, CDOT plans to report the portions of the NHS not on the state system as a separate category in the TAMP.

Including Other Assets Besides Pavement and Bridges in the TAMP

Scott Bowles from FHWA asked if Colorado DOT would have preferred to include only pavement and bridge assets in the TAMP. William Johnson responded by explaining that CDOT did include assets beyond the scope of MAP-21, incorporating “everything under the sun.” Scott Richrath from Colorado DOT added that this was a high priority for Colorado regardless of the MAP-21 requirements. Ancillary asset owners compete for preservation funds; therefore the state believed it was a priority to have a thorough understanding of those assets.

The Effect of Budgets on Targets

Josh Becnch-Brescher asked the other panel participants if the existing budget affected the selection of targets in the TAMP. Richard Heineman reported that prior to development of its TAMP, PennDOT had targets but these were not tied to funding. Moving forward PennDOT will set funding-constrained targets.

Angela Alexander noted that Georgia will need to go back and perform additional analysis to determine whether to adjust existing targets. Dave Kuhn added that NJDOT has previously set aspirational targets that were not tied to funding. William Johnson noted that CDOT had previously established aspirational targets. For pavement and bridge, the targets were tied to expected MAP-21 goals. For other assets, the state gave consideration to the “optimal target” independent of budget. Michael Bridges in Louisiana described a loose relationship between targets and budget.

Mark Nelson from Minnesota DOT explained that in the case of Minnesota, historically the DOT developed aspirational targets based on customer expectations and engineering judgment. Now the state is beginning to rethink the purpose of these targets. For the NHS, there is an expectation that states will determine the target that they intend to reach given available funding. It is possible that this will result in two types of targets: a goal set without considering available funds, and a predicted value given available funds.

Assessing Tradeoffs and Risks

Dave Kuhn asked the panel about the tradeoff between preservation and other objectives. For example, what were the assumptions in the DOTs’ financial plan? What tradeoffs were being considered or was the budget for preservation set to a given value without considering tradeoffs?

Angela Alexander described Georgia’s experience. GDOT has a financial summary with the approved budget and historic data that was considered in the TAMP development. It is unclear if there will be a tradeoff analysis in future TAMPs.

Michael Bridges explained that for LADOTD much of the funding is dedicated and not subject to tradeoffs. In Louisiana there is a section of the budget labeled “capital for highway and bridges” that gets divided into other subcategories. Further, any capacity projects are funded with external funding source. Thus, LADOTD does not perform analysis trading off capacity versus preservation. However, there may be a need to consider tradeoffs between different categories of the capital program.

Next Tim Henkel asked Richard Heineman to explain how the PennDOT risk approach is being used in decision-making. Richard responded that the risk profile would be used as a communication tool. PennDOT acknowledges that it faces many other risks besides the pavement risks captured by the approach (e.g., bridge risk), but they expect the approach Richard described will nonetheless be helpful.

William Johnson noted that CDOT has established a risk register. Also, CDOT bridge management staff do a good job of managing risk, and they use a variety of factors to determine what preservation work to perform. Ideally, managers will use the risk registers to tailor their projects. Angela Alexander added that Georgia is performing an interstate risk assessment. So far, they have considered this in their maintenance process review, and will include the results of the assessment in future TAMP versions.

Data Management

John Preiss asked if other agencies have found a need to make asset data more accessible throughout the department in order to develop the TAMP. David Kuhn responded that New Jersey has a data warehouse initiative that makes information from management systems accessible. This can be accessed through a database or a spreadsheet platform. The important issue for the agency was determining the appropriate level of detail needed in the data. For instance, initially staff charged with sign management recommended collecting detailed data on signs. Ultimately NJDOT decided to avoid collecting detailed data on signs, and instead replace signs on a seven-year cycle. For traffic signals, the agency realized it needed better data and used NCHRP Synthesis 371, “Managing Selected Transportation Assets: Signals, Lighting, Signs, Pavement Markings, Culverts, and Sidewalks” to determine what data needed to be collected. Michael Bridges described LADOTD’s enterprise resource planning (ERP) system effort. The ERP system was implemented in 2010 and has been integrated with the asset management system. This integration has the potential to further improve the TAMP development process, although LADOTD still needs to perform more work to determine what data to exchange between the systems.

Cooperation with FHWA

Anita Bush asked what steps each agency is taking in order to ensure that the TAMP is certifiable by FHWA. Michael Bridges explained that LADOTD is including the FHWA division asset management lead in order to ensure that their plan will include the appropriate elements. Rich Heineman noted that PennDOT is involving FHWA through their steering committee. The other panelists described taking similar approaches.

Michael Bridges noted that between division offices, there are varying levels of engagement in the TAMP process. He encouraged other agencies to ensure that all division offices are actively engaged in the process. Rich Heineman added that PennDOT meets every six months with FHWA to address a variety of topics and this has helped the division offices to stay involved in the process over time.

Steve Gaj from FHWA asked the panelists if the asset management plan development should be included in the stewardship and oversight agreements. Many agreed that TAMP development

should be included in stewardship and oversight agreements, but some disagreed, pointing out that in other areas the approach used is for states to certify data/processes then submit to FHWA. Steve discussed the fact that the intent is that the process for TAMP development will be certified, not the state's TAMP.

Richard Heineman explained that PennDOT did not have an asset management plan, but performance measures are built into stewardship and oversight agreements. Angela Alexander added that although GDOT has stewardship and oversight agreements, it is not clear if the TAMP needs to be added to these.

Other Questions on the Presentations

Melany Reynolds of Georgia DOT asked William Johnson to elaborate on the process for integrating the asset management plan with other plans. William Johnson explained that CDOT incorporated references in its various plans. For example, performance targets were already part of the statewide transportation plan. In some instances the TAMP used the same metrics and/or referenced the statewide plan directly.

Melany asked Dave Kuhn to clarify how New Jersey assesses itself in its plan. Dave Kuhn explained that NJDOT developed a scorecard that evaluates maturity in different areas of the plan.

TAMP Builder Tool

Hyun-A Park noted that four of the TAMPs that had been discussed - those from Georgia, Colorado, New Jersey and Wyoming - were accessible through the TAMP Builder Tool, hosted by AASHTO. Steve Gaj added that while these TAMPs were valuable resources, FHWA has not yet certified any state's TAMP development process.

Angela Alexander asked about the TAMP Builder Tool and how the functionality of the tool could help agencies to develop their own asset management plans. Hyun-A Park described the functionality of the tool. It was designed to provide states with basic and custom outlines for their TAMPs. The outlines detail what sections should be included in the TAMP. For each section the outlines have links to examples from existing TAMPs that include the same sections.

4 Making TAM Performance Measures Work

4.1 Tri-State Performance (ME, NH, VT)

Glenn Davidson, New Hampshire DOT, presented on the tri-state partnership established through a memorandum of understanding (MOU) between Maine, New Hampshire, and Vermont. The intent of the relationship between these three states is to develop a regional approach to track and compare asset performance. The partnership is led by project development leaders from the three states: Joyce Taylor from Maine DOT, Bill Cass from New Hampshire DOT, and Rich Tetreaut from VTrans. Initially the leaders of the three DOTs met several times a year to discuss national topics, regional challenges and risks, and state strategies and approaches for managing assets. In 2010, when performance measures became an important national topic, the tri-state partnership was created. Formalizing the relationship between the three states allowed them to develop a regional voice for discussion of performance measures at a national level. The agencies can also develop a regional approach to tracking asset conditions and create a methodology for sharing information and ideas across DOTs.

The tri-state partnership currently tracks performance in five areas:

- Business performance
- Bridge condition
- Pavement condition
- Traffic signs
- Safety performance

These areas were selected in anticipation of national standards. The three states also decided that the performance measures should directly address regional challenges including aging infrastructure, climate change, and risk.

