The objectives of the International Conference on Winter Maintenance and Surface Transportation Weather are to provide a forum for the exchange of information on the state-of-the-art and state-of-the-practice in research and technology applications to improve snow removal and ice control operations with support of surface transportation weather information.

The conference was a Non-Traditional conference with the technical presentations posted online and available on Demand to conference registrants. Workshop participants were encouraged to watch the on demand presentations and access associated materials prior to the in-person workshop.

**Pre-Conference On-Demand Sessions/Presentations**
The On-Demand Presentations were organized in 8 Topic areas including: (1) Cost Benefit of Winter Maintenance Activities; (2) Large Volume Snow Control; (3) Best Practices to Reduce The Environmental Impacts Of Winter Maintenance; (4) The Application of Innovative Technologies In Decision Support For Winter Operations; (5) Decision Support in Winter Operations; (6) Assessing Road Surface and Road Weather Conditions; (7) Innovative Solutions and Equipment for Snow And Ice Control; and (8) Policy and Management for Winter Maintenance and Weather Services.

Each Preconference On-Demand presentation included:
- A video of the presentation
- A PDF of the PowerPoint Presentation
- A One page Summary of the Research

The On-Demand Sessions can be accessed at:  

**Workshop Breakout Sessions:**
The in-person workshop centered around 6 interactive breakout sessions that provided an discussion on six major topic areas. The workshop breakout sessions included key issues that were raised in pre-conference on-demand presentations but were not limited to those topics. The six interactive breakout session discussion topics are listed below.

1. **Decision Support Part 1**: Tools to aid travel planning
2. **Best Management Practices**: Sustainability, Administration & Management
3. **Equipment & Materials**
4. **Big Data & Winter Maintenance**: Turning data into useful information
5. **Decision Support Part 2**: Maintenance Operations
6. **Resilience & Climate Change**
WELCOME AND INTRODUCTIONS
1. Attendee Introductions
   James Bryant, TRB, Senior Program Officer - Maintenance and Preservation Engineer

2. Fort Collins, CO Winter Maintenance Activities
   Larry Schneider, City of Fort Collins

3. 2016 Conference Objectives and Challenge to Attendees
   Workshop Organization and Logistics, introduce workshop leaders
   Max Perchanok, Ontario Ministry of Transportation

WORKSHOP BREAKOUT SESSIONS SUMMARY PRESENTATIONS

   Moderator: Dr. Roemer Alfelor, Federal Highway Administration

Decision support systems are so much more than simply saying when to plow and how much chemical to apply. Speed and travel time are also of critical concern to road users. This session contains presentations that explore novel uses of decision support systems and investigate how these uses can benefit winter operations.

Main discussion topics:

- **Determining and monitoring travel conditions during inclement weather**
  - Using instrumented vehicles and sensors to determine road weather conditions, and using this info for road weather forecasting and travel time estimation
  - Identifying locations that are prone to experiencing low visibility due to blowing snow.

- **Speed modeling and speed management**
  - Effectiveness of VSL in improving safety during bad weather
  - Determining and forecasting impacts of winter road conditions on traffic speeds

- **Driver decision support tools (for routing, travel planning, etc.),**
  - Determining the optimal routes for snow plows taking into account travel time/distance, quantity of materials, number of vehicles, road priorities and storm intensities.
  - Real-time information for truck drivers on road conditions and decisions made by other drivers
  - System to alerts drivers of low visibility conditions for travel planning and decision-making

- **Driver Behavior in Winter Operations**
  - Factors affecting driver fatigue during winter maintenance operations
5. **Best Management Practices**  
**Moderators:** Dr. Wilfrid Nixon, Salt Institute, and Richard Nelson, AASHTO  

Administrative and management policies for winter maintenance vary across agencies as well as the types and providers of services. Research and analysis are needed to evaluate the effectiveness of these policies and identify potential improvements. Having well trained, well equipment personnel is also a keys for successful winter maintenance operations. This breakout session will focus on management practices that support sustainability in use of materials, and other resources. It will also explore training and other programs that are used in support of preparing operations and administrators for winter maintenance operations.

