Development of Weather Responsive Traffic Management Strategies

National Rural ITS Conference     August 27, 2013
Session C2: Best Practices for Weather Management
By Jakin Koll, Minnesota DOT on behalf of
FHWA Road Weather Management Program
Weather Impacts on Transp. System

- **Safety**
  - Approx. 1.6M weather-related crashes, 673K injuries, 7K fatalities per year

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

- **Productivity**
  - Weather-related delays + ~$3.4B/yr. to freight costs

- **Environment**
  - Chemicals affect air quality & infrastructure
Weather Responsive Traffic Management (WRTM)

Objectives:

- Better understand the impacts of weather (i.e. snow, rain, fog, wind, heat, etc.) on traffic flow and operations

- Develop, promote & implement strategies and tools to mitigate those impacts
Major WRTM Strategies

1. Speed management strategies
2. Vehicle restriction strategies
3. Road restriction strategies
4. Motorist advisory and alert/warning systems
5. Traffic signal control strategies

FHWA-JPO-11-086 – Developments in WRTM Strategies
1) Speed Management Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Applicable Weather Events</th>
<th>Delivery/Communication Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speed Advisories</strong></td>
<td>Falling Snow and Rain, Wind conditions, Limited Visibility</td>
<td>Dynamic Message Signs (DMS)</td>
</tr>
<tr>
<td>Advisories</td>
<td></td>
<td>Variable Speed Advisory Signs</td>
</tr>
<tr>
<td>Advisories are intended to achieve voluntary compliance with a recommended safe travel speed for the prevailing conditions. The speed advisory messages would not be considered enforceable by law enforcement personnel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Enforceable Speed Limits/Variable Speed Limits</strong></td>
<td>Falling Snow and Rain, Wind conditions, Limited Visibility, Ice and Snow Accumulations</td>
<td>Dynamic Message Signs (DMS)</td>
</tr>
<tr>
<td>New speed limits or restrictions in response to weather conditions. Speed limits would be considered enforceable by law enforcement personnel.</td>
<td></td>
<td>Variable Speed Advisory Signs</td>
</tr>
</tbody>
</table>
Mn/DOT Variable Speed Limits

- Advisory Only
- Detection measures traffic speeds downstream
- Speeds are posted up to 1 1/2 miles upstream

Example of Speed Management Strategies
VSL system uses a constant deceleration rate to determine advisory speed limit values.
  - Preferred deceleration rates are different during weather.

Upper speed limit cap is 5 MPH less than posted speed limit.
  - System posting 60 MPH during snow events.
  - Have since changed upper speed limit cap to 50 MPH

Developing new techniques for VSL operations during weather events.

Example of Speed Management Strategies
## 2) Vehicle Restriction Strategies

<table>
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<tr>
<th>Strategy</th>
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<th>Delivery - Communication Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size/Height/Weight/Profile Restrictions</strong></td>
<td>High wind conditions, Snow and Ice Accumulations</td>
<td>Dynamic message signs (DMS), Static signs with variable message inserts Highway Advisory Radio Agency Websites</td>
</tr>
<tr>
<td><strong>Tire Chains/Alternate Traction Devices</strong></td>
<td>Ice and Snow Accumulations</td>
<td>Dynamic message signs (DMS), Static signs with variable message inserts Highway Advisory Radio Agency Websites</td>
</tr>
</tbody>
</table>
## 3) Road Restriction Strategies

<table>
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<tr>
<th>Strategy</th>
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<th>Delivery-Communication Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lane-Use Restrictions</strong></td>
<td>Ice and Snow Accumulations, Rain, Flooding</td>
<td>Dynamic message signs (DMS), Static signs with variable message inserts, Highway Advisory Radio, Agency Websites</td>
</tr>
<tr>
<td>Requiring specific vehicles to use specific lanes (e.g., trucks use right lane). May also include restricting the use of special lanes by certain types of vehicle or all vehicles (e.g., right lane closed ahead).</td>
<td><strong>Parking Restrictions</strong></td>
<td>Snow Accumulations, Flooding</td>
</tr>
<tr>
<td><strong>Parking Restrictions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special parking restrictions or requirements in response to developing or forecasted weather conditions.</td>
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</tbody>
</table>
### 3) Road Restriction Strategies continued

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<tr>
<th>Strategy</th>
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<tbody>
<tr>
<td>Access Control and Facility Closures</td>
<td>Snow and Ice Accumulation, Flooding, Limited Visibility, High winds</td>
<td>Dynamic message signs (DMS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highway Advisory Radio, Access control gates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agency Websites, Barricades</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-Scene Personnel</td>
</tr>
<tr>
<td>Contraflow/Reversible Lane Operations</td>
<td>Hurricane, flooding, developing major snow storms</td>
<td>Dynamic message signs (DMS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Static signs, Highway Advisory Radio, Access control gates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>barricades, Traffic Signals, On-scene personnel</td>
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Mn/DOT I-35W
Intelligent Lane Control Signals

- ILCS located every ½ mile over every lane.
- A total of about 190 ILCS.
- ILCS are a 4ft x 5ft full color matrix signs.
- Use of the ILCS is for incident management, speed harmonization and priced dynamic shoulder lane.

Example of Road Restriction Strategies
**Mn/DOT Priced Dynamic Shoulder Lane (PDSL): Segment: 3 miles**

- Priced Dynamic Shoulder Lane North of 42\textsuperscript{nd} St on NB 35W
- Maintains existing 4 lanes with an added PDSL Lane
- Effectively extends the lane to downtown Minneapolis using existing road space

Example of Road Restriction Strategies
Mn/DOT PDSL During Snow & Ice

- PDSL is left open during snow & ice events
- Traffic helps to spread de-icing material

Example of Road Restriction Strategies
4) Motorist Advisory/Alert/Warning Systems

Strategy

Passive Warning Systems via Static signs
Static informational and/or warning signs. May or may not be in effect.

