Federal Highway Administration
Road Weather Management Program

STSMO Weather Workshop
September 12, 2017

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Agenda

• The Challenge
• Framing The Approach
• Program Highlights
• Loose Ends and Summary
The Challenge
Average Annual Fatalities Under Adverse Weather

Adverse Weather-Related Fatalities
(10-yr. Annual Average 2006-2015)

- Flood: 84
- Lightning: 31
- Tornado: 110
- Hurricane: 11
- Extreme Heat: 113
- Extreme Cold: 32
- Winter Storm: 18
- Wind: 57
- Rain, Fog, Hail, Ice: 6
- Miscellaneous: 87
- Total NWS-Tracked: 549
- Adverse Road Weather: 5,488
Weather-Related Crashes

Total Annual Crashes
Average = 5,761,121

Weather Related Crashes
By Road Weather Condition*

- Other Crashes 79%
- Weather-Related Crashes 21%
- Wet Pavement 71%
- Snow/Slushy Pavement 14%
- Icy Pavement 13%
- Fog 2%

*Crashes that occurred under adverse conditions; additional factors such as rain, snow, and fog are not disaggregated from pavement conditions in this graphic. The percentage due to fog is for those crashes that occur under foggy conditions, but not wet, icy, or snowy pavement conditions.

Source: Road Weather Management Program, Table: Weather-Related Crash Statistics (Annual Averages), Available at: http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm
Other impacts of adverse road weather

• **Mobility**
  - About 25% of non-recurring delays are due to weather
  - Congestion costs about $9.5B/yr. for 85 urban areas*

• **Productivity**
  - Weather-related delays add about $3.4B/yr. to freight costs

• **Environment**
  - Chemicals used for anti-icing affect watersheds, air quality and infrastructure

*Source: 2015 Urban Mobility Scorecard  http://mobility.tamu.edu/ums/
Framing The Approach
Approaching The Road Weather Challenge

- Weather Data Environment
- Pikalert (Vehicle Data Translator)
- Analysis, Modeling & Simulation
- Integrated Modeling for Road Prediction
- Guidelines for CV-Enabled WRTM
- Road Weather Performance Management Tool
- Benefit-Cost Analysis Compendium
- Road Weather Management CMF

Weather-Savvy Roads
Program Highlights

- Weather Data Environment
- Pikalert (Vehicle Data Translator)
- Integrated Modeling for Road Prediction
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- Benefit-Cost Analysis Compendium
- Road Weather Management CMF
- Weather-Savvy Roads
Weather Data Environment (WxDE)

- A web-based platform to ingest, quality control, display and disseminate fixed and mobile RWIS/Environmental Sensor Station observations
- Provides a workspace to be able to study and manipulate the data so that we better understand its potential
- https://wxde.fhwa.dot.gov/

Lead: Gabe
WxDE Screen Captures
Pikalert / Vehicle Data Translator

- Software that processes and analyzes connected vehicle observations such as air and road temperature, wiper status, braking and traction control information
- It then uses this information in conjunction with standard weather observations and forecasts to develop segment-based characterizations of current and predicted road weather conditions
- It also uses those segment-based descriptors to feed into 2 apps:
  - Enhanced Maintenance Decision Support System
  - Motorist Advisory and Warnings
- It is open source software available from the Open Source Application Development Portal (itsforge.net)
Analysis, Modeling & Simulation (AMS)

- The goal of AMS effort is to evaluate the impacts of Connected Vehicle Dynamic Mobility Applications and Active Transportation and Demand Management strategies.
- The Chicago Testbed enabled us to better understand the effectiveness of the strategies under various weather conditions.
- Numerous reports have been published:
  - FHWA-JPO-16-374  (Analysis Plan for Chicago Testbed)
  - FHWA-JPO-16-376  (AMS Evaluation Plan)
  - FHWA-JPO-16-381  (Calibration Report for Chicago)
  - FHWA-JPO-16-387  (Evaluation Report for Chicago)
  - FHWA-JPO-16-388  (Evaluation Summary for Chicago)
Integrated Modeling for Road Condition Prediction (IMRCP)

Develop an integrated, predictive system that...

