March 2018

Research Results Implementation Update

Completed Projects

Quantifying the Impact that New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations (November 2017)

Results: This project produced a decision tool used to quantify the anticipated impact that new capital projects will have on the costs for winter maintenance.

Implementation & Benefit Opportunity: This project helps maintenance and planning staff to better assess the financial impacts on winter maintenance of new construction projects before they are undertaken.

Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow Operators (October 2017)

Results: This project identified in-cab and external equipment factors that cause operator fatigue and makes recommendations to reduce, eliminate, or correct these factors.

Implementation & Benefit Opportunity: This project identifies implementable improvements to snowplow trucks that reduce fatigue in operators. The report includes recommendations for quick turnaround and low cost solutions, which can be implemented by state DOTs and possibly shared with the trucking industry.

Snowplow Operator and Supervisor Training (May 2017)

Results: This project resulted in the production of 22 winter maintenance training materials for operators and supervisors that includes presentations, course guides, and assessments/evaluations.

Implementation & Benefit Opportunity: This is an easy, low-cost way to fill any gaps in an agency's training program. Presentations, course guides and exams are available to all member states to modify or update as needed, saving agencies time on developing effective training materials.

Snow Removal Performance Metrics (May 2017)

Results: A matrix of agency goals, performance measures, and measurement costs shared by DOTs around the country.

Implementation & Benefit Opportunity: Agencies can learn from each other regarding collected performance metrics for assessing the efficiency and effectiveness of winter maintenance activities.

Plug and Play Phase II (February 2017)

Results: This project identified the most appropriate standard protocols and made recommendations regarding the transmission of data from vehicle to point location.

Implementation & Benefit Opportunity: This project is part of the larger Plug and Play Initiative. By adopting the specifications and standards developed through the initiative, Clear Roads will move one

step closer to the integration of new components onboard winter maintenance vehicles to make winter maintenance activities easier and cheaper for all states.

North American Study on Contracting Snow and Ice Response (February 2017)

Results: A compilation and analysis of the snow and ice control contracting practices used by agencies around the country.

Implementation and Benefit Opportunity: This document, which compiles best practices, costs, benefits, and lessons learned by state DOTs when contracting for snow and ice control, will help agencies determine how best to modify and improve their own practices to save money and more effectively manage resources.

Snowplow Route Optimization (December 2016)

Results: This project provides a synthesis of best practices for route optimization and facility placement, including a matrix that illustrates the project characteristics of RSIC optimization efforts that have been undertaken by winter maintenance organizations to date.

Implementation & Benefit Opportunity: This project provides winter maintenance managers with effective approaches to route optimization to improve their agency's efficiency.

Synthesis on GPS/AVL Equipment Used for Winter Maintenance (September 2016)

Results: A synthesis document, which analyzes the different GPS/AVL systems in winter maintenance, including how well each one performs and their systems requirements and constraints.

Implementation & Benefit Opportunity: This project helps states better understand the systems options available (systems and components) to them for a variety of situations and truck configurations and identify the best solutions for their circumstances.

Identifying Characteristics, Benefits, and Mechanisms of Commonly Used Agricultural and Mineral By-Products in the Deicer Industry (November 2015)

Results: The final report contains a best practices manual that includes, 1) parameters for effective use of agricultural and mineral by-products, 2) specifications that can be used in the procurement for each product, and 3) guidelines for application and storage.

Implementation & Benefit Opportunity: The project furthers knowledge of how nine commonly-used non-chloride liquid agricultural products and one solid complex chloride/mineral product perform, and the environmental impact of these chemicals, so as to guide the states in their use.

Roadway Salt Best Management Practices (November 2015)

Results: A manual of best management practices for procurement, storage, and use of salt.

Implementation & Benefit Opportunity: The manual describes each BMP on a single page, front and back. Researchers organized it this way so that information about each BMP could be separated from the manual and shared with relevant personnel or placed in a break room so staff could review and consider the information in easily digestible chunks.

