



Wisconsin Winter Maintenance Manual

Parking Lots, Sidewalks and Trails

Created by Fortin Consulting Inc. for the City of Madison Wisconsin Salt Wise Certification Program for Parking Lots, Sidewalks and Trails. Adapted from the Minnesota Pollution Control Agency's Smart Salting Program.

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Acknowledgements

Project Leader:

Phil Gaebler – City of Madison, Engineering Division

Advisors:

Christal Campbell – Dane County Land & Water Resources Department

Angie Dahl – Epic

Catherine Harris – Madison Metropolitan Sewerage District

Doug Jerdee – City of Madison, Engineering Division Operations

Emily Jones – Madison Metropolitan Sewerage District

Hannah Mohelnitzky – City of Madison, Engineering Division

Dan Nelson – City of Madison, Water Utility

Susan Sandford – Dane County Land & Water Resources Department

Rob Stickney – City of Madison, Parking Utility

Training Manual Development:

Jessica Jacobson – Fortin Consulting

Connie Fortin – Fortin Consulting

Lauren Schultzenberg – Fortin Consulting

Photo Credits:

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Angie Dahl and Justin Dahl

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The outline and major topics for this manual came from the training content.

Former City of Madison Mayor Soglin

Mayor Soglin had the vision to have a certification program.

Introduction

Since the 1950s, the chloride levels in the Madison, Wisconsin metropolitan area surface waters and groundwater have been increasing. Much of the chloride comes from the road salt applied during the winter. In response to the increasing chloride levels, then Madison mayor Paul Soglin directed the creation of a voluntary certification program to educate winter maintenance professionals and decision makers about the chloride problem and the many winter maintenance practices that could be used to reduce salt without compromising safety.

This manual was created to accompany the City of Madison's Winter Salt Certification training. It is a guide to help educate winter maintenance professionals who maintain sidewalks, parking lots and trails about how to use salt responsibly. It contains the high-level building blocks of winter maintenance and is not intended to be a comprehensive collection of information on winter maintenance. Instead of reading this manual in one sitting, use this manual as a reference book. Each organization may find different value in each chapter and can adopt practices that fit their organization's needs.

The goal of the training program and this manual is to reduce the amount of chloride entering Wisconsin's groundwater and surface water.

Chapter 1: Impacts of Winter Maintenance

Overview

All deicers and abrasives used in winter maintenance impact the environment. Water pollution is a notable problem caused by deicing practices. Only two and a half percent of all the water on Earth is fresh water, only a small fraction of the fresh water (less than one percent) is accessible for use.¹

Water in urban areas is more at risk of chloride pollution from winter maintenance.^{2,3} In urban areas, water drains from impervious surfaces, which includes roads and parking lots, through storm drains. In places that have separate stormwater and sanitary sewer systems, storm drains transport water to a lake, river or stream. This water is not sent to a treatment plant first, which means that chlorides and any other pollutants in the stormwater runoff end up in local waterways. Even in areas with combined sewer systems, many treatment plants are not able to remove chloride from the water without costly upgrades to their facilities.



Water and pollutants that enter storm drains go into the nearest surface water.

In rural areas, water drains through networks of drainage tiles and ditches. Rural areas have less roads, sidewalks and other impervious surfaces, which relates to less chloride pollution from winter maintenance in surface waters.^{2,3}



Photo credit: Paolo Vegilo

You have the power to reduce the effects of winter maintenance pollution on our water.

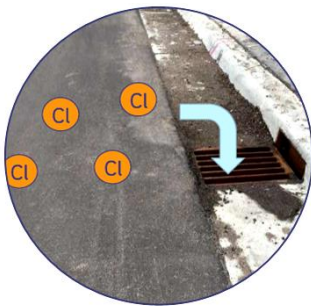
Everyone has the power to protect our water. By making smart, informed and advanced decisions about winter maintenance, you can protect the water and continue to keep people safe.

This manual includes tips and strategies to practice responsible and effective winter maintenance. Use these tips to promote innovation within your organization and become a leader in winter maintenance.

Winter Maintenance Material Pollution Overview

Chlorides (salt)

Most common deicers contain chloride



- Road salt contains chloride.
- Chloride is a toxic pollutant.
- Chloride is very difficult and costly to remove.

Abrasives

Sand



- Collects oils and grease
- Clogs storm drains and fills in water bodies
- Clouds water

Non-chloride deicers

Acetates and agricultural by-products



- High biochemical oxygen demand, which lowers oxygen levels in water and can harm aquatic life

Chloride: long-lasting impact

Most common deicers, like rock salt (NaCl), magnesium chloride (MgCl_2) and calcium chloride (CaCl_2), contain chloride. Chloride can be toxic to aquatic life at certain levels. Wisconsin established chloride water quality standards of 395mg/L (chronic) and 757mg/L (acute).⁴ Once chloride is in the water, there is no simple way to remove it. Chloride is considered a permanent pollutant because it does not break down, but accumulates in water. Because road salt accumulates in water and soil, it is expected to take years or decades until the reduction of salt use will result in reduction of salt levels in the environment.⁵

Abrasives: impact on aquatic life

Winter abrasives (sand) can clog storm drains and fill in water bodies. Abrasives can also cloud water, irritate fish gills, and cover habitat, all of which harm aquatic life. Oil and grease from cars can also become attached to sand and be transported into our waters.

Non-chloride deicers: highly visible, but shorter lasting impacts

Organic products, such as acetates or agricultural additives (i.e. beet juice, molasses, distillers' solubles, and corn syrup), break down in the water. This process of breaking down consumes a high amount of oxygen from the water (referred to as high biochemical oxygen demand). The resulting drop in aquatic oxygen levels can harm aquatic life. They also increase nutrient content of the water, which leads to algal blooms in lakes and ponds. These problems can be severe and lead to fish kills. These products are safer for vegetation, noncorrosive and are not permanent pollutants.

 **Tip** *Help protect the environment by using the product that will perform the best in the smallest amount.*

Salt Impacts on Water Bodies

Lakes

Chloride used in winter maintenance may wash into lakes. Salty water is heavier than fresh water, so it will sink to the bottom of lakes and pose a threat of chemical layering (stratification). Heavy, bottom layers may disturb the natural, seasonal turnover that occurs in lakes. Without this turnover or with an altered turnover cycle, the nutrients and oxygen are not optimally distributed throughout the lake.⁶



A full turnover of a non-salty lake (left) and an altered turnover in a salty lake (right).

Streams

Chloride also washes into streams. The United States Geological Survey (USGS) found between 1990 and 2010, chloride increased in northern U.S. streams. The USGS found that the increases were most pronounced in urban areas with high amounts of snowfall.³

Groundwater

Chloride can pollute groundwater, which supplies about half of the United States' drinking water supply.⁷ Groundwater is the source of drinking water for more than two-thirds of the residents in Wisconsin.⁸ Shallow groundwater also feeds some surface waters, which can lead to elevated chloride in surface water, even during non-deicing periods.³

Drinking Water

Chloride can be detected by taste at concentrations greater than 250mg/L.⁹ Chloride in drinking water generally affects the water aesthetically, meaning it is not harmful but affects the taste of water. However, in some places the salt concentration in drinking water can be high enough to affect people who are on low-sodium diets.⁵

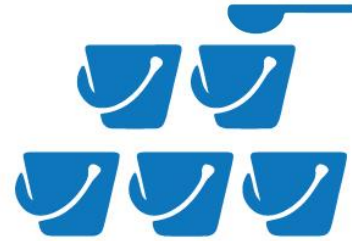
Increased chloride in drinking water sources increases the corrosiveness of the water. Corrosion of metal components can mobilize heavy metals into drinking water. Older pipes can contain metals that are dangerous to human health, such as lead or copper. The Flint, Mich. water crisis, which involved high levels of lead in drinking water, was caused in part by a new water supply with a high level of chloride.¹⁰

Water Bodies in Wisconsin

The average amount of salt applied yearly to just public roads in Wisconsin is 650,000 tons¹¹, which is enough to pollute over 400 billion gallons of water. To see a list of Wisconsin's chloride impaired waters, visit the [Wisconsin DNR's Impaired Water Search](#).

Aquatic Life

The federal government has established a chronic chloride concentration of 230mg/L, which is lower than the Wisconsin standard due to different research methods. Above this level, chloride can harm aquatic life including fish, amphibians, macroinvertebrates and insects.¹² Chloride can affect these species' rate of survival, reproduction and growth. Lower chloride concentrations impact smaller organisms and eggs and disrupt the food chain. Higher chloride concentrations can impact larger organisms.



Graphic Credit: Wisconsin Saltwise
*One teaspoon of salt pollutes
five gallons of water (230mg/L)*

Other Impacts of Salt

Infrastructure

Chloride corrodes the metal used in infrastructure such as bridges and roads. This corrosion can cause potholes and possibly require complete roadway replacement.¹³ Considering the damage to infrastructure, the real cost of road salt adds up to about five times the initial cost of the road salt and labor to apply it.¹⁴

Vegetation

Deicers can affect vegetation if salt spray comes into contact with stems, buds, needles or leaves by causing salt burn and drying out buds.¹⁵ Chloride may also be transported into the plant through the root system and reach toxic levels to plants after repeated exposure.¹⁶ In the worst cases, this may result in plant death and require replacing landscape plants, turfgrass or even trees in the spring. In addition to roadside vegetation, aquatic vegetation in surface waters can be harmed by a high chloride concentration.¹⁷ In some places, the native plant community could be affected. This could lead to replacement of native species with salt-tolerant, invasive species.¹⁸

Soils

When rock salt gets into soils near roads and sidewalks, sodium can alter the soil chemistry and structure. The altered structure leads to poor drainage and compaction.¹³ Sodium can also make soil more alkaline, which can reduce available nutrients important to vegetative growth.¹³ Salt may also kill soil bacteria, which can increase erosion.¹⁹



An example of dead turf grass next to the sidewalk caused by chloride



Rusting and concrete damage caused by corrosion from chlorides

Practice Questions

Answers can be found in the back of this manual.

- 1) Chlorides, such as rock salt, are
 - a. the most common deicer.
 - b. impractical and expensive to remove from water.
 - c. dangerous to aquatic life.
 - d. All of the above

- 2) All types of deicers
 - a. are bad for the environment.
 - b. corrode metal.
 - c. could and should be used in any situation.
 - d. can cause algal blooms in lakes.

- 3) The EPA's chloride standard, the concentration of chloride that is harmful to aquatic life, is 230mg/L of water. This is the equivalent of
 - a. 1 pound of salt per 5 gallons of water.
 - b. 1 bag of salt per 5 gallons of water.
 - c. 1 teaspoon of salt per 5 gallons of water.
 - d. 10 pounds of salt per 5 gallons of water.

Chapter 2: Prepare for the Year

Overview

Preparation is the backbone for success in any field of endeavor. Preparation before the season will save time and trouble when a snow storm comes.

Training

The future of winter maintenance is based on lower salt use strategies. Training exists in several forms. The most common certification programs used in Wisconsin are the [City of Madison Winter Salt Certification training](#) and the [Minnesota Pollution Control Agency's Smart Salting training](#). Both offer individual and organizational certification.



Other organizations, such as [Snow and Ice Management Organization \(SIMA\)](#), also offer a large selection of educational opportunities for improving winter maintenance efficiency.

Industry leaders have both individual and organizational level certifications in winter maintenance.

After training, it may be helpful to follow up with your crew:

- Lead an internal discussion within your organization about the training.
- Make copies of the training manual for your crew.
- Provide opportunities for idea exchange that promotes innovative and progressive thinking.

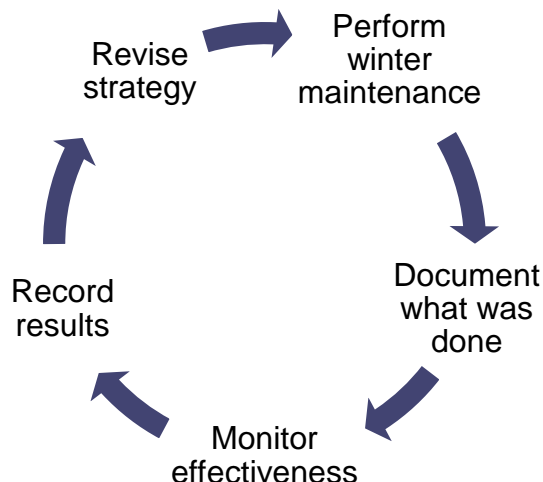
Pre-Winter Checklist

Create a check list before the season starts with the following ideas:

- Repair equipment.
- Calibrate equipment.
- Train staff.
- Calculate parking lot and sidewalk areas.
- Select and order deicers.
- Make and distribute documentation forms.

Calibration of all equipment that spreads deicer should be done prior to the season. This is also a good tool to debug equipment problems. For more information on calibration, see Chapter 3.

Documentation



To improve performance, we monitor and adjust our actions. To monitor, we record our actions and compare our actions to our results. As we monitor our actions and see our results, we can make adjustments to improve winter maintenance. The cycle of process refinement is a never-ending loop. We are always looking for new and better ways to improve winter maintenance efficiency and lower environmental impacts.

Maintenance policy

A maintenance policy is a written strategy for how and when you will handle weather events. The policy will help to inform staff and customers about what to expect. Set expectations for your staff and customers by explaining your maintenance policy.