**Main discussion topics:**  
- Development of snowplow routes and snow plans  
- Salt management including management, storage, and handling in a sustainable way  
- The human element in winter maintenance

6. **Equipment & Materials**  
**Moderators:** Lisa Kunzman, California Department of Transportation  

Effective snow and ice control is a critical aspect of highway winter maintenance. Snow removal equipment, especially, is a key element that is affected by harsh conditions. This session discussed issues relevant for fleet management and maintenance & operations personnel who have winter maintenance responsibility.

**Main discussion topics**  
- Accuracy of data collected from equipment/vehicles (scales and plow sensors)  
- New equipment (plow lighting, plug and play communication protocol) and cost benefits (plow blades, tow plow)  
- Mitigating corrosion  
- Effective use of winter maintenance materials  
- Optimizing computer-based plow routes to minimize completion time, balance work load, reduce wasteful deadheading

7. **Big Data & Winter Maintenance: Turning Data into Useful Information**  
**Moderator:** Tina Greenfield, Iowa Department of Transportation  

The fields of automated and connected vehicle technologies will have a strong impact on winter maintenance operations in coming years. The emergence of remote sensing and mobile data collection technologies will also impact the amount of data that is collected to support winter maintenance operations. This breakout session focused on tools and techniques to turn data into useful information for decision making.

- Mobile data collection – imagery, sensors, and vehicle state data  
- Crowd-sourced road condition information – using driver speeds or citizen reports to gauge road conditions or operations performance  
- Operations analysis using GPS/AVL  
- In-cab considerations: informed and connected vs. distracted and data-overloaded
• Sharing maintenance data with the public and researchers

8. **Decision Support Part 2: Maintenance Operations**  
   **Moderator:** Max Perchanok, Ontario Ministry of Transportation

Roadway condition determinations remain a critical component of winter maintenance, and many decisions are based upon data received from static and mobile sensors. This session explores the techniques to assess sensor accuracy, placement, and equipment and will discuss issues and opportunities revolving around data confidence in decision making.

**Main discussion topics**

- Using road surface-state and infrastructure monitoring technology
- Integrating roadside data with mobile observations
- Implementing Enhanced Maintenance Decision Support Systems
- Active plow routing

9. **Resilience & Climate Change**  
   **Moderator:** Chris Albrecht, The Narwhal Group

People are fond of saying "if you don't like the weather, wait a day, it will change". Climate does change and how it changes can affect the way transportation agencies maintain the roads especially in winter. What are some of issues your agency is dealing with in regards to climate change, extreme weather events and resiliency to future events? This session focused on how agencies are facing changes and building in resilience to winter weather.

**Main Discussion Topics**

- These trends have been noticed when averaged globally, as well as within individual countries, states and cities.
- Storm patterns are changing, which can contribute to changes in local wind speeds and directions. A greater number of, and/or more intense, blowing snow events can occur as a result. Equations have been developed to help quantify visibility and blowing snow issues.
- Changes in storm patterns also alter precipitation patterns. This can lead to increases or decreases of average or expected precipitation amounts per storm or per year.
- Precipitation is able to occur at greater intensities in a warmer atmosphere, and this has been noted in many locations around the world. Heavy snow has resulted in winter maintenance issues.

10. **Summary of Emerging Issues: Industry, Academic, Public Sector**  
    **Wilfred Nixon, Salt Institute**

This presentation summarizes the emerging issues raised during the discussions throughout the workshop. This presentation touches on all of the issues raised within each breakout session. The sessions provide the opportunity for all workshop participants to weigh-in on the collective list of emerging issues.
The TRB Winter Maintenance and Surface Transportation committees sincerely appreciate and thank the following organizations for their generous patronage of the 2016 International Conference & Workshop on Winter Maintenance and Surface Transportation Weather.

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Special thanks to Federal Highway Administration for support of the Winter Maintenance and Surface Transportation Conference & Workshop.