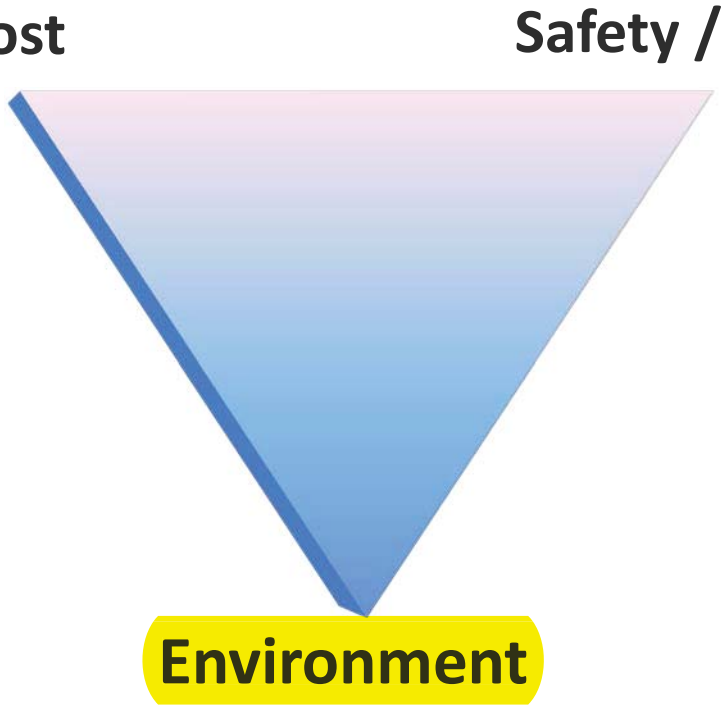
Maine Environmental
Best Management Practices (BMP)
Manual for Snow and Ice Control



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The Maine Snow and Ice Control Best Practices Working Group
Maine Local Roads Center (LTAP)
Maine Department of Environmental Protection (Maine DEP)
Maine Department of Transportation (Maine DOT)
Maine Turnpike Authority (MTA)

Maine Environmental "Best Management Practices" Manual for Snow and Ice Control

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Maine Environmental "Best Management Practices"
Manual for Snow and Ice Control

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Introduction

The purpose of this manual is to present tools and best practices for snow and ice control, when they should be used, and their limitations. The manual establishes clear and consistent guidelines for municipalities and contractors to achieve an acceptable level of safety balanced with cost and environmental impacts of chlorides and abrasives on Maine's land and water resources by promoting the understanding of the tools, best practices, and limitations for snow and ice control. The manual will also help snow and ice control professionals increase their understanding of when to use and when not to use these tools and practices. In addition, it encourages progressive changes in snow and ice control practices that will help reduce salt/sand use and environmental impacts while meeting the safety and mobility needs of roadway users. By adopting and following the standards, snow and ice control professionals can show due diligence in their snow removal practices.

The Triple Bottom Line:
The underlying issues in snow and ice control are public health and safety, cost, and environmental health. If public safety can be maintained and costs decreased while also reducing the impact of chlorides on the environment, then this triple bottom line may be achieved.

This manual provides options for consideration and presents decision makers with a set of best management practices (BMP) that have the potential to reduce chloride use and potentially limit the impacts of chlorides or abrasives on infrastructure, investments (such as equipment and vehicles) and the environment without reducing the level of service.

What does the manual cover? This field handbook includes suggestions for improved practices, such as anti-icing, pre-wetting, and pretreating, and standard best practices in quality snow and ice control programs that are likely to result in identifying the right amount of product being spread and minimizing reapplication requirements.

This manual provides the following information for each BMP:

- What is the BMP?
- How does it work?
- How is the BMP implemented?
- What are the planning or technical considerations?
- What are the potential benefits?
- What is the cost to implement the BMP?
- Links to additional information.

Adapting BMPs to local needs and conditions: We encourage you to test, document, and refine the practices from this manual based on your local experiences, and send comments to Maine Local Roads Center for future updates of this manual:

Maine DOT Maine Local Roads Center, Attn: Peter Coughlan - Peter.Coughlan@maine.gov

Section 1: Impacts of Snow and Ice Control Activities

Impacts of chloride pollution include:

Economic impacts to infrastructure and equipment, associated with salt storage, material costs, accidents, commerce and remediation;
Social and Public Safety Impacts associated with crashes, groundwater and drinking water contamination, and mobility on roadways; and
Environmental Impacts from road salts to streams, wetlands, lakes, drinking water, soil, aquatic and semi-aquatic life, roadside vegetation, and urban trees and plants. There are also critical impacts from sand to streams, waterbodies and the air.

For more detail on these impacts, see ***Appendix A.***

(Photo title: Oversalting of Sidewalks by a Private Contractor' Photo credit: City of Portland, Maine)

Impacts of Increasing Winter Salt on Maine's Freshwater Resources

Salt on paved surfaces has become part of the winter landscape as we walk on sidewalks and drive on roads. We all know salt is a very effective tool to keep paved surfaces clear of ice/snow, which increases safety for all users. But what happens to salt when it dissolves into melting snow and runs off the pavement? The salty water disappears from view, flows with the runoff from the hard or impervious surface and ends up in groundwater, streams, wetlands, rivers, lakes and bays.

Just like in people, a little salt is fine but too much salt causes an imbalance in freshwater. Most freshwater bodies can receive quite a bit of salt before they reach levels that are unhealthy or toxic for the plants and animals. Salt reaches toxic levels when the concentration of chloride reaches 860 parts per million or mg/L. (By comparison, lead is toxic at 0.01 parts per million). Because the toxic level seemed relatively high, few used to be concerned that the widespread use of salt on roads would result in toxic levels in receiving streams. We now know there is an upward trend for salt concentrations in many northern freshwaters.

Because there are no effective measures for removing dissolved salt from freshwater, it is critical to minimize the amount of salt used. This is the purpose of this BMP manual.

1.1 SNAPSHOT OF THE CHLORIDE ISSUE FOR URBAN IMPAIRED STREAMS

Chloride impacts from winter road salting activities are a serious problem, especially if a municipality has streams that have been designated as urban impaired. Important small aquatic animals like beetles, crayfish, mayflies, stoneflies, and a host of worms that live in bottom sediments (also called macroinvertebrates) cannot live in streams or waterways with high levels of chlorides. These animals play an important role in the health of our rivers and streams. Even for salting roadways, high levels of chloride from rock salt use occur in many of our streams.

The chlorides and undissolved rock salt are moved in stormwater by way of roadside ditches, curbing, and catch basins which then direct this untreated stormwater to streams, rivers, ponds and lakes. There is no economically feasible way to remove chlorides from the waters. Chlorides also enter waterways by way of melting snowpiles and dumps, from inappropriate snow plowing practices, or directly from open sand/salt piles. They either travel directly to the water body or ultimately reach streams by way of catch basins, sheet-flow to culverts and roadside ditches during melting periods, or are pushed directly off of bridges by plow crews removing snow from the shoulder of the roadway.

(Photo Title: LANDSAT image of the Penobscot River Watershed).

Streams or other water bodies directly adjacent or near to high impact roadways, including interstate highways, shopping centers and large parking lots, exhibit chronic levels of chloride impacts when compared to streams that are surrounded primarily by residential or undeveloped land uses. A city that is approximately 50 sq. miles in size might have as many as 400 catch basins, 300 outfalls and 40 miles of roadside ditches all directing untreated stormwater to waterways. In addition, chlorides infiltrate and can stay in the groundwater.

In times of drought or dry spells, when there is less surface water runoff into streams, groundwater makes up a larger percentage of stream (base flow). When the groundwater is high in chloride and not diluted by other water, it can cause the concentration of chloride to increase to levels that are toxic to macroinvertebrates.

Section 2: Administrative Considerations

2.1 COST-BENEFIT DECISIONS

This section of the manual does not try to provide a formal cost-benefit analysis for the reduction of chloride and sand use nor the adoption of specific BMPs listed here in the manual. Cost-benefit analysis, when done to identify dollars invested and saved from specific decisions, requires technical expertise and investments outside the scope of this document. True cost-benefit analysis requires a commitment to developing a multi-disciplinary partnership with economic, biological, transportation and public safety expertise, at a minimum, in order to provide input and conduct the economic analysis. Discussed below are some considerations that may be used when conducting a cost-benefit analysis.

While there is currently no economically viable alternative to the use of salt in most municipalities, voluntary action to reduce the overuse and misuse of chlorides and sand has been associated with numerous benefits. By taking a closer look at best practices that can reduce the overuse, misuse, and accidental loss of chlorides or sand, it becomes possible to balance expectations for level of service with economic and environmental impacts.

Common benefits of reduced chloride use include:

- Reduction in chloride contributions to stormwater pollution
- Water quality and ecosystem improvements
- Reduced presence of invasive plant species
- Reduction in groundwater pollution and well intrusions
- Reduced corrosion on vehicle fleets and equipment
- Reduced damage to highways and bridges
- More effective use of product through How is this BMP Implemented?
- Avoidance of Clean Water Act enforcement (including penalties up to $36,500/day per violation; reducing the likelihood of becoming the target of a Residual Designation Authority (RDA) action; and the need for chloride Total Maximum Daily Loads, referred to as TMDLs).

Road Salt Impacts on Groundwater

"Potentially the greatest long term environmental threat from road salt is to groundwater, largely because of the process of chloride sequestering, where some percentage of salt remains in the groundwater after a yearly cycle, and that percentage is gradually increasing each year. This means that in the long term (maybe very long term), the water in many aquifers near roads will become unfit for human consumption. If salting of roads were to end today, vegetation would recover, corrosion would cease, but the salt already in groundwater will persist for decades or even centuries." **~ Josh Katz, Former Maine DOT Geologist**

Additional Costs to consider when implementing BMPs to reduce chloride or sand use: There may be initial costs for investments in staff time to plan how to implement best practices at the local level and equipment and/or products that will make better use of chlorides and sand. These changes in practice may also require an initial investment in equipment or technology and some associated training. Most of the BMPs in this Manual improve the level of service and keep traffic moving.

2.2 LIABILITY

Will following these environmental BMP's reduce our municipal liability? The answer is: "maybe." A road crew following proper BMPs will likely result in a more controlled application of chlorides or sand and should minimize any possible well contamination claims. By calibrating equipment, using better technology, and training crews in these practices; it should improve overall operations and reduce any claim possibilities. Municipalities should consult with legal counsel to better understand what protections they have and how changes to practices will affect their liability.

Protections for Private Contractors Hired to Service Municipal Roads: Although municipalities are offered some protection through tort laws, this is not true for private contractors. Although there may be benefits to following best practices, contractors should consult with legal counsel about their liability.

Relevant Maine Laws

- **Town Ways:** Maine law (23 MRSA 3651) requires that town ways be kept open and in good repair so as to be "safe and convenient" for travelers with motor vehicles. Additionally, if a town way is "blocked or encumbered" with snow, it must be opened and made passable within a reasonable time (23 MRSA 3201). This obligation to remove snow from town ways also requires the removal of snow and ice from sidewalks; however, the municipality is immune from liability for accidents caused by ice and snow on streets and sidewalks (23 MRSA 1005-A and 3658).

- **State Aid Roads**: Maine law (23 MRSA 1003 and 1007) requires towns to keep state aid highways cleared of snow during the winter season or such part of the year as the Department of Transportation (MaineDOT) may direct, so that they may be reasonably usable by motor vehicles. Snow on such state aid highways shall be removed to the outside edges of the shoulders of the road, and in a manner satisfactory to MaineDOT, whose judgment shall be final. The towns shall sand the state aid highways to the satisfaction of MaineDOT, and in case the towns fail to sand the highways to the satisfaction of MaineDOT, MaineDOT shall be authorized to make arrangements for the proper sanding and the cost of such sanding shall be paid by the towns.

- **Liability for Contamination of Wells:** Under Maine law (23 MRSA 3659), a municipality may be liable for contaminating private water supplies as a result of road construction, reconstruction or maintenance. "Maintenance" is not defined in this law, but presumably includes contamination resulting from salting-sanding operations in the winter. The municipality is not liable when: (1) the well is located inside the right-of-way of the road; (2) the well is so situated that it does not provide for adequate surface drainage in the first place; or (3) the well was contaminated by another source before the town's road construction or maintenance.

In claims under this law, the municipality should always try to determine the type of contamination. The municipality will not be liable if it can establish that the contaminant came from another source, either natural or man-made.

There is no statute imposing liability on the municipality for lawns or trees killed by road sanding operations. In fact, the municipality is immune from liability under the Tort Claims Act. Liability might attach, however, where the salt contamination is so bad as to completely destroy the property and constitute a "taking" of the property without compensation; there are no such cases reported in Maine, but the Law Court has found that such a claim is not barred by the doctrine of "sovereign immunity."

Relevant Federal Laws

- **Americans with Disabilities Act (ADA):** This act states that "A public agency must maintain its walkways in an accessible condition, with only isolated or temporary interruptions in accessibility." 28 CFR §35.133. Part of this maintenance obligation includes reasonable snow removal efforts. For more information: http://www.fhwa.dot.gov/civilrights/programs/ada_sect504qa.cfm#q13

Section 3: Administrative BMP

3.1 DEFINING A LEVEL-OF-SERVICE (LOS)

What is it? Snow and ice control LOS is a defined set of operational guidelines and procedures that specify the extent to which maintenance services will be provided. Due to the variable nature of the weather events and the fact that budgets and resources are limited, a defined LOS policy provides a realistic basis for a winter maintenance operations program.

How does it work? A LOS policy will require establishing a prescribed end-of-storm road condition for various types of roads, explaining what intermediate conditions are acceptable, and/or the frequency of snow and ice control maintenance operations. Some components of an LOS policy would include: overall approach, time to bare pavement, truck cycle times, % bare pavement, acceptable snow cover during and after a storm, materials used, typical application rates, plow route length, and time periods of reduced coverage.

How is this BMP Implemented? The LOS policy will, at a minimum, be a published policy document that is used by the municipality or transportation agency to support and explain its overall approach to winter operations within the limits of its budgetary and staffing resources and within context to local sensitive environments. Some communities choose to formalize a LOS policy into local code along with other requirements for public and private property snow removal.