- Incorporates real-time and archived data from a variety of forecast and probabilistic models
  - atmospheric and road weather and hydrology
  - traffic
  - work zones and winter maintenance ops
  - incidents
  - special events
  - demand
- Fuses them in order to predict the current and future overall road/travel conditions
- Presents them to aid travelers, transportation operators, and maintenance managers

Lead: Gabe
IMRCP: Functions

Data Collection
- Wx
- Traffic
- Hydro

Forecast
- Wx
- Traffic
- Hydro

Map/Notifications

Data Store
- Wx
- Traffic
- Hydro

Reports

Subscriptions
- Subscription Files
- Subscription Events

Data is stored in the data store. It is then collected and displayed in the forecast. The forecast is updated regularly and can be accessed through the map and notifications. Reports can be generated to summarize the data collected. Subscriptions allow users to be notified when certain conditions are met.
IMRCP: The Map Interface for KC

- Provide guidance to agencies on using Connected Vehicle (CV) data for Weather Responsive Traffic Management (WRTM)
- Describe required capabilities for CV-WRTM
- Identify appropriate pathways for CV-WRTM implementation
- Provide concepts and examples of CV-WRTM applications
- Currently working with Washington and Delaware DOTs to kick the tires


Lead: Roemer
CV-WRTM Guidelines

Three Pathways for Implementation

Pathway #1 – Intelligent Agency Fleets

Pathway #2 – Connected Vehicles

Pathway #3 – Connected Third Party Services and Travelers

Cellular/Radio-connected Agency Vehicles

DSRC-enabled Agency Vehicles

Other DSRC-enabled Vehicles

Leveraging Connected Vehicles for WRTM
Pathway #1 - Intelligent Agency Fleets

Starts with equipping agency-owned fleets to collect weather and road condition data (Cellular, UHF, and/or DSRC communications)

Supports:
- Adjust speed limits
- Determine closures
- Provide traveler information (e.g., DMS and HAR)
- Determine vehicle restrictions
- Enhance incident response
Road Weather Performance Management Tool

• An application that leverages Connected Vehicle and other data to help DOTs maximize the effectiveness of their maintenance resources (i.e., efficiently and dynamically adjust deployments as road conditions and traffic flow change)

• Tested and evaluated by MnDOT over the 2015-2016 winter:
  - Presented traffic control, motorist advisory and maintenance recommendations based on CV data, Pikalert output, etc.

• It is open source and available from the Open Source Application Development Portal (itsforge.net)
Benefit-Cost Analysis for RWM: Compendium and Briefs

- The compendium provides detailed guidance on benefit-cost analyses for transportation operations with a focus on Road Weather Management Strategies.

- It has seventeen case studies and three technical briefs:
  - Principles and Examples of Benefit-Cost Analysis for Road Weather Management
  - Conducting Benefit-Cost Analysis of Road Weather Management Strategies
  - Benefit-Cost Analysis of Road Weather Connected Vehicle Applications

- A Workshop on conducting Road Weather Management Benefit-Cost Analyses is available to you (contact Roemer)

Lead: Roemer
Road Weather Management
Capability Maturity Framework

- This framework assesses the ability to effectively manage traffic flow and operations before and during adverse weather conditions
- It includes maintenance and operations activities undertaken by an agency to prevent or mitigate the impacts of adverse weather conditions on the transportation system
- The electronic tool is available to assess current levels of maturity and to identify concrete actions that agencies can take to raise their capabilities to the desired levels

Lead: Roemer
Weather-Savvy Roads

- Every Day Counts is a state-based model to identify and rapidly deploy proven but underutilized innovations
- Weather-Savvy Roads was selected to be one of 11 solutions promoted under EDC-4
What is Pathfinder?

- **Collaboration** between the National Weather Service (NWS), State DOTs, and support contractors to share and translate forecasts into consistent public transportation impact statements

- Disseminates road weather information that is:
  - clear,
  - concise,
  - impact-based, and
  - consistent

**Intended Outcome** - Drivers are well informed and able to make safe and efficient travel decisions
Pathfinder Core Partners

- **National Weather Service**: Experts at weather forecasts
- **Private Sector Weather Providers**: Experts at road weather forecasts
- **State DOTs**: Experts at operating and maintaining the roadways - knowledgeable about the state of the roadways and the impact to the traveling public
- **State Emergency Managers**: coordinate activities during high impact events

Source: FHWA
The document . . .