Business performance in the tri-state partnership is tracked using three measures:

- Percent on-time delivery, with the goal of advertising projects within 30 days of the construction advertisement plan (CAP) schedule
- Total delivery, comparing construction value and number of projects delivered versus CAP schedules
- Estimated versus awarded construction cost, with the goal of having 50% of project awarded within 10% of the estimated cost

These measures were developed to ensure that the agencies are delivering projects on time and on budget. The construction advertisement plan is developed annually and submitted at the first of the year. The

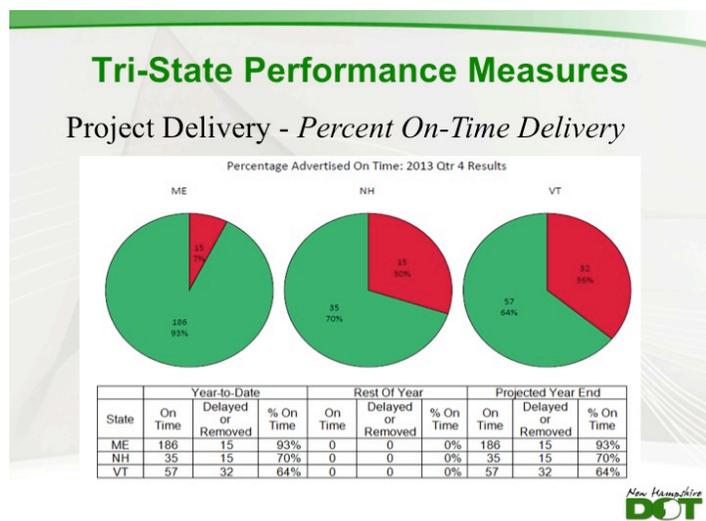


Figure 4.1.1 Tri-State Performance Measures: Project Delivery

performance measures are meant to determine how closely the CAP and the project delivery align. Initially, the three agencies compared their CAPs and project histories and found a number of discrepancies. The tri-state partnership allowed the agencies to create a “no-judgment zone” to foster data sharing and allow the states to use performance comparisons to resolve problems and make improvements. **Figure 4.1.1** shows an example comparison across states with respect to project delivery.

The tri-state partnership developed two bridge condition performance measures:

- Bridge condition index (BCI)
- Percent bridges structurally deficient by deck area

The BCI was developed by the partnership to gauge the general health of the bridge networks for regional comparison. The BCI is a composite condition rating that considers three major bridge elements: the substructure, superstructure, and deck area. Each of these factors is weighed by relative bridge size and health factor. The BCI value is rated on a five-point scale from A to E ranging from Excellent to Unacceptable.

The tri-state partnership measures pavement condition using IRI. This was a preexisting measure common between the states. IRI provides a relative health of the pavement surface and general effectiveness of resurfacing strategies. Each state measures IRI by mileage and vehicle miles traveled (VMT). Each state also created slightly different ranges for good/fair/poor condition by network.

For signs, the three agencies measure the percent of signs above service life (for non-interstate highways). Signs that are above service life are still functioning as intended and providing adequate guidance to the traveling public. This performance measure is evolving, since none of the states have comprehensive data for sign systems and the states use different approaches for measuring sign conditions. New Hampshire conducts a nighttime visual assessment, while Vermont and Maine base service life on age.

The tri-state partnership also developed a target for safety, measuring fatalities with the goal of reducing fatalities by 50% in 20 years. This measure was adopted from the vision of “Towards Zero Deaths.” This translates to a 3.4% reduction per year in fatal crashes. So far, the region is on track to meet the targeted goal. The states also report fatalities per 100 million vehicle miles traveled (VMT) and fatality rate and incapacitating injury per 100 million VMT.

The next step for the tri-state partnership is to continue to collect and report asset performance pending implementation of rules for implementing the performance reporting requirements of MAP-21. The tri-state partnership will continue to meet to compare their results and share ideas to improve asset performance at both the state and regional level. Maine, New Hampshire and Vermont also will collaborate as each individual state begins to develop their TAMP. Thus far, New Hampshire and Maine have chosen to use the pavement and bridge measures on state maintained highways as a starting point for their TAMPs. Vermont is still deciding which assets they include. Potentially VTTrans may include pavement, bridge, rail, central garage equipment, signs, signals, and rock slopes on state-owned NHS and non-NHS highways. The partnership hopes that the same collaborative and innovative relationship that helped to implement a successful performance measurement program will continue to help all three agencies during the TAMP development process.

do not typically resonate with the public. Therefore, the division is looking for new and creative solutions to communicating how the Iowa DOT is performing.

Leadership

Iowa DOT developed a program called Leadership4Change to help provide training on asset management concepts. Working from the assumption that 20-25% of an organization needs to support an initiative before it succeeds, Iowa DOT is aiming to train 600 “champions” through the leadership program. The goal is to create excitement around asset management as a tool for restructuring and reinventing the agency. Although Iowa DOT seeks to maximize involvement in the program, training groups have been kept small to facilitate discussion, address potential issues, and relate concepts presented to participants’ individual positions.

Strategic Planning

Ultimately, all of these concepts have to be formalized and tied to the agency strategic plan. In addition to training and promoting asset management, Iowa DOT is beginning to examine the steps necessary for developing a TAMP. The agency philosophy is that a strategic plan should speak of a journey: Where is the agency currently? What are the agency’s values? Where does the agency hope to be in the future? Condensing these questions into a formal plan will be difficult, but Iowa hopes that having fostered a comprehensive understanding of asset management principles throughout the agency will help them moving forward. Figure 4.2.2 shows a prototype of how a web site presenting the strategic plan might appear (provided for illustrative purposes).

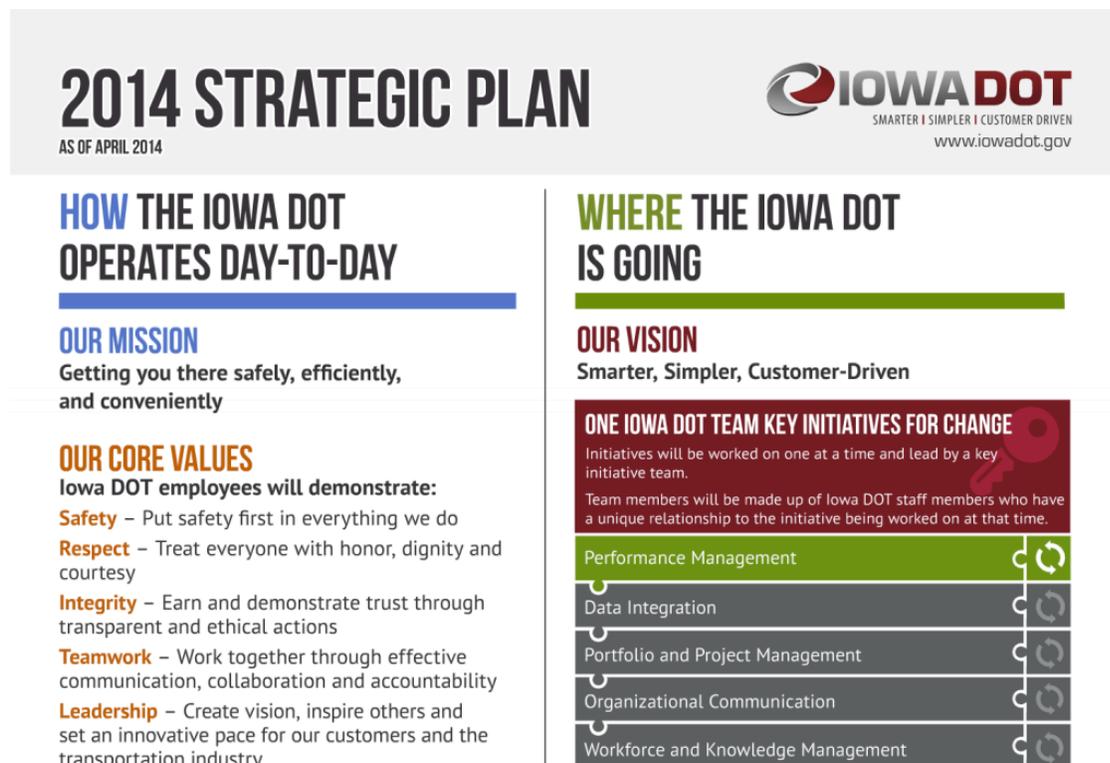


Figure 4.2.2 Prototype Strategic Plan Site

4.3 Asset Management and Transportation Performance at Oregon DOT

Jerri Bohard presented on asset management and transportation performance at Oregon DOT. Oregon has had an asset management steering committee for approximately twelve years and performance management has been an important initiative for the agency since the 1990's. Oregon DOT's performance measurement program began with a pilot program in the Director's Office. At that time, the agency developed a Transportation Management System based on the Intermodal Surface Transportation Efficiency Act (ISTEA) and set policies for mobility standards and targets for pavements and bridge. The management system continued since then, and currently includes pavement, bridge, safety, traffic congestion, public transportation and intermodal facilities.