What are the planning or technical considerations? The Level of Service policy will largely be determined by the importance of the road and the average daily traffic count, but may also include consideration of sensitive environmental areas. A community should define its LOS policy with the input of transportation stakeholders which will require an evaluation of traffic levels, road classification in both urban and rural areas, road speeds, average plow route length and typical staffing and resources. These priorities identify the order in which the roads will receive attention when choices must be made and will also help to define the level of maintenance each priority level will receive under various activities. The use of geographic information systems (GIS) may make this evaluation easier and maps generated through the process assist in the graphical representation of traffic counts, road types, environmental conditions, that can assist a community in achieving informed input. While the focus of this BMP is on roads, LOS plans can be developed for parking lots and sidewalks as well.

What are the potential benefits? A LOS policy allows a community to defend its decisions to provide for maximum efficient use of traction and anti-icing/de-icing materials through timely and carefully controlled applications. This will provide for the safe passage of road users while respecting the

environment in general and fresh water resources in particular. It can also list the priorities of specific roads in regards to traffic, environment or other factors

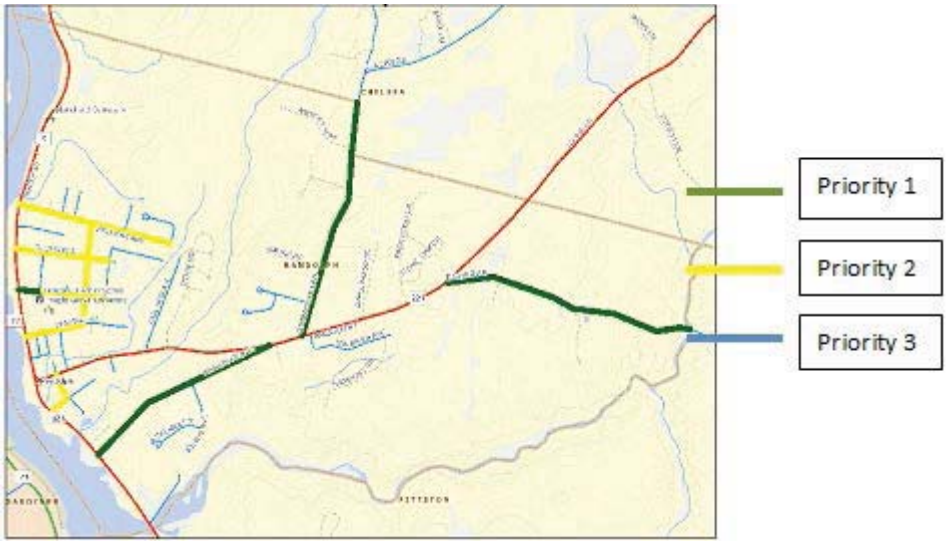
What is the cost to implement? The LOS policy development primarily requires an investment in time for roadway managers. The investment will depend on the level of detail of the policy and the desired level of engagement of road users and interested citizens. Additional investments may be made depending on the nature of the technology used to evaluate existing and future conditions, including GIS. The LOS policy development may require limited data collection regarding sensitive receiving waters and local road conditions (e.g. winter shade areas, difficult to manage surfaces).

Where can I get more information?

- MaineDOT Snow & Ice Control LOS
  http://www.maine.gov/mdot/winterdriving/pp.htm

- National Cooperative Highway Research Program (NCHRP) Report 526: Snow and Ice Control: Guidelines for Materials and Methods
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_526.pdf

Example of a Snow Removal Priority Map
Town of Randolph Maine



3.2 PRE-STORM AND POST-STORM MEETINGS

What are they? Pre and post storm meetings may be informal or formal discussions between the snow fighting crews and their supervisors to discuss a wide range of issues such as:

- What procedures and equipment will be implemented for the expected incoming weather event;
- What issues/problems occurred during the storm event that may have affected the operation;
- What the crews did well during the storm; and
- What effect these actions had on the operation.

How do they work? Crew supervisors schedule and conduct pre- and post-storm meetings to be held where crews normally meet for their day to day operations (field office, garage, "camp", etc.).

How is this BMP implemented? Pre- storm meetings should be held just prior to the arrival of an expected storm event and after the type of event (heavy snow, freezing rain, temperature ranges, wind speeds, etc.) is determined. The supervisor will typically advise the crew how to handle the incoming weather by reviewing policy and/or based on experiences from previous storms. Post-storm meetings should be held two to four days after storm clean-up is completed. This meeting will benefit the supervisor because it gives him/her the opportunity to "download" information from the crew. The discussion should include actual weather and road conditions encountered, staffing levels, material handling and use, equipment issues, and trouble spots along the plow routes that need to be addressed.

What are the planning or technical considerations? In order to conduct a full analysis of the team's performance, plan the meeting for a time when all storm related activities have been completed. Also, choose a location where all attendees can sit comfortably and interact with one another and the meeting coordinator, such as the lunch or break room. Technical considerations for this type of meeting may be minimal if you are just having an open discussion with the crew. However, if you develop a multimedia presentation with data and pictures from the storm, then you will need to verify that your meeting place can support this.

What are the potential benefits? Effectively communicating policy and procedure to snow fighting crews prior to getting out on the road can reduce costs by ensuring that crews are using the right equipment and materials, in the right place, and at the right time. Ensuring that the crews know their roles so they can make a coordinated attack works to reduce costs as well. Finally, fighting storms is hard work, and keeping crew morale high is very important. Increasing the crew's involvement in decision making process will most likely translate into better morale.

What is the cost to implement? Time is money, as they say, and that is the cost to implement this BMP. Costs per person for meeting attendance may be calculated in wage and benefit costs per hour. For example, if 10 people are in the meeting at $50 per hour for each person, the meeting cost is approximately $500. There are also opportunity costs associated with conducting pre and post storm meetings, i.e. personnel could be performing other tasks assigned to them at that time but cannot because they are in the meeting.

Where can I get more information?

- Clear Roads, Post-Storm Meetings: A Survey of State and Local Practice
  http://www.clearroads.org/synthesisreports_files/tsrpoststormmeetings.pdf

- Salt Institute, Snow Fighter Handbook
  http://www.saltinstitute.org/wp-content/uploads/2013/07/Snowfighters_HB_2012.pdf

3.3 WEATHER FORECASTING SERVICES

What are they? Weather Forecasting Services are contract services that provide localized weather forecasts to help to determine what type and what amounts of precipitation are most likely to be encountered during a storm cycle.

How Do they Work? Weather forecasting firms implement the same technologies and forecasting techniques that other governmental agencies employ, such as the National Oceanic and Atmospheric Administration (NOAA), but with more attention to a specific region, which can allow for a much more accurate forecast. More accurate forecasting allows the snow fighting crews to prepare better for impending storms, and reallocate resources during storm events as needed to maintain the level of service required.

How is this BMP Implemented? First you will need to identify an appropriate meteorological service and contract with them for weather forecasting services. Typically, an agency or municipality employs this service from November through April. After selecting a service, you will need to review observed local weather phenomenon, typical road trouble spots, unusual terrain features such as a mountain or river valley, and any other conditions that may affect the local forecast. You will want to review what data that you will need to see on the daily reports from the service, what format the data is best presented in for all who will be reviewing it, and what time the report will be issued each day. Forecast information should be used to more effectively implement snow and ice control operations, including the use of chlorides.

What are the planning or technical considerations? Meeting with meteorologists from the service you wish to hire is very important. You will want to ensure that they are properly staffed with professional meteorologists that can provide 24 hour, 7 day week coverage, and that the staff has experience forecasting in your area. You also want to make sure that the service can be reached by phone at any time, are responsive to your questions and concerns, and can provide updated forecasting reports when appropriate.

What are the potential benefits? An accurate and continually updated forecast will allow you to better plan how to attack a storm, which can translate into cost savings and efficiency. During a storm event, for example, it may be that some areas will see less storm activity than others, and crew members and their equipment can be reassigned to areas that are predicted to see more storm activity.

What is the cost to implement? Typically, an agency or municipality employs this service from November through April. Fees for this six month period typically range from $1,200 to $1,600.

Where can I get more information?

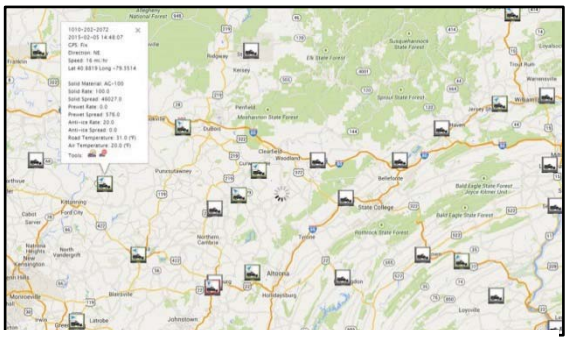
- Salt Institute's *Snowfighter's Handbook* (40th anniversary issue issued November 2007)
  -
- Federal Highway Administration, Road Weather Management Program http://ops.fhwa.dot.gov/weather/

- The National Weather Service, Directory of Commercial Weather Providers www.nws.noaa.gov/im/dirintro.htm

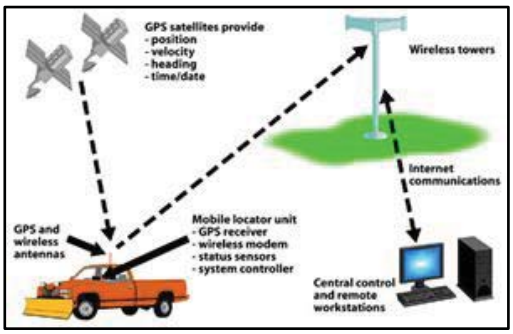
3.4 AUTOMATIC VEHICLE LOCATING SYSTEMS

What are they? Automatic Vehicle Locating Systems (AVL) are a data collection tool that uses the Global Positioning System (GPS), communication networks, and street mapping software to remotely track the location, direction of travel, and speed of snow removal vehicles during operations and display this information on a base mapping system. AVL systems can integrate with a whole host of onboard sensors and even dash mounted cameras, to collect data on material usage, air and pavement temperature and condition, plow position (up/down), and liquid systems output, and send this data with location data for a more complete picture of what is happening in the field. Snow removal operations managers use these data to observe, analyze, and optimize snow removal operations in real time and for post storm analysis.

How do they work? A GPS receiver and antenna are installed in the vehicle to calculate the location, speed and direction of vehicle travel after receiving signals from a network of GPS satellites. These data are then sent via cellular networks to a computer system that receives, process, and displays the data using base mapping software in real time.



GPS data displayed on a base mapping



Schematic of an AVL system.

How is the BMP Implemented? AVL systems can be used to locate your vehicles, optimize plow routes, manage material inventory, adjust application rates, and verify damage claims. Web-based services are used to receive, process and display data via the internet in their operations office (or for larger agencies, their traffic management center), which eliminates the need for resident hardware and software required to manage the huge amount of data that is generated by AVL systems. Other vehicle sensor data, such as spreader rates of application, plow gear sensor data, video or still photos, and temperature sensor data are also sent with the location data and are typically collected using the modern spreader control unit as a "hub" for these sensors to plug into.

What are the planning or technical considerations? Initial planning for an AVL system should begin by determining what you want to do better with your fleet, and then determining what data needs to be collected to support your goals. Optimizing plow routes requires knowing where your fleet is/was, so GPS location data is what you need at a minimum. A lot of agencies and municipalities implement AVL to monitor spreader output rates in an effort to verify that they are using the correct amounts of salt and aggregate on the roadway for the conditions, so spreader data and possibly road temperature/air temperature data will need to be collected for analysis. You will need to determine your data collection needs carefully, because data costs money, and sensor hardware, system installation and maintenance, and even cellular service plans are impacted by the amount of data collected and transmitted.

What are the potential benefits?

Vehicle Location	Knowing where all of your vehicles are at any time is very important for coordinating efforts during a storm event. Having the ability to see your entire fleet on a base map updated in real time will allow you to allocate resources to problem areas much more effectively.
Plow Route Optimization	Being able to "replay" vehicle location and movement data on a base mapping system after storms allows managers to plan plow routes more effectively. Effective plow routes can eliminate plow route overlap, decrease unproductive time traveling to and from material storage areas and route locations, increase level of service, reduce fuel consumption, and reduce unnecessary material usage.
Material Inventory Management	AVL helps to manage how much material and where material goes during snow removal operations. This data is also extremely useful for environmental reporting if required in your jurisdiction.
Application Rate Adjustments	By utilizing AVL data collected such as current pavement and air temperature, the application rate of material may be adjusted allowing you to possibly reduce the application rate while still providing the same level of service. This can translate into real cost savings by the end of a snow season and reduce environmental impacts as well.
Verification of damage claims	Using AVL location data and plow sensor data to determine if the truck was at the scene with plow down, it can be determined if damage claims are reasonable. If they are not, paying for damages that were not caused by your crews may be avoided

What is the cost to implement? Regarding hardware and sensors, Initial system cost can range from $800 per truck to $2,500 per truck depending on what sensors you want to run on the vehicle. The lower end of the estimate would be for a GPS antenna and receiver, cellular antenna and modem. Air and pavement temperature sensors can run up to $500 with about $150 for installation. Additional sensors installed in the truck's hydraulic system to monitor plow position will vary depending on the system configuration but may be in the range of $200 for sensors and $150 for installation. Annual service fees from the AVL provider (which typically includes cellular service for each vehicle) are typically around $40 a month per vehicle. Some service providers allow agencies to reduce the monthly fee in the non-winter months to $10 a month, which keeps the account open for that vehicle to be reactivated the following snow season. Please note that costs associated with the material spreader, computer hardware at the base station, administrative and internet connection costs are not included in these estimated costs.

Where can I get more information? The Salt Institute, Federal Highway Administration, Equipment Manufacturers and Service Providers.

Section 4: Snow and Ice Control Product Selection

4.1 CHOOSING THE RIGHT TREATMENT PRODUCT

What is it? There are several different products available today to help maintain safe driving conditions on Maine roads. Products will vary in cost, availability, and effectiveness and may require different equipment for application. Before purchasing any product you should research the product and make sure it is a practical option for your area and feasible given your available resources. Some primary products you will choose from are:

- Salt
- Sand
- Liquid Calcium or Magnesium Chloride
- Salt Brine
- Liquid Blends
- Pretreated Salt

How does it work? The products on the market today deal with either preventing or removing ice and snow buildup on the road surface. They could be in a liquid or solid state, depending on your objective. Each product has limitations and is designed to work within certain parameters, such as specific temperatures and moisture types.