A maintenance policy may include items such as:

- Procedures that will occur leading up to, during and after a winter event
- The order these procedures will occur, which areas on a property are higher priority
- Outline of level of service and expectations

For example and model policies visit, [Wisconsin Salt Wise Model Snow and Ice Policy page](#).

Tip *Creating, updating, following and documenting results of your snow and ice policy may help protect you legally.*

Maintenance contract

Advocate for a maintenance contract that will allow you to use best practices when maintaining properties. Never use a contract that charges by amount of deicer used. A low-salt (but not a low level of service) [model contract](#), produced by the City of Edina, Minnesota, is available at Wisconsin Salt Wise's model contract page.

Tip *Wisconsin's lakes and rivers pay the price for contracts that charge by the amount of material applied.*

Wisconsin DNR Salt Reporting

If employed by an organization that is required to have an MS4 permit, operators must record and submit the following:

- Type and amount of deicer used
- Equipment used
- Service area
- Snow disposal locations
- Salt reduction strategies

For more information, contact the [DNR stormwater representative](#) for your area.

Document Maintenance Areas and Level of Service

- Document the size of each area.
- Associate a level of service with each area.
- Give information to the maintenance crew.
- Compare the level of service accomplished with level of service goal.

The Wisconsin DNR [Surface Water Data Viewer](#) is a good resource to measure maintenance areas and create maps.

Accomplishing a level of service higher than the target often indicates an over-application of salt.



The example above shows a map of parking lots. Size (sq. ft.) and level of service (color) both included.

Practice Questions

Answers can be found in the back of this manual.

- 1) **Is a winter maintenance contract that charges by the amount of deicer used a good strategy?**
 - a. **Yes**
 - b. **No**

- 2) **What levels of winter maintenance certification are available in Wisconsin?**
 - a. **City of Madison Winter Salt Certification (individual and organizational)**
 - b. **Minnesota Pollution Control Agency Smart Salting certification (individual and organizational)**
 - c. **State of Wisconsin individual and organizational certification**
 - d. **Both A and B**

- 3) **How can you help your staff be more effective at winter maintenance?**
 - a. **Give them the size of the areas they are maintaining**
 - b. **Provide the level of service target they are trying to hit for each area**
 - c. **Send them to training**
 - d. **All of the above**

Chapter 3: Calibration

Overview

Calibration is the process of measuring and recording how much material is discharged at each setting. Annual calibration is a winter maintenance industry standard. Calibrated equipment provides insight on application rates. Calibrated equipment standardizes operations and allows implementation of the advice given on application rate charts. All equipment can be calibrated: both manual and ground speed controls, liquid and granular equipment, from push spreaders to plow trucks.

To be on the varsity team of winter maintenance, calibrate each piece of equipment for each material and for every setting you intend to use.

When considering calibration, there are two major categories of spreaders:

- *Manual controlled spreaders* – Discharge rate is determined by gate opening and speed of travel. Target discharge rate is difficult to control as the equipment slows down or speeds up.
- *Ground speed-controlled spreaders* – Discharge rate is determined by selecting a target rate (entering the rate into a computer in the cab). The computer communicates with the distribution system to constantly adjust so that discharge is always at a targeted rate.

Most equipment used today in sidewalk and parking lot winter maintenance is a manual controlled spreader. The calibration process produces a calibration chart. This chart will be unique to each spreader and provide an application rate based on setting and speed.

By calibrating equipment, the shop talk changes from “use setting No. 4” to “aim for 6 lbs./1000 sq. ft.” Setting a target application rate and understanding which setting can deliver that application rate is exactly where the conversation needs to be to reign in salt use in winter applications.

Ground speed-controlled technology is available for motorized equipment including ATVs and trucks. These spreaders are more accurate and take less effort to calibrate than manual controlled spreaders. Look for opportunities to upgrade manual-controlled spreaders to ground speed-controlled spreaders. It is the future of this industry.

Calibration of Push Spreader

Every year, calibrate push spreaders for each setting and material type. Push spreaders can get banged around in the back of the truck. They may require recalibration mid-winter.

Step by step instructions on calibrating and creating calibration charts for push spreaders can be found at Wisconsin Salt Wise’s [calibration page](#) and on the next two pages.

Step by Step Calibration of a Push Spreader

The process for calibrating a push spreader includes pushing the spreader on each setting and weighing the amount of the material that comes out. This should be calculated for each setting and for each different material used. Record the results in the table on the next page in the corresponding column.

Tools you will need:

- The material(s) you are spreading
- Tarp (10 feet or longer)
- Scale
- Broom
- Shovel

If the spread pattern is wider than the tarp, it is wider than a sidewalk. If you are intending to use a spreader for narrow area, such as a sidewalk, install a shield on the spreader before calibrating and while using it.

Calibration steps



1. Fill the push spreader with the material you are applying.
2. Record the lever position/setting for the gate/chute (**B**). If there are no numbers for the positions, make permanent marks on the equipment to identify the positions. These calibration steps should be repeated for each position so you know how much material is being applied at each setting.
3. Lay down a tarp and measure out a 10-foot long stretch (hint: use tape on the tarp so you can easily see the 10-foot area). A longer test area can be used. The longer the test area, the more accurate the results will be. If a longer test area is used you will need to adjust this in the table on the next page.
4. Using a constant speed (**A**), apply one pass of material to the 10-foot test area. Measure the width the material is spread or bounces, in feet (**D**).
5. Sweep up and weigh the material that is within the marked 10-foot stretch (**C**)
6. To improve accuracy, repeat this two more times at each setting and calculate the average weight of material applied.

After the first pass, you can put a bag around the discharge point to catch and easily weigh the discharged material. The first pass needs to be unbagged to determine the spread width.

Calculating application rate

Test Area Length = 10 feet*

If your test area is longer than 10 feet, use that number in your calculation for column E (e.g. if your test is 20 feet long, the calculation for column E would be (Dx20).

A	B	C	D	E	F	G
Speed (mph)	Lever position or gate setting	Weight of material spread in test area	Spread width (feet)	Coverage area (sq. ft.) (Dx10)*	Application rate (lbs./1000 sq. ft.) C ÷ E x 1,000	Application rate (lbs./ lane mile) (12 ft width) F x 63
2						
3						
4						
5						
6						
7						
8						
9						
10						

Figure 1: Calibration chart for a push spreader (a larger version of this blank chart can be found the Resources Chapter)

Create a chart for each spreader

After creating a calibration chart, make one copy for the office and one smaller card for the spreader. Laminate and attach the card to the equipment. Teach the operator how to use the card in association with the application rate chart. See Chapter 10 for the application rate chart.

Setting	Square feet	Pounds	Pounds/1000 sq. ft.
3	130	3.1	196
4	130	6.2	390
5	130	8.5	536



Attach a laminated card (example left) to each spreader (right). Each spreader will have its own unique card.

Calibration of Motorized Equipment

Calibration of manual controlled motorized equipment

Every year, calibrate motorized equipment (i.e. ATVs or trucks) for each setting and material type intended to be spread. At each setting, collect the material for one minute of the equipment running, then weigh the material that was discharged. The pounds discharged per minute for each setting is used to calculate the pounds per mile at each speed (see Figure 2). If service areas are measured in 1,000 sq. ft. instead of pounds per mile, use the additional conversion in Figure 3 after calculating pounds per mile.

Creating calibration charts

A calibration chart documents how much material is going out of the spreader for each setting and each speed. The material is discharged for one minute then collected, weighed and recorded for each setting. From this number, the amount of material discharged per mile can be calculated based on the speed of travel. Using the multiplication factors in the top row, the pounds per mile can be calculated. Blank charts are available in the Resources chapter.

For example:

- Setting 1: **39** pounds per minute discharged
- Travelling **10** miles per hour
- Takes **6** minutes to travel 1 mile

Calculation:

- $39 \times 6 = 234$ pounds per mile rate

Setting	Lbs./Minute	3 MPH Walking (x20)	5 MPH (x12)	10 MPH (x6)	15 MPH (x4)	20 MPH (x3)
1	39	1,170	468	234	156	117
2	86	2,580	1,032	516	344	258
3	127	Fill in the whole chart				
4	153					

Figure 2: Calibration example for calculating pounds/mile

To determine pounds per 1,000 square feet, divide the numbers in the above chart by 63.

For example:

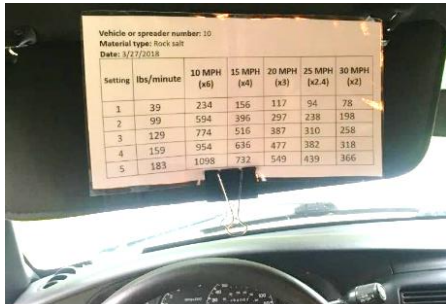
- Rate is 234 pounds per mile (this number is calculated in Figure 2)

Calculation:

- $234 \div 63 = 3.7$, rounded to **4** for easy use

Setting	Lbs./Minute	3 MPH Walking	5 MPH	10 MPH	15 MPH	20 MPH
1	39	59	7	4	3	2
2	86	129	16	8	6	4
3	127	Fill in the whole chart				
4	153					

Figure 3: Calibration example for calculating pounds/1,000 sq. ft.



Put a calibration card on visor for easy access.

After creating a calibration chart, make one copy for the office and one smaller card for the truck or ATV. Place the card on the visor for easy access. Teach the operator how to use the card in association with the application rate chart. See Chapter 10 for the application rate chart.

Calibration of ground speed-controlled equipment

Ground speed controls are more accurate and require less time calibrating than manual controls. Run the spreader for one minute and weigh the material that comes out. This is called a catch test. Only one setting needs to be calibrated for each type of material that will be applied. Enter the data from the catch test into the computer. The system will take care of the rest. Since each computer-controlled system has a unique calibration mode, check with your vendor for specific calibration instructions.



Above, an operator is performing a catch test with a scale box.

\$ Tip *Scale boxes that can be zeroed out instead of emptied between catch tests can save you time and strain on your back.*

Liquids

It is just as important to calibrate liquids as well as solid materials. Liquids are calibrated in gallons/minute. They can be calibrated much like solid materials. First, run the equipment for a timed interval. Then, collect the liquid in containers and measure the amount in the containers.

In addition to catch tests, applying a test pattern gives easy insight into nozzle problems.



Individual catch test buckets give nozzle discharge plus total discharge

Equipment Discharging at a Rate that is too High

After calibrating, the equipment may still be discharging too much, even at the lowest setting, to be able to use the application rate charts found in Chapters 9 and 10. To solve this, investigate equipment modifications or equipment upgrades. Be aware that after-market modifications may void equipment warranties. When purchasing new equipment, select equipment that can accurately deliver low application rates. Obtaining or modifying equipment that can apply materials at lower rates is a challenge. This is because for years the industry was asking for equipment to apply high application rates. We are experiencing the growing pains of a changing industry.

Practice Questions

Answers can be found in the back of this manual.

- 1) **Which equipment can be calibrated?**
 - a. **UTVs with a tank and spray bar**
 - b. **Push spreaders**
 - c. **Trucks with ground speed controllers**
 - d. **All of the above**

- 2) **When is the best time to calibrate?**
 - a. **After the winter is over**
 - b. **After the first snowfall**
 - c. **Before the first snowfall**
 - d. **You should not calibrate**

- 3) **It is an industry standard to calibrate your equipment.**
 - a. **True**
 - b. **False**

Chapter 4: Storage

Storage of Deicers

It is important to store salt properly. Without proper storage you are letting salt get into the water, and wasting your product. These principles also apply to storage of sand with any deicer added.

Wisconsin Regulation for Granular Salt Storage

Wisconsin has a regulation, [TRANS 277](#), that outlines storage of salt piles (five percent or greater salt) greater than 1,000 pounds. This regulation applies to anyone who stores salt piles temporarily or permanently.

The law includes six key provisions:

- All temporary or permanent storage sites must be registered with the Wisconsin DOT.
- Salt must be stored on an impermeable surface whether the salt is stored inside or outside a structure.
- The pile must be covered year-round by either a roof or a secure tarp not weighted down by excess salt.
- The area surrounding the building or stock pile that is used to receive salt or load vehicles must be kept clear of salt residue.
- Buildings, pavements, and coverings must be kept in good repair to prevent wind or precipitation from displacing salt.
- New salt storage facilities are required to be:
 - 250 ft. from any existing private well
 - 1,200 ft. from municipal wells
 - 50 ft. from shorelines



Proper storage of deicers prevents wasted product and water pollution.

Correct:
Covered, impermeable floor



Deicer storage should be covered year-round.

Incorrect:
Uncovered deicer



Uncovered deicer will pollute water and become difficult to use.

Housekeeping

A proper storage area is just the first step:

- Always keep buildings, pavement and covers in good repair.
- Sweep up excess salt from loading areas.
- Be sure the storage shed or container is closed when leaving the storage area.



No "rivers of salt" should be leaving the storage area.

Liquid Storage

When storing liquid, follow these principles:

- Tanks should have secondary containment for recovery and containment of leaks. This could be a double-walled tank or a capture area.
- Know the freezing point of the liquid before storing it outside.
- Label all containers and/or tanks.
- Agitate liquid mixes that are stored for long periods of time.



The short, concrete, wall is an example of secondary containment.

Storage of Abrasives

Use the same guidelines as granular deicers storage if any salt is mixed into the sand pile.

Storage of Snow

It is important to consider where snow is piled or dumped.