Triggers to Get Started

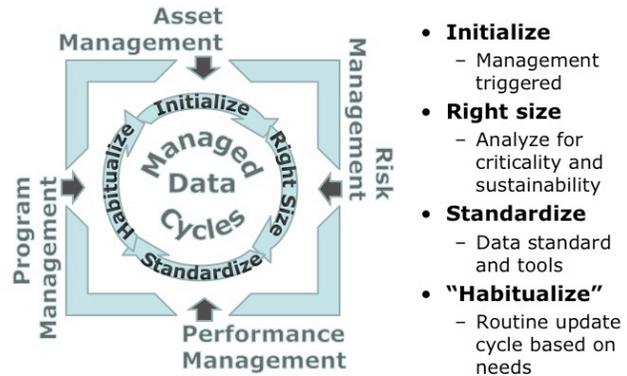


Figure 4.3.1 Triggers to Get Started

In the 2000's, ODOT developed an *Asset Management Strategic Plan* and an Asset Management Integration Unit. Asset management has typically been integrated with the planning process at the agency, and the DOT is required biannually to develop a state of the system report that addresses condition and trends. This includes ten key performance measures reported to the legislature as part of their budgeting that covers the state of pavements, bridges and other assets. Recently, Oregon DOT created a performance management position in the director's office in preparation for implementation of MAP-21.

Jerri discussed the factors that were necessary for successfully integrating a management program at the agency that combines asset management, risk management, performance management, and program management. **Figure 4.3.1.** illustrates the triggers for initiating this effort. Once the effort was initialized it focused on needs for analyzing asset criticality and sustainability, opportunities for standardizing data and tools, and approaches to "habitualize" the process. To aid the successful implementation of the program Oregon DOT developed the *Asset Management Strategic Plan* in 2007, which was centered on four distinct goals: integrated decision-making, establishing reliable statewide inventories, integrated data systems, and integrated tools. The plan was updated again in 2011. The four strategic principles helped to make asset management a central component of how Oregon DOT conducts business. In order to ensure buy-in throughout the agency, Oregon DOT also releases a monthly newsletter called "Inside ODOT," which often contains an article on asset management.

Jerri presented a slide depicting the evolution of inventory data in Oregon over time, reproduced in **Figure 4.3.2**. When asset management was first introduced, data were being collected only for major assets, such as bridges, ITS, Pavement, and Right of Way. By 2010, the agency either had inventory data or was beginning to collect inventory data for all assets. Today, Oregon DOT has begun to prioritize what data should be collected for which assets. The agency is committed to using pavement, bridge and safety assets in future asset management planning initiatives, but is still determining what other assets to include. Jerri presented traffic barriers as an example: the goal is to replace all traffic barriers constructed before 1980 not compliant with current standards. To evaluate this measure Oregon DOT had to build an inventory of traffic barriers, and place each barrier on a good/fair/poor scale based on degree of compliance with standards. Through this exercise, Oregon DOT realized that having a performance measure was not enough. It is also important to establish an asset inventory and define a data collection program with a defined update schedule to ensure data are consistently available. Defining data collection priorities helps allow for incremental progress in building the program.

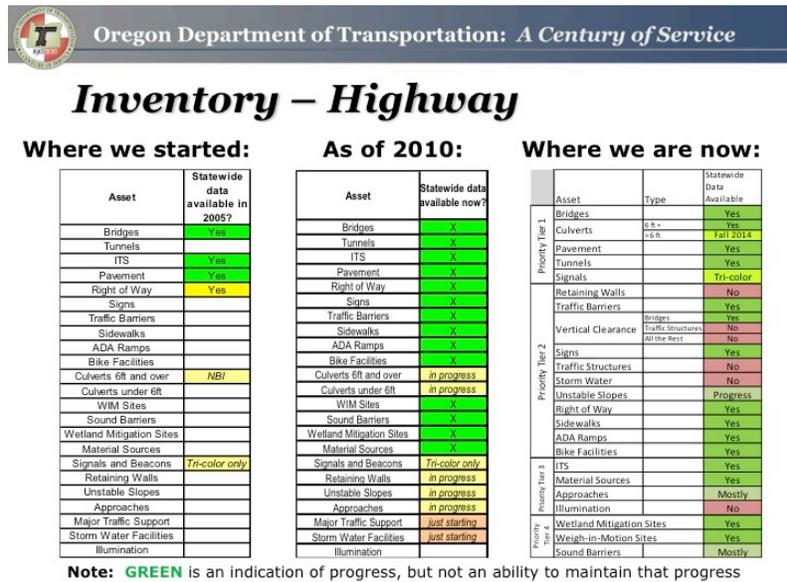


Figure 4.3.2 Inventory – Highway

Next Jerri discussed how data on conditions are used to support funding decisions, showing examples of predicted conditions over time that have been used by Oregon DOT’s transportation commission to establish funding. Oregon DOT will continue to use its existing processes for performance reporting while complying with MAP-21 reporting requirements.

Prior to passage of MAP-21 Oregon DOT began a research initiative to examine the performance measures currently in use and determine areas for improvement. To complete this project, Oregon DOT compared existing performance measures to national goal areas. These include safety, infrastructure condition, system reliability, freight movement, congestion reduction, and environmental sustainability. For each of these categories, a number of national performance measures were reviewed. These were then compared to Oregon DOT key performance measures to determine if the national scale was appropriate for adoption by the agency. In some instances, Oregon DOT discovered areas for improvement or used the national performance measures to justify data that they already collect and report. In other instances, the state determined that the national measures were on a scale that was incompatible with data that the agency currently collects. The ongoing measures will each fall into one of three categories: delivery, stewardship,

and societal. Ultimately, a series of measures will be collected throughout Oregon DOT and rolled up into key measures that reflect agency performance as a whole. The final report on this performance measure improvement effort should be available in 2014.

While Oregon has made great strides in its asset management program, there is still work to be completed. Jerri presented a table that included the current status of all assets at ODOT. For each asset, the table summarized the status of the inventory, any relevant systems or tools, the existence of performance measures, and the level of risk management development. For major assets, condition reports are required biannually, to support development of the Statewide Transportation Improvement Program (STIP). ODOT has been challenged to consider all assets in the asset management process, including rail, pedestrian, marine, aviation, etc. In attempting to determine the comprehensiveness of the data and methodology used for each asset type, Oregon DOT has had to develop a lexicon that works for all modes. In some instances, it has forced the agency to rethink the principles, data, and tools necessary for each asset type. Based on the information presented in the table, ODOT has already identified that risk management and lifecycle issues are areas that require improvement across all assets.

Jerri ended the presentation with a series of key factors for success, all centered on the theme of coordination and developing an agency culture inclusive of asset management. In particular, Jerri stressed the need for strong executive sponsorship. This ensures that the entire agency is encouraged to consider asset management principles in daily functions and communicate across divisions and localities. Also, education is important to developing buy-in. In Oregon the agency newsletter and professional training on data management and governance best practices are educational initiatives that have helped build support for asset management.

4.4 Q&A Panel

The Q&A panel for the session included the presenters and three contributors: Tim Henkel from Minnesota DOT, Martin Kidner from Wyoming DOT, and Mark Lester from South Carolina DOT.

Tim Henkel began with a question for Glenn Davidson. He commented that the tri-state partnership approach seems to be an example of exactly what MAP-21 is trying to accomplish. He asked what the states do with targets and if they negotiate consistent targets for roadways that cross state boundaries. Glenn responded that the targets are only for project delivery. At this point, the states have yet to set targets in other areas. The current focus is to share information in an effort to improve, which will assist in future efforts.