How is this BMP Implemented? In the following section, this document will provides BMPs for the most commonly used road treatment products for our area. Taking the time to assess your needs and the options provided by different products can improve the efficiency and effectiveness of your snow and ice control operations and limit unnecessary chloride overuse. Consider the pros and cons of each product and select your treatment products based on careful assessment. In addition to those products listed in this manual, there are others that can be considered (e.g. alternative products like beet juice).

What are the planning or technical considerations? With any treatment product you need to know how readily available it is in your area, how is it stored, the equipment needed to apply it and the product limitations? Other things to consider: environmentally sensitive areas within your community, road conditions, traffic flow, climate and available personnel.

What are the potential benefits? Using the proper road treatment products can save your community time and money. Safer roads mean fewer vehicle accidents, fewer impacts to the business and retail community, and reduced time and costs (employee overtime / call-ins) responding to poor traveling conditions. Using the right treatment products will also allow you to return to normal driving conditions faster after the storm.

What is the cost to implement? The cost of a road treatment product varies. It will depend on the availability, delivery cost and production cost. The type and cost of the application equipment varies and should be considered as well.

Where can I get more information?

- Maine Local Roads Center
  http://www.maine.gov/mdot/csd/mlrc/

- Salt Institute, Snow Fighter Handbook
  http://www.saltinstitute.org/wp-content/uploads/2013/07/Snowfighters_HB_2012.pdf

4.1.1 SALT

What is it? Road Salt/Rock Salt (NaCl) is a sodium chloride crushed to a specific gradation to be spread on paved road surfaces. It has a chemical composition of 95% purity and should have moisture content between 0% and 1%.

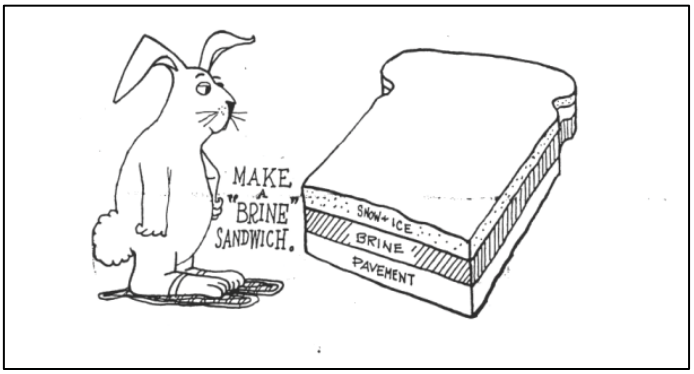
How does it Work? Salt is used to melt snow and ice from the road surfaces but only down to about 15 degrees Fahrenheit (F). It can be used in anti-icing and de-icing applications. Salt requires moisture to work – either from the environment or a substitute such as salt brine, liquid calcium chloride, liquid magnesium chloride, or other commercial liquids. It forms a brine which keeps snow and ice from bonding to pavement.

How is this BMP Implemented?

- Calibration of spreading equipment
- Awareness of environmental and weather conditions so proper application rates can be used
- Awareness of product limitations -- make sure material meets specifications

What are the planning or technical considerations?

- Make sure you have an adequate supply of product on hand and a system for replenishing supply in a timely fashion
- Make sure product meets specifications – gradation and moisture content
- Make sure spreading equipment is calibrated and functioning
- Train personnel in proper methods with modern technology
- Buy a pavement temperature gun and use it
- Get out early in the storm and create a “brine sandwich” between the pavement and snow/ice



What are the potential benefits?

- When the roads are clear, personnel are able to restore bare pavement conditions faster than when snow/ice bonds to the pavement
- Fewer accidents with improved travel conditions during and after the storm
- Fewer call-ins for public works crews before and after the storm. Improved mobility with a faster return to bare pavement

- Reduced Spring clean-up– salt dissolves while sand accumulates in road side ditches and drainage structures that requires follow-up cleanouts.

What is the cost to implement? Cost of product will vary, depending on your location. Current Maine prices are between $50.00 and $75.00 per ton.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- Salt Institute
  http://www.saltinstitute.org/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

4.1.2 SAND

What is it? Sand is an aggregate that meets a specific gradation and is used on road surfaces to address slippery conditions and provide traction. Sand will always be a tool and certain storm conditions may require the use of sand as an abrasive. MaineDOT and many towns/cities have dramatically eliminated huge volumes of sand while other towns continue to haul, load, spread, and pick up hundreds of thousands of cubic yards of sand every year at a significant expense. When sand is stockpiled and used, a cubic yard of sand is typically mixed with about 100 pounds of straight salt primarily to prevent the pile from freezing.

How does it Work? Sand is spread on road surfaces to provide grit / traction for vehicles during slippery conditions as long as it stays on the road. It does not melt any snow/ice. The over-application of sand is detrimental to the environment. Sand clogs storm drains, ditches and culverts, introduces silt into waterways, and carries pollutants, such as coolants and petroleum products from automobiles, from the roadway to watersheds . It can also cause claims for windshield damage to vehicles.

How is this BMP Implemented?

In general:

- A rule of thumb for sand application is 1 cubic yard per mile
- Make sure spreading equipment is calibrated
- Make sure material meets specifications (generally ½-inch minus, clean, durable, coarse)
- Be aware of weather conditions and product limitations
- Use sand sparingly because of its short-term effectiveness of sand for traction
- Specific to parking lots: if sand is used, sweep parking lot areas midwinter as well as in spring

Used sand is contaminated with pollutants such as oil, grease, metal, and rubber and should be disposed of at a landfill, never on a stream bank, in vegetation, or in any other natural area.

What are the planning or technical considerations?

- Outside storage will require mixing the sand with salt to keep it from freezing. Any outside piles should be covered and stored properly
- Make sure the product meets specifications
- Make sure equipment is calibrated and set for the product you are using
- Know your service areas and environmental concerns such as your stormwater permit requirement
- Product will require spring sweeping and roadside maintenance over time. The cost to provide this maintenance should be factored into the cost of the product. The cheap up front cost of sand is more commonly NOT the most economical option

What are the potential benefits? Reductions in sand use may lower the cost of cleaning storm drain system structures, reditching, and reduce the impact on local and regional water bodies and the costs addressing the pollution. However, the use of sand can provide:

- An excellent source of traction during certain conditions, including when there is icing, on steep slopes and on gravel roads
- An often readily available low cost option

What is the cost to implement?

- Depending on your location, sand usually costs $5.00 to $10.00 per cubic yard without salt mix.
- Costs to clean up, store and (where necessary) dispose of sand and grit from shoulders, ditches, catch basins and other infrastructure should also be included in implementation costs for sand as a BMP to control ice and snow.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

- Canadian Parking Assn., Tech. Bulletin No 6. Best Management Practices for Salt Use, 2005
  www.canadianparking.ca/files/Bulletin_6%20Best%20Mgnt%20Practices%20for%20Salt%20Use.pdf

- Minnesota Winter Parking Lot and Sidewalk Maintenance Manual, 2010
  www.pca.state.mn.us/index.php/view-document.html?gid=13562

4.1.3 LIQUID CALCIUM OR MAGNESIUM CHLORIDE

What is it? Both of these products are liquid solutions commonly used as additives in winter maintenance to pre-wet salt or sand and reduce the "bounce-and-scatter" effect. Calcium chloride is available in various concentrations but typically used at 32% concentration in Maine. Both can be enhanced with other additives to improve performance and minimize corrosion issues.

How does it Work?

- Liquid chlorides are commonly used for anti-icing, de-icing, pretreatment and salt wetting.
- When used in these applications, it reduces the freezing point, allowing treatment in colder temperatures. Typically, $CaCl_2$ extends the use of rock salt down to minus 15° F whereas $MgCl_2$ extends the use down to about +5°F.
- When sprayed directly on product (sand / salt), it also helps control bounce and scatter which keeps more product on the road.

How is this BMP Implemented?

- Calibration of spreading equipment.
- Proper product specifications.
- Awareness of weather conditions and product limitations.
- Application rates vary; Direct spray of 32% solution to road surface (25 to 32 gal / Lane Mile); Pre-wetting of material (6 to 10 gal / cubic yard)

What are the planning or technical considerations?

- Adequate product supply on hand.
- Effects of corrosion on equipment.
- Various types of application equipment and methods, and required training with that equipment.
- Awareness of environmental and weather conditions for your area.
- Awareness of product limitations –Requires moisture to work.

What are the potential benefits?

- Allows for winter road maintenance during cold temperatures below 15°F.
- Very effective in fighting ice.
- If used as recommended, will not harm vegetation.

What is the cost to implement? Cost will depend on your location, availability and concentration required. $CaCl_2$ is estimated to cost at least $2.00 per gallon whereas $MgCl_2$ is a bit cheaper. There will also be additional equipment costs associated with the storage and application system as well as employee training and safety.

Where can I get more information?

- Maine Local Roads Center**,** Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

- Product Suppliers

4.1.4 SALT BRINE

What is it? A liquid agent that is simply rock salt dissolved in water. The water is saturated to 23.3% concentration and is effective down to about 15°F. Every gallon of salt brine contains 2.3 pounds of dissolved salt. It is made locally at several places around Maine. It is applied pro-actively to the

pavement surface prior to the accumulation of frozen precipitation (pretreating), or directly onto rock salt as it is being applied to the road (pre-wetting).

How does it Work? Liquid brine is used primarily as an anti-icing agent. In pretreating with a winter storm normally above 20°F, the brine will begin working as the first snowflake falls and will delay the accumulation of snow and ice on the pavement. In pre-wetting, the storm is in progress and the brine activates the rock salt and helps it stick to the pavement so it doesn't bounce and scatter off the road. Both methods help reduce the overall rock salt that is necessary over a winter.

How is this BMP Implemented?

- Specially modified tanker trucks or customized liquid distribution bar
- Proper product concentration
- Awareness of weather conditions, along with product limitations
- Proper training and experimentation to maximize efficiency

What are the planning or technical considerations?

- Adequate storage tanks and modified equipment to apply liquids
- Can be produced easily, but must be 23.3%
- Required training or experimentation with liquids if only familiar with sand/salt
- Awareness of environmental and weather conditions for your area
- Awareness of product limitations

A Local Maine Road Treated with Brine

What are the potential benefits?

- Cost can be 1/10 of other liquid chlorides
- Allows crews to be proactive and able to prevent bonding on entire routes
- More environmentally friendly even though it is still a corrosive product

What is the cost to implement? Estimated cost is about 10-20 cents per gallon. There are additional costs for application equipment, storage tanks, and employee training. However, proper implementation of this BMP can minimize the amount of product necessary over the entire winter.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

- Product Supplier

4.1.5 Liquid Blends

What is it? A liquid additive that is applied to pre-wet rock salt at lower temperatures. The liquid is a blending of magnesium or calcium chloride mixed with sugars such as molasses, high fructose corn syrup

or other carbohydrate base products. Typical industry names include "Ice-B'Gone" or "Ice Ban" or "70/30 blend" (mix rates are provided by manufacturers and can be compared with recommended mix rates from SIKA). Ice B'Gone has been recognized by EPA under its Design for the Environment (DfE) Formulator Program. For more information about liquid blends, refer to this BMP Manual's sections on Anti-icing using Pre-treatment and Pre-treatment Equipment.

How does it Work? Sugars added to salt in specific proportions will significantly lower the working temperature of chloride salt, allowing longer working time and greatly reducing corrosion.

How is this BMP Implemented?

- Calibration of spreading equipment.
- Awareness of when and when not to use
- Proper product specifications
- Awareness of environmental and weather conditions, along with product limitations

What are the planning or technical considerations?

- Awareness of types of application equipment and methods and the required training with that equipment
- Awareness of environmental and weather conditions for this product in your area
- Awareness of product limitations

What are the potential benefits?

- Treated salt works to temperatures well below 0° F
- Corrosion inhibitor
- Reduces bounce and scatter and prevents a bond from forming between the road and snow accumulation
- Lower working temperatures along with better adherence and residual effects
- Reduces the overall corrosive effects of salt on equipment
- Reduces the levels of sodium and chloride ion exposure to wells, vegetation and surface water.
- low impact on water and vegetation

What is the cost to implement? Estimated cost is at least $1.50 per gallon. There are additional costs for application equipment, storage equipment, and employee training. However, the addition of liquid blends can minimize the amount of salt used thus reducing inventory costs and corrosion potential.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

- Suppliers

4.1.6 PRE-TREATED SALT

What is it? Salt pre-treated with a liquid blend.

How does it Work? Pre-treatment provides moisture to the salt and allows for lower operating temperatures. When applied to the road, it forms a brine that keeps snow and ice from bonding to the road surface.

How is this BMP Implemented?

- Calibration of spreading equipment / application rates
- Material specifications
- Awareness of weather conditions and product limitations

What are the planning or technical considerations?

- Adequate supply of product on hand
- Not usable in all temperatures so review product limitations prior to using

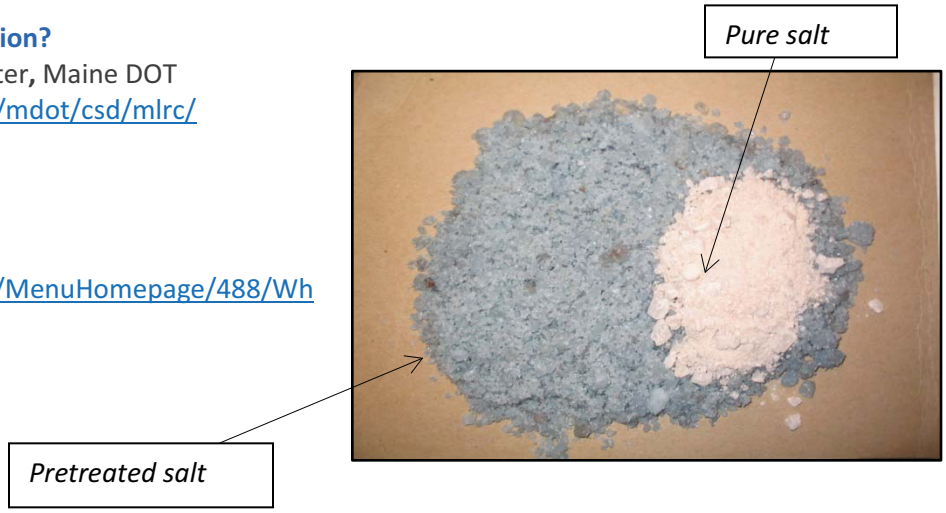
What are the potential benefits?