Active Warning Systems via Static signs with Flashing beacons
Supplementing the passive warning signs with flashing beacons to alert travelers that the conditions specified on the static sign is currently in effect.

Applicable Weather Events

Icy conditions, Wind Warning, Fog, Blowing Snow, Floods

Example – Active Warning Strategy Pathway

- **Pathway**
  - WRTM Strategy (Broadly Defined)
  - Specific Strategy/System Implementation
  - System Outputs
  - Expected Benefits/Outcomes
  - Achievement of National ITS Goals

- **Example**
  - **Active Warning System**
    - Automated system to warn travelers that ice may be present on a bridge at a specific location and to proceed with caution
    - Accuracy of warning relative to conditions
    - Timeliness of warning
      - initiation
      - removal
    - Reduction in vehicle speeds
    - Reduction in crashes, injuries, and fatalities
    - Changes in driver perceptions of understandability and usefulness of the warnings
    - Improved safety
    - Improved driver satisfaction
## Motorist Advisory/Alert/Warning Systems

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<tr>
<td><strong>Pre-Trip Road Condition Information and Forecast Systems</strong></td>
<td>Snow and Rain Accumulations, High Winds, Flooding, Limited Visibility, Tornados, Black Ice, Snow Accumulations, Flooding</td>
<td>511 Agency and private websites Media Outlets Text Messages Social Networks (Twitter®)</td>
</tr>
<tr>
<td><strong>En-Route Weather Alerts and Pavement Condition Information</strong></td>
<td>Snow and Rain Accumulations, High Winds, Flooding, Limited Visibility, Tornados, Black Ice, Snow Accumulations, Ponding, Flooding</td>
<td>Dynamic Message Signs (DMS) Highway Advisory Radio (HAR) 511 FM/AM Radio Text Message Alerts In-vehicle Displays</td>
</tr>
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Disseminating information about current and forecasted weather and pavement conditions to travelers before they initiate their trip.

Real-time information and alerts about specific weather and pavement conditions currently existing or developing ahead.
Investigating the use of rainfall sensor to deploy warning message or advisory speed limit.

Shoulder designed to allow some ponding during heavy rainfall.

Section of I-35W

Example of Motorist Advisory/Alert/Warning System
MnDOT Safe Corridor Enhancements

- AVL equipped trucks send message to VMS network
- Help spread awareness to public of snow operations

Example of Motorist Advisory/Alert/Warning System
## 5) Traffic Signal Control

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<tr>
<td><strong>Vehicle Detector Configuration</strong></td>
<td>Snow and Ice Accumulations, Heavy Rainfall, Limited Visibility</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Reconfiguring detector settings or implementing special detector schemes/layouts to ensure detection of vehicles at traffic signals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle Clearance Intervals</strong></td>
<td>Rain and snow accumulation, heavy rainfall, ice, limited visibility</td>
<td>Signal Timing Changes</td>
</tr>
<tr>
<td>Altering the time duration of vehicle and pedestrian clearance intervals (i.e., yellow change interval, all-red interval, and pedestrian clearance interval)</td>
<td>Yellow clearance interval, All-red intervals Pedestrian WALK/DON'T WALK intervals</td>
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## 5) Traffic Signal Control continued

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<tr>
<td><strong>Interval and Phase Duration Settings</strong></td>
<td>- Rain and snow accumulation, heavy rainfall, ice, limited visibility</td>
<td>- Signal Timing Changes&lt;br&gt;Longer minimum green intervals&lt;br&gt;Longer phase durations&lt;br&gt;Longer gap settings</td>
</tr>
<tr>
<td>Altering the time duration and/or sequencing of traffic signal phases to account for increases in start-up lost time, reduced travel speeds, and reduced pavement traction.</td>
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</tr>
<tr>
<td><strong>Traffic Signal Coordination Plans</strong></td>
<td>- Rain and snow accumulation, heavy rainfall, ice, limited visibility</td>
<td>- Signal Timing Changes&lt;br&gt;Weather responsive signal timing plans</td>
</tr>
<tr>
<td>New signal timing coordination plans designed to improve progression and account for reductions in travel speeds</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ramp Control Signals/Ramp Metering</strong></td>
<td>- Rain and snow accumulation, heavy rainfall, ice, limited visibility</td>
<td>- Signal Timing Changes&lt;br&gt;Longer/shorter green times,&lt;br&gt;Longer/shorter cycle lengths.</td>
</tr>
<tr>
<td>Special timing plans to account for lost freeway capacity, slow travel speeds, and increased start-up time at ramp control signals</td>
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</table>
Currently, WRTM Strategies have focused on freeways
Limited implementation of arterial-specific strategies during weather
FHWA WRTM Next Steps

1. Complete WRTM Implementation Projects
   - Utah DOT (Citizen Assisted Reporting and Traffic Signal Timing)
   - Oregon DOT (Wx- Responsive ATM)

2. Initiate new implementations focusing on the use of mobile data for WRTM

3. 2nd National WRTM Stakeholder Meeting (Sept 25-26)

4. Continue to deliver WRTM web-based training course (Consortium for ITS Training and Education)
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Road Weather Management Website

www.ops.fhwa.dot.gov/weather/index.asp