Follow these principles for snow storage:

- Never dump snow in a lake, river, wetland, pond or rain garden, since snow contains sand, trash and debris
- Store the pile where trash can be recovered after it melts.
- Store downhill of salt storage to avoid melt water from running into your salt pile.
- Determine a location where refreeze will not cause problems.
- Avoid sensitive vegetation as snow piles will damage some vegetation.

Practice Questions

Answers can be found in the back of this manual.

1. **It is important to store salt**
 - a. in a shed.
 - b. where it is covered year-round and on a water proof floor.
 - c. in the easiest to access location.
 - d. where water can be used to wash away spilled salt.

2. **Planning a proper snow storage area**
 - a. prevents sand, trash and debris from polluting water.
 - b. keeps melt water from washing away your salt pile.
 - c. can reduce later maintenance work to fix refreeze problems and replace damaged vegetation.
 - d. All of the above

3. **Secondary containment is**
 - a. used to prevent liquid deicer from freezing.
 - b. used primarily to contain sand.
 - c. a double walled tank or second container used to contain spills or leaks of liquid deicer.
 - d. only needed if your liquid deicer is stored near a well.

Chapter 5: Mechanical Snow Removal

The Basics

Mechanical removal is always the best approach to winter maintenance. It should always be the preferred approach during and after a snow storm. The better the mechanical removal, the less chemicals needed.

Effective mechanical removal should occur early and often to avoid compaction.



Icy compaction, such as the parking lot in this photo, can possibly be avoided with early mechanical removal.



Tip *Early and aggressive mechanical removal saves on salt.*

One-pass Mechanical Removal Method for Lighter Snows

Often times for a lighter snow, one pass over with the broom or shovel brings the pavement to nearly bare. For longer or heavier events, a two-pass method may provide better results.

Two-pass Mechanical Removal Method for Heavier Snows

One effective method for mechanical removal is called a two-pass method. This method involves using two different tools to more effectively clear an area. The first pass will remove the bulk of the snow, and the second pass will get closer to the pavement. One example is first plowing an area to remove heavy snow then following it with a broom to remove what is left on the pavement.



An example of a two-pass strategy: operators first use a snow blower followed by a broom.

Staffing Adjustments

To make mechanical removal shine, you may need to adjust staff's hours to stay on top of mechanical removal. You will be rewarded with a lower salt operation and less damage to infrastructure and the environment.

Tools

Select the tool that will help you use the least amount of salt. Investing in better and newer equipment is a good way to reduce salt.

Brooms and blowers are both effective tools for removing snow from sidewalks and trails. Brooms, often attached to UTVs, are useful for clearing light and fluffy snow and clearing as snow is still falling. Blowers are also excellent for clearing light and fluffy snow.



Brooms (left) remove snow closer to the pavement than most other tools (right).

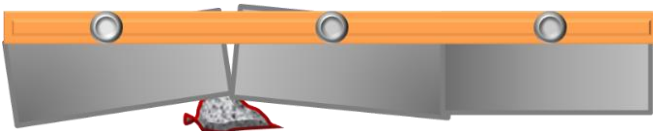
Handheld scrapers and plow blades clear compacted snow and ice from the pavement. Handheld scrapers that have flexible blades can wiggle under compaction and can be used to easily clear smaller areas.



Photo credit (middle and right): Jim

Schmidt, Fox Valley Parks

*Invest in new and innovative tools to improve mechanical removal and reduce salt.
Left to right: flexible scraper, power shovel and riding snow blower*



Above is an illustration showing how segmented blades contour to pavement.

There is a lot of innovation today in better plow blades. Investigate options such as segmented blades. These blades will better contour to the pavement and be more comfortable for plow drivers to use, as shown in the illustration. Rubber or plastic blades have been shown to work well on sidewalks with less damage.

Practice Questions

Answers can be found in the back of this manual.

- 1) You should use mechanical removal strategies
 - a. during and after a storm.
 - b. early and often to avoid compaction.
 - c. always before granular deicers are applied to reduce dilution.
 - d. All of the above

- 2) How should you decide what mechanical removal equipment to use?
 - a. They all work the same.
 - b. Choose equipment that is motorized.
 - c. Choose equipment that will help you use the least amount of salt.
 - d. Choose the most expensive equipment.

- 3) Mechanical removal should be your No. 1 reactive approach to a storm.
 - a. True
 - b. False

Chapter 6: Weather Information

Weather information is critical to winter maintenance operations. Following the weather forecast and pavement temperature trends will help prepare you for winter events.

Precipitation Type and Wind

Our maintenance strategies will depend on the type of precipitation we expect and the wind associated with it. Most notably, our use of anti-icing tactics is taken out of play when a rain precedes a snow event or when strong winds accompany the snow. This is only one example of changing tactics based on weather prediction.

Pavement Temperature

Air temperature is what you see when you check the day's weather and is generally the same for all of your maintenance sites.

Pavement temperature will vary within an area depending on sunlight, shading, pavement materials and other factors. Pavement temperature will determine what amount and type of material should be applied. As pavement temperatures drop into extreme cold, deicers are removed from our tool kit and alternate strategies such as mechanical methods and abrasives should be employed.

Pavement temperature is more important than air temperature.

Pavement temperature can be measured with a no-contact, infrared temperature sensor. These devices can be hand-held or mounted to the side-view mirror on a truck. Hand-held sensors can be purchased for about \$50. Always calibrate a hand-held sensor by leaving it outside for 10 minutes before using. Never use a hand-held sensor while driving. Mirror-mounted sensors are at least 10 times more expensive, but they are less likely to get lost than a hand-held sensor and provide a continual data stream.

Test your hand-held sensors by aiming at a glass of ice water- it should read 32° F



Photo credit: Angie Dahl, Epic

Hand-held temperature sensor



Photo credit: Bryan Johnson, Madison Streets Dept.

Mirror-mounted temperature sensor

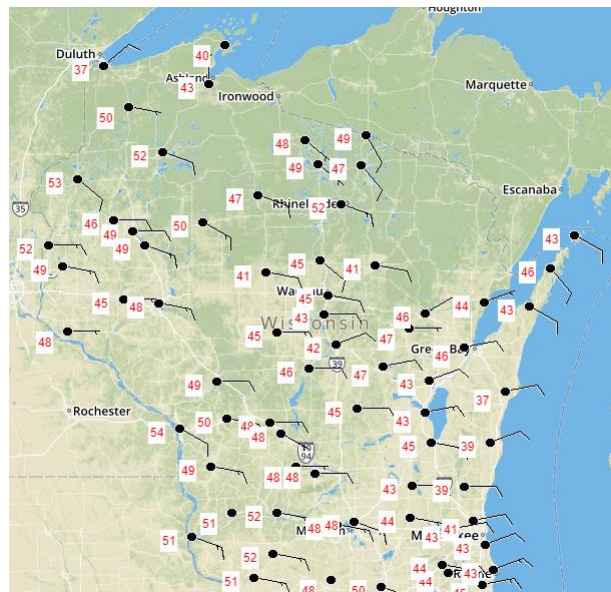
Road Weather Information Systems (RWIS) are available in many states. RWIS collects accurate and up-to-date road weather information. This information generates a forecast that includes pavement temperature, precipitation probability, snow rate and accumulation and other information. The RWIS site for Wisconsin is currently unavailable but is expected to be accessible winter 2019.

Dane 418 [USH 12/14, N jct. USH 14 to W jct. USH 18/151]
 USH 12/14 - N jct. USH 14 to W jct. USH 18/151

Time (GMT-0600)	Temp	Precip Prob (%)	Snow Rate (in/hr)	Snow Accum (in)	Roadway		Wind				Precipitation				Vis Obsr	Time (GM)								
					Frost	Maintenanc	Air Temp	Dew Pt	Humidity	Wind Direction	Wind Speed (mph)	Gust (mph)	Wind Chill (F)	Type			Rate (in/hr)	Ice Rate (in/hr)	Ice Acc (in)	Sn Rate (in/hr)	Sn Accum (in)			
on 9am	17	90	0.00	0.00	72	---	20	20	97	↙ NNE	6	---	12	SN	90	0.00	0.00	0.00	0.00	0.18	4.1	1.17	---	Mon 9am
on 10am	19	90	0.00	0.00	55	🚧	21	20	96	↙ NNE	10	---	10	SN	90	0.00	0.00	0.00	0.00	0.15	4.2	2.00	---	Mon 10am
on 11am	20	90	0.00	0.00	30	---	20	18	90	↙ NNE	13	---	7	SN	90	0.00	0.00	0.00	0.00	0.16	4.4	2.00	---	Mon 11am
on 12pm	19	90	0.00	0.00	10	---	19	14	81	↙ NNE	16	---	4	SN	90	0.00	0.00	0.00	0.00	0.16	4.4	2.00	---	Mon 12pm
on 1pm	19	70	0.00	0.00	5	🚧	18	11	74	↙ NNE	17	---	3	SN	70	0.00	0.00	0.00	0.00	0.18	4.7	2.50	---	Mon 1pm
on 2pm	19	68	0.00	0.00	0	---	17	10	73	↙ NNE	17	---	1	SN	68	0.00	0.00	0.00	0.00	0.04	4.9	5.00	BLSN	Mon 2pm
on 3pm	17	57	0.00	0.00	5	---	15	9	75	↙ N	16	---	1	SN	57	0.00	0.00	0.00	0.00	0.04	4.9	5.00	BLSN	Mon 3pm
on 4pm	15	40	0.00	0.00	5	🚧	13	6	74	↙ N	17	---	1	SN	40	0.00	0.00	0.00	0.00	0.04	5.0	5.00	BLSN	Mon 4pm
on 5pm	12	38	0.00	0.00	5	---	11	4	75	↙ NNW	16	---	1	SN	38	0.00	0.00	0.00	0.00	0.04	5.0	5.00	BLSN	Mon 5pm
on 6pm	10	28	0.00	0.00	5	---	8	3	77	↙ NNW	14	---	1	SN	28	0.00	0.00	0.00	0.00	0.01	5.1	5.83	BLSN	Mon 6pm
on 7pm	8	18	0.00	0.00	5	---	6	0	78	↙ NNW	12	---	1	SN	18	0.00	0.00	0.00	0.00	0.01	5.1	10.00	---	Mon 7pm
on 8pm	6	10	0.00	0.00	5	---	4	-1	80	↙ NNW	10	---	1	SN	10	0.00	0.00	0.00	0.00	0.01	5.1	10.00	---	Mon 8pm
on 9pm	4	8	0.00	0.00	5	---	2	-4	78	↙ NNW	8	---	1	SN	8	0.00	0.00	0.00	0.00	0.01	5.1	10.00	---	Mon 9pm
on 10pm	3	2	0.00	0.00	5	---	-1	-7	75	↙ NNW	6	---	1	None	2	0.00	0.00	0.00	0.00	0.00	5.1	10.00	---	Mon 10pm
on 11pm	1	12	0.00	0.00	5	---	-3	-8	78	↙ NNW	6	---	1	SN	12	0.00	0.00	0.00	0.00	0.01	5.1	10.00	---	Mon 11pm
on 12am	2	22	0.00	0.00	5	---	-2	-7	81	↙ W	8	---	1	SN	22	0.00	0.00	0.00	0.00	0.01	5.1	10.00	---	Tue 12am
on 1am	1	30	0.00	0.00	5	---	-2	-7	81	↙ W	10	---	1	SN	30	0.00	0.00	0.00	0.00	0.03	5.1	10.00	---	Tue 1am
on 2am	0	27	0.00	0.00	5	---	-3	-8	79	↙ W	11	---	1	SN	27	0.00	0.00	0.00	0.00	0.03	5.1	10.00	---	Tue 2am

Example of an hourly forecast generated by RWIS. Information, the new Wisconsin site may look different

MesoWest Data from the University of Utah is a good resource for weather information at a glance. As of July 2019, it did not show pavement temperature.



Example of a MesoWest temperature map

Practice Questions

Answers can be found in the back of this manual.

- 1) **Pavement temperature**
 - a. helps determine the type of deicer to apply.
 - b. helps determine the amount of deicer to apply.
 - c. allows an operator to use an application rate chart.
 - d. All of the above

- 2) **To find pavement temperatures,**
 - a. use air temperatures, they are the same as pavement temperatures.
 - b. use a no contact, infrared temperature sensor. Pavement temperature will vary from site to site.
 - c. assume it is 32°.
 - d. feel the pavement.

Chapter 7: Materials

Overview

Different materials will work for different situations. Having multiple options and choosing the correct materials for the situation can greatly increase the efficacy of any treatment.

Deicers – *Chlorides and acetates*

- Melt snow and ice
- Available in liquid and granular forms
- Chlorides are the most commonly used deicer.

Abrasives – *Sand*

- Provides traction on top of snow and ice
- Does not melt snow and ice

Organics – *Agricultural byproducts*

- Lowers the freezing point of deicers
- Sticky
- Alters ice crystal formation
- Does not melt snow and ice



Top: Salt, Middle: Sand, Bottom: Organic-treated salt

Abrasives

Abrasives, such as sand, can be used for temporary traction on top of snow and ice. It does not melt snow and ice once on pavement.

This material works well at cold temperatures when deicers are not effective.

Less than 10 percent salt should be mixed into winter sand to keep it flowing.

Salt-sand mix

If you add more than 10 percent salt to your sand, you are trying to melt with sand, which is inefficient. If you are trying to melt, switch to deicers.

If you are using a 50-50 salt-sand mix, you are always half wrong!