Use of Equipment Lighting During Snowplow Operations (September 2015)

Results: A summary of best practices by state DOTs regarding their use of headlights, work lights, and warning light technology in snowplow operations.

Implementation & Benefit Opportunity: The synthesis makes recommendations regarding the optimum use of various lighting technologies, including mounting techniques and location guidelines.

Cost Benefit Analysis of Various Winter Maintenance Strategies (September 2015)

Results*:* An assessment of the costs and benefits of three winter maintenance strategies to better understand the safest and most cost-effective approach based on the desired level of service.

Implementation & Benefit Opportunity: This project resulted in a matrix of winter maintenance strategies and impacts that is concisely and clearly written for a broad audience of stakeholders, including winter maintenance professionals, DOT management, legislators and the public. This matrix will help agencies select the most appropriate strategies for a given level of service and gain consensus on the most effective approaches to winter maintenance.

Snow and Ice Control Environmental Best Management Practices Manual (July 2015)

Results: A national *Snow and Ice Control Environmental Best Management Practices Manual* that provides the most up-to-date recommendations, based on a foundation of leading research and resources nationwide.

Implementation & Benefit Opportunity*:* This resource helps to articulate responsible snow and ice control practices for DOT staff, legislators and other interested parties, so that the priorities of safety, efficiency, cost, and environmental protection can be appropriately balanced.

Best Practices for the Prevention of Corrosion to DOT Equipment: A User's Manual (May 2015)

Results: An easy-to-use guide that summarizes in layman's terms the best practices to prevent corrosion to maintenance equipment.

Implementation & Benefit Opportunity: Guidelines for corrosion management on highway maintenance equipment for use by fleet managers, garage supervisors, and staff that will minimize the costs and impacts of corrosion.

Winter Severity Mapping Enhancement (March 2015)

Results: A set of state-specific weather severity maps tailored to each member state's needs.

Implementation & Benefit Opportunity: This project provides a state-focused version of each of the five weather severity maps (hours of blowing snow; hours of freezing rain; hours of snowfall; inches of snow and overall severity) to facilitate more detailed comparisons of weather and operations between states.

Establishing Effective Salt and Anti-icing Application Rates (February 2015)

Results: The project, though terminated early, does provide a collection of information (literature review) and updated guidelines, which contain an overview of liquid and solid chemical usage, including comparative tables for chemical performance; tables for minimum temperature bands for solid and liquid

applications; chemical characteristics for most common anti-icers; and state practices regarding chemical usage (weather, costs, application rates).

Implementation & Benefit Opportunity: Provides a basis for pursuing an in-depth synthesis of current practice in the field of anti-icing.

Comparison of Materials Distribution Systems (December 2014)

Results: A photographic catalog of all the different types of material distribution systems identified throughout the project.

Implementation & Benefit Opportunity: This is a great resource for DOTs that want to improve their bounce and scatter performance, improve their pre-wetting systems, or add features to their current systems. The catalogue includes agency contact information for each item pictured to facilitate follow-up connections.

Development of a Totally Automated Spreading System (May 2014)

Results*:* Three guides to help agencies assess the automation technology available and how best to implement the latest components into DOT fleets: Best Practices and Functions of Automated Spreading Systems, Levels of Automation, and Challenges and Currently Available Systems.

Implementation & Benefit Opportunity: This research offers a vision of the features of a totally automated spreader system, which can serve as a guide for equipment manufacturers and state and local agencies contemplating purchases.

Environmental Factors Causing Fatigue in Snowplow Operators (March 2014)

Results: Recommendations for cost-effective solutions to mitigate driver fatigue and potential avenues for further research.

Implementation & Benefit Opportunity: State DOTs may be able to reduce fatigue-related snowplow incidents by implementing policy and training recommendations resulting from this study. In addition, Clear Roads has funded a follow-up project aimed at identifying the *equipment* factors that cause fatigue in snowplow operators.