Martin Kidner asked Glenn Davidson to expand on the tri-state method for working with decision-makers. Glenn added that the states all examine bridge and pavement assets annually, but engaging decision-makers continues to be a challenge. John Selmer agreed that it can be difficult to engage decision-makers, and described his experience in this area in Iowa, concluding it is very helpful to report on conditions periodically. Tim Lattner, Florida DOT, added that monthly reporting addresses if the agency is meeting its plan. Conditions, however, should be measured annually.

Mark Lester asked how the other panelists engaged their transportation commissions in embracing organizational change and asset management principles. John Selmer responded that Iowa DOT

scheduled many meetings with their commission during the process of implementing asset management. The general response across the panelists was that they would like to see more of this at their respective agencies. Even if people are disinterested in engineering details, they often become interested in the broader concepts that are explored as part of implementing asset management concepts. This interest can lead to increased support from stakeholders and leadership.

Jerri Bohard provided a counterpoint, noting it was not necessarily useful to discuss asset management when trying to secure funding. In Oregon's case, a study of the economic impacts from bridge closures was a more effective tool. The agency also spends a lot of time developing funding scenarios and discussing the impacts of various scenarios on the overall condition of the system.

Glen Davidson explained that New Hampshire has a public works committee rather than a commission. The agency has been pushing the need for preservation to this body, and has had some success in communicating the need for preservation funding.

Scott Bowles of FHWA described Missouri's experience in attempting to shift emphasis away from capacity building towards increased focus on preservation. In this case it was difficult to build support for increasing preservation funds, as the concept of expansion seemed to resonate with the majority of stakeholders. Mark Lester provided additional examples of this dynamic. Corey Pope, Utah DOT, explained how Utah had successfully communicated with its commission. The key was to spend time with each commissioner in order to explain the needs and process, making sure that each individual's questions were addressed.

5 TAMP Development and Risk - Climate Change and Extreme Weather Events

5.1 Asset Management and Adaptation to Extreme Weather and Climate Change

Rob Kafalenos from FHWA began the next session by discussing asset management and adaptation to extreme weather and climate events. He first described different events that could potentially be caused by extreme weather and/or compounded by climate change. These include a number of issues caused by flooding, such as erosion, embankment failure, debris from large floods, hydroplaning safety issues, flooded underpasses, and surcharged storm drains, as well as issues caused by heat, such as road buckling.

Rob maintained that all states should consider climate change risks. While the issues and risks vary from state to state, every DOT should consider the risks that face their region and begin developing methods for mitigation. To this end, FHWA has developed climate resilience pilots, to encourage states to focus on the issue and work with and learn from states that are working to address climate concerns.

All states must develop asset management plans that address risks. These risks are not limited to extreme weather and climate change, but could also include financial risks due to under-investment, economic risks, etc.

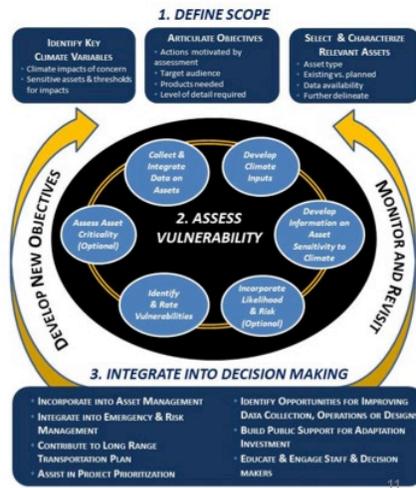
In addressing climate change adaptation, FHWA has developed a series of goals. The overall project goal is to ensure the systematic consideration of climate change and extreme weather vulnerability and risk in transportation decision-making at a systems level integrated with asset management and planning efforts and at a project level that covers engineering, design, construction, operations and maintenance. At a systems level, FHWA is working on a series of projects on the Gulf Coast, New Mexico, and Hurricane Sandy relief areas. In addition, the agency is performing climate resilience pilots with a number of states and MPOs. The key product of these activities will be an updated *Climate Change & Extreme Weather Vulnerability Assessment Framework*, to be released in 2015. The approach will be to develop and share information on tools and methodologies that are currently being utilized as an example for state DOTs and MPOs that are hoping to assess risk. On the project level, FHWA is conducting engineering assessments to address adaptation and resiliency at specific locations. Some of the climate resilience pilots will also be used to determine techniques that have been used to address risk in project planning and execution. FHWA is also undertaking additional hydrology and hydraulic engineering research efforts. One resource that is currently being developed is the *HEC 25- Volume 2: Highways in the Coastal Environment: Extreme Events*. The result of this research will culminate in a series of updated engineering manuals, methods, and processes.

FHWA's Climate Change & Extreme Weather Vulnerability Assessment Framework (Dec 2012)

1. Define Project Scope
 - Objectives
 - Relevant Assets
 - Climate Variables
2. Assess Vulnerability
 - Climate Inputs
 - Asset data, criticality, sensitivity
 - Vulnerabilities, risk
3. Integrate Vulnerability Into Decision Making



Figure 5.1.1 FHWA's Climate Change & Extreme Weather Vulnerability Assessment Framework (Dec 2012)



The *Climate Change & Extreme Weather Vulnerability Assessment Framework* was first developed in 2012.

The assessment has three main components: defining the project scope, assessing vulnerability, and integrating vulnerability into decision-making.

Figure 5.1.1 shows how these three processes work together to create the framework. The first step consists of defining the project objectives, determining the relevant assets, and making a list of climate variables that could

be a factor in the region. Second, the agency should compare use the climate inputs in combination with information on asset criticality and sensitivity to determine vulnerabilities and risk. The final step is to use this information to make better decisions. This framework was piloted among five state DOTs and MPOs before being updated in 2012. It can be used as an organizing mechanism for transportation agencies planning to conduct an extreme weather event or climate change assessment. FHWA is working to develop a section of the website devoted to this framework, which will include additional information, examples, and resources.

Rob next described a set of five pilot projects conducted between 2010 and 2011. Participants included the Metropolitan Transportation Commission (MTC), Oahu MPO, Washington State DOT, New Jersey DOT, and Hampton Roads in Virginia. FHWA is now sponsoring a second round of 19 climate resilience pilot projects using the developed framework. The projects range from engineering studies to broad studies of vulnerabilities, risks, and adaptation. Some of the environmental factors that are being explored include sea level rise, storm surges, heat waves, and flooding. The experience gained and lessons learned from these pilots will be incorporated into the FHWA 2015 framework update. Rob described the example of the Gulf Coast II project as an example. This project includes work to conduct a vulnerability assessment and determine adaptation options. The task began with identifying critical transportation assets in Mobile, Alabama, then identifying climate effects that could damage infrastructure. The project is ongoing, and the next steps will include performing a high-level analysis to screen the assets that would most likely be vulnerable to climate change. The project will also include an engineering assessment of 11 assets types in Mobile. Finally, the project will work to develop transferable risk management tools.

Next, Rob related climate change and extreme weather events to risk management. He stressed that all states must develop asset management plans that incorporate risk; examples of risks could include risks due to current and future weather. For the risk sections of TAMPs, Rob suggested identifying risks that would affect the safe and efficient movement of people and goods. Next, states should review the likelihood and effects of a risk occurring. Using this information, DOTs can prioritize risks and develop plans for monitoring and addressing critical risks. Extreme weather risks that Rob mentioned included heat waves, intense precipitation, storms, high sea levels, storm surges, and seismic risks. While extreme weather presents a significant risk to transportation agencies, Rob added that other risks should be included in a TAMP, such as financial and economic risks.

Climate change and extreme weather can also have implications for asset management. Weather events are likely to affect maintenance cycles, causing higher maintenance and operations costs. Changing weather can also affect design cost by requiring states to consider adaptation techniques during the design phase. The goal of including climate change and extreme weather in the TAMP is to anticipate these issues, and hopefully save money by developing proactive strategies that can mitigate the results of an event. **Figure 5.1.2** depicts the influence of climate change on maintenance cycles.