- Less scatter of product
- Quicker reaction time
- Environmentally friendly
- Less corrosive to equipment and infrastructure than other products

What is the cost to implement? Cost will depend on geographic location but it may be typically at least $20 more per ton than plain salt - $70.00+ per ton in Southern Maine.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/
- Vendors
- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are



Section 5: Application Process BMP

5.1 ANTI-ICING AND PRETREATMENT

What is it? Anti-icing begins by using carefully calibrated equipment to spread a measured amount of salt early in a storm, and as necessary throughout, to prevent the snow and ice from bonding to the road When anti-icing in the early stages of an event, fallen snow begins melting on pavements as soon as it comes in contact with the material, as opposed to the snow packing onto the roadway as in "de-icing". Pre-treating roadways is the first step to anti-icing.

There are two common forms of pre-treatment to accomplish anti-icing: 1) The use of standard dry or pre-wetted, *not to be confused with pre-treated,* rock salt; and 2) Application of salt brine (typically a 23% salt solution) directly to the roadway. The temperature range of use is typically 20-30 degrees Fahrenheit and application is generally 40 gallons per lane mile. Application should occur 6-12 hours before a storm. Both measures are performed prior to the onset of a storm and both are considered pre-treatment.

How does it Work? By preventing the snow and ice from bonding to the pavement, vehicle tires have much more contact with the pavement surface and the roads will clear much sooner after the storm ends. Under either approach, roads can still become slippery from time to time during the storm events; however, anti-icing dramatically reduces the amount of time that the traveling public is exposed to icy conditions.

Simple Homemade Brine Application Unit
(Photo courtesy of Town of Pownal, Maine)

How is this BMP Implemented? Pre-treating with dry or pre-wetted rock salt should be done as close to the onset of the storm as possible to form a brine on the roadway before the snowpack occurs.

For all anti-icing material applications, roadway and weather conditions must be monitored during the storm and re-applications made accordingly to assure that the moisture does not freeze to the roadway surface. Applicators should be aware of ambient and roadway temperatures and watch for changes in the roadway (i.e. pack occurring, slush beginning to freeze etc.)

Specific to parking lots and sidewalks:

- A spray truck with a mounted spray bar can be used to apply liquid anti-icing on parking lots.
- A spray truck with a hose and wand can be used to apply liquid anti-icing to sidewalks. A hand held pump sprayer or backpack sprayer can also be used. Leave a pattern of wet and dry to reduce the chance of creating slippery conditions.
- Always remove snow prior to applying liquids. By plowing, blowing, or sweeping first, the chances of refreeze diminish and slush build-up is minimized.

What are the planning or technical considerations?

- This approach does require better training, equipment and technology, but it also provides a much higher level-of-service at a lower overall cost.

- Weather conditions and temperatures (both air and pavement) play a part in deciding on application rate and timing, as well as proper calibration and maintenance of equipment.
- Special equipment is required to prepare the brine and indoor space is required for the equipment.
- Application of salt brine can be undertaken during normal working hours the day before the onset of the storm.

What are the potential benefits? In some circumstances, anti-icing can dramatically cut the cost of maintaining a safe road surface over conventional deicing. Many Maine towns have reported success pre-treating with salt brine. Anti-icing (brine application) also gives maintenance crews more time to react to precipitation events that happen after normal working hours because of the prolonged time it takes for snow and ice to bond to the roadway surface.

What is the cost to implement? The cost of a pre-wetting system depends on the system you choose to purchase. In some cases, a system can be fabricated in-house for a few thousand dollars. Several vendors offer complete automated systems.

Where can I get more information?

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- MCAPWA Network
  http://maine.apwa.net/MenuHomepage/488/Who-We-Are

- Salt Institute
  http://www.saltinstitute.org

- Canadian Parking Association, Technical Bulletin No 6. Best Management Practices for Salt Use, 2005,
  www.canadianparking.ca/files/Bulletin_6%20Best%20Mgnt%20Practices%20for%20Salt%20Use.pdf

- Minnesota Winter Parking Lot and Sidewalk Maintenance Manual, 2010,
  www.pca.state.mn.us/index.php/view-document.html?gid=13562

- Local Equipment Vendors and Liquid Suppliers

5.2 PRE-WETTING

What is it? Pre-wetting is the process of spraying salt with a solution of liquid chemical before spreading the salt on the roadway.

How does it work? Pre-wetting salt helps it work more effectively as a deicing agent for two reasons: 1) Wet salt clings to the road instead of bouncing off or being swept off by traffic; and 2) to be effective as a deicing agent, salt requires moisture.

Moisture dissolves the salt, releasing heat and thereby melting the ice and snow, as well as breaking the ice-road bond. Pre-wetting the salt ensures that there is enough moisture to facilitate the melting process. Pre-wetted salt works faster and at lower temperature than dry salt, with less waste.

How is this BMP Implemented?

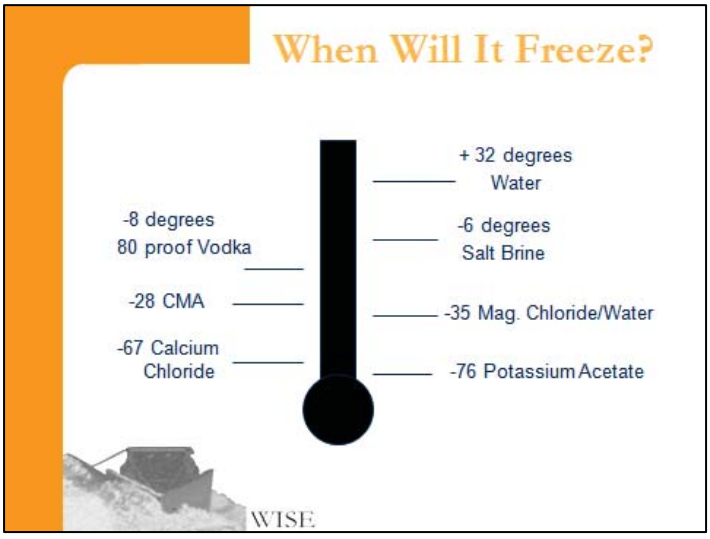
- Calibration and maintenance of spray systems,
- knowledge of different products used for pre-wetting,
- application rates and familiarity with alternatives, such as salt brine, calcium chloride, magnesium chloride and "Ice B'Gone" are effective alternatives.

What are the planning or technical considerations?

- Knowledge of commercial spray systems, or "homemade" versions
- Planning for a pre-wetting system which could be onboard, or shower style or manual loading/mixing
- Personnel training

What are the Potential Benefits? When temperatures drop below 15° F and/or there is no moisture on the road, dry salt alone is less effective, wasteful, and requires changing to other options. Pre-wetting supplies moisture and, depending on the product used, can reduce the "freeze point" of salt, allowing it to work at lower temperatures. Because wet salt clings to the road, the result is that less salt is spread, less bounce-and-scatter, saving money and minimizing the impact to the environment.

What is the cost to implement? Simple systems could be a matter of a few hundreds of dollars to more expensive commercial systems in the thousands. Personnel training and other associated costs may be offset by using less product.



Where can I get more information?

- Maine DOT, Vendors, Other Municipalities

5.3 MATERIAL PRE-WETTING EQUIPMENT

What is it? Pre-wetting Equipment Systems allow the operator to spray a liquid product directly onto salt prior to spreading on the road. These systems will include a truck mounted pump, spray nozzles and tanks to hold liquid product. They are usually tied into computerized spreading system that allows you to control the liquid application rate.

How does it work? These systems allow the operator to spray liquid product directly on the salt before spreading. The operator can control the application rate of the liquid depending on conditions and product used.

How is this BMP Implemented? Chose the correct system for your operation by considering a number of factors (see detail in the technical and planning considerations section below) including:
Budgetary constraints

- Level of performance/ material tracking
- Level of maintenance for system
- Lane miles
- Storage Requirements

What are the Technical and Planning Considerations?

- Budgetary constraints are usually the main factor when considering a system. As with all equipment, systems can be basic or quite complex. Creativity and mechanical ability can go a long ways in building a system that meets your needs. Components can be purchased separately and installed in house or a vender can design and build the system for you in their shop.
- Deciding what you want out of the system: What other systems do you have on the truck and do they need to work together or can they operate separately? How do you want to control the application and track usage?
- Maintenance: Do you have the technical ability to repair and maintain these systems or access to someone who can? Systems can be quite basic or quite high –tech, so thinking about how you will service these systems is important.
- The size, type of route and level of service you provide should also be taken into consideration when choosing a system.
- Choosing to operate pre-wetting equipment will require you to store bulk liquid on site so that you can refill truck tanks when needed. Fleet size, available space, the dispensing equipment required should all be taken into consideration.

What are the Potential Benefits? Pre-wetting Equipment Systems allow the operator to spray a liquid product directly onto salt prior to spreading on the road, a system which can save money and create efficiencies. Selecting the appropriate equipment for your operation is an important part of this process, with selection taking into account cost-benefit decisions.

What is the cost to implement? Vender supplied / installed systems can run from $3,800 to $6,500, depending on the system you specify. Components can also be purchased through other suppliers and a basic system can be built in house for around $1000.00.

Where can I get more information?

- Area Municipal Snow Plow Equipment Vendors
- Maine Local Roads
- Other Municipalities

Section 6: Application Equipment BMP

6.1 MATERIAL SPREADING EQUIPMENT

What is it? Material spreading equipment allows the operator to apply snow and ice control material directly to road and parking lot surfaces.

How does it Work? Select the appropriate material spreading equipment for your operation and properly maintain it to maximize efficiency, effectiveness and longevity.

How is this BMP Implemented? Selecting your material spreading equipment should take into account:

- Budgetary constraints
- Level of performance/ material tracking
- Level of maintenance for system
- Lane miles
- Storage Requirements

What are the planning or technical considerations?

- Budgetary constraints are usually the main factor when selecting material spreading equipment.
- Deciding what you want out of the equipment is important. What other systems do you have on the truck and do they need to work together or can they operate separately? How do you want to control the application and track usage?
- The size, type of route and level of service you provide should be taken into consideration when choosing equipment.
- Spreader maintenance is a year round task that will ensure the accuracy of material spreading. First, properly maintained (and calibrated) spreaders can help reduce over-application of materials. Components of a spreader that requires routine maintenance are the sander chain, spinner and associated hydraulic system. Spreader chains that are not adjusted correctly are prone to jamming and breaking. Second, keeping up on oil changes in the gear box during the winter months helps ensure that the oil does not become contaminated with water.

Winter Tasks: Components of a spreader that require routine maintenance are the sander chain, spinner and associated hydraulic system. Sander chains that are not adjusted correctly are prone to jamming and breaking. During the winter months chains should be checked for appropriate tension on a weekly basis or at each use during storms. Chains that are too tight or loose are prone to binding and breaking. Chains should also be checked for corrosion and thinning linkages and replaced when needed to prevent breakage with a load of material on the truck (which can end up in hand shoveling the material to allow for changing the chain). Keep up on sander gear box oil changes during the winter month to ensure the oil does not become contaminated with water a good rule of thumb is to change the gear oil monthly during the winter period. Lastly, trucks should be emptied and thoroughly cleaned after each storm with special attention paid to the chain and spinner mechanisms.	**Off-season Tasks:** There are a couple of options for off season maintenance of the sander chain. The chain can be removed from the unit for a thorough evaluation and stored in a clean, dry area for reinstallation prior to the next winter. There are products available for treating chains left in sanders to prevent corrosion. They in include Viscotene and Rhomar, among others.

Proper spreader maintenance will help you control your costs, improve your level of service, and minimize your impact on the environment. Poorly maintained spreaders lead to increased down time of your equipment and increased response times in treating your roads.

Planning considerations consist of allotting the time for these tasks to occur. During the winter a visual check is all that is needed and takes only a few minutes. Adjusting spreader chains can require removing the unit from the dump body to allow access to the adjustment mechanism. Consult individual manufacturers' information for your specific sander.

What are the potential benefits? Selecting the appropriate equipment for your operation is an important part of this process, with selection taking into account cost-benefit decisions.

What is the cost to implement? Costs for spreader chains vary from $500 to $1500 depending on style and size. Other items such as gear oil and grease are readily available at a low cost.

Where can I get more information?

- Salt Institute, Snow Fighter Handbook
  http://www.saltinstitute.org/wp-content/uploads/2013/07/Snowfighters_HB_2012.pdf

- Controller Manufacturer Procedures/Manuals
  Examples include Compu-Spread, Cirus, DICKEY-John, FORCE America, Certified Power Inc. and Pengwyn.

6.2 LIQUID ANTI-ICING APPLICATION EQUIPMENT

What is it? Liquid anti-icing application equipment is used to apply liquid chloride solutions through gravity-fed or pressurized hydraulic systems onto the roadway surface prior to storm events. On-board systems will consist of a holding tank or series of tanks, hydraulic pump and spray bar (for pressurized systems), manifold bar (for gravity-fed systems), and associated valves, plumbing and control systems. Liquid application equipment can be installed on dedicated carrying vehicles or trailers, or can be self-contained systems that allow for easy installation and removal from the carrying vehicle.

How does it work? Liquid application equipment disperses liquid chloride solutions directly to the pavement surface. This is accomplished by either spraying the solution on to the pavement surface with a pressurized system or allowing it to gravity feed to a piping manifold which distributes it across the traveled lane.

(Photo caption: Liquid Spray Bar for Brine)

In a simple gravity-fed system, the operator will actuate a valve system that allows him/her to control the rate of

application by limiting flow to the manifold or sprayer bar. In this system, the rate of application will decrease as the fluid level in the tank decreases. In a more sophisticated pressurized system, the pumping system can be connected to an electronic unit that controls the pumping rate and flow control valves which allows the operator to better control the application rate. A pressurized system allows for more consistent application rates as the pressure at the nozzle is controlled by the flow in the system, and not the level of fluid in the tank.