Determining the Toxicity of Deicing Materials (January 2014)

Results: A final report and a concise quick-reference guide that summarizes the toxicity rankings of deicing chemicals and helps winter highway maintenance managers consider both expected levels of service and potential harm to the environment when selecting a deicer to use.

Implementation & Benefit Opportunity: The results can help agencies balance both cost and environmental impacts of winter maintenance when selecting which deicing chemicals to apply.

Mapping Weather Severity Zones (September 2012) and Understanding the True Costs of Snow and Ice Control Operations (January 2014)

Results: As a first effort, the weather severity project produced a series of maps that depict winter weather severity across the U.S. in a manner similar to the plant hardiness zone maps used for agriculture. The follow-up project on the true costs of winter operations resulted in a tool that allows users to analyze and

compare the labor and material costs of up to four different storms or time periods. This tool leverages the weather maps developed to facilitate comparisons among states with similar climates.

Implementation & Benefit Opportunity: If implemented, the True Cost Tool enables what-if testing on unit costs; helps practitioners communicate cost drivers in winter maintenance to policymakers and the public; helps managers to better understand and manage costs; simplifies the comparison of costs across storms, districts or regions, and states; and simplifies comparison of winter maintenance costs over time.

Cost-Benefit Analysis Toolkit (Phase I: November 2010, Phase II: June 2013)

Results: A standard Web-based tool and manual for cost-benefit analysis of specific winter maintenance practices, equipment and operations. Phase II included enhanced features and expanded functionality to address additional materials, equipment and methods.

Implementation & Benefit Opportunity: Many DOTs have put this to good use. For example, it helped Iowa DOT demonstrate that it could achieve significant savings by purchasing and using automatic vehicle location and geographic positioning systems. Massachusetts DOT used the toolkit to assess alternatives for salt spreader controllers and to help support capital spending decisions.

Snow Removal at Extreme Temperatures (March 2013)

Results: A compilation of strategies for winter maintenance during extreme cold that have been used by DOTs and other jurisdictions.

Implementation & Benefit Opportunity: This project confirmed current practices.

Effectiveness of Deicing Materials and Procedures (December 2009) and Training Video for Field Testing of Deicing Materials (December 2011)

Results: The first project on deicer materials and procedures resulted in a practical field guide for testing the effectiveness of deicers. The follow-up project then produced a training video that explains the testing methodologies outlined in the field guide.

Implementation & Benefit Opportunity: DOTs have broadly adopted this testing method, integrated it into training and distributed the video to their districts.

Standardized Test Procedures for Carbide Insert Snowplow Blade Wear (September 2010)

Results: The report identifies lab tests that could be used to predict field performance of carbide insert snowplow blades, provides recommendations for developing a national standard for carbide inserts, and provides recommendations for implementing a purchasing approval framework.

Implementation & Benefit Opportunity*:* If an agency adopts the recommended process for testing and acceptance of carbide inserts, poor performance of carbide-insert blades should be minimized. The carbide inserts will last longer, which will reduce replacement costs, and will also reduce the time, cost and equipment downtime associated with changing plow blades. These benefits would expand if the procedures are accepted as a national standard or are developed into model specifications that any agency could implement. Using standardized tests would improve agencies' purchasing processes, reducing management time and validating purchase decisions.

Identifying Parameters for Effective Implementation of Liquid-only Plow Routes (September 2010)

Results: The report identifies parameters for the safe and effective use of liquid-only routes during winter storm events and provides an assessment of the viability of field testing.

Implementation & Benefit Opportunity: This project identifies the best circumstances to use the innovative technique of direct liquid applications during winter storm events. It also provides a quick-reference guide that makes it easy to implement.

Correlating Lab Testing and Field Performance for Deicing and Anti-icing Chemicals: Phase I (August 2010)

Results: The report provides recommendations for how to proceed with lab and field testing that measures performance characteristics of deicing and anti-icing chemicals.

Implementation & Benefit Opportunity: This project confirmed current practices.

Development of Interface Specifications for Mobile Data Platforms on DOT Vehicles (April 2010)

Results: The report provides communication and data format specifications that support a "plug and play" approach to integrating sensors and other devices with mobile data platforms used by state DOTs.