Deicers

Deicers melt snow and ice. The purpose of using chemical deicers is to loosen the bond between the snow and/or ice and the pavement so the snow can be physically removed. Chemical deicers are not intended to melt all the snow and/or ice from an event. Using that much deicer is impractical financially, in terms of time, and for the environment.

How Deicers Work

Salt works by lowering the freezing point of water allowing snow and ice to melt at colder temperatures. Deicers work faster at warmer temperatures and slower at colder temperatures.

Dry materials must go into a solution before they can melt. Liquids work faster than dry salt (see Chapter 8).

Ice Melt Capacity and Speed

Ice melt capacity is a measure of how much ice a fixed amount of deicer will melt. Each deicer is different. Pavement temperature will change the speed of melting, but not the total ice melt capacity.

The warmer the temperature, the faster deicers work. When it is too cold, deicers will not melt at all. A large reason why we over use salt is that we think that more salt will speed up melting. If you already have the proper amount of salt down, more salt will not make the snow and ice melt faster.

\$ Tip *Adding more of the same granular deicer to try to speed melting wastes money and salt.*

Speed of Ice Melt Chart

Pavement Temperature °F	One Pound of Salt (NaCl) Melts	Melt Times
30	46.3 lbs of ice	5 min.
25	14.4 lbs of ice	10 min.
20	8.6 lbs of ice	20 min.
15	6.3 lbs of ice	1 hour
10	4.9 lbs of ice	Dry salt is ineffective and will blow away before it melts anything.
5	4.1 lbs of ice	
0	3.7 lbs of ice	
-6	3.2 lbs of ice	

Figure 4: Speed of melting chart²⁰

Chlorides

Chlorides are the most commonly used deicers. They have a variety of practical temperature ranges and are corrosive to infrastructure.

- **Rock Salt, also known as Sodium Chloride**

Road salt, also known as sodium chloride (NaCl), is the most common and least expensive deicer. NaCl is effective at pavement temperatures 15 °F and warmer.

- **Magnesium and Calcium Chloride**

Magnesium chloride (MgCl₂) and calcium chloride (CaCl₂) melt faster at colder temperatures. MgCl₂ to -10 °F and CaCl₂ to -20 °F.

MgCl₂ and CaCl₂ will melt better at colder temperatures than NaCl.

If over-applied in warm or humid temperatures, MgCl₂ and CaCl₂ may create a greasy surface. This is because they are hygroscopic, meaning they pull moisture from the air.

- **Potassium Chloride**

Potassium chloride (KCl) melts at a similar temperature range as sodium chloride, but costs more. Potassium is a nutrient often found in fertilizers that can be utilized by plants.

- **Acetates**

Acetates are a non-chloride deicer option. The two most commonly used acetates are calcium-magnesium acetate (CMA) and potassium acetate (KAc). Acetates are readily available and are more expensive than salts. Acetates are less corrosive than chlorides.

- **Organics: Agricultural Byproducts (ABP)**

Agricultural byproducts (beet juice, molasses, distillers' solubles, and corn syrup) are most often a chloride additive. They do not melt snow or ice but may be helpful in reducing the freeze point of brine, interfering with ice crystal formation, reducing corrosion, and improving adherence to pavement. [Clear Roads project 13-02 has more information on ABPs.](#)

Chemical Properties of Deicers Chart

The practical melting pavement temperature refers to real-world conditions. The eutectic melting pavement temperature refers to a lab setting.

Deicer	Practical Melting Pavement Temp.	Eutectic Melting Pavement Temp.
Sodium Chloride (NaCl)	15 °F	-6 °F
Magnesium Chloride (MgCl ₂)	-10 °F	-28 °F
Calcium Chloride (CaCl ₂)	-20 °F	-60 °F
Calcium Magnesium Acetate (CMA)	20 °F	-18 °F
Potassium Acetate (KAc)	-15 °F	-76 °F
Blends	Talk to supplier	Talk to supplier
Abrasives	Does not melt	Does not melt

Figure 5: Chemical properties of deicers²⁰

Bagged Product Labeling

Using bagged blends is like taking on a research project. You must understand which ingredients are in the product and how they work. Generally, the cheaper the bag the more NaCl will be in the blend. Bagged blends generally include a smaller grain size which will allow for easier movement through spreaders.

When using blends do not rely on the information on the bag. There are no labeling requirements for deicers therefore the information on the bag may be misleading.



Because there are no labeling regulations, bagged products often falsely claim to be "environmentally friendly."

Work with your vendor to understand what is in the blend and what is the practical melting range for that product.



Some crews use less salt if it is provided to them in smaller bags.

Practice Questions

Answers can be found in the back of this manual.

- 1) **Abrasives will melt snow and ice.**
 - a. **True**
 - b. **False**

- 2) **Which type of deicer will work fastest?**
 - a. **No deicer**
 - b. **Liquid deicer**
 - c. **Dry rock salt**
 - d. **Sand**

- 3) **What is the most common type of deicers?**
 - a. **Acetates**
 - b. **Beet juice**
 - c. **Waste stream products**
 - d. **Chlorides**

Chapter 8: Liquids

Overview

Liquid deicers work faster than granular deicers. Adding liquids to dry products will jump-start the dry product, giving faster results. The wet material will stick to surfaces better than a dry product. There are several ways liquids can be incorporated into operations:

- *Pretreated stockpiles* – a liquid added into the salt stockpile.
- *Prewetting* – liquid and granular products stored separately in a truck/equipment. As the materials are discharged, they are mixed, often this mixing occurs at the spinner or in the auger.
- *Anti-icing* – a liquid-only application before the storm to reduce the bonding between the snow and pavement. For more information see Chapter 9.
- *Direct Liquid Application (DLA)* – a liquid-only application during or after the storm. For more information see Chapter 10.

Adding in liquids

The most common combination rock salt (NaCl) with salt brine (NaCl and water). When combining liquid and granular products that are not NaCl, it's always a good idea to talk to the vendor and discuss how to combine liquid and granular products. It is possible to pick two products that would create a negative reaction.

Liquids offer many benefits:

- Liquids can melt snow faster than granular salt.
- Liquids stay in place and reduce the possibility of the salt being kicked or moved off target.
- Less granular products are needed when adding in liquids, which could reduce costs
- Could be less harmful for the environment (if application rates are controlled). Brine is 77 percent water.



A cup of brine causes less damage than a cup of granular salt.

Pretreated salt stockpile

Pretreated stockpiles are a mix of mostly road salt with a small amount of liquid. It works faster and at a colder temperature range. It can be purchased or made on site. Leaching, or runoff of a deicer out of the stockpile, is a risk with pretreated stock piles.



Example of a pretreated stock pile

Purchased pretreated products are less likely to leach than homemade pretreated stockpiles because they have been blended at the proper ratio with ingredients proven to stay in the stockpile.

Proper storage keeps the moisture away from stockpiles and reduces the chance of leaching.

Homemade pretreated stockpiles are often mixed in smaller quantities (enough for one event). This avoids difficulty storing the stockpile and leaching from becoming issues.

These are the most common ingredients in stockpile additives:

- Deicing liquid – Magnesium chloride ($MgCl_2$), Calcium chloride ($CaCl_2$)
- Organic additives (i.e. beet juice or corn syrup)
- Dye

These ingredients should **not** be added to stockpiles:

- Salt brine – Sodium chloride brine ($NaCl$) will evaporate out of piles and form a crust.
- Water – It will evaporate out of piles and form a crust.

Pros of pretreated stock piles:

- Can be purchased ready to go
- No new equipment is needed.
- Less salt is needed to get the same results as dry salt.
- Works faster and at colder temperatures (if $MgCl_2$ or $CaCl_2$ are added)
- Can lower application rates

Cons of pretreated stock piles:

- Extra time to mix piles or extra cost to purchase premium product
- It is better than dry salt, but only a small amount of liquid is used. It is slower acting than strategies using a higher percentage of liquids (i.e. prewetting).
- Difficult to store

Guidelines for making pretreated salt:

- Start with dry salt.
- The mixing area should be in a storage shed with a waterproof floor.
- Mix rock salt with liquid deicer (not brine) or stockpile additive.
- Use 4-6 gallons/ton. Higher amounts of liquid increase the risk of leaching.
 - See Figure 14 in the Resources Chapter for ounces/pound conversion.
- Best practice is to mix stockpiles before each storm because these stockpiles are difficult to store properly.

Prewetting

Prewetting is the practice of adding liquid to the road salt as it leaves the truck/equipment.

The most common combination is rock salt and salt brine.

What liquids to use:

- Most common is salt brine (NaCl)
- Next most common is a brine blend
 - Many options for brine additives
 - Research options before blending.
- Other options exist for extreme cold or for situations where chlorides should be avoided.

Pros of prewetting:

- Easily change the liquid/granular ratio
- Easily change type of liquid
- NaCl brine can be used, which is easy and inexpensive to make
- Easily lower application rate

Cons of prewetting:

- Requires additional equipment (e.g. tanks, hoses, pumps)
- Requires additional training for crew
- Requires accessible liquid storage to refill tanks

Guidelines for prewetting on board

- Average application of prewet is at a ratio between 8-12 gal/ton.
 - See Figure 14 in the Resources Chapter for ounces/pound
- The higher the ratio of liquid to granular, the faster it works.

Brine Specifics

Brine is the mixture of rock salt (NaCl) and water. It works at the same temperature range as dry salt.

If you are new to liquids, start by using brine on pavement temps above 15° F.



An example of a prewetting tank is shown above. This tank holds liquid deicer which is added to the granular deicer as it leaves the truck.

Purchasing brine

Many companies sell liquid deicers. The City of Madison and Dane County both make brine locally and have it available for sale. See Chapter 15 for more information on purchasing brine from the City of Madison or Dane County.

Making and testing brine

You can easily make your own brine with rock salt and water. Combine to a 23.3 percent concentration. This will ensure effectiveness at the coldest possible temperature. It is important to use a salt brine hydrometer to test brine concentration. To read the hydrometer and determine the salt concentration, look for the number at the surface of the brine. Mixing brine to other concentrations could create problems as it will freeze at warmer temperatures.

To make brine you will need:

- Water
- Rock salt
- Salt brine hydrometer

How to make brine:

1. Combine rock salt and water at approximately 2.3 lbs. of salt to 1 gallon of water ratio
2. Brine can stratify in the tank. Stir before testing concentration.
3. Use hydrometer to check concentration of brine solution
4. Adjust as needed
 - a. If concentration is below 23.3 percent, add more salt.
 - b. If concentration is above 23.3 percent, add more water.

Brine additives

It is becoming more popular to add other products to brine to enhance performance in cold conditions by lowering the freezing point. This practice is sometimes called a “hot mix”.

There is a large selection of different brine additives. Talk to your vendor about how much product to use, how to test that it is properly mixed and what the practical melting range for the blend is. There should be a protocol in place for measuring and mixing the additive with the brine to ensure accuracy. Ignoring or not implementing a proper protocol can result in damage to equipment, dangerous conditions or other unwanted results.

Refer to Chapter 4 for best practices when storing brine and other liquids.



The photo above shows where to read a hydrometer to determine concentration. (marked by the arrow and dotted line)

Optimal Concentration of Deicers Chart

Deicer	Optimal Concentration
Sodium Chloride (NaCl)	23.3%
Magnesium Chloride (MgCl ₂)	27-30%
Calcium Chloride (CaCl ₂)	30%
Calcium Magnesium Acetate (CMA)	32%
Potassium Acetate (KAc)	50%
Blends	Talk to supplier

Figure 6: Optimal concentration of deicers²⁰

Waste stream products

The repurposing of other waste stream products such as water softener discharge, pickle juice, cheese brine, soy sauce, or perfume factory alcohols is a tempting idea. However, research is required. You may be creating more of a problem than you are solving. Here are two case studies about waste stream products. One from the [Minnesota Local Road Research Board](#), where Carver County, Minnesota evaluated pickle brine as a potential deicer. Another is a [water softener reclamation operation](#), at Steve Brown Apartments in Madison, Wisconsin.

Routine maintenance required

Routine maintenance of equipment is required when working with liquids. Liquids should be flushed out of lines, hoses, pumps and nozzles after every storm or before switching chemicals to reduce clogging of nozzles and corrosion.

Practice Questions

Answers can be found in the back of this manual.

- 1) Adding liquids to dry salt will jump-start the melting process.
 - a. True
 - b. False

- 2) Purchasing a pretreated stockpile has what advantages over mixing your own stockpile?
 - a. Less likely to leach
 - b. Get the proper mix of products
 - c. Don't need a large covered area to mix
 - d. All of the above

- 3) What is the optimum concentration for sodium chloride (NaCl) brine?
 - a. 12 percent
 - b. 74 percent
 - c. 23.3 percent
 - d. 58 percent

Chapter 9: Anti-icing

Overview

Anti-icing is a proactive approach. Liquid chemicals are spread before a storm or frost to reduce the bonding between the snow and the pavement surface. Liquids, not granular products, are used in anti-icing. Anti-icing can help melt snow more quickly and reduce the likelihood that ice will form. Anti-icing requires 1/4 the material and is 1/10 the overall cost of deicing.²⁰

Anti-icing will not melt all of the snow that falls. It is intended to be a first step, before the storm, in maintaining a parking lot or sidewalk. Follow-up steps could include mechanical removal or applying deicer.



In this photo, notice the lines showing effective anti-icing application on the sidewalk.



Anti-icing before the storm can be time efficient and save salt.