How is this BMP Implemented? Choosing the correct system for your operation can be determined by considering a number of factors including:

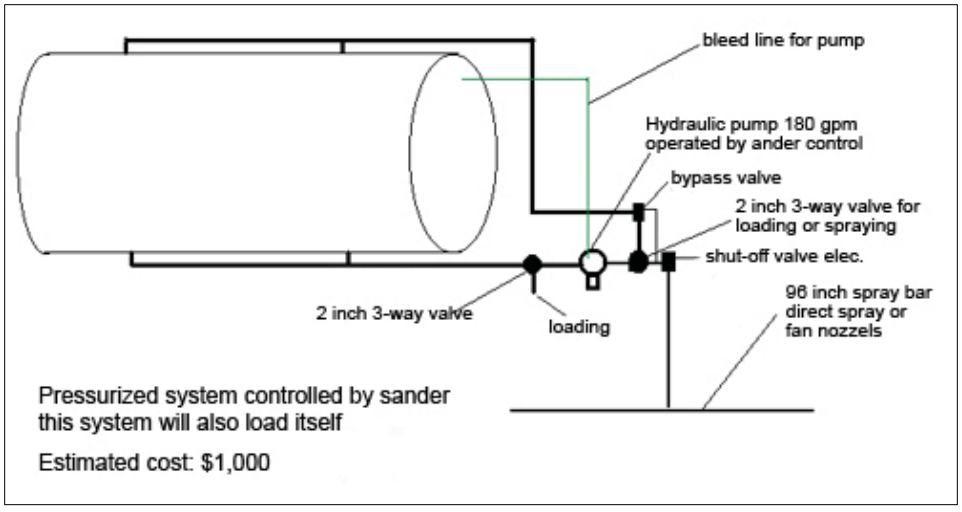
- Budgetary constraints
- Level of Service to be provided
- Number of lane miles to be maintained

Budgetary constraints will likely be your most important consideration. You can only afford to purchase equipment that falls within your budget. In this case, gravity-fed systems can be fabricated more cheaply in your maintenance shop using readily available parts than an electronically controlled pressurized system.

Another important factor to consider is the **expected Level of Service** that you are required to provide on your roadways. If you operate a high speed roadway or a major arterial, then the level of service you are required to provide is probably higher than rural connector roads. In this case, you will need to acquire equipment has a higher degree of control in the application rate, and therefore a more sophisticated pressurized system will be desired. If you are operating a more rural network of roadways, then a gravity-fed system could be all you need.

Still another factor is the **number of lane miles** you would consider pretreating. More lane miles to treat means more liquid chemical to apply. If your Agency only has 20 miles of road to treat, a simpler gravity-fed system could be all that you need to treat your roadways in a reasonable amount of time. Agencies that maintain hundreds of lane miles with various types of roadways in the network will need to implement more sophisticated systems with larger fluid capacities to cover these areas more quickly and efficiently, and therefore electronically controlled pressurized systems would be more desirable.

What are the planning or technical considerations? Figure 1 shows the schematic of a typical pressurized system. Gravity-fed systems are similarly constructed, but without the hydraulic pump and additional plumbing.



Schematic of a Typical Pressurized System

For both systems, holding tanks, ball valves, fittings and piping will need to be made of UV resistant polyethylene similar in type to what is used in agriculture to prevent corrosion. Corrosion is a problem for electrical systems as well, so weatherize them as much as possible.
Sizing of the tanks will depend on the number of lane miles to be treated and the weight and space capacity of the carrying vehicle. You may also consider purchasing the largest tank that will fit in/on the truck so future expansion of pretreating area can be accommodated.

What are the Potential Benefits?
Selecting the appropriate equipment for your operation is an important part of this process, with selection taking into account cost-benefit decisions.

What is the cost to implement? Cost to implement can vary greatly depending on how sophisticated the systems are. A simple shop fabricated (DIY) gravity-fed system can cost as little as $1,000 in parts, with most of that cost going to the purchase of the storage tank. The more sophisticated slide-in pressurized systems can be $13,000 to $15,000 each depending on the size of the storage tank and the sophistication of the electronic application rate equipment. This cost may be reduced if electronic spreader systems already installed on the vehicle can be utilized.

Where can I get more information?

- Salt Institute, Snow Fighter Handbook
  http://www.saltinstitute.org/wp-content/uploads/2013/07/Snowfighters_HB_2012.pdf

- Iowa DOT - Office of Maintenance: Brine Information
  http://www.iowadot.gov/maintenance/materials.html

- Equipment Manufacturers
  Examples include Compu-Spread, GVM Snow Equipment, Certified Power Inc. and Varitech Industries

6.3 CALIBRATION

What is it? Calibration is an important procedure and involves adjusting the spreader to apply known amounts of material at specific settings. A snow fighter needs to be confident that a spreader is delivering the specific amount of material requested. Regular calibration ensures that this will happen.

How does it work? Each spreader must be calibrated individually, and for each type of material. A typical calibration

will require a scale, a canvas or bucket, chalk or some other type of marker, a watch with a second hand, and a calculator. For some types of automated ground speed controls, a speed simulator may be required, although newer models have eliminated this necessity. Each calibration will normally take 30 to 60 minutes. Specific calibration procedures may be found in the reference material identified below.

How is this BMP Implemented? You will need to calibrate each piece of equipment, or at least confirm that the current calibration is still correct, annually and after any work performed on the equipment that affects the spreader operation.

What are the planning or technical considerations? Overall costs will depend on the type of spreader controls selected. Although initially more expensive, serious consideration should be given to automated spreader controls due to their ability to save money on materials because material is being supplied appropriately.

What are the potential benefits? The primary benefits of calibration include: controlling your costs, improving your level of service, and minimizing your impact on the environment. Poorly calibrated spreaders either waste materials and money or will not apply the necessary amount of materials to the road, creating unnecessary hazards.

What is the cost to implement? You should plan on approximately $2,000 to $6,000 per spreader to install minimum controls that can be reasonably calibrated. Return on investment may be as quick as the first season, depending upon current practices.

Where can I get more information?

- Maine Local Roads Center DVD (free)
  http://www.maine.gov/mdot/csd/mlrc/

- Salt Institute, Snow Fighter Handbook
  http://www.saltinstitute.org/wp-content/uploads/2013/07/Snowfighters_HB_2012.pdf

- Clear Roads Calibration Accuracy of Manual and Ground-Speed-Control Spreaders
  http://clearroads.org/project/calibration-accuracy-of-manual-and-ground-speed-control-spreaders/

- Controller Manufacturer Procedures/Manuals
  Examples include Compu-Spread, Cirus, DICKEY-John, FORCE America, Certified Power Inc. and Pengwyn.

6.4 TEMPERATURE SENSORS

What are they? Pavement temperature sensors are used to measure the pavement surface temperature, which is the point at which the bond between ice and the pavement takes place. Pavement temperature sensors can be hand held units, stationary units, or vehicle mounted. Two

common types of sensors used by snowfighters are non-contact infrared (IR) thermometers, and in-pavement temperature sensors.

A non-contact IR thermometer

How do they work? Non-contact **Infrared (IR) thermometers** are hand-held, stationary or vehicle mounted units that measure the amount of infrared energy emitted at the pavement surface. **In-pavement temperature sensors** are installed directly into the pavement and use thermistors to measure pavement temperature.

How is this BMP Implemented? For hand-held **IR thermometers**, acclimate the unit to ambient air temperatures prior to taking a reading for best accuracy. The pavement surface must be clear of snow and ice. Take a series of readings by pointing unit perpendicular to the ground and report the average reading to determine the pavement surface temperature. For vehicle mounted IR thermometers, pavement surface temperature readings are taken continuously as the vehicle moves down the roadway. Take readings from the dash mounted digital gauge. **In-pavement temperature sensors** are usually installed as part of more sophisticated systems that use data loggers connected to computer networks via wireless or land line services. Pavement surface temperature data, and a host of other data sets, are usually made available in real-time for use on a web based service provider or from an agencies' network if downloaded directly. In some instances, it may be possible to share this data with other agencies and municipalities.

What are the planning or technical considerations? Hand-held IR units are fairly straight forward to use, but do require some training. Vehicle mounted IR units should be mounted away from heat sources and have a clear view of the pavement beneath the vehicle. Stationary units in general, whether using an IR sensor or an in-pavement sensor, need to be strategically located to provide temperature information that can be extrapolated to a larger area with some degree of confidence. Locating a stationary unit will also require the identifying power and communication sources. Agencies and municipalities considering a stationary unit may also want to discuss cost sharing of the installation(s) with other municipalities or agencies that could benefit from these systems.

What are the potential benefits? Using pavement surface temperature information in conjunction with current and expected weather conditions will allow you to make the right call on chemical application rates and snow and ice removal methods. A warmer roadway surface requires less salt to melt ice and snow, and a colder roadway surface may require that additional chemical be used, such as pre-wetting with magnesium chloride. Knowing the surface temperature of the pavement will allow you to adjust your application rate to the appropriate amount needed to provide the desired level of service. This will help reduce your salt usage under some conditions (warmer pavement conditions in general), which will reduce your labor and equipment usage costs, and reduce the amount of salt that you are discharging to the environment.

What is the cost to implement? Hand-held IR units are usually $50 to $200 per unit, while vehicle mounted units are approximately $250 installed per unit. As noted, in-pavement sensors are incorporated into larger more sophisticated stationary weather systems that can range in costs from $3,000 to $20,000 depending on what other instruments are installed at the site and what power and communication utilities need to be installed.

Where can I get more information?

- Snow and Ice Management Association's White Paper on *Pavement Surface Temperature as the* Key

- Factor in Snow and Ice Control
  http://www.sima.org/

- NCHRP Report 526 *Snow and Ice Control Guidelines for Materials and Methods*
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_526.pdf

- Equipment Manufacturers
  Examples: Vaisala, Boshung America, Fluke

Section 7: Storage, Loading, and Washing BMP

7.1 SAND AND SALT STORAGE

What is it? Proper storage and handling of salt, sand-salt mixtures, and other solid deicing or dust control materials.

How does it work? Meeting proper siting and operational requirements for salt and sand-salt storage areas reduces the likelihood of damaging materials getting into the local water system or private wells. According to Maine law (38 M.R.S.A. §413 2-D), a storage area includes all salt or sand-salt piles, any building or buildings in which these piles are contained, and all locations where storage, mixing, loading, unloading or other associated salt or sand-salt activities occur. Any exposed pile discharges chloride to the groundwaters of the State of Maine is thus required to obtain a "waste discharge license" from Maine DEP, unless exempted.

How is this BMP Implemented?

Pile Management:

- All new storage areas registered after October 1, 1999 must comply with the registration, siting, and operational requirements of the Maine Department of Environmental Protection rule: Chapter 574, "Siting and Operation of Road Salt and Sand-Salt Storage Areas". Storage Site Selection: Store salt or salt/sand mix away from wells (300 ft. min), aquifers, catch basins, ditches, wetlands, streams and other surface waters. It is preferred to store material in an area which drains to the sanitary sewer.
- Store material on an impervious asphalt pad and regularly inspect integrity of pad
- Store material under cover to protect it from precipitation and wind. Weighted tarps can be used to cover the pile if a salt/sand shed is not available
- Use concrete barriers to keep the material within designated area
- Do not overload the storage shed
- Use proper material loading and handling procedures to avoid spills; Do not overload equipment
- Employ good housekeeping practices including spill clean-up and sweeping to reduce material tracking
- Routinely inspect piles and corresponding drainage areas for problems

Brine Management:

- Storage Site Selection: Store brine and mixing equipment away from wells, aquifers, catch basins, ditches, wetlands, streams and other surface waters
- Use secondary containment
- Install barriers to protect storage tank and mixing equipment from vehicle/equipment traffic
- Routinely inspect tanks, hoses, fittings, and corresponding drainage areas for wear or leaks
- Use catch basin covers during material transfer
- Develop and implement spill procedures

What are the planning or technical considerations? Selection of storage options may be limited by site and resource constraints.

- Map storage site drainage and water features; and
- Identify impervious surface, nearby wells, stormwater management structures, streams, etc. and use this information to guide storage, loading and handling decisions.

To better understand the options available under Maine law, contact Maine DEP for guidance. The Sand and Salt Pile Program is a cooperative effort of the Maine Dept. of Transportation (DOT) and Maine Dept. of Environmental Protection (DEP).

- Environmental and siting issues, including new sand/salt pile registration, should be directed to Erich Kluck at DEP - (207) 592-2068.
- Facility construction and municipal or county funding issues should be directed to Peter Coughlan at DOT - (207) 624-3270.

What are the potential benefits? Proper salt or salt/sand mix storage reduces costs by preventing product loss due to exposure, improving material handling, reducing equipment clogging and preventing surface and groundwater contamination. Similarly, proper storage and maintenance of brine prevents product loss, protects water quality and ensures compliance with federal and state laws.

What is the cost to implement? Storage costs vary greatly depending on the quantity of product being stored, the type of storage and the cost of materials and labor. Although the cost of siting and constructing storage may seem steep, it may be dwarfed by fines and/or penalties resulting from a potential water quality violation from DEP or USEPA.

Where can I get more information?

- Maine Revised Statutes 38 §413
  http://water.epa.gov/scitech/swguidance/standards/wqslibrary/upload/38-MRSA-413-2011-06.pdf

- Maine Dept. of Environmental Protection, *What to Know Before Starting A New Sand/Salt Storage Area*:
  http://www.maine.gov/dep/water/wd/sandsalt/whattoknow.htm

- Maine Local Roads Center, Maine DOT
  http://www.maine.gov/mdot/csd/mlrc/

- Environment Canada Road Salt Technical Document
  http://www.ec.gc.ca/nopp/roadsalt/en/rpt.cfm

- Transportation Association of Canada, *Synthesis of Best Road Practices Road Salt Management Section 7. Design and Operation of Road Maintenance Yards*
  http://tac-atc.ca/sites/tac-atc.ca/files/site/doc/resources/roadsalt-7.pdf

7.2 LOADING

What is it? Next to proper site selection and storage of winter de-icing materials, use of best practices for material handling and loading is one of the most effective means of limiting product waste, reducing costs and protecting water quality.

How does it work? Eliminates material spills during and after loading, prevents exposure of materials to the elements and reduces material tracking. These practices reduce product waste, limit the number of times the material needs to be handled and prevents environmental impacts to surface and ground waters.