Implementation & Benefit Opportunity: The implementation efforts for this project have continued in the Clear Roads Plug and Play Initiative, which involves collaborating with the vendor community to develop a protocol that would support a "plug-and-play" approach to integrating electronic devices and sensors on plow trucks. Establishment of this protocol will mutually benefit Clear Roads member states and their vendors by standardizing how critical operational data is shared on modern snow and ice vehicles, namely between compatible Automatic Vehicle Location (AVL) devices and anti-icing/deicing Joystick and Spreader Controller systems.

Development of Standardized Test Procedures for Evaluating Deicing Chemicals (March 2010)

Results: The report identifies standardized tests and procedures that help states determine the relative performance of deicers.

Implementation & Benefit Opportunity: This project confirmed current practices.

Developing and Evaluating Safe Winter Driving Messages (March 2010)

Results: Public service announcements and Internet banner ads targeted at high-risk demographics to change their winter driving behavior.

Implementation & Benefit Opportunity: Almost every Clear Roads member state and many other states have adopted the use of these collaborative materials, saving the money, time and resources that would have been necessary to develop this campaign independently.

Calibration Accuracy of Manual and Ground-Speed-Control Spreaders (February 2008)

Results: The report provides guidelines to help snowplow operators establish and maintain accurate calibration of ground speed controllers. The project also included the development of a Calibration Guide for use in the field.

Implementation & Benefit Opportunity: Member states are reporting reduced net salt usage between 4% and 10% by implementing updated calibration strategies and techniques. For example, if a Clear Roads member state uses 600,000 tons of salt each year at $50 per ton for an annual cost of $30,000,000, a 5% savings in material would result in a savings of $1,500,000 each year.

Research in Progress

Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous or Permeable Pavements

Expected Results: Best practice guidelines to help determine the optimum winter maintenance strategies for porous or permeable asphalt pavements.

Expected Completion Date: January 2018

Anticipated Implementation & Benefit Opportunity: This project could be used to help construction staff understand the maintenance cost impact of porous and permeable pavements or help maintenance staff identify the most efficient ways to safely clear those pavement types during winter events.

Developing a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts

Expected Results: A 15- to 20-minute video that showcases the most efficient pass sequences to properly clear various interchange and intersection layouts.

Expected Completion Date: May 2018

Anticipated Implementation & Benefit Opportunity: The resulting videos should provide an easy way for agencies to train staff on the most efficient ways to clear challenging interchanges.

Synthesis of Material Application Methodologies for Winter Operations

Expected Results: A key deliverable of this project will be a concise, authoritative handbook for winter maintenance professionals on the selection and use of winter maintenance materials.

Expected Completion Date: May 2018

Anticipated Implementation & Benefit Opportunity: The guide will help winter maintenance professionals make decisions regarding material application rates, methodologies, and material usage. It will also help agencies optimize their winter maintenance processes to improve safety and save money.

Utilization of AVL/GPS Technology: Case Studies

Expected Results: This project will help state DOTs make more informed decisions with respect to implementation of winter maintenance AVL/GPS.

Expected Completion Date: September 2018

Anticipated Implementation & Benefit Opportunity: Detailed agency case studies developed in this new project will bring to light more nuanced issues related to winter maintenance AVL/GPS. Clear Roads expects that such case studies will highlight the types of issues that agencies should consider, provide guidance for successful implementation, and serve as possible templates for agencies to get the best value out of different levels of AVL/GPS applications.

Standards and Guidance for Using Mobile Sensor Technology to Assess Winter Road Conditions

Expected Results: Through rigorous testing of sensor equipment and development of standardized scales, Clear Roads will create guidance to make better use of road sensor data for decision-making than is now currently available.

Expected Completion Date: April 2019

Anticipated Implementation & Benefit Opportunity: The guidance developed from this project will help in multiple aspects of winter maintenance—in the short-term for responding to a winter storm in real time, and in the long-term in making policy and planning decisions based on performance trends. It will also help practitioners avoid guesswork by providing guidance based on vetted equipment and reliable numerical standards.