Rob concluded the presentations by warning of the implications of not considering climate change and extreme weather. He stressed that it is important to consider environmental conditions and resulting costs over a project life, rather than only the upfront costs of adaptation strategies. He also addressed issues with climate projections, noting that climate models may not match the data that engineers currently use. Climate projections are typically uncertain,

therefore engineers need to address a range of values and consider

multiple scenarios in the design process. Ultimately, FHWA wants agencies to be better prepared for a range of scenarios, having considered the potential risks and developed mitigation and adaptation strategies that can be utilized to reduce the effects of climate change and extreme weather events.

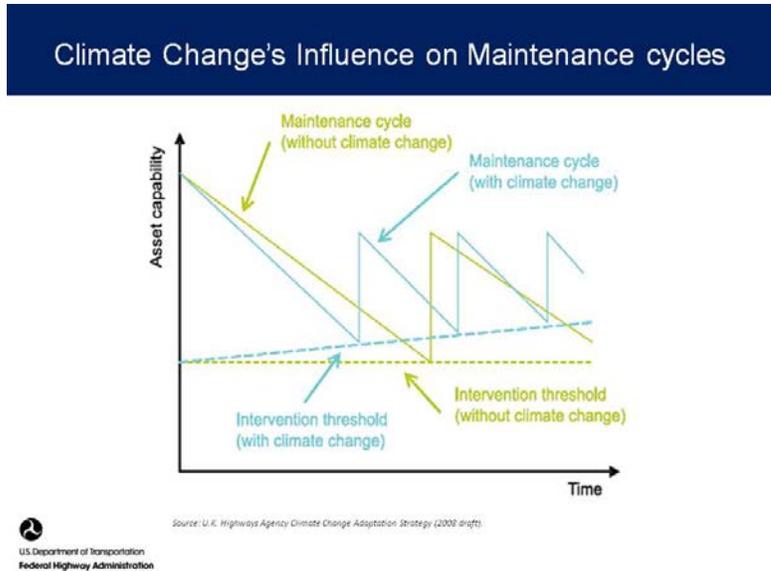


Figure 5.1.2 Climate Change's Influence on Maintenance Cycles

5.2 Climate Change and Transportation Asset Management

Garth Hopkins, Chief of the Office of Regional and Interagency Planning at Caltrans, began his presentation by describing the history of California's interest in climate change as it relates to asset management. Caltrans has sponsored a number of initiatives at the agency to learn more about the

effects of climate change, and has conducted research to learn from other states that have made considerable headway in this area, such as Washington and Oregon. Caltrans manages a large and diverse set of assets; therefore effective asset management is critical. California is also the third largest state, extending nearly 800 miles from north to south. As a result the state has an unparalleled variation in climate, topography, and ecology across the state. The state has already begun to experience increases in temperature, changes in precipitation patterns, and extreme weather events. The effects of climate change and extreme weather events have already cost the state millions in repairs and the severity of these events is only likely to increase.

Caltran’s executive management has established an asset management committee to develop a vision for the state’s asset management. In July 2012, an internal program review stated that Caltrans will “fully commit to asset management of the state highway system infrastructure, with focus on performance.” Since then Caltrans has been working to develop a TAMP, which will initially focus on pavement, bridge, culverts and ITS elements. The asset management committee also established eight sections to be included in the final document:

- Asset inventory and conditions
- Asset management objectives and measures
- Performance gap analysis
- Lifecycle cost considerations
- Risk management analysis
- Financial plan
- Investment strategies
- Asset management process enhancements

Within these sections, subgroups were created to focus on the development of various aspects of the TAMP, such as finance, data and integration, and organizational change. The first draft of the TAMP is scheduled to be completed in 2014 with a final version to be released in 2016.

In February 2013, Caltrans established the Office of Enterprise Risk Management (OERM). The office was

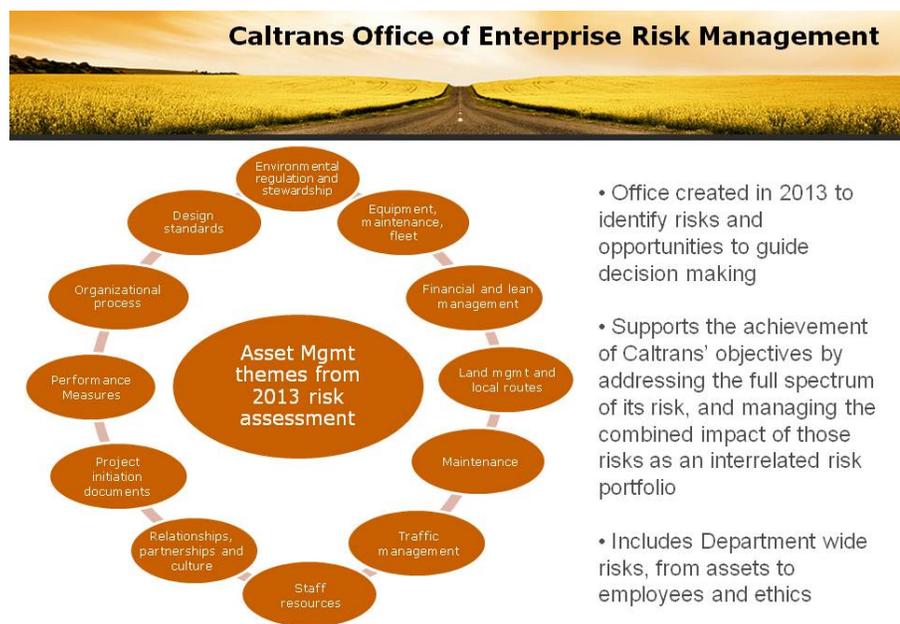


Figure 5.2.1 Caltrans Asset Management Themes from 2013 Risk Assessment

instituted to identify risks and opportunities to guide decision-making. This includes addressing the full spectrum of potential risks and determining how the impacts are related. The risks covered

by the OERM range from assets to employees to ethics. OERM began their process by meeting with each Caltrans Program and District separately to determine risks. **Figure 5.2.1** shows a range of asset management themes from the 2013 risk assessment. OERM then evaluated all risks based on frequency, likelihood and potential impact. Using a modified affinity analysis technique, OERM identified the top fifteen categories of risk for Caltrans. These categories provided the foundation for the Federal Information Security Management Act (FISMA) and the Caltrans Enterprise Risk Register. The risk management initiative has also been invaluable to developing the TAMP. OERM will conduct risk assessment sessions with MAP-21 teams to review threats and opportunities to the four assets that will be included in the TAMP. This will include any risks associated with extreme weather events and climate change.

Garth discussed the importance of integrating asset management with a comprehensive risk strategy. Thus far, extreme weather has caused millions of dollars in damage to Caltrans assets and these events have the potential to cause future disruptions to the transportation system. Asset management can help to mitigate these effects. As an example, Garth discussed the adaptation project at Devils Side. Along an original section of Route 1, rock slides posed a problem, causing considerable damage and sometimes closing the road for long periods of time. When a tunnel solution was first proposed in 1973, it was deemed too costly, but as rock slides continued to affect the area, the benefits began to outweigh the costs. In 1996, the tunnel solution was approved. The final design both addressed the rock slides and assisted in preserving the local environment. In this instance, having a comprehensive understanding of the assets in the area and the risks posed by the local environment allowed Caltrans to arrive at a feasible solution that preserved the condition and performance of the highway assets at Devils Side.

Although there are clear and established benefits from addressing the risks of climate change, Garth noted a number of challenges to developing a successful program. Climate change and extreme weather events, by definition, cannot easily be predicted. Currently there is a lack of uniform climate projections that can be used by state DOTs. One basic challenge is that past trends are not a reliable indicator of the future. Despite this, many assumptions are made based on past trends. Even when estimates are available, such as for rainfall and temperature fluctuations, it is challenging to draw conclusions based on the range of sources and estimates. Garth added that it would be beneficial to have a single federal source, responsible for providing the estimates that should be used.