- Describes 8 basic steps and associated requirements
- Provides examples from State DOT implementations
- Characterizes agency organizational structure
- Companion workbook walks team through the implementation process
Pathfinder Guidance (8-Step Process)

1. Identify Partners
2. Determine Qualifying Collaboration Events
3. Select Communication Mediums and Set Procedures
4. Establish Point Person at Each Participating Entity
5. Synchronize Forecast Schedules
6. Establish Definitions and Create Shared Resources
7. Create Shared Impact Message for the Public
8. Conduct Post Event Review and Data Archiving
What is Integrating Mobile Observations?

- Weather and road condition data collection from fleet vehicles for a more comprehensive view of network conditions.
- Advanced, vehicle-based technologies are deployed to collect, transmit, and use weather, road condition, and related vehicle data.

**Intended Outcome** - Utilizing vehicle-based data for more informed system management (maintenance, traffic, asset, performance)

Source: Minnesota DOT
Why implement IMO?

Improve efficiency, enhance effectiveness, increase accountability

- Fill gaps in road weather observations
- Spur development of new applications
- Dramatically enhance existing systems
  - Aid in overall salt reduction strategies
  - Optimize the use of maintenance resources
  - Generate actionable, automated alerts and messages to TOC/TMCs, maintenance personnel, work zone teams
  - Provide traveling public with more timely and valuable information
IMO Pilots

Three states explored the feasibility of using vehicle-based data to improve transportation safety & mobility

<table>
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<th>Minnesota DOT</th>
<th>Michigan DOT</th>
<th>Nevada DOT</th>
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<tbody>
<tr>
<td>~590 Vehicles</td>
<td>~15 IMO Vehicles + 310 Snow Plows</td>
<td>~60 Vehicles</td>
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<tr>
<td>Data</td>
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Michigan IMO System Framework

- 15 - IMO MDOT Vehicles & 310 Snow Plow Trucks
- Communication Line
- website & mobile app
- DOT TOC/TMC
- LOW VISIBILITY
  NEXT 5 MI
  REDUCE SPEED
- changeable message board

Source: Michigan DOT
Weather-Savvy Roads - IMO

- Integrating Mobile Observations (IMO) Adoption (23)
- Active but not Adopting Under EDC-4
- Not Implementing
FHWA is developing a suite of educational materials and events for agencies interested in:

- Building their understanding of Pathfinder and IMO
- Exchanging information
- Deploying Weather-Savvy Roads

For more information, visit:
Loose Ends and Summary
Operations and Extreme Weather

- Exploring the impacts of extreme weather on Operations & Maintenance

- Recently published a report, “Planning for Systems Management & Operations as part of Climate Change Adaptation”
  (http://www.ops.fhwa.dot.gov/publications/fhwahop13030/fhwahop13030.pdf)

- Completing a study that considers the climate resilience aspects of all the TSMO Capability Maturity Frameworks

- Promoting the use of INVEST for Operations and Maintenance (www.sustainablehighways.org)
Other Research

- Effective Messaging for Non-recurring Events
- Weather and Social Behavior (Natl. Academies)
- Automated Vehicles and Weather
- Connected Vehicle Standards (esp. SAE J2945\3)
Knowledge & Technology Transfer

- Web-based Training Courses
  - Principles and Tools for RWM (currently being delivered)
  - RWIS Equipment and Operations (Spring 2018)
  - Weather-Responsive Traffic Management (last delivered Nov 2016)

- Other Guidelines / Resources / Publications
  - Guidelines for Disseminating Road Weather Messages
  - Guidelines for the Use of Variable Speed Limit Systems in Wet Weather
  - ESS/RWIS Siting Guidelines
  - Integrating Weather in TMC Operations
  - Road Weather Management Performance Measures
  - Weather Responsive Traffic Management Field Tests (MI, SD, OR, UT)
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