How is this BMP Implemented? Provide a clear procedure to follow and train staff on that procedure

- Use only what you need
- Handle and load materials on an impervious pad to avoid seepage
- Handle and load materials under cover wherever possible
- Don't overfill or exceed capacity of equipment, particularly smaller equipment like holders, which could result in material spills along the travel route
- Clean-up after handling or loading product to reduce waste and material tracking, specifically sweep up any excess material on the ground surface
- Any material remaining in trucks or equipment after snow and ice control operations are complete should be returned to the stockpile to avoid water pollution

What are the planning or technical considerations? Develop material handling and loading procedures to meet the specific site and equipment needs. Minor alterations in practices (e.g., Load under cover) or site upgrades (e.g., Install loading pad) can improve operations and reduce environmental impact. Training for personnel is critical.

What are the potential benefits? Best management practices for handling and loading materials reduces product waste, handling time, spillage/tracking, and operations costs and helps the facility meet federal and state environmental protection requirements and avoid contributing to potential water quality violations.

What is the cost to implement? Implementation costs depend on the kinds of best management practices that will be used, but costs associated with developing materials loading/handling, and employee training are relatively low. Site upgrades or alterations tend to cost more.

Where can I get more information?

- Maine Dept. of Environmental Protection, *What to Know Before Starting A New Sand/Salt Storage Area*: http://www.maine.gov/dep/water/wd/sandsalt/whattoknow.htm

- Transportation Association of Canada, *Synthesis of Best Road Practices Road Salt Management:* http://tac-atc.ca/en/bookstore-and-resources/free-resources-and-tools/syntheses-practice

7.3 RINSING AND WASHING

What is it? Rinsing is different from **washing**, in that it is low pressure washing and no additives, like detergent or degreasers, are applied when rinsing. Therefore, *rinsing* can take place outside, preferably at a designated rinse point so excess sediment can be swept up regularly. However, *washing* uses higher pressure and is generally restricted to areas where washwater is directed to a holding tank or sanitary sewer. Washing includes steam cleaning, which dislodges grease, oils and other pollutants. Both rinsing and washing should include structural and operational controls to minimize or prevent pollution from vehicle washing activities.

How does it work? Outside: Wastewater from outdoor washing should be conveyed to a municipal wastewater treatment facility if practicable and authorized by the treatment facility. If a sewer is not available, wastewater from outdoor washing should be conveyed to a closed-loop, wash water recycling system, such as a holding tank, if practical. Otherwise, washing performed outside must take place on impervious areas to capture solids that sheets flow to a vegetated buffer and additives are limited to phosphate-free detergent only (i.e., no degreasers, waxes, etc.). No power washing or under carriage

spraying should take place outside. Preferably, only rinsing should take place outside. Furthermore, identifying a designated rinse point, where excess sediment is swept up regularly, will also help to control sediments from entering stormwater and receiving waters.

Inside: Wastewater from indoor washing should also be conveyed to an oil/water separator that is connected to either a municipal wastewater treatment facility (under an authorized agreement by the treatment facility) or closed-loop system, like a holding tank or washwater recirculation system. Power washing and under carriage washing should be performed in these areas only (e.g., inside connected to treated discharges). Knowing where all indoor floor drains discharge is imperative to avoid uncontrolled discharges to the environment and possibly to waters of the State.

How is this BMP Implemented?

- Washing should be limited to an area that connects or drains to a sanitary sewer, combined sewer not subject to combined sewer overflows (CSOs), or holding tank.
  - A holding tank that is managed appropriately (e.g., pumped out regularly and delivered to (and in agreement with) a wastewater treatment facility) is the preferred method for washing vehicles and equipment.
  - Areas draining to the sanitary sewer are the next preferred disposal option and, where possible, should be implemented only with the permission and assistance of the local sewer or treatment plant authority.
  - If connection to a holding tank or the sanitary sewer is not possible, the options include:
    1) Using a commercial car wash;
    2) Rinsing only to eliminate the discharge of detergent, degreasers and other pollutants;
    3) Conducting washing with phosphate-free detergent only on impervious surfaces directed to vegetated areas as sheet flow, away from storm drains and surface waters.
- Do not discharge into septic or stormwater drainage systems
- Unless a closed-loop, controlled system collecting the discharge
- Unless a closed-loop, controlled system (e.g., holding tank, sanitary drain, etc.), washing activities should be limited to:
  - Using only a phosphate-free detergent (**no other additives**, like degreasers or regular detergent should be used)
  - Rinsing only at a designated location
  - Limiting undercarriage washing and pressure washing
  - Steam cleaning and pressure washing is not recommended because it is more likely to dislodge grease, oils, and other potential pollutants from the surface of equipment.
- Use anti-corrosive products for washing, if possible**.** The use of non-toxic, biodegradable, phosphate-free cleaners with cold water is recommended. Use soaps and detergents sparingly.
- Water hoses should not be allowed to flow freely. Nozzles should be attached to all hoses to provide additional pressure and decrease overall usage of water.

What are the planning or technical considerations? Although not the preferred control for washing activity, runoff from certain outdoor washing activities performed on impervious areas may be directed to vegetated areas where it can infiltrate, provided this method does not cause erosion or sedimentation problems and is not located over sensitive areas, such as sand gravel aquifers.

- Verify that all floor drains and associated oil-water separators are connected to the sanitary sewer system and are registered with Maine DEP. When not in use these drains should be covered to protect them from spills.
- Holding tanks should be inspected and maintained regularly following Maine DEP recommended procedures and tested periodically to ensure that hazardous waste management and disposal rules do not apply.

What are the potential benefits?

- Compliance with state and federal laws (For example: In Maine, 8 M.R.S.A. § 413(1).
- Avoidance of the release of toxic chemicals, detergents, soaps, and steam or heated water into local waters, as well as avoidance of water quality standards.
- Prolonged vehicle lifespan by reducing corrosion.

What is the cost to implement? Costs range from $0 to that of installation of a covered outdoor or indoor washing station. It should be noted that wash water recovery systems and designated wash bays can run $50,000-$100,000 or more, depending on the scale of the operation and type of equipment. .

Where can I get more information?

- Maine Department of Environmental Protection, including *DEP Issue Profile: Outdoor Washing (DEPLW0514A, August 2013)* Available in the Municipal Toolbox Section of Maine's ThinkBlue website: www.ThinkBlueMaine.org

- Maine Revised Statutes 38 §413 http://water.epa.gov/scitech/swguidance/standards/wqslibrary/upload/38-MRSA-413-2011-06.pdf

7.4 SNOW PILE PLACEMENT

What is it? Careful siting and management of snow storage sites to avoid discharge of pollutants to surface or ground waters.

How does it work? Locate and design snow storage sites to prevent water pollution resulting from contaminated snowmelt, including pollutants collected in the snow pile and any that can be picked up as runoff moves across the site.

How is this BMP Implemented?

- Avoid storing snow on disturbed, unstabilized, or highly erodible sites
- Avoid storing snow at a highpoint where runoff is likely to collect sediment and other pollutants as it melts and flows downhill to a storm drain or surface waters
- Direct snowmelt and runoff to the sanitary sewer, wherever possible. If piled properly, this should not be an issue. Meltwater can be discharged to a vegetated buffer area providing there is a sufficient distance between the snow pile and nearby surface waters. Do not discharge snowmelt

The Maine DEP has established a set of best management practices for siting, operation and management of snow dumps (Maine DEP Chapter 573 – see reference). This chapter states: "Snow dump means a facility or area that is used for the storage or disposal of snow and incidental materials collected in the process of removing snow from public or private ways or parking areas" Bark mulch (i.e. erosion control mix) or silt fence should be used to control sediment, as opposed to straw bales. Staked straw bales are often incorrectly installed and are not recommended here as a BMP. Silt fences should be checked regularly to ensure they are still functioning properly. Under some circumstances, snow dumps might require a waste discharge license, be covered under an existing waste discharge license or general permit, or at least be registered with the state. For more information about silt fence installation, see Section 3 of Maine DOT's BMP Manual for Erosion and Sediment Control (2008): http://www.maine.gov/mdot/env/docs/bmp/BMP2008full.pdf

to a storm drain system unless it is specifically designed to treat pollutants commonly found in snowmelt (e.g., metals, hydrocarbons, sediment, etc.) before discharging to surface waters. Licensing is required for "discharges from meltwater to groundwater from snow dumps that are located wholly or partially within a significant sand and gravel aquifer" or to Waters of the State that do not meet setback/BMP design guidelines (Source: DEP Ch. 573).

- Do not plow or push snow into treatment systems, streams, brooks, wetlands or other surface waters; or into/onto storm drainage and/or treatment systems, including rain gardens, soil filters, porous pavement, swales or forebays associated with these treatment systems
- Specific to Parking Lots:
  - Snow should be stored on paved areas where melt water will not drain into a parking area where it could refreeze and cause the need to apply more salt.
  - Snow should be stored in low areas of the parking lot where puddles frequently form to deter use of that area by vehicles and pedestrians.
  - Snow piles should not block stormdrains
  - Do not push snow into small streams, onto stream banks, wetlands, lakes, ponds, or other natural areas. This will make clean-up of remaining debris difficult and harm the water quality and vegetation
  - If possible, snow should be stored in a sunny location to promote rapid melting.
- Specific to watershed management or permitted areas:
  - Snow should be stored in accordance with any Operations and Maintenance (O&M) Plan or permit requirements established for your facility.

What are the planning or technical considerations? Proper siting of snow storage areas requires careful site assessment in order to protect surface and subsurface waters from contamination and to prevent the illicit discharge of pollutants to the storm drain system. The Maine DEP has established a set of best management practices for siting, operation and management of snow dumps (see reference below). Under some circumstances snow dumps might require a waste discharge license, be covered under an existing waste discharge license or general permit or at least be registered with the state. Maine DEP Chapter 573 establishes best management practices and standards for snow dumps.

What are the potential benefits?

- Prevent surface and groundwater contamination
- Avoid water quality violations
- Compliance with federal and state laws
- Reduce long term water resource management costs

What is the cost to implement? Implementation costs vary greatly by site, but include site assessment, potential permitting, site improvements (e.g.: drainage, treatment, stabilization, etc.) and ongoing maintenance costs associated with sediment/erosion control and runoff management.

Where can I get more information?

- Maine Department of Environmental Protection: *Chapter 573. Snow Dumps: Best Management Practices for Pollution Prevention*
  http://www.maine.gov/sos/cec/rules/06/096/096c573.doc

- Transportation Association of Canada, *Synthesis of Best Road Practices Road Salt Management:*
  http://tac-atc.ca/en/bookstore-and-resources/free-resources-and-tools/syntheses-practice

- Canadian Parking Association, Technical Bulletin No 6. Best Management Practices for Salt Use, 2005, www.canadianparking.ca/files/Bulletin_6%20Best%20Mgnt%20Practices%20for%20Salt%20Use.pdf

- Minnesota Winter Parking Lot and Sidewalk Maintenance Manual, 2010, www.pca.state.mn.us/index.php/view-document.html?gid=13562

7.5 SNOW MELTING EQUIPMENT

Snow storage is often overlooked or underestimated in the course of site planning and can become a challenging and expensive management issue during the winter months. Space must be found on site for snow storage or the snow must be hauled to designated off-site snow dumps at significant expense. During the most challenging winters some communities use or explore the feasibility of using snow melting equipment to dispose of snow when they run out of traditional options for storing it.
While melting equipment can be an effective snow management tool, there are several important factors to consider before deciding to make the investment:

- **Snow melting operations cannot discharge *directly* to surface waters or a storm drain (MS4):** Snow melters are designed to screen out trash, aggregate and heavier sediment, but not fine sediment, hydrocarbons or other pollutants found in snow melt. Steps must be taken to manage both the volume and pollution content of meltwater runoff prior to discharge to a storm drain or surface water. Where possible, such discharges should be directed to the sanitary sewer system in cooperation with the local POTW. Facilities operating under a Multi-sector Industrial Stormwater Permit should determine how snow melting operations might impact their Stormwater Pollution Prevention Plan (SWPPP). For guidance on stormwater pollution prevention Best Management Practices (BMPs) for snow melting operations contact the Bureau of Water Quality at the Maine Department of Environmental Protection (Maine DEP): https://www1.maine.gov/dep/water/index.html.
- **An Air Emissions License may be required**: Air emissions from snow melting equipment, particularly diesel-fueled melters, may be regulated by the Maine DEP. Contact the Bureau of Air Quality for information on licensing and guidance on air pollution prevention BMPs: https://www1.maine.gov/dep/water/index.html.
- **Snow melters are expensive:** A typical unit costs $150,000-200,000 or more; Depending on the scale of the operation more than one unit might be necessary to meet the snow melting demand of a community or large facility.
- **High operating costs:** Melters usually burn diesel or natural gas to melt snow and fuel consumption for diesel models typically runs between 50-200+ gallons per hour, depending on the capacity of the unit.
- **Staging considerations:** Snow melting operations must be carefully located on sites where heavy equipment noise, truck traffic and air emissions will not be problematic and where proper wastewater disposal or treatment options are available.

Where can I get more information?

- State of Colorado Low Risk Discharge Guidance: Discharges from Snow Melting Machines, June 2008: https://www.colorado.gov/pacific/sites/default/files/WQ%20LOW%20RISK%20SNOW.pdf

- The City of Calgary Water Resources: Application Information for Commercial Snow Melter Drainage Permits, October 2011: http://www.calgary.ca/UEP/Water/Documents/WaterDocuments/Commercial_Snow_Melting_Blanket_Drainage_Permit%20Information.pdf?noredirect=1

7.6 PARKING LOTS

What is it? The concern for pedestrian safety and the fear of "slip and fall" lawsuits often leads to over salting and sanding of parking lots, especially if they are maintained by a private contractor. Many streams near large parking lots have high chloride levels as a result of runoff from these over-salted areas. Because the groundwater near these areas may become contaminated with salt from the runoff, some of these streams have high chloride even during summer, when the streams are fed mainly by groundwater.

How does it work? Parking lot BMPs try to balance the often high level of service needs for parking lots, while minimizing the overuse of materials and the impact on local water.

(*Excessive salt use in parking lot*).