California is currently conducting a pilot in District 1, located in the northern coastal section of the state, to perform a climate change and extreme weather event vulnerability assessment in a four-county area. Previous events that have impacted the transportation system in their area include, flooding, landslides, and wildfires. Following the high-level vulnerability assessment across the four county area, the pilot will identify specific actions to mitigate projected sea level rise impacts at the four most vulnerable locations in the district. Once the pilot is complete, the program will expand to make assessments for other districts locations throughout California. The detailed plans developed during the course of the pilot will provide each District with some mitigation strategies that can be implemented over time.

5.3 Vulnerability and Adaptation

Kevin Walsh, the Director of Environmental Services at Massachusetts DOT (MassDOT), presented on MassDOT’s efforts to address vulnerability to climate changes and adaptation.

Massachusetts has recently experienced an increase in extreme weather events. In March 2010, three 25-50 year storms occurred over a three-week period, prompting the closure of over 30 state highway locations and hundreds of local roads. As a result of these storms MassDOT began developing an inventory of flood-prone transportation assets. In August 2011, while the inventory was still being compiled, Hurricane Irene arrived, causing additional damage throughout the state. The extensive flooding and damage caused by these two events forced local officials to carefully consider a new method for responding to extreme weather events in the future. During this time, the Governor of Massachusetts created an initiative requiring the development of adaptation strategies for the short, medium and long-term. MassDOT chose to expand the scope of this initiative, and is also considering ongoing adaptation strategies.

Three climate change projects are currently being conducted at MassDOT. The first of these initiatives was to develop an inventory of flood prone areas in Massachusetts. The inventory utilized data collected during the 2010-2011 period. MassDOT identified locations of repeat flooding based on staff interviews with Maintenance, Construction, and Project Development personnel. Workshops were held in each District to verify the data. **Figure 5.3.1** shows the results of this survey, mapping the annual flood frequency in various locations throughout the state.

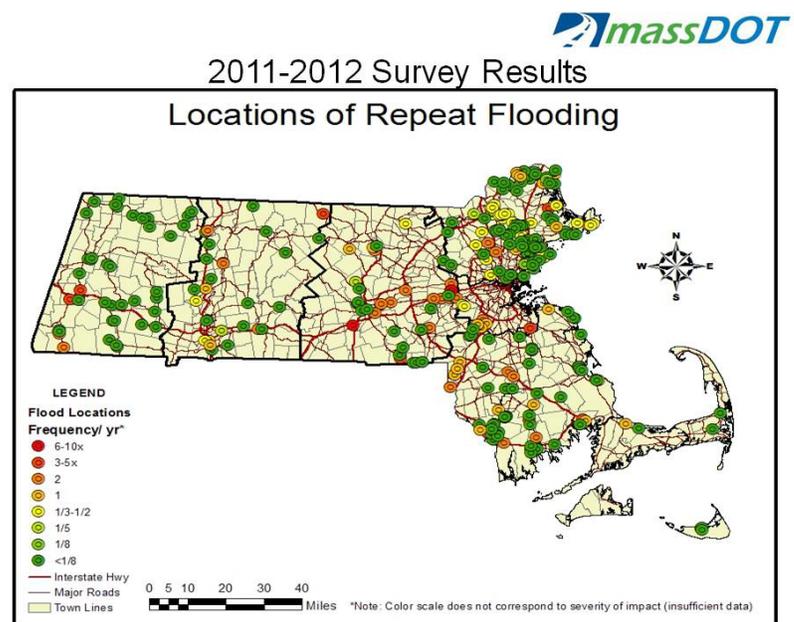


Figure 5.3.1 MassDOT 2011-12 Survey Results: Locations of Repeat Flooding

A second project, the Deerfield River Watershed Vulnerability Pilot, is working to map the whole watershed of the Deerfield River. During Hurricane Irene, in this area approximately 20 miles of Route 2 was destroyed by flooding. This project will develop a vulnerability assessment for roads and road-crossings, including infrastructure vulnerability maps for present and future conditions to improve MassDOT’s ability to prepare for and respond to future floods. MassDOT is using a technique called Fluvial Geomorphological Mapping (FGM) for this effort. FGM is the scientific study of valley and channel landform development as influenced by moving water. This data is being used in conjunction with other sources, including the Conservation Assessment and Prioritization System (CAPS). The CAPS system is a tool for prioritizing ecological improvements and conservation. Data from FGM and CAPS will be compared to the road network to identify stream crossings for aquatic life. This data will also be used to evaluate the potential locations and

designs for new infrastructure, including bridges and culverts, which will preserve the watershed while withstanding future weather events.

Finally, the Central Artery Study is being co-sponsored through the FHWA Climate Resiliency Program and attempts to address vulnerabilities of the Central Artery to flooding from a coastal storm. The Central Artery is the section of Interstate 93 which runs, primarily in tunnel, through Downtown Boston. The project will investigate options for reducing identified vulnerabilities and establish an emergency response plan to protect the Central Artery tunnels. Kevin noted a number of agencies are working to advise MassDOT with the technical aspects of this project, including the Woods Hole Oceanographic Institution, the Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), Army Corp of Engineers, and National Oceanic and Atmospheric Administration (NOAA).

Kevin presented the maps shown in **Figures 5.3.2** and **5.3.3** to illustrate the importance of considering sea level rise in the region. These maps were prepared by The Boston Harbor Association (TBHA) and depict the impact of various amounts of sea level rise on the city of Boston. These maps show huge impacts to the city and the surrounding areas.

While the TBHA flooding maps illustrate the importance of considering and mitigating sea level rise, more work is needed to ensure that the models used to develop the maps are accurate. Currently, the models are validated based on data from the Blizzard of 1978 and storm of 1979. The approach used in developing the maps does not consider all of the effects of flooding, including bathymetric effects, changing coastline geometry, damage to infrastructure, frictional effects, and effects to coastal processes, such as waves or tides.

The Central Artery Study MassDOT will use Hydrodynamic modeling, specifically the Advanced Ocean Circulation Model (AdCirc), to more accurately model the potential for flooding in the project area. The model incorporates physical processes, such as tides, storm surge, wind, waves, river discharge, and future climate scenarios, as well as the effects that MassDOT identified as lacking in current models. This model requires a considerable amount of data from various data sources. Kevin presented a table of required data and a list of sources. Once the required data are assembled, MassDOT will be able to run a number of additional



Figure 5.3.2 (Top) What if it happened here? Boston Inner Harbor, Mean High Water Plus 5 Feet

Figure 5.3.3 (Bottom) What if it happened here? Boston Inner Harbor, Mean High Water Plus 7 Feet

scenarios. MassDOT will determine the surge and sea level rise to simulate flooding for 2030, 2070, and 2100 with sea rise set to various depths based on current estimates. The model will also include tropical storm sets to account for any extreme weather events that might occur. The model will predict water elevations at each location on model grid, and will be used to generate time-varying inundation maps, illustrate flood pathways, and identify current and future vulnerabilities. This information will be used to develop preparedness plans and the ability to test the potential performance of engineering adaptations.

Kevin concluded the presentation by identifying project challenges. As part of the project MassDOT conducted a LIDAR survey of downtown Boston to establish elevations. Conducting such a survey in an urban area is difficult, as there are a number of obstructions that must be accounted for. Also, modeling Nor'easters, which are common storms in New England, also presented a challenge. These storms typically last longer than other weather events, often over multiple tide cycles. These storms have never been modeled before but were important to incorporate into the study. Finally, institutional knowledge was crucial for completing the project. MassDOT personnel, such as maintenance, construction, plumbers, and electricians, were some of the most well-informed sources for the project. They were often acutely aware of the most important vulnerabilities facing the tunnel systems.

5.4 Climate Change and Asset Management

Dave Wresinski, Bureau of Transportation Planning Director at Michigan DOT, presented on the relationship between asset management and climate change. Dave began the presentation by reviewing the climate, geography, and infrastructure of Michigan. He noted that the Great Lakes have a moderating effect on the climate in Michigan. Dave also added that transportation is crucial to the state economy. Trucking accounts for 67% of all freight tonnage moved in Michigan and any climate impact could have a considerable effect on the ability of companies to move goods throughout the state.