A good way to think about how anti-icing works is to picture an egg and a frying pan. The egg is the snow and the frying pan is the pavement. To prevent the egg from sticking to the pan, grease the pan. Like the grease, anti-icing chemicals will reduce the bond between the snow or ice and pavement.



The cooking spray will prevent the egg from sticking just like anti-icing prevents the snow and ice from sticking to the pavement

Equipment

Non-vehicle Equipment:

There is a variety of different equipment available for anti-icing from one-gallon hand sprayers to higher capacity backpacks or push sprayers. If an operator is using a dual-purpose piece of equipment (like a pesticide sprayer), the salt will corrode parts of the equipment. Equipment designed for winter maintenance is protected against corrosion.

Be sure the sprayer creates a solid stream, not a fan stream.



Above is a small hand-held anti-icing sprayer

Vehicle Equipment:

Equipment needed to outfit trucks or UTVs includes tanks, a boom with holes or nozzles, hoses, and chemicals (salt brine or other liquid products). There are many options and price ranges for outfitting a vehicle from purchasing a complete system to crafting a boom out of PVC pipe. Nozzles should spray a solid stream and not a fan stream to achieve the proper spread pattern. Space nozzles about eight inches apart and place the bar 12-14 inches from the ground for large trucks.



Above an ATV is applying deicer in a wet/dry spread pattern

Spread Pattern

The safest application is to apply in a wet/dry spread pattern. This will look like lines on the pavement. If something goes wrong, you will still have traction on the dry pavement.

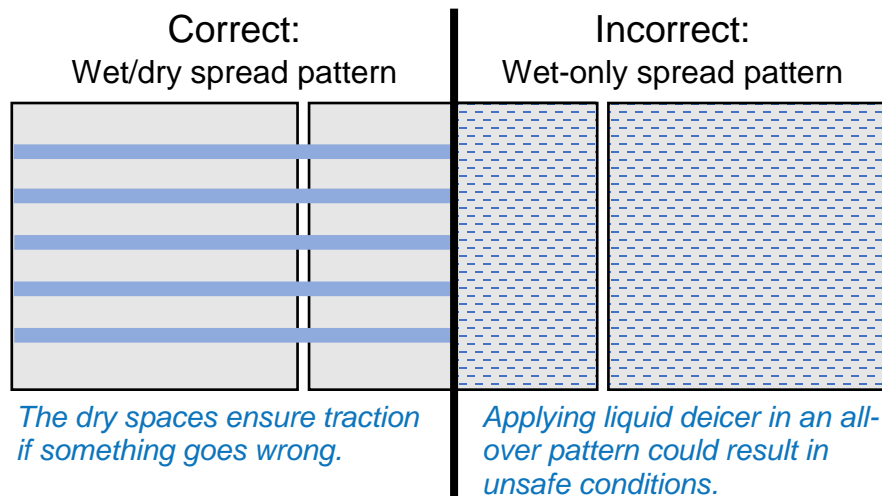
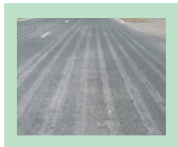


Figure 7: Anti-icing on a sidewalk

Communication with your Customers

Tell customers what the anti-icing application will look like. Many people are not familiar with anti-icing and liquid products. Let them know about this proactive approach, and they will soon learn to love the lines!

Love the Lines



Stripes on roads before a storm are anti-icing. They show that your professional maintenance crew is concerned about safety and is saving money, time and protecting our environment!

Graphic from Wisconsin Saltwise

Timing

The best timing rule for anti-icing is to apply the treatment as close to the storm as possible to obtain the best results.

Consider these factors while choosing the appropriate time to anti-ice:

- The amount of salt that is already on the pavement (from previous storms or anti-icing treatments)
- The amount of traffic from people or cars that will pass on the pavement- The more traffic between application and when it snows the sooner the anti-icing treatment will wear away.
- The predicted weather conditions

Other Considerations

Other tips that are helpful for achieving good results when anti-icing:

- Calibrate equipment.
- It is better to apply less. Over application can create a slippery surface.
- Experiment in lower traffic areas to become confident in applying liquids.
- Anti-icing works well for heavy frosts.
- Apply according to weather forecasts and not on a schedule.
- Consider how liquids will be tracked by traffic. For example, do not spray right in front of building entrances.

Chemicals

- NaCl brine (23.3 percent) is the most commonly used product (freezing point is -6° F).
- At colder than 15° F, other liquids should be used.
- Ask your vendor for application instructions for products other than NaCl brine.

Application Rates

To use an interactive version of the chart, go to the [Salt Wise application calculator](#).

Anti-Icing Application Rate Guidelines for Parking Lots, Sidewalks and Trails		
Anti-icing is a proactive practice intended to reduce the bond between the pavement and the snow and ice		
Predicted Weather	Recommended rates	
	23.3% Salt Brine (NaCl) gallons/1000 sq. ft.	Other Products
Frost/Sleet	0.3	Follow manufacturers' recommendations
Black Ice	0.5	
Freezing Rain	Not recommended	
Light Snow (<1/2 in./hr.)	0.5	
Moderate or heavy snow (≥1/2 in./hr.)	0.6	

***Maximum rates can be calculated by increasing recommended rate by 0.15 gal/ 1000 sq. ft.** Dane County Department of Land and Water Resources (LWRD) has determined that these guidelines establish a best maintenance practice for those fighting winter storms so they can provide high quality service and a lower impact on our environment. By issuing these guidelines, LWRD does not intend to extend its liability beyond that imposed by state statutes.

Figure 8: Anti-icing application rate guidelines for parking lots sidewalks and trails



Anti-icing is not suited for all conditions. Do not anti-ice when:

- It is blowing or windy conditions.
- Heavy rain is forecast before snow (it will wash away the salt)
- There is already salt on the pavement.
- There is already snow or ice on the pavement.
- It is too cold.
- On broken-up parking lots or gravel
- If you do not need to achieve bare pavement

Practice Questions

Answers can be found in the back of this manual.

- 1) **What chemicals are used for anti-icing?**
 - a. Granular products
 - b. Liquid products
 - c. Sand
 - d. Any product you have on hand will work

- 2) **The purpose of anti-icing is to**
 - a. melt all of the snow or ice on pavement.
 - b. be the last method used after snow and ice are compacted.
 - c. treat freezing rain.
 - d. break the bond between snow/ice and pavement.

- 3) **Equipment for anti-icing**
 - a. is only available for pick-up trucks.
 - b. is varied but should be able to create a wet/dry spread pattern.
 - c. should use fan style nozzles.
 - d. is used to spread granular products.

Chapter 10: Deicing

Overview

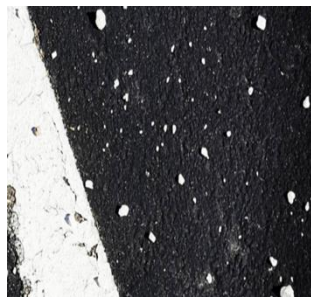
Using chemicals during or after a storm is considered deicing. Deicing is often necessary to loosen the bond between ice or snow and the pavement. Aggressive mechanical removal before applying deicers will reduce salt use.

Deicing materials are not intended to melt all of the snow on a surface.

Spread Pattern

When applying granular materials, leave space between the grains. Deicers should not be spread on thick or in clumps. Any spilled or excess salt should be cleaned up.

Correct:
Spaces between granules



Spacing between granules, as seen above, will vary with rate.

Incorrect:
Thick spread of salt



Piles of salt, shown in the photo above, are an example of a wasteful practice

When deciding where to apply salt, consider how salt moves. Foot traffic will spread deicer to the edges of sidewalks and into building entrances. Sidewalks spread with a narrow-spread pattern will allow for salt to stay on the sidewalk for more melting, less wasted product and less damage to plants and soil next to the sidewalk. If a broadcast spreader is too wide for the sidewalk, add a shield for an easy fix. Drop spreaders have been shown to be effective in reducing salt use.



Example of a shield for a spreader to create a narrower spread pattern

Speed and Control

When using a vehicle to apply deicer, drive at slower speeds to keep salt on target. Granular products bounce off target at higher speeds.

Rates

Your equipment should be calibrated before using a rate chart. See Chapter 3.

Using the Rate Chart

You will need to know: type of material and the **pavement** temperature.

The steps to using the application rate chart:

- Determine the pavement temperature. (Chapter 6)
- Determine the product to use. (Chapters 7 and 8)
- Where the pavement temperature (left) and material (top) intersect equals application rate

*40, 5x5
sidewalk
squares =
1,000 sq. ft.*

The chart will give a range for application rate. If pavement is warming or cooling, determine what end of the range is appropriate (warming = less, cooling = more).

Note: Gray areas mean the product is not recommended for the temperature range.

To use an interactive version of the chart, go to the [Salt Wise application calculator](#).

De-icing Application Rate Guidelines for Parking Lots, Sidewalks and Trails						
For best results remove as much snow and ice as possible before applying deicers						
Pavement Temp. (°F)	Application Rate in lbs./per 1000 square foot area Apply with calibrated equipment					
	Rock Salt*	Bagged Blend Mostly Sodium Chloride	Bagged MgCl ₂ or CaCl ₂	Wet at 6-12 gal/ton		Winter Sand**
				Rock Salt wet with Salt Brine	Rock Salt wet with other liquids	
28 ° to 32 °	2.3	2.3		1.6		
23 ° to 28 °	2.3-4.5	2.3-4.5		1.6-3.2		
15 ° to 23 °	2.3-6.8	2.3-6.8		1.6-4.8		
0 ° to 15 °			2.3-6.8	3.2-4.8	3.2-4.8	Spot treat as needed
-5° to 0°			6.8		4.8	
< -5°	Plow Only					
SPEED of melting	AVERAGE The colder it is the slower it works	Faster than rock salt if gradation is finer	ABOVE AVERAGE	FAST	FAST	NONE

* Dry rock salt is not recommended in cold temps. It is slow to melt and leads to over application.

**Winter sand contains ≤ 5% salt. It will not melt snow or ice. It is used for traction only.

For subsequent passes use ½ rate to the full initial rate.

Dane County Department of Land and Water Resources (LWRD) has determined these guidelines establish a best maintenance practice for those fighting winter storms so they can provide high quality service and a lower impact on our environment. By issuing these guidelines, LWRD does not intend to extend its liability beyond that imposed by state statutes.

Figure 9: Deicing application rate guidelines for parking lots sidewalks and trails

Evaluation

Document the conditions and strategies for every storm. A post-storm debriefing form may be helpful for documentation (see Chapter 12). If salt is found on dry pavement after a storm, too much was applied. Granular salt found on dry pavement should be swept up.

Direct Liquid Application

Direct Liquid Application (DLA) is applying a straight liquid product before, during or after the storm. When used before the storm it is commonly called anti-icing. See Chapter 9 for more information on anti-icing.

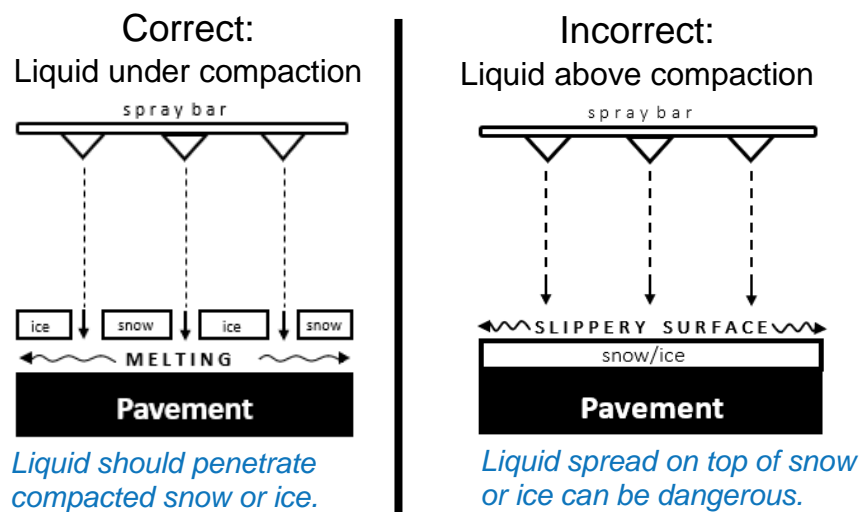
When used during or after a storm, the liquid is sprayed at a high pressure with streamer nozzles through the snow and ice. This penetrates the snow and ice and creates a layer of melting between the snow and the pavement. This strategy is not intended to melt all of the snow or ice on the pavement.

- DLA is an advanced technique and should not be attempted unless you are familiar with using liquids.
- DLA requires penetration through the ice and snow to melt from the bottom up. Otherwise you will create a slippery surface.
- If liquids do not penetrate, but spread on top of snow and ice, a dangerous situation may be created.

Good situations to try DLA include:

- Micro layer of ice
- Warm or warming pavements

Since DLA is a new strategy, there is limited information available about rates. Most use application rates equal to or greater than anti-icing rates.



Practice Questions

Answers can be found in the back of this manual.

- 1) **Deicing with granular materials**
 - a. is meant to melt all of the snow or ice on pavement.
 - b. should occur before mechanical removal.
 - c. is cheaper and better for the environment than anti-icing.
 - d. should follow an application rate chart or calculator for guidance.