Emergency Operations Methodology for Extreme Winter Storm Events

Expected Results: This project will provide guidance to transportation agencies seeking to develop or improve their current plans and policies for handling severe-to-extreme storm events.

Expected Completion Date: December 2018

Anticipated Implementation & Benefit Opportunity: Clear Roads members expect that much can be learned by capturing experiences and best practices from among their peer agencies. Implementation of such guidance is expected to result in more robust, coordinated plans nationwide and with improved execution of such plans.

Weather Event Reconstruction & Analysis Tool

Expected Results: This project will identify easily usable data sources and develop a user-friendly data retrieval interface. A second phase to this project, if approved by the TAC, will include development of a web-based analysis tool and the affiliated support and training materials to adapt or extend existing data sources to make the data more accessible and usable by DOTs.

Expected Completion Date: January 2019

Anticipated Implementation & Benefit Opportunity: By finding, cataloging and categorizing available web-based data sources, this project will help agencies spend less time finding and preparing data and let them move quickly to analysis and follow up.

Training Video for the Implementation of Liquid-Only Plow Routes

Expected Results: This project will create a video training tool designed to explain the benefits of liquid-only plow routes, the fundamentals of how and when to use liquid-only plowing, and steps to implement a program of liquid-only plow routes.

Expected Completion Date: June 2018

Anticipated Implementation & Benefit Opportunity: The goal of this project is to help state DOTs garner support for and accelerate the implementation of liquid-only plow routes. The video will serve to gain buy-in from multiple audiences within a DOT (executives, managers, maintenance staff, and operations staff) and beyond (lawmakers and the public) and give agencies a tangible tool with which to make the next step in putting this practice to work.

Developing Test Bed Software to Qualify Plug and Play Technology

Expected Results: Clear Roads members will be provided with a software suite composed of an SQL database, a web portal, and a device test application.

Expected Completion Date: June 2019

Anticipated Implementation & Benefit Opportunity: This Test Bed will allow Clear Roads to easily and consistently identify vendors that are in compliance with the Plug and Play protocol developed via the Plug and Play Initiative. This should make it easy for states to select vendors that can support the "plug and play" approach to adding spreader controllers, sensors and other components.

Standard Specifications for Plow Blades with Carbide Inserts

Expected Results: A set of common standard specification, including but not limited to the following:

- Carbide inserts, geometry, and dimensions
- Blade materials, assembly details, and dimensions
- Plow blade configuration (front, underbody, or tow blade) and blade dimensions (length and height)
- Quality assurance inspections and accept/reject procedures
- Details of procedures to accept/reject inserts

Specifications will include text and AutoCAD details of insert dimensions, insert material, blade dimensions, and mounting details, including: bolt pattern and inside measurements, amount of insert inside a blade, and the blade/insert mounting configuration.

Expected Completion Date: January 2019

Anticipated Implementation & Benefit Opportunity: By developing a set of standard specifications that can be used by agencies across the country to specify carbide-insert plow blades, states can simplify and streamline the procurement process for both state DOTs and vendors. The buying power connected to widely accepted specifications would be greater, and procurement coalitions could potentially use the standard specifications for bidding. In addition, if more agencies specified the same product, vendors could reduce their costs and pass those savings on to state DOTs.

Research to Award

Integrating Advanced Technologies into Winter Operating Decisions

Anticipated Implementation & Benefit Opportunity: This project will provide a systems-level guidance on the many new technologies available to evaluate road conditions in an integrated blueprint. Thus, this project will give state DOTs a better understanding of how to integrate these technologies into their winter maintenance programs.

Aftermarket Cameras in Winter Maintenance Vehicles

Anticipated Implementation & Benefit Opportunity: This project will assist with operational decisions and increase situational awareness for snowplow operators, thus giving state DOTs the best possible information for selecting and employing such cameras.