In Michigan, climate change has resulted in more frequent and severe rain events. Damage from these storms has caused the washout of transportation infrastructure. Climate change has also resulted in extreme temperature fluctuations, including prolonged summer temperatures and changes in the freeze/thaw cycles. In the northern areas of the state, the freeze thaw cycles are increasing. Meanwhile, in southeastern Michigan, there is a decrease in freeze thaw events. Michigan has also seen an increased frequency of lake-effect snowstorms along the Great Lake shorelines. In 2013, the total snowfall reached 262 inches (22 feet), causing numerous road closures. These factors have all contributed to an increase in maintenance spending, and the growing frequency of extreme weather events suggests that future changes in maintenance funding may be required. For example, current winter maintenance costs approximately \$129 million per year, while previous winters have typically cost \$70 million.

In response to these factors Michigan DOT (MDOT) has performed a climate vulnerability assessment. MDOT applied for an FHWA pilot study to compare climate models with MDOT asset management data to determine vulnerabilities. The pilot is identifying infrastructure at risk for climate change, including culverts, drainage systems, and pump stations. Roads along rivers and lakes might also be vulnerable during times of heavy precipitation and/or flooding. Roadways are also susceptible in the regions with increased freeze thaw cycles. The risk

assessment will be incorporated into existing asset management systems and the FHWA Framework. The FHWA Framework is a guide for transportation agencies interested in assessing vulnerabilities to climate change and extreme weather events. The framework requires that agencies study objectives and scope, assess vulnerability, and incorporate the results into decision-making.

The first task was to establish an Advisory Committee of external stakeholders, responsible for overseeing the project and providing council, including the project

consultant. The next task was to compile an inventory of assets maintained in the asset management datasets. **Figure 5.4.1** shows a list of assets that MDOT identified during the pilot. Next MDOT reviewed the inventory to identify any gaps between the asset management inventory and data critical to performing a vulnerability assessment. Upcoming tasks include identifying the most appropriate climate models for Michigan, and using the selected model to identify risks to Michigan transportation infrastructure. The results of this risk assessment will be used to determine specific “at risk” assets as part of task. Then MDOT will determine a method for incorporating risk assessment information into asset management systems and an asset management plan. Developing this material will allow MDOT to incorporate consideration of risk into future asset management decisions and planning.

Dave concluded the presentation by urging participants to recognize the importance of planning to adapt to climate change. Thus far, MDOT has found that the pilot study has been invaluable to understanding the risks faced by the agency for consideration in developing the state’s long range plan, call for projects, and TAMP.

5.5 Q&A Panel

The TAMP development and risk panel included the presenters, as well as Jennifer Brandenburg from North Carolina DOT, Dave Kuhn from NJDOT, and Scott Richrath from CDOT.

Modeling Climate Change Impacts

Jennifer Brandenburg began the discussion by asking the other panelists how they discovered the best long-term climate predictions. Garth Hopkins responded that finding accurate projections has been an issue for Caltrans. He added that things are getting better; for example, Caladapt is a tool under development that incorporates data such as snow level and sea level rise. Rob Kafalenos added that Army Corps has a useful website for projecting sea level rise along the U.S. coasts. Another approach that FHWA has taken is to work with local universities.

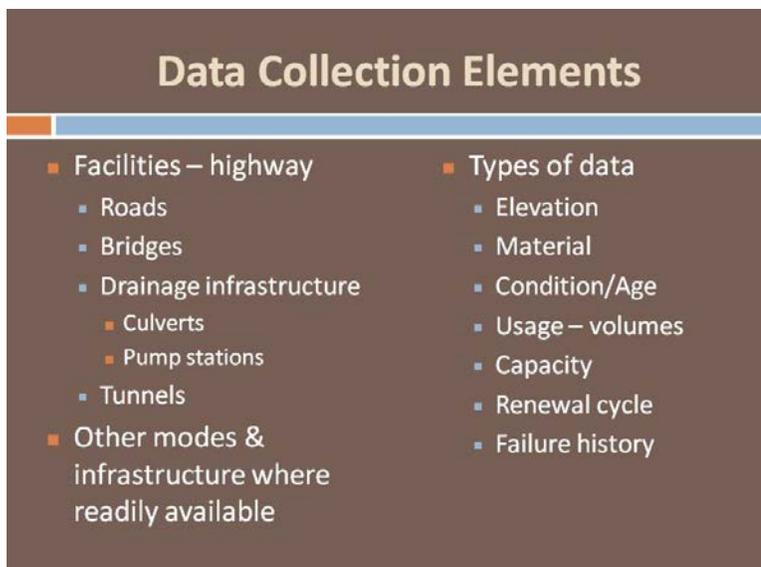


Figure 5.4.1 Data Collection Elements

Kevin Walsh responded that in the case of Massachusetts, the DOT is on a sea level rise panel. There, they work with other agencies to determine where to “set the bar.” As conditions change, projections are adjusted. Inland, it is more difficult to get good projections; therefore the panel is looking to address this. The USGS is simultaneously updating precipitation and stream flow data in New England, which can be incorporated into these efforts.

Using Vulnerability Assessments for Prioritization

Dave Kuhn asked the panel about their vulnerability assessments: once you have identified critical infrastructure, how is this factored into prioritization? Dave Wresinski responded that MDOT recognizes there will be an impact, such as needs for changing bridge designs. However, the impacts have not yet been determined. Garth Hopkins agreed with Dave Wresinski. Steve Gunther from Caltrans added that it is still early in the process and the impacts of the vulnerability assessment will have to be discussed further.

Steve Gaj from FHWA agreed that this discussion will continue to occur as state vulnerability programs become more developed. Kevin Walsh agreed that vulnerability and identified critical infrastructure will factor into future planning. Kevin added that some adaptation steps may be relatively low cost.

Hyun-A Park from Spy Pond Partners asked if any agencies had a formal process for using vulnerability studies for prioritization, but none did. Steve Gaj noted that incorporating critical infrastructure and risk into decision-making will be an issue for all states. While the presentations emphasized states near large bodies of water or addressing flooding, climate change and extreme weather events can take many forms and impact every DOT.

Approaches to Risk Mitigation

Scott Richrath asked if any of the participating states had discussed mitigating risks versus allowing them to happen and budgeting for the potential impacts. Kevin Walsh responded that MassDOT had been looking at adaptation as an opportunity. Often MassDOT incorporates adaptation into scheduled projects, ensuring that new construction includes the latest technology to avoid being susceptible to weather events. Making mitigation part of future projects ensures that mitigation expenditures are incremental costs. The one exception was the Central Artery project. Because the Central Artery is crucial to the surrounding infrastructure, the project was scheduled independent of other rehabilitation or reconstruction tasks.

Garth Hopkins noted the importance of considering the life of the project when deciding to incorporate adaptation measures. Caltrans is starting to explore when it is cost effective to incorporate adaptation measures into projects. Mike Culp from FHWA noted FHWA is encouraging agencies to follow this approach and incorporate adaptation measures into projects rather than handling adaptation strictly as an emergency response item.

Tim Lattner from Florida DOT described his perspective on incorporating consideration of adaptation in project planning. In Florida, the DOT has completed a set of vulnerability assessments for bridges in the state. Florida found that the cost to address all of the identified vulnerabilities is prohibitively high. Thus, in some cases Florida DOT can incorporate climate change adaptation steps into their project plans, while in other cases it simply may not be feasible to do so.

Martin Kidner of Wyoming DOT noted that in the case of Wyoming, the DOT is considering performing a risk assessment considering a range of different risks, but the TAMP will not necessarily address the cost of mitigating all of the identified risks. Instead, this information will be addressed as appropriate in the Long Range Transportation Plan (LRTP). Richard Heineman added that Pennsylvania DOT is following a similar approach.

John Preiss from Rhode Island DOT noted that the purpose of a risk assessment is to identify risks, then to consider the frequency and likelihood of a risk occurring. This information could be used by states to identify mitigation projects, or to predict the necessary funding that will be required annually to respond to predicted weather events. William Johnson from Colorado DOT concurred with approach.

Other Issues

Jerri Bohard, from Oregon DOT, added that other extreme weather events, beyond those discussed in the presentations, are being addressed by states. While Oregon is gradually working on a program to address climate change, the immediate risks to the transportation system are seismic events. The state has already identified seismic needs. To do so, they looked at the projected losses of life during an event, in addition to effects on the infrastructure.

Jennifer Brandenburg asked how agencies are addressing competing interests in determining how to mitigate climate change-induced risk. Kevin Walsh and Garth Hopkins described approaches being used in their states to balance competing interests. Garth Hopkins added that in California, it is often a political decision when it comes to programming for a key piece of infrastructure. Often these programs have to be presented to decision makers, who are given the relevant information and the responsibility to decide on a course of action.

Dave Kuhn asked how much other agencies are coordinating with local partners as part of state initiatives in this area. Garth Hopkins responded that the pilot effort he described was performed only for state-owned assets, though Caltrans would ultimately like to coordinate a broader effort. Dave Wresinski suggested that as local partners also own infrastructure, it is important that they are included in the process. The issue that Michigan has noticed, however, is that the local data is rarely as comprehensive as the state data. This can be prohibitive when it comes to including all assets in the final product.

Rob Kafalenos encouraged participants to pull in stakeholders from different levels, using an iterative approach. Kevin Walsh noted that in the case of Massachusetts, other agencies are interested in utilizing the analysis being performed by MassDOT for a statewide effort, and to help inform discussions with the Federal Emergency Management Agency (FEMA) on flood maps. Thus, while initial DOT efforts might not include local assets, the results of these projects can have a broader impact.

6 Round Table Discussion

The round table discussion at the conclusion of the peer exchange allowed all participants to contribute on issues identified during the presentations and by the panels. Cory Pope from Utah DOT and Andrew Williams from Ohio DOT facilitated the discussion. The following paragraphs detail the topics that the group discussed.

Risk

Andrew Williams asked how different agencies are defining risk in the context of developing their TAMP. Tim Lattner of Florida DOT described Florida's wave vulnerability study, the risks associated with climate changes, and other physical, environmental and financial risks Florida DOT is considering. He warned that it is impossible to plan for every risk. In Florida, the DOT has been forced to prioritize, based on limited funding. For instance, in the case of mitigating risks of bridges vulnerable to increased wave height, Florida DOT must focus on hardening a limited number of vulnerable bridges. As a follow-up question, Andrew asked if any agencies were including public perceptions of risks in their TAMPs. William Johnson of Colorado DOT reported that CDOT was considering this.

Andrew Williams next asked how agencies were measuring asset value, and whether this was being considered in connection with risk. William Johnson reported that Colorado DOT has performed a study of the asset value of the infrastructure and calculated the economic value of the system, but this was not a factor in the risk assessment approach.

Butch Wlaschin from FHWA encouraged agencies to consider high-level approaches to evaluating risk in their TAMPs. It may be difficult to incorporate specific mitigation activities in a TAMP, but ideally agencies will use risk registers and/or other approaches to discuss types of risk they face in their TAMPs.

Andrew next asked if states were considering risk in their TAMP financial plans. In Ohio decreasing buying power (inflation) has been identified as a risk that should be considered in future financial planning. Michael Bridges noted LADOTD is considering funding risk (risk of not receiving needed funds). Other states agreed that losing federal funding posed a significant risk. Michael added that receiving more money than budgeted also presents certain risks for an agency. Garth Hopkins from Caltrans expressed his concern about the reduced purchasing power of the fuel tax, and suggested the potential for investigating the approach taken by states such as Oregon and Washington, where the state collects mileage-based user fees.

Interaction with MPOs and Local Governments

Participants were next asked if any were including MPOs in the TAMP development process. Angela Alexander responded that Georgia was not currently collaborating with MPOs on TAMP development, but that the DOT would explore this idea. Butch Wlaschin suggested that interaction with MPOs might be addressed as part of the performance-based planning rule, as this will address the integration of asset management plans with the planning process. Steve Gaj of FHWA added that New York State DOT had explored this issue in their TAMP pilot. Their

solution was to include MPO representatives in the asset management steering committee. The draft TAMP is also being shared with MPOs to allow for their input in the final product.

The group then discussed interaction with MPOs and local partners concerning performance measures. Several participants reported that they had established measures and targets at a state level, but they reported varying levels of interaction with local partners. The group discussed different instances in which MPOs had been involved in defining measures and targets.

Scott Omer of Arizona DOT noted that in some cases MPOs develop plans that conflict with DOT goals. He asked how or if DOTs should respond to the information released by the MPO. John Preiss, from Rhode Island DOT, noted that one possible solution is to allow MPOs to participate in the TAMP development. If they are included in the process they are less likely to consider publishing conflicting documents. Andrew Williams added that this is the approach Ohio DOT has followed, ensuring that MPOs are involved from the beginning.

Beyond Pavements and Bridges

Every TAMP that was discussed during the presentations includes pavement and bridge assets. Beyond that, assets included in the TAMP seemed to vary from state to state. The facilitators asked peer exchange participants how their states will determine what assets to include in the TAMP, and if they plan to expand the included assets in the future.

Anita Bush from Nevada DOT explained how Nevada reviewed the available data, then placed assets in three tiers based on the availability and maturity of existing data. This list was used to make recommendations on which assets should be included in the TAMP. It was important that sufficient data were available for the assets included in the TAMP. Thus, Nevada chose to include pavement, bridges, and ITS assets in its TAMP.

Andrew Williams discussed the Ohio approach, which involved performing a risk-based assessment of the assets. Like Nevada, Ohio DOT established different tiers, but the categories were based on risk rather than the available data for each asset. The results showed that pavement, bridges, and culverts were all assets crucial to the agency and their criticality ensured their inclusion in the TAMP. The group then discussed how assets should be prioritized. One participant noted there may be a difference between what assets are critical and what assets have sufficient data to support their inclusion in a TAMP. For example, tunnels are generally a critical asset, but one for which data may be limited. It was suggested that states with tunnels collaborate on an approach for incorporating tunnels into a TAMP.

The facilitators then asked how states were addressing cases where a need for additional funding was identified for other assets. Participants described different approaches for addressing this issue, from encouraging greater coordination between staff responsible for capital funding and maintenance, establishing separate funding streams, and using a corridor approach to allocate funds.

The facilitators asked agencies how they are predicting lifecycle costs of assets. Martin Kidner, of Wyoming DOT discussed different approaches to addressing this issue. Others expressed concerns about not having the necessary data to calculate lifecycle costs. Steve Gaj acknowledged that states may not have all the data needed to perform an idealized lifecycle cost analysis. Tim Lattner suggested that the discussion should focus on acknowledging the cost of maintaining an

asset over its life, rather than just the initial cost. Florida does perform this analysis for bridges and they are hoping to extend this process to other assets. John Selmer and Andrew Williams discussed efforts to better quantify pavement lifecycle costs.

Other Topics

Participants next discussed how they were integrating management systems into the TAMP and the TAMP development process. They described using a variety of methods and management systems for TAMP development. PennDOT performed all analysis required for its TAMP using a spreadsheet tool. Other agencies had implemented management systems, but had yet to start the TAMP development process and were still unsure about how the systems would be used to create the TAMP. Colorado has already begun developing a TAMP and is using AMIS to support the development process. CDOT has written into policy that 75% of pavement recommendations should be consistent with those recommended using the AMIS tool.

Rich Heineman discussed the need for considering safety in agency TAMPs. The PennDOT TAMP does not include a section on safety. The agency does, however, recognize that the staff responsible for safety often require some of the same information as those in asset management. He is interested in trying to coordinate between these departments to increase efficiency at the agency.

Peer exchange participants were asked if they will include their freight networks in their asset management plans. Most states had identified some of freight network, but the consensus of the group was that consideration of freight networks and freight issues were not likely to be incorporated in DOTs' TAMPs.

7 Peer Exchange Wrap-Up

Steve Gaj from the FHWA Office of Asset Management and Pavements and Construction concluded the peer exchange. He observed that the meeting was full of important conversations, with a large number of representatives from across the U.S. participating. He observed that a number of FHWA division staff members participated in the peer exchange, as well. It is rare to have opportunities where FHWA and state DOT staff can participate in these conversations, but it is useful to have such an exchange of ideas. He closed by thanking all of the peer exchange presenters, organizers and participants.