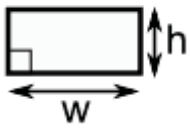
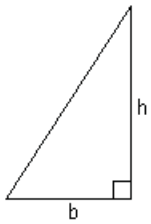
How is this BMP Implemented? At a minimum, the BMPs in this manual should be followed for parking lots:

- When deicing, always plow prior to applying salt/deicer.
- Follow salt/deicer temperature specifications and application rate guidelines.
- Broadcast spreaders should be used on parking lots to provide rapid coverage since traffic cannot be relied on to spread the salt around as much as traffic does on a road.
- In high salt areas (which most commercial and retail parking lots are), take steps to make sure that the salty stormwater is not getting into the ground. For example, do not plow on to pervious areas such as grass or vegetated areas (unless they have been designed as a buffer). Instead keep snow banks on pavement which drains to a secure stormwater system.
- It is hard to push shopping carts through salt and sand accumulations in parking lots. Clean up excess, or better yet, apply only appropriate amounts.
- Handicap parking spots should not get excess salt and sand. Excess may cause more harm than good.
- Consider patterns of sun and shade on your individual site. Areas with more sun exposure will likely see faster melting than more shaded areas. However, meltwater from sunny areas may refreeze and require additional salt. If parking spaces exceed needs, consider closing more shaded spots during the winter season. Also consider closing access to parking spaces where meltwater drains and then refreezes.

Roads usually have traffic to mix the salt and snow and will clear quicker than parking lots which have less traffic that is slower moving. You may be able to use less deicer in high traffic areas of parking lots, like driveways and entrances, compared to the low traffic areas of the lot. Consider avoiding spreading

deicer on the service road in front of the buildings and instead spreading on the traffic lanes and back service roads to allow the traffic to spread the deicer near the building where foot traffic is higher. This approach reduces tracking into the building and over-application in a high-traffic area.

The amount of deicer needed is based on the size of the parking lot. To calculate the area, review a scaled map of the facility so you can calculate areas. Determine the size of the area that will be treated. Measure the area to be treated using the following calculations:

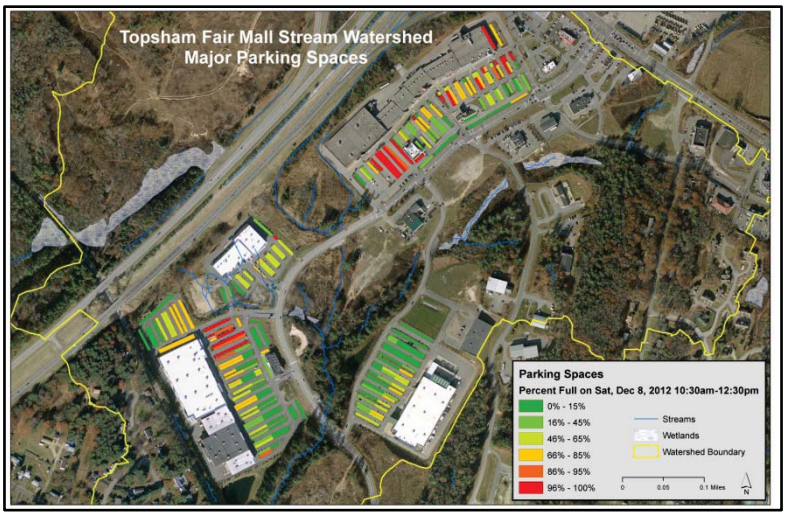
The area or square feet of a square or rectangle is **Length (L) X Width (W)** 	The area or square feet of a circle is **π r²** or **3.14 x (r x r)** where the radius (**r**) is half of the distance across the circle. 	The area or square feet of a right triangle is **Base (b) X Height (h) divided by 2** 

Measuring your area along with knowing the pavement temperature will allow you to use application rate charts. A good source for application rates can be found in the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual (2010) which can be downloaded from: https://deicemandave.files.wordpress.com/2014/09/parkinglotmanual-june061.pdf

Salt should never be used to reduce snow piles or to open frozen stormdrains. Instead, use a heat source to open frozen stormdrains.

What are the potential benefits?

- Salt only needs to melt 1/16 inch to prevent the bond between the pavement and the ice. Save money by applying salt before the ice bonds so you don't need to melt through it.
- Prevent surface and groundwater contamination.
- Avoid water quality violations.
- Compliance with federal and state laws.
- Reduce long term water resource management costs.



In many parking lots, even on the busiest shopping days of the year, there is often extra parking which could be cordoned off for the post-holiday winter season.

What are the planning or technical considerations? At the beginning of the season, calculate the area of the parking lot, service roads, and sidewalks to assist with estimating materials to order and for use

later in determining how much material to use. Identify snow storage areas before snow cover. Check that the stormwater system is secure and not leaking into the groundwater table.

Consider reducing the area to plow/salt by closing off low-use areas of the parking lot after the busy holiday season. Handicap parking spots are often over salted and over sanded. They should get the same amount of material as other areas. If the groundwater is contaminated with chloride or is at risk of being impaired by chloride because the parking area drains to a pervious area or a stormwater filtration system, consider using non-chloride deicers (such as acetate or sodium formate).

What is the cost to implement? Although additional time may be required to assess and calculate the higher and lower traffic areas, savings may be realized by minimizing the amount of salt and abrasives applied as a result of the pre-planning.

Where can I get more information?

- Canadian Parking Association, *Technical Bulletin No 6. Best Management Practices for Salt Use*, 2005, www.canadianparking.ca/files/Bulletin_6%20Best%20Mgnt%20Practices%20for%20Salt%20Use.pdf

- Minnesota *Winter Parking Lot and Sidewalk Maintenance Manual*, 2010 www.pca.state.mn.us/index.php/view-document.html?gid=13562

Section 8: Location-Specific BMP

8.1 SIDEWALK & BUILDING ENTRANCES

What is it? Despite their somewhat small area, sidewalk and building entrances often are salted and sanded at a higher rate due to fear of "slip and fall" lawsuits. Sidewalks are often the most over-salted of all areas in winter maintenance. Sidewalks are the area of highest tracking into the building. Extra salt and sand contribute to slippery entryways inside the building. This section describes what the basic BMPs are for sidewalks and building entrances.

How does it work? Using BMPs assures these surfaces are safe for pedestrians while not wasting product, reducing product being tracked into the building, and reducing harm to local vegetation, streams, and groundwater.

How is this BMP Implemented? Focus on aggressive mechanical removal of snow. Always remove snow prior to applying deicer. The less snow, the less deicer required resulting in a safer walking surface. Do not use a scoop for deicer distribution. Use hand-held spreaders or drop spreaders rather than broadcast spreaders to increase the amount of salt that ends up on the sidewalk. This makes the dispersed salt more effective and protects nearby landscaping vegetation. If you are using a broadcast/rotary spreader, adjust the opening to limit dispersion of material onto the sidewalk or install shields to restrict the spread pattern.

Look for opportunities to close extra entrances during the winter to reduce the need to use chemicals on all sidewalks and steps.

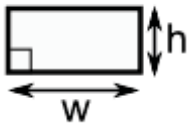
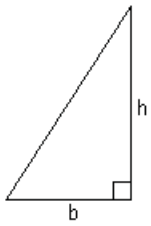
Guidelines for spreading deicer on steps, stairs, and small sites:

- Even spread pattern of granules, aiming to avoid the clumping of granules.
- No piles of deicer.
- No deicer on dry pavement.
- No deicer in vegetation.

Example of overuse and poor spreading of deicer on stairway.

If you are not responsible for sidewalk maintenance, consider providing this information to the building occupants to educate them on these best practices for winter maintenance.

The amount of deicer needed is based on the size of the sidewalk/entranceway. To calculate the area, review a scaled map of the facility so you can calculate areas. Determine the size of the area that will be treated. Measure the area to be treated using the following calculations:

The area or square feet of a square or rectangle is **Length (L) X Width (W)** 	The area or square feet of a circle is **π r^2** or **3.14 x (r x r)** where the radius (**r)** is half of the distance across the circle. 	The area or square feet of a right triangle is **Base (b) X Height (h) divided by 2** 

Measuring your area along with knowing the pavement temperature will allow you to use application rate charts. A good source for application rates can be found in the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual (2010) which can be downloaded from:
https://deicemandave.files.wordpress.com/2014/09/parkinglotmanual-june061.pdf

What are the potential benefits? Aggressive snow removal leaves less snow, which requires less deicer and creates a safer walking surface. Hand-held spreaders provide more even distribution, reduce the amount needed, reduce tracking into buildings, save money due to reduced material application, and reduce impact to the building from corrosion. Hand-held spreaders save at least 50% of the salt used spreading with a scoop, without reducing the level of safety.

What are the planning or technical considerations? Explore closing any extra non-essential, high maintenance building entrances during the winter. Heated or textured mats may work for small problem areas such as sidewalks or steps. However note that deicers can harm heated sidewalks.

What is the cost to implement? Although additional time may be required to assess and calculate sidewalk and entranceway, savings may be realized by minimizing the amount of salt and abrasives applied as a result of the pre-planning.

Where can I get more information?

- Canadian Parking Association, *Technical Bulletin No 6. Best Management Practices for Salt Use*, 2005, www.canadianparking.ca/files/Bulletin_6%20Best%20Mgnt%20Practices%20for%20Salt%20Use.pdf

- Minnesota *Winter Parking Lot and Sidewalk Maintenance Manual*, 2010 www.pca.state.mn.us/index.php/view-document.html?gid=13562

Appendix A: Impacts from Chlorides

Appendix A1 ECONOMIC IMPACTS

Infrastructure

- Chloride ions increase the conductivity of water and accelerate corrosion.
- Chloride can penetrate and deteriorate concrete on bridge decking and parking garage structures, and damage reinforcing rods, compromising structural integrity. (City of Madison Wisconsin, 2006; Shi et al., 2009).
- Chloride ions from road salt may cause corrosion from pitting and severely damage stainless steel structures (Asaduzzaman et al., 2011).
- Abrasives will have a "sand-blasting effect" on some surfaces and also collect in hidden places and retain moisture in bridge joints and on beams and abutments/piers. (City of Madison Wisconsin, 2006).
- It damages vehicle parts such as brake linings, frames, bumpers, and other areas of body corrosion. (City of Madison Wisconsin, 2006).
- It impacts railroad crossing warning equipment and power line utilities by conducting electrical current leaks across the insulator that may lead to loss of current, shorting of transmission lines, and wooden pole fires. (City of Madison Wisconsin, 2006).
- The cost of corrosion damage and corrosion protection practices for highways and the automobile industry have been reported to cost a staggering 16-19 billion dollars a year. (City of Madison Wisconsin, 2006).

Equipment

- In comparison to other regions in the United States, the Northeast experiences extremely high automobile corrosion rates, primarily due to atmospheric corrosion (exposure to pollutants in the air) stemming from deicing salts (Tullmin & Roberge, 2000).
- Sodium chloride causes vehicle corrosion, resulting in potentially significant repair expenses for families, schools, commercial businesses, and governments (Rubin et al., 2010).
- The corrosion-related cost to American consumers with regard to automobiles is estimated at approximately $23.4 billion per year. This is divided up into three components: (1) increased manufacturing cost due to corrosion resistant materials and engineering ($2.5 billion), (2) repairs and maintenance necessitated by corrosion ($6.5 billion), and (3) corrosion-related depreciation ($14.4 billion) (FHWA, 2001).
- There are potentially significant costs associated with properly **rinsing** public works and safety vehicles to protect the fleet from corrosion, while also minimizing environmental impacts from **washing**[1]. Other associated costs include expenses for connecting wash areas to holding tanks for washwater, installing washwater recirculation systems, capturing washwater via other methods (e.g., sewer or septic), and directing washwater to vegetated buffers[2].

[1] Please note that RINSING is different from WASHING, in that NO ADDITIVES, like detergent or degreasers, are applied when RINSING. Therefore, RINSING can take place outside, preferably at a designated rinse point so excess sediment can be swept up regularly. However, WASHING is generally restricted to areas where washwater is directed to a holding tank or sanitary sewer.

[2] "Directing washwater to vegetated buffers" can only be done when limiting additives to phosphate-free detergent (i.e., no other additives can be used, such as waxes, degreasers, etc.).

Salt Storage

- Salt storage facilities are critical for reducing large-scale point-source pollution from road salt. Costs of these facilities vary, depending on amount of material, quality of storage facility, and types of structures.
- Typical costs for any building is now $100+/- per cubic yard of storage which could range from Quonset style to "stick built" .
- DEP rule Chapter 574 covers the minimum requirements for new or relocated pile sites. They require a covered paved pad with lateral containment barriers. This could be at least $50,000 to build.
- Doing nothing and letting piles remain exposed to the elements could lead to:
  1. Receiving DEP non-compliance/fines, and/or
  2. Replacing local drinking water wells or adding new water mains, and
  3. Losing salt through dilution from precipitation and runoff, and
  4. Losing macroinvertebrate organisms in affected streams, and/or
  5. All of the above.
- Well contamination claims can be common in Maine and ultimate remediation of a contaminated aquifer or water source can be costly.
  1. USEPA has established a Secondary Maximum Contaminant Level (MCL) of 250 mg/L in drinking water.
  2. In October 2012, Maine's Center for Disease Control, an office of the Department of Health and Human Services, established a Maximum Exposure Guideline (MEG) for sodium (Na) of 100 mg/L for healthy people, and 20 mg/L for people on a sodium-restricted diet.
  3. For more information about MCLs:
  4. http://water.epa.gov/drink/contaminants/secondarystandards.cfm
  5. For more information about MEGs: https://www1.maine.gov/dhhs/mecdc/environmentalhealth/eohp/wells/documents/megtableoct2012.pdf

Material Costs

- According to Rubin et al (2010), on average, Maine municipalities spent almost 70 million dollars on winter road maintenance in 2008-2009 and used 55% of the total salt statewide.
- According to MaineDOT , they spent an average of $6 million on winter road maintenance over the last 5 years, with the high cost being $9million and the low cost being $5 million and used an average of 110,000 tons of salt annually. Compared to other New England state DOT's, MaineDOT uses less salt per lane-mile than all other New England States.

Accidents

- The average cost of crashes year-round in Maine over a 10 year period (1999-2009) was $1.5 billion dollars (Rubin et al., 2010, p. 58).
- Total crash costs are declining in Maine due to fewer crashes year-round on Maine roadways.

Commerce

- According to a study funded by the Salt Institute (2011), blizzards that shut down roadways may cost between $62 and almost $600 million per day in lost wages, sales, and revenue, depending on the state. During winter storms, wind can play a role in shutting down highways, as well as snow and ice.
- Further research is needed to quantify the economic benefits of clear roads for the trucking and business industries. *

Remediation

- According to a 2004 report in the *Maine Townsman*, well-water contamination claims may cost municipalities thousands of dollars in assessment costs. If contamination is discovered, remediation may cost tens of thousands of dollars (Taylor et al., 2004, par. 2).
- Actions taken to investigate and remediate salt contamination of private wells may include well replacement, connection to public water supplies, water treatment, improvements in highway drainage and use of salt substitutes. For more information on the annual cost of addressing chloride contamination of wells contact either Maine DEP or the Maine Municipal Association.

*Additionally, a useful report that is often cited in the literature is the Transportation Research Board's (1991) Special Report 235 on Highway Deicing: *Comparing Salt and Calcium Magnesium Acetate*, which can be downloaded from: http://onlinepubs.trb.org/onlinepubs/sr/sr235.html

Appendix A2 SOCIAL AND PUBLIC SAFETY IMPACTS

Crashes

- Research indicates that as road conditions deteriorate (e.g. icy roads) crash frequency increases (Usman et al., 2010). Factors such as traffic volume, visibility, and precipitation must also be considered.
- Over the last decade, Maine saw a significant reduction in fatalities on its highways during the winter months (Rubin et al., 2010). Rubin et al. (2010) note that safer cars and safer roads both contribute to this reduction.
- Research demonstrates that salt runoff into roadside ditches and depressions attract animals such as moose and deer thus increasing the likelihood of animal collisions with motor vehicles (Grosman, Jaeger, Biron, Dussault, & Oellet, 2011)

Surface Water, Groundwater and Drinking Water Contamination

- In accordance with US EPA's drinking water limit and Maine CDC's MEG, concentrations of sodium in drinking water should not exceed 100 mg/L for the average person and 20 mg/L for people on a restricted diet, and chloride levels should not exceed 250 mg/L (US EPA and Maine CDC, 2015).
- According to the Maine water quality standards[3], concentrations of chloride in freshwater bodies should not exceed 860 mg/L at any one time (i.e., CMC) or should not remain above 230 mg/L for prolonged periods of time. There is currently no CMC or CCC for Sodium. Magnesium or Calcium.

Mobility

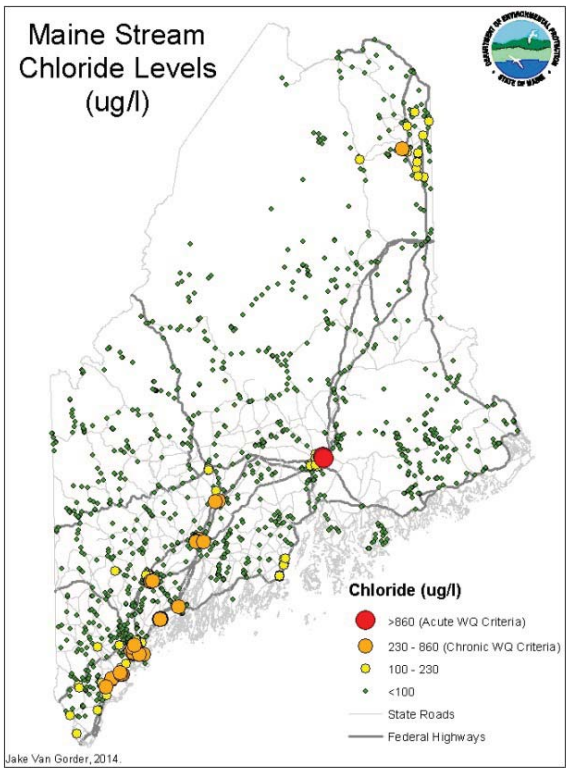
- Due to improved winter roadway maintenance, people can travel more during winter months in Maine (Rubin et al., 2010)

[3] Maine water quality standards are included in the Code of Maine Rules (CMR) Chapter 584 – Surface Water Quality Criteria for Toxic Pollutants that is administered by the Maine Department of Environmental Protection (DEP). The Criteria Maximum Concentration (CMC) for chloride in freshwater is 860 mg/L, while the Criterion Continuous Concentration (CCC) is 260 mg/L.

Appendix A3 ENVIRONMENTAL IMPACTS

Streams

Over time salt has accumulated in the groundwater and wells near roads, parking lots, snow dumps and road salt stockpiles. Salt can be retained in groundwater for a long time. As groundwater becomes saltier, so do the streams that are fed by groundwater. Due to the relationship between groundwater and streams, Maine DEP has discovered urban streams with higher than average chloride levels during the summer months. These streams are also vulnerable to salty runoff from impervious surfaces and DEP has found spikes of toxic chloride during the winter and early spring in these same streams. So the salt is reaching the stream from two sources, groundwater and snow melt running off pavement.



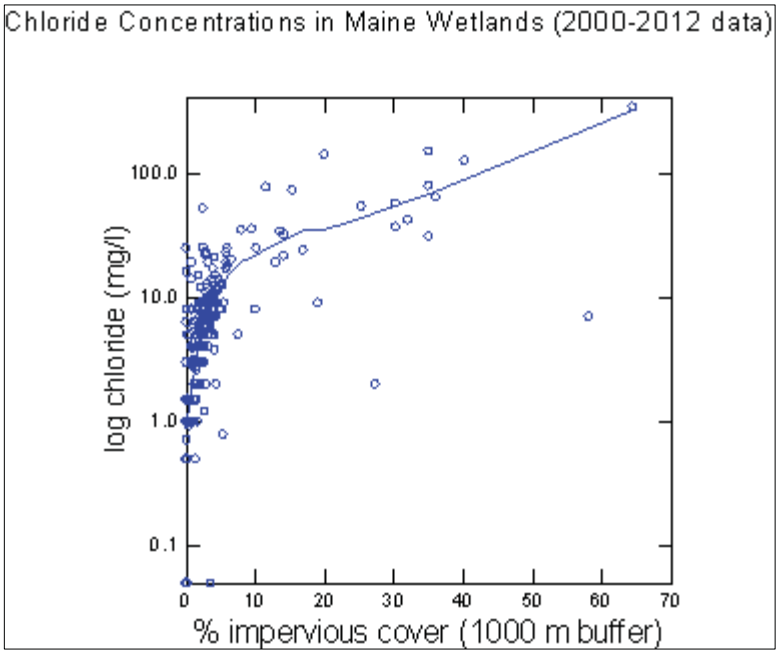
Since "dilution is the solution to pollution", the smaller the stream, the greater the impact of salty runoff. Small streams generally respond more quickly to the influence of runoff that drains from surrounding land. Therefore the size of the receiving stream is important when formulating potential remedies to reduce the influence of salt. Not all conditions are the same and local solutions need to reflect where the runoff is going, the size and characteristics of the receiving stream, and how many roads, parking lots and other impervious surfaces are draining into the stream.

Streams near large shopping plazas (with lots of parking and sidewalks) often have high chloride in winter and early spring. Some of these streams, those mainly fed by groundwater, even have high chloride during summer if the groundwater is contaminated by salt.

Wetlands

Road salt runoff has potentially serious adverse effects on wetland biota, including invertebrates, amphibians and plant communities. Freshwater salinization from road deicers causes both direct and indirect impacts to wetland plants, animals and food web structure, even at relatively low chloride concentrations (Lob and Silver, 2012, Van Meter et al., 2011). For example, salamander growth may be reduced in breeding sites having only moderate salt contamination due to toxic effects on their invertebrate prey. Amphibian abundance and diversity has also been shown to decline with increasing chloride levels (Petranka, et al., 2013, Sadowski, 2002). High salt concentrations impact vegetative communities by reducing native species abundance, richness, evenness, and overall cover. Chloride contaminated surface or ground-water results in significant loss of wetland biodiversity as native plant communities are replaced by more salt-tolerant, opportunistic and/or invasive species such as narrow-leaf cattail (Typha augustifolia), common reed (Phragmites australis) and purple loosestrife (Lythrum

salicaria). Widespread replacement of natural plant communities with these species severely degrades critical nesting and breeding habitat for birds and other wildlife. Wetland restoration sites receiving high chloride concentrations in salt runoff may develop plant assemblages that vary significantly from the target species, which should be considered in the planning process (Panno et al., 1999, Richburg et al., 2001, Miklovic and Galatowitsch, 2005). Studies show that chloride accumulates in wetlands from year to year, resulting in increasing concentrations throughout spring and summer even after salt application has ceased (Sadowski, 2002).



Lakes

- In freshwater locations where sodium chloride is applied for deicing, chloride concentrations of urban lakes have increased to levels that can change natural lake-mixing behavior and influence aquatic life (Novotny & Stefan, 2010).
- Studies show that previously contaminated, chloride-enriched groundwater continues to seep into lakes, even after salt application load is reduced (Toran et al., 2010).

Drinking Water

- 60% of drinking water in Maine comes from groundwater sources and about 40% of Mainers rely on private groundwater wells for their drinking water. (Maine Geological Survey, Water Resources in Maine)
- Two-thirds of Maine residents supplied by public water systems are supplied by a few large systems, such as those serving Portland, Lewiston/Auburn and Bangor, which use surface water sources (ASCE Report Card, December 2012)
- Sodium chloride has the potential to contaminate drinking water resources through infiltration to groundwater after runoff or direct runoff to surface water.

Soil

- Road salt can mobilize heavy metals in soils (Nelson et al., 2009) and decrease heavy metal (copper, zinc, cadmium, and nickel) retention in stormwater treatment systems (Tromp et al., 2012).
- Road salt impacts soil chemistry, structural composition (Findlay & Kelly, 2011), and dissolved organic carbon (DOC) levels (Green et al., 2009).
- Impacts of road salt (sodium chloride specifically) vary with soil chemistry (Nelson et al., 2009) and type (Olofsson & Lundmark, 2009), prior soil exposure to sodium chloride (Green et al., 2009), and the bioavailability of the released compounds (Nelson et al., 2009).

Aquatic and Semi-aquatic Life

- High levels of chloride (above 1300 mg/L) may be toxic to freshwater mussels (Gillis, 2011), the most endangered group of animals in North America (ME Inland Fisheries & Wildlife, 2010, par. 7).
- Many amphibians breed in agricultural or stormwater ponds, which become reservoirs of road-deicing agents when located along or near roads. In New England, researchers found road salt contamination in vernal pools up to 172 meters from the highway, although road salt concentrations decrease exponentially with increasing distance from the road (Karraker et al, 2008).
- Amphibians exposed to high concentrations of sodium chloride experience significant physiological changes, such as slower developmental rates (Karraker et al., 2008) and slower movements that may decrease the likelihood of escaping predators (Denoel et al., 2010). The potential aquatic toxicity of liquid agents has not been thoroughly studied and thresholds at which these products affect aquatic organisms are largely unknown. (Government Engineering, March –April 2014).

Roadside Vegetation and Urban Tree and Plants: Road salt and other chloride products can impact street trees and plants in two ways:

1) Salt spray can adversely affect foliage and buds, and
2) chlorides dissolved in stormwater runoff can soak into the soil around plants resulting in poor water and nutrient exchange between the soil and roots, increased soil toxicity (as a result of heavy metal mobilization and salinity) and increased soil compaction, which further reduces the ability of plant root systems to access water and air.

Winter sand, usually treated with salt, can contribute to these problems if not properly cleaned up in the spring. The impacts of chlorides are manifested in multiple ways including "poor growth, stunted leaves, heavy seed loads, twig and branch die-back, leaf scorch and premature leaf drop" (Gould, 2013) and even death of the plant. Rain gardens, vegetated soil filters and other vegetated green infrastructure systems may be particularly susceptible to the adverse effects of road salt unless they are designed and maintained to flush excess chlorides out of the soil.

The best approach for minimizing the adverse impacts of chlorides on streetscape vegetation is to avoid *excessive* use of road salt and sand on sidewalks, streets and parking areas. In areas where salt spray is a problem, screens or barriers can be installed during the winter months to protect sensitive vegetation. Salt-tolerant trees and plants may be used in streetscape applications where the use of road salt and deicers is unavoidable. Finally, a good maintenance program is essential to preserving the health of street trees and vegetation. This includes the removal of excess road sand and salt, soil aeration and the use of organic soil amendments, where necessary, to promote a healthy environment for the plants.
Also, invasive plant species tend to persist in salt contaminated areas where salt-intolerant vegetation has declined (Rubin et al., 2010).

Impacts of Sand to Streams, waterbodies, and the Air

The time-tested and typical use of sand for winter operations seems pretty innocuous to most people but it creates significant impacts to aquatic life and air quality. Historically, sand was the most commonly used winter maintenance product up until about the turn of the century. Typically it was mixed with about 100 pounds of salt per cubic yard to keep it from freezing in the pile and provide some melting on the roads. Over a winter, a typical two lane road might have been covered with about 50 to 100 cubic yards of this salted sand.

Sand does not melt snow. Sand provides limited traction on many roads but has to go somewhere after the winter season. It either stays on the road or gets moved or pushed or blown off the road. As the sand degrades, it becomes airborne and can create large dust clouds and decrease air quality and visibility to zero. As an air pollutant, sand can contribute to particulate matter (PM_{10}) in the air.

Mechanically picking up sand with sweepers or brooms also can create large dust clouds plus disposal issues. More importantly, much sand, or its finer components of minute particles, can be easily washed into ditches, streams, lakes and ponds, and other waterbodies. This sediment can have the following impacts:

- Cloudy water makes it difficult for fish to see and feed properly and it can damage their gills which impairs breathing;
- Finer particles in cloudy water can "scour" aquatic plants and animals;
- Cloudy water reduces sunlight penetration and inhibits photosynthesis in aquatic plants;
- Sediment deposits settle on the bottom and cover fish spawning habitat;
- Finer articles in cloudy water can "scour" aquatic plants and animals;
- Sediments can build up in streams , resulting in shallower and wider streams, which can cause them to heat up more quickly than deeper streams; and
- Sediments carry and store toxic materials that can contaminate small organisms.

If sand does not reach a waterbody, then it can easily fill up ditches, cover up vegetation, fill in catch basins, and require more maintenance.

As roadside ditches fill up with sand, they need to be maintained. The greatest cause of phosphorus release comes from soil exposed during the ditching process. Therefore, more ditching releases more phosphorus to the environment.

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