- 2) **Direct liquid application**
 - a. is applying a straight liquid product before, during or after the storm.
 - b. is intended create a layer of melting under snow or ice.
 - c. is an advanced and cutting-edge technique.
 - d. All of the above

For the following practice questions, use the deicing chart found earlier in this chapter or the online product application calculator

- 3) **If your pavement is 17° F and you have rock salt (NaCl) what rate should you use?**
 - a. 1.6-3.2 lbs/1000 sq ft
 - b. More than 6.8 lbs/1000 sq ft
 - c. Less than 1.6 lbs/1000 sq ft
 - d. 2.3-6.8 lbs/1000 sq ft

- 4) **The pavement temperature is 25° F and you are using rock salt wet with brine on a parking lot with an area of 10,000 sq ft. How much material will you need to treat the parking lot?**
 - a. More than 50 lbs
 - b. Less than 15 lbs
 - c. Between 16 and 32 lbs
 - d. Between 33 and 48 lbs

- 5) **The pavement is negative 8° F, what material should you use?**
 - a. Rock salt
 - b. Bagged MgCl₂
 - c. Plow only, deicers will not work at this temperature. Apply sand only where needed for traction.
 - d. Rock salt wet with other liquids

Chapter 11: Property Managers

Overview

Property managers are the gate-keepers for good or poor salt use practices. A trained and certified winter maintenance professional working with an uninformed property manager often finds a difficult path forward with salt reduction strategies.

Here are some ways to kickstart a discussion with property managers about good winter maintenance practices:

- Share information on progressive winter maintenance with property managers.
- Introduce them to view [Salt Wise resources](#).
- Encourage them to attend [MPCA Smart Salting training designed for Property Managers](#).

Building Entrances

Place tools in building entrances. Provide the option to remove snow mechanically.

If salt is provided in the building entrance, also provide winter maintenance guidance and tools such as:

- “Always shovel before applying salt.”
- “Give salt time to work before reapplying. The colder it is, the slower it will work.”
- Diagram of a proper spread pattern
- Quantities recommended for that entrance area
- Scoop with proper amount indicated
- Spreader with proper amount indicated
- Broom to sweep up extras after the storm and instructions for returning extras to salt bucket

There is no exact amount of deicer to use in every situation because pavement temperature and conditions vary. Dane County’s application rate chart is in Chapter 10. This provides recommended application rate ranges based on pavement temperature and deicing materials used.



If you give them a bucket of salt, they may salt. If you give them a shovel, they may shovel. Provide a variety of lower salt options as well as guidance on how to use each strategy while maintaining safety.



Place a mechanical removal option, or better yet multiple options, in building entrances.

Lower salt tips


- Provide a smaller bucket of salt.
- Provide a smaller scoop.
- Have all users watch the [Mississippi Watershed Management Organization's "Small Sites Video"](#) before earning the right to use a salt bucket.
- Provide a shaker of salt instead of a bucket of salt.
- Provide sand and guidance if the temperature is too cold for salt to work.

SAND


Salt does not melt ice when the temperature drops below 15 degrees.

Use sand from this bucket for traction.

If you use salt from this bucket, please be ...



Wisconsin Salt Wise



Shovel first to remove snow

Scatter salt (if needed) leaving space between the grains

Switch to sand if the temperature is below 15 degrees

This is what the right amount of salt looks like.

Use the **right amount** of salt this winter to protect our lakes, streams and drinking water.

Learn more at wisaltwise.com

Sand guidance (top) and salt guidance graphics (bottom) for your entryway are available from [Wisconsin Salt Wise](#).

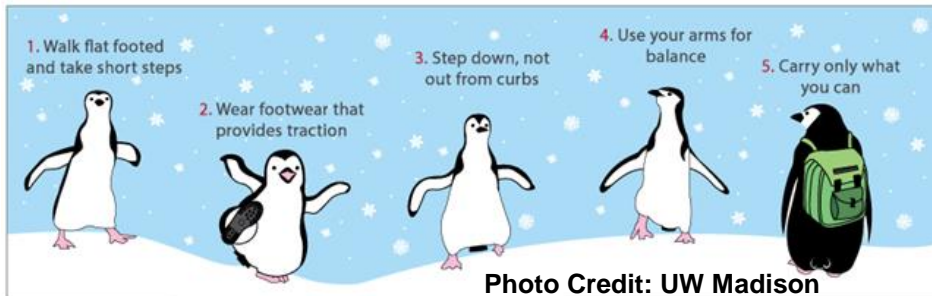


Tools that encourage lower salt use: a salt shaker that only allows for slow release of salt (top) and a small cup with guidance for a salt bucket (bottom) (template available at [Wisconsin Salt Wise](#))

Communicate with Users

Notify building users on what to expect. Encourage them to walk and drive carefully. Alert them to changes they may see:

- New products (e.g. liquids)
- New approaches (e.g. anti-icing)
- Restricted use areas
- Hazards
- New equipment (e.g. back pack blowers)



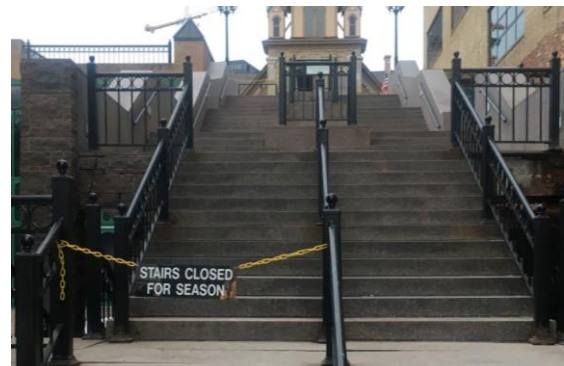
Above are examples of signs that encourage users to walk carefully (left) and alert them of possible slippery conditions (right). These signs could help improve safety.

Drainage Problems

Document drainage problems to fix in the summer. Drainage problems are high risk, high salt and high maintenance areas in the winter.

Close High Risk, High Maintenance Areas

Survey your service areas to determine what locations can be closed for the winter. This might include duplicated sidewalks, wide staircases, or high-risk areas. This could reduce your maintenance time, salt use and risk to users.



Example of half-closed staircase to reduce maintenance and risk.



A trained crew will know how to handle a problem like the salt spill shown above.

Train your Crew

Train your crew to be on the lookout for problems and to document or fix problems as they arise. Leaving a problem behind is a poor reflection of your organization. Review your philosophy of leaving problems versus fixing problems with your crew. Reiterate your expectations of a job well done. Having a well-trained crew makes your job easy!

Practice Questions

Answers can be found in the back of this manual.

- 1) **Mechanical removal options, such as a shovel, in a building entrance may encourage less salt use.**
 - a. **True**
 - b. **False**

- 2) **Should property managers talk to their crew and contractors about lower salt winter maintenance strategies?**
 - a. **Yes**
 - b. **No**

- 3) **What does a drainage problem look like?**
 - a. **Ice on the steps for a dripping roof**
 - b. **A frozen pond in the middle of the parking lot**
 - c. **Frozen river of ice on top of sidewalk where downspout ends**
 - d. **All of the above**

Chapter 12: After the Snow and Season

After the Storm

Post-Storm Debriefing

It is important to document and evaluate the strategies used for each storm. Share results in a post-storm debriefing. Just as in sports, a meeting following a big game is designed to go over what went well and what needs work. Post-storm meetings are to be used to share constructive ways to improve, better understand what happened and make adjustments before the next event.

If it is not possible to meet in person, post the results and share them with the team.

This will help you decide and remember which strategies work and which don't work for each area you are treating and for different storms. Documentation can help you improve performance and save materials. It can also help you reflect on ways to reduce cost and harm to the environment.

You will want to make a form for your crew to fill out during/after each storm. One easy way to record and evaluate your strategies is by using a [Post-storm debriefing form](#) (an example form is available at Wisconsin Salt Wise training resources and the following page). You can download and print the document from the website, make copies of the next page or create your own form.

If you create your own form, some items you will want to record include:

- Date
- Operator
- The site treated
- The weather including the pavement temperature, air temperature and the precipitation amount and type
- Which material(s) was used
- How much material(s) was used
- The reasoning behind choosing the material and strategy (i.e. weather, location, cost)
- The equipment used, including which truck or spreader if you have multiple
- Observations of the conditions before, during, and after the maintenance strategies have been used. This is where you would write down the results and be able to determine how effective the strategies were.



A post-storm meeting can be as informal or formal as you would like. This photo shows an example of a post-storm meeting.

Please complete one form for each storm event. If you make more than one pass using products during a storm, fill out a form for just one pass.

Storm Date: _____ Site: _____

Name: _____ Company/Organization: _____

Phone: _____ Email: _____

- Check box if you used calibrated equipment for this storm.
- Check box if you used liquids (brine) before the storm.

Pavement Temperature	Pavement Condition Before Applying Product	Product Applied	Application Rate Used (lbs. per 1000 square foot area)	How Did it Work?
<input type="checkbox"/> 28 ° to 32 °	<input type="checkbox"/> Almost bare pavement	<input type="checkbox"/> Rock Salt		
<input type="checkbox"/> 23 ° to 28 °	<input type="checkbox"/> Very clean; ¼ inch or less snow/ice	<input type="checkbox"/> Bagged Blend Mostly Sodium Chloride		
<input type="checkbox"/> 15 ° to 23 °	<input type="checkbox"/> More than ¼ inch snow/ice	<input type="checkbox"/> Bagged MgCl2 or CaCl2		
<input type="checkbox"/> 0 ° to 15 °		<input type="checkbox"/> Rock Salt Wet With Salt Brine		
<input type="checkbox"/> -5 ° to 0 °		<input type="checkbox"/> Rock Salt Wet With Other Liquids		
<input type="checkbox"/> < -5 °		<input type="checkbox"/> Winter Sand		
		<input type="checkbox"/> Other		

Other comments:

Please keep all Post-Storm Debriefing Forms for the entire season, then mail them to 5201 Fen Oak Dr., Madison, WI 53718. This information will be used only to evaluate the effectiveness of the new winter maintenance application rate guidelines (<https://tinyurl.com/ARGuidelines>) and make improvements. If you prefer to fill this form out online, visit <http://tiny.cc/PostStormEval>.

Questions? Contact the Dane Co. Office of Lakes and Watersheds -- lakes@countydane.com or (608) 224-3730.

Figure 10: Post-storm debriefing form

Cleanup

Equipment Cleanup

Equipment is often cleaned regularly to reduce the corrosive effects of salt. Before washing take time to remove as much salt as possible and put it in salt storage. If the equipment is washed indoors or at car washes, the salty water will end up at the sewage treatment plant or your septic system. This salt is not removed by either system. If the equipment is washed outdoors, the salty water will end up in the storm drain and end up in lakes, rivers, wetlands near your shop.

 **Remove as much salt as possible before washing your equipment. This will**
Tip **reduce the amount of salt going down the drain.**

Clean up Salt Spills

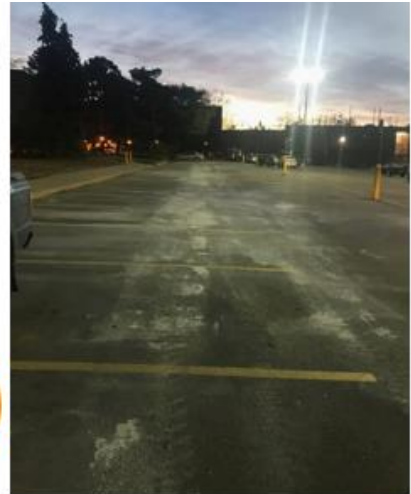
Train your crew what to do in case of a salt spill or over-application – clean it up. Don't wait for a customer complaint to clean up spills.



Customer complained



Second trip to clean it up



Customer happy

Snow Cleanup

The best place to pile snow is a location on a hard surface where debris can be collected after the snow has melted. As the snow pile melts, it is important to clean up the debris and sweep the area.



This photo shows what it looks like when debris mixes into snow piles.

Sand Cleanup

Clear excess salt or sand off surfaces. At the very least, sand should be cleaned in early spring before the rainstorms wash the sand away. For the most sand recovery, it is recommended that sand is cleared early and often, even in the winter during melt days.

Disposal of Sand Sweepings

The recovered sand must be disposed of properly. Once recovered, the sand will be full of debris, chemicals, oils and grease. Dispose of sweepings in a landfill, never in the wetland or low area. Keep sand piles away from playgrounds, schools and other areas where children may play on them.



This photo shows one example of equipment used for sand sweeping.

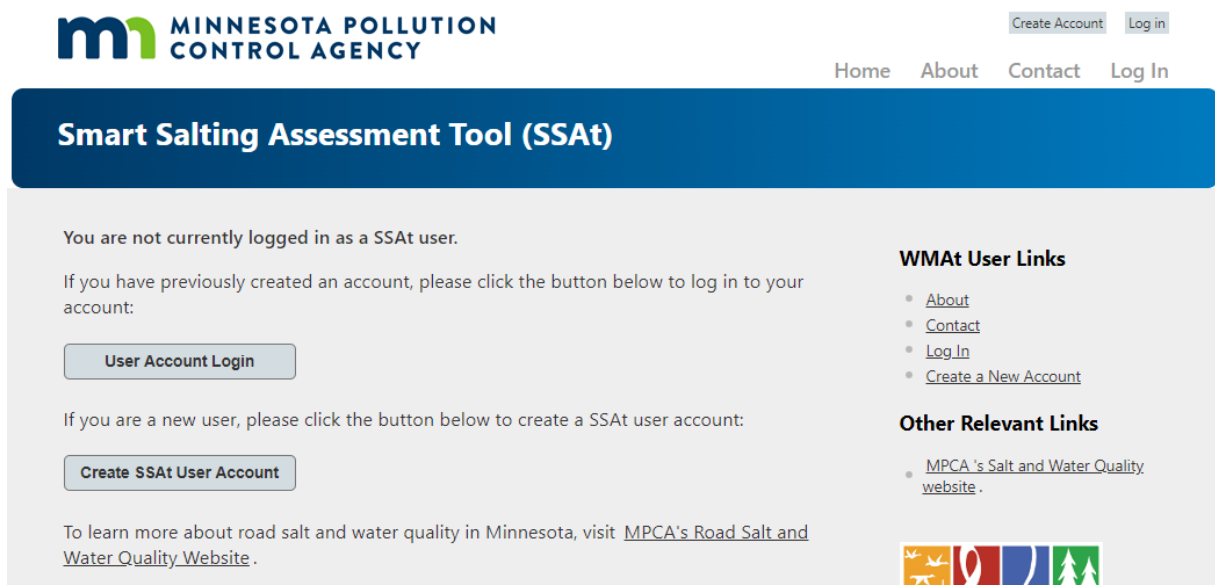
After the Season

Assessment of Operations

At the end of the season, take time to reflect on operations:

- How did the season go?
- Where can you make improvements?
- Do you need new equipment to replace aging pieces or incorporate new technology such as anti-icing or pre-wetting?

One tool that can provide insight into your operations is the [Minnesota Pollution Control Agency's Smart Salting Assessment tool \(SSAt\)](#). It will allow you to create a free account and conduct assessments of winter operations. It will also let you predict future practices. It then creates charts and graphs to help you understand what areas to make improvements in your operations.



The screenshot shows the top of the SSAt website. The Minnesota Pollution Control Agency logo is on the left. On the right, there are links for 'Create Account' and 'Log in'. Below the logo, there are navigation links for 'Home', 'About', 'Contact', and 'Log In'. A blue banner at the top of the page reads 'Smart Salting Assessment Tool (SSAt)'. The main content area has a message: 'You are not currently logged in as a SSAt user.' It provides instructions for existing users to log in and for new users to create an account, with corresponding buttons for 'User Account Login' and 'Create SSAt User Account'. At the bottom left, there is a link to 'MPCA's Road Salt and Water Quality Website'. On the right side, there are two sections: 'WMA User Links' with links for 'About', 'Contact', 'Log In', and 'Create a New Account'; and 'Other Relevant Links' with a link to 'MPCA's Salt and Water Quality website'. At the bottom right, there is a small graphic with icons for a bird, a water drop, a tree, and a recycling symbol.

Reporting

For organizations that are required to have an MS4 permit, reports must be submitted to the Wisconsin DNR. For more information on reporting requirements see Chapter 2.

If applying for the City of Madison Winter Salt Organizational Certification, it will require applicants to complete some post-season reporting. See Chapter 15 for more details.

Practice Questions

Answers can be found in the back of this manual.

- 1) Which of the following should be included in your record for an event?
 - a. Type of material
 - b. Pavement temperature
 - c. Precipitation type and amount
 - d. All of the above

- 2) You should remove as much salt from the spreader as you can before washing.
 - a. True
 - b. False

- 3) Where is the best place to pile snow?
 - a. In a rain garden
 - b. On a hard surface with good drainage
 - c. On the playground
 - d. In the nearby wetland

Chapter 13: Marketing

Best management practices that reduce salt can save money, reduce environmental impacts, and keep a desired level of service. You can also promote your business as environmentally sustainable.

Wisconsin Salt Wise will recognize your winter maintenance expertise

Certified applicators and businesses that receive organizational certification are showcased as trained on the [City of Madison website](#). Wisconsin Salt Wise partners encourage residents and businesses to choose certified applicators, so inclusion on this website helps promote your business.

Find Certified Applicators
Looking to hire a certified winter maintenance professional? The table below lists individuals who have taken the Winter Salt Certification training class and passed the exam. People who have been certified but cannot be hired for winter maintenance (such as City and County employees) will not be included on this list.

Name	Business	Date Certified	Certification Expiration
Suzie Abbott	Wisconsin Plowers	2014	2019
Bob Adams	Best Snow Removal	2017	2022
John Akin	ABC Lawn Service	2016	2021

Example list of certified applicators on City of Madison website

Pay attention to when certification will expire. Renew it before you or others in the company are removed from the list.

Help create informed customers

As you use best practices, you can educate customers about these changes. For example, you could communicate with your customers, “When pavement temperatures drop below 15 °F, rock salt won’t work. That is why we use a variety of products.” Having an informed customer can help manage expectations and increase acceptance of new practices. Take time to explain to customers why you are using best practices including liquids, and lower salt application rates.

One way to further inform customers is to offer to help them create a salt reduction plan. Winter maintenance professionals should take a tour of the site or property with their customers. Ask questions about the level of service they expect in various locations. Does everything need to be bare pavement? This will give you an opportunity to share some innovative salt reduction approaches they might not be aware of, but may be open to.

Other potential ways to promote your salt certification include posting to your website, sending a press release to media outlets or posting on social media. You can tell followers the practices you are doing to reduce your salt use and encourage them to do the same. Educate customers about practices and certification.

Chapter 14: Success Stories

Overview

It is possible to reduce your salt use while maintaining safety and a high level of service. Below, are different organizations that embraced the salt saving strategies and proved it works. It can work for you, too.

The Mall Concourse

The Mall Concourse is located in downtown Madison, Wis. where sidewalks are maintained year-round, seven days a week. The leaders from the Mall Concourse staff attended City of Madison Winter Salt Certification training in 2017. In the 2017-2018 season, they were able to cut their total salt use from 84.5 tons used in the previous season to 47.6 tons. Some changes they made to reduce their salt use include:

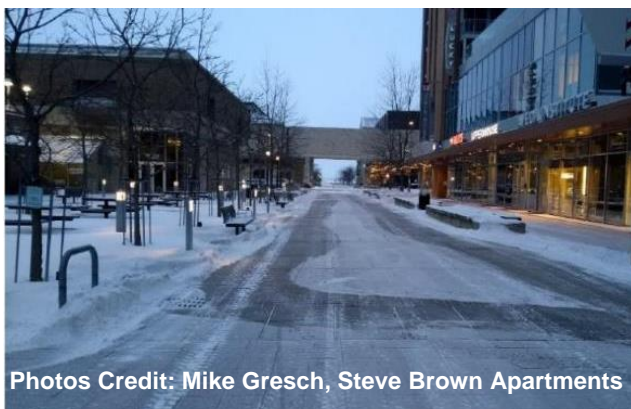
- Trained entire staff
- Calibrated equipment
- Used standard application rates
- Tracked salt use for each storm
- Measured pavement temperature
- Created a winter maintenance plan



The Mall Concourse team maintains all city sidewalks in the greater State Street and Capitol Square area in Madison

Steve Brown Apartments

Steve Brown Apartments manages a large, mixed-use facility in downtown Madison with 1,000 residents, a University health building and 12 businesses. Mike Gresch, the property manager, had the idea to recycle the brine from the facility's water softening unit and use it for anti-icing treatment on the grounds. Softener brine is typically discharged to the sanitary sewer. This an issue for the local wastewater treatment plant because it is not designed to remove salt, and all the chloride it receives ends up in local waters. By capturing some of the softener's discharge brine, the facility is able to reduce chloride from the sanitary sewer and reuse the chloride as a deicing material. Gresch also created his own equipment for spreading the brine. Gresch has found brining to be simpler and it uses less salt compared to using dry salt. For more information on this project, visit the 2018 Road Salt Symposium site and view his presentation file ["Bitter Brine Reclaim for Winter Maintenance."](#)



Photos Credit: Mike Gresch, Steve Brown Apartments



Before (left) and after (right) a treatment of brooming and brining

Epic Campus

Epic has a large campus located just outside of Madison, Wisconsin. Epic has steadily reduced salt use over four seasons between 2014-2018. In that time, Epic has reduced bulk salt from 224 tons to 62.4 tons. Changes they have made to reduce their salt include:

Season	Bulk salt total (tons)	Bag salt total (tons)
2014-2015	224	22
2015-2016	134	22
2016-2017	94.4	12
2017-2018	62.4	8.4

Figure 11: Salt savings at Epic campus

- Calibrating equipment
- Educating all of the operators about proper salt application rates
- Communicating to the company's 10,000+ employees about changes to winter maintenance and safe driving and walking expectations
- Use application rates based on pavement temperatures
- Using salt brine to anti-ice before storms
- Created salt tracking documents and kept them in each truck and where the salt is stored

Barnes Inc.

Barnes Inc. is a snow removal company that services 150 commercial buildings and 300 residential customers. In 2017, they trained several employees and upgraded their equipment. They saved over three tons of salt per snow event in the 2017-2018 winter season on sidewalks alone. Because of Salt Wise strategies, Barnes Inc. saved \$30,000 savings in annual salt purchases.

Barnes Inc. made the following changes to reduce salt use:

- Trained staff
- Communicated expectations
- Changed company culture to emphasize low salt use through adapting quality control evaluation procedures. Over-salting was added as a criterion for evaluating services performed, effectively holding individual applicators accountable for over-salting.
- Tried new equipment and practices

For more information about Barnes, Inc. and additional success stories, visit Wisconsin Salt Wise's [Case Studies page](#).

If you have a salt reduction success story, share your story on the [City of Madison Winter Salt Certification Page](#).

Chapter 15: Madison Section

Environmental Impacts

The heavy use of salt in the Madison area over several decades is apparent in chloride trends in local waterways. All Madison-area lakes have experienced a steep increase in chloride concentrations due to winter road salting (Figure 13). Some local waterways, including Pheasant Branch Creek and Starkweather Creek, have been designated as impaired due to high chloride levels.

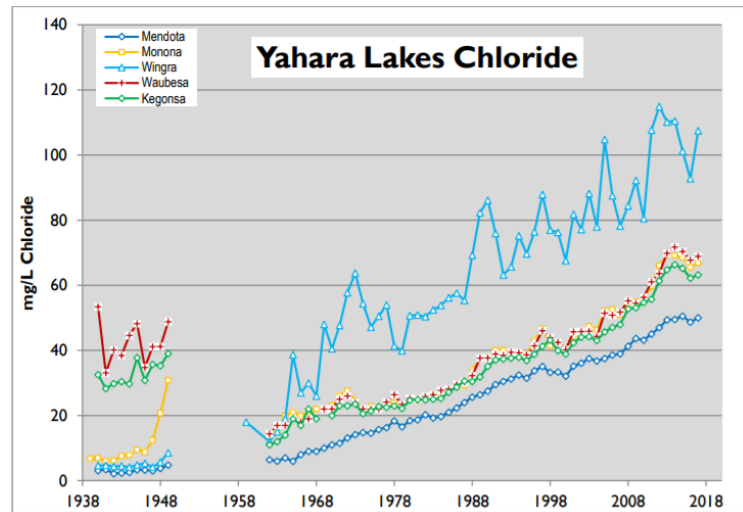


Figure 12: Chloride levels in Madison-area lakes²¹

Meanwhile, chloride has seeped into local drinking water wells, increasing chloride in groundwater to the point that one well's chloride concentration is more than twice as high as it was in 2000²². It is necessary to reverse the chloride trend to prevent more pronounced environmental impacts and associated regulatory and economic consequences.

Chloride levels in wastewater, in particular, present a regulatory challenge in the Madison area. The local wastewater treatment utility, Madison Metropolitan Sewerage District, is not designed to remove chloride, so all the chloride it receives leaves in the treated water into two freshwater streams south of Madison. However, the district is still required by its discharge permit to keep chloride levels under a specified limit. Currently, the sewerage district occasionally exceeds the Wisconsin chloride criterion of 395 mg/L, so the sewerage district needs to reduce chloride at the plant to consistently be below this target.



Photo credit: Village of DeForest

Open pick holes in manhole covers are points where salt-rich stormwater can enter the wastewater sewer.

The main source of chloride to the treatment plant is water softeners, which are in nearly all buildings in the Madison area due to the region's hard water. However, the wastewater sewer system also receives some stormwater and groundwater and the chloride they carry. The wastewater plant can receive tens of thousands more pounds of chloride on a day when snowmelt or winter rain brings road salt into the sewer, causing peaks in chloride levels (Figure 14). These peaks can put the treatment plant at risk of exceeding its chloride limit.

The sewerage district is working to reduce both road salt and water softener salt. Reducing these sources of chloride to the treatment plant is much more cost-effective than constructing expensive treatment technology at the plant to remove chloride after the fact. If the district can meet chloride targets without building technology, it will keep residents' sewer bills lower while protecting our local fresh water.



Reducing salt use on roads or in water softeners can help prevent a sewer bill increase of 55-500 percent that would be associated with implementing chloride removal technology.

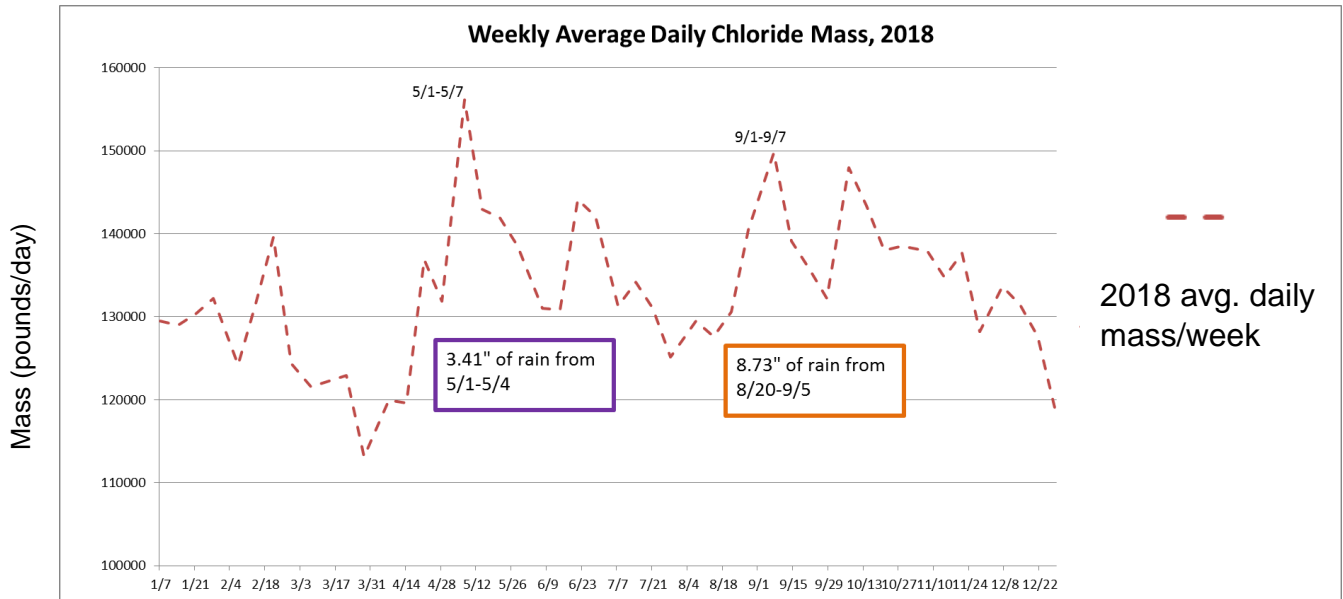


Figure 13: 2018 weekly average daily chloride mass at MMSD (data from MMSD)

Material Restrictions -Agricultural additives

Under Development

Certification

Under Development

Dane County interactive Mapping (DCiMap)

Dane County's interactive mapping tool, [DCiMap](#), can be used for creating maps and measuring service areas in Dane County. To use the measuring tool, click the ruler on the upper right-hand side of the application. Lengths of sidewalks, areas of parking lots and more can be measured using this tool.

Purchasing Brine in Dane County

Dane County

Contact: Dan Behrend, Dane County Highway Department
Behrend@countyofdane.com

- Dane county can only sell to municipal or public entities.
- The price will vary each season. The price for the 2018-2019 season was 33 cents per gallon

City of Madison

Contact: John Blotz, City of Madison Streets West Shop
608-267-4956
jblotz@cityofmadison.com

- Prices will vary each season
- Price for 2018-2019 season:
 - Minimum charge is 25 dollars per fill of 50 gallons of brine.
 - Additional brine is 30 cents per gallon.
- City of Madison can only fill vented tanks equipped with a 1-1/2" male, cam & groove or camlock style coupling.



The photos above show male, camlock coupling hardware needed to buy brine from City of Madison

Grant Funding from Madison Metropolitan Sewage District

Funding is available in the Madison area to help your organization reduce salt use. As of 2019, the Madison Metropolitan Sewerage District offers road salt grants to help applicators purchase equipment or make other changes that allow for less salt. Some of the [case studies](#) on the Wisconsin Salt Wise website, including Barnes, Village of Shorewood Hills, and Village of DeForest, feature projects that received grants from the sewerage district.

These grants are available to both public and private salt applicators that operate within the district's [service area](#). More information, including applications, will be available on the district's [chloride grants](#) page seasonally.

Appendix 1: Answers

Chapter 1: Impacts of Winter Maintenance

- 1) **D:** Chlorides, NaCl, MgCl₂ and CaCl₂ are the most common deicers. Once chloride gets into the water it is not simple to remove and it is toxic to aquatic life.
- 2) **A:** All deicers are bad for the environment even if it is labeled as “safe” or “environmentally friendly.” Chlorides can corrode metal leading to damage to infrastructure and cars. Organic deicers, such as acetates or agricultural by-products, can cause algal blooms in lakes.
- 3) **C:** It only takes 1 teaspoon of salt to pollute 5 gallons of water.

Chapter 2: Prepare for the Year

- 1) **B:** Contracts that charge by the amount of deicer used often lead to over application of deicer.
- 2) **D:** City of Madison will recognize anyone in Wisconsin fulfilling the requirements of their certification program as will the state of Minnesota.
- 3) **D:** The more educated and informed your crew is on winter maintenance in general and on their sites in particular, the better qualified they are to perform at a high level.

Chapter 3: Calibration

- 1) **D:** All types of liquid and granular spreaders can and should be calibrated at least once a year.
- 2) **C:** Always calibrate before the first snow fall and before using any new equipment.
- 3) **A, True:** All equipment including liquid equipment can and should be calibrated.

Chapter 4: Storage

- 1) **B:** Salt should be stored and covered year-round on a waterproof floor. Salt should not be leaving your salt pile unintentionally.
- 2) **D:** Proper snow storage could lessen pollution and save time and money on later maintenance.
- 3) **C:** Secondary containment is necessary to properly store liquid deicers and prevent a leak or spill from contaminating water.

Chapter 5: Mechanical Snow Removal

- 1) **D:** Mechanical snow removal strategies should be your first approach during or after a storm to use the least amount of salt.
- 2) **C:** Choosing the best equipment will depend on the weather conditions and treatment area. A good rule to follow when deciding the best equipment for the situation is to use the equipment that will require the least amount of salt to meet the level of service required.
- 3) **A, True:** Mechanical removal should always be the No. 1 reactive approach to a storm. Applying deicers before plowing can lead to dilution of the salt making it less effective.

Chapter 6: Weather Information

- 1) **D:** The pavement temperature will determine which type and amount of chemicals will be effective. It is necessary to use the application rate chart.
- 2) **B:** The pavement temperature will vary depending on pavement type, color and location. An infrared thermometer can be hand-held or mounted to a vehicle.

Chapter 7: Materials

- 1) **B, False:** Abrasives do not melt snow or ice. They are only used for traction.
- 2) **B:** Liquid deicer will work faster than dry rock salt but has less melting power.
- 3) **D:** Rock salt, also known as sodium chloride, is the most common deicer. Magnesium chloride and calcium chloride are also commonly used. All of these deicers contain chloride.

Chapter 8: Liquids

- 1) **A, True:** Since salt must go into solution to work, and liquids are already in solution, they increase the speed of the melting process.
- 2) **D:** A good entry point for pretreated stockpiles is to purchase the product already professionally blended. If you find success using a treated stockpile you can then decide if you want to move ahead with mixing your own or continue using a professionally mixed product.
- 3) **C:** 23.3 percent is the optimal concentration of brine.

Chapter 9: Anti-icing

- 1) **B:** Anti-icing is always completed using liquid chemicals.
- 2) **D:** Effective anti-icing will break the bond between the pavement and snow and ice. It is intended to make mechanical removal easier.
- 3) **B:** There are lots of types of equipment available for anti-icing. Whatever equipment you choose should be able to create a wet/dry spread pattern. The dry spots will help with traction if something were to go wrong.

Chapter 10: Deicing

- 1) **D:** Deicing will decrease the bond between snow/ice and the pavement and should not be used to melt all of the snow/ice. Always use mechanical removal before using deicing materials to prevent dilution. Use an application rate chart or calculator to guide your decisions on what materials to use and how much.
- 2) **D:** Direct liquid application (DLA) is an advanced technique that uses straight liquid, not granular, deicers. This technique creates a thin layer of melting under snow which will make mechanical removal easier.

3) **D:** Your rate is found on the chart where 17° F and rock salt intersect.

De-icing Application Rate Guidelines for Parking Lots, Sidewalks and Trails						
For best results, remove as much snow and ice as possible before applying deicers.						
Pavement Temp. (°F)	Application Rate in lbs/per 1000 square foot area					
	Wet at 6 to 12 gallons per ton			Apply with calibrated equipment		
	Rock Salt *	Bagged Blend Mostly Sodium Chloride	Bagged MgCl ₂ or CaCl ₂	Rock Salt wet with Salt Brine	Rock Salt wet with other liquids	Winter Sand **
28 ° to 32 °	2.3	2.3		1.6		
23 ° to 28 °	2.3-4.5	2.3-4.5		1.6-3.2		
15 ° to 23 °	2.3-6.8	2.3-6.8		1.6-4.8		
0 ° to 15 °			2.3-6.8	3.2-4.8	3.2-4.8	Spot treat as needed
-5° to 0°			6.8		4.8	
< -5°	Plow Only					
SPEED of melting	AVERAGE The colder it is the slower it works	Faster than rock salt if the gradation is finer	ABOVE AVERAGE	FAST	FAST	NONE


4) **C:** Your rate is where 25° F and rock salt wet with brine intersect. This rate of 1.6-3.2lb/1000 square feet is multiplied by the area of service and then divided by 1,000.

$$1.6-3.2 \times 10,000 = 1,600-3,200$$

1,600-3,200/1,000 = 16-32 pounds of salt will be needed.

De-icing Application Rate Guidelines for Parking Lots, Sidewalks and Trails						
For best results remove as much snow and ice as possible before applying deicers						
Pavement Temp. (°F)	Application Rate in lbs/per 1000 square foot area					
	Wet at 6 to 12 gallons per ton			Apply with calibrated equipment		
	Rock Salt *	Bagged Blend Mostly Sodium Chloride	Bagged MgCl ₂ or CaCl ₂	Rock Salt wet with Salt Brine	Rock Salt wet with other liquids	Winter Sand **
28 ° to 32 °	2.3	2.3		1.6		
23 ° to 28 °	2.3-4.5	2.3-4.5		1.6-3.2		
15 ° to 23 °	2.3-6.8	2.3-6.8		1.6-4.8	1.6-4.8	
0 ° to 15 °			2.3-6.8	3.2-4.8	3.2-4.8	Spot treat as needed
-5° to 0°			6.8		4.8	
< -5°	Plow Only					
SPEED of melting	AVERAGE The colder it is the slower it works	Faster than rock salt if the gradation is finer	ABOVE AVERAGE	FAST	FAST	NONE

5) **C:** If you follow the “<-5° F” row across the chart, you will see no deicer is recommended. Only mechanical removal and spot treating with sand are recommended.

De-icing Application Rate Guidelines for Parking Lots, Sidewalks and Trails						
For best results remove as much snow and ice as possible before applying deicers						
Pavement Temp. (°F)	Application Rate in lbs/per 1000 square foot area					
	Wet at 6 to 12 gallons per ton			Apply with calibrated equipment		
	Rock Salt *	Bagged Blend Mostly Sodium Chloride	Bagged MgCl ₂ or CaCl ₂	Rock Salt wet with Salt Brine	Rock Salt wet with other liquids	Winter Sand **
28 ° to 32 °	2.3	2.3		1.6		
23 ° to 28 °	2.3-4.5	2.3-4.5		1.6-3.2		
15 ° to 23 °	2.3-6.8	2.3-6.8		1.6-4.8		
0 ° to 15 °			2.3-6.8	3.2-4.8	3.2-4.8	Spot treat as needed
-5° to 0°			6.8		4.8	
< -5°	Plow Only 					
SPEED of melting	AVERAGE The colder it is the slower it works	Faster than rock salt if the gradation is finer	ABOVE AVERAGE	FAST	FAST	NONE

Chapter 11: Property Managers

- 1) **A, True:** If there are mechanical removal options in the entryway, users may use that instead of salt. You may want to consider replacing a salt bucket with only mechanical removal options.
- 2) **A:** Property managers are often blamed as the one who calls contractors or staff back to apply more and more salt. Educating property managers about smart salting and fostering discussion between winter maintenance pros and property managers will help us reduce salt but not reduce safety.
- 3) **D:** Drainage problems come in many varieties but they all create a more dangerous area to walk or drive. They often require more salt than any other maintenance areas.

Chapter 12: After the Snow and Season

- 1) **D:** These are a few of the key things to keep note of in your record for each storm. Keeping records will help you decide and remember which strategies work and can also help if a lawsuit comes up.
- 2) **A, True:** If the equipment is washed indoors or at car washes, the salty water will end up at the sewage treatment plant or your septic system. This salt is not removed by either system. If the equipment is washed outdoors the salty water will end up in the storm drain and end up in lakes, rivers, wetlands near your shop.
- 3) **B:** Snow should be piled in an area where any leftover debris can easily be collected and properly disposed. If you have an onsite salt pile, it is important to consider that when the snow melts it will not run through your salt pile.

Appendix 2: Acronyms and Abbreviations

ABP – Agricultural By-Products

CaCl₂ – Calcium Chloride

CMA – Calcium Magnesium Acetate

DCiMap – Dane County interactive Mapping

DLA – Direct Liquid Application

DNR – Department of Natural Resources

gal – Gallon(s)

KAc – Potassium Acetate

lbs. – Pounds

MgCl₂ – Magnesium Chloride

mg/L – Milligrams per liter

MPCA – Minnesota Pollution Control Agency

NaCl – Sodium Chloride

RWIS – Road Weather Information System

SIMA – Snow and Ice Management Association

sq. ft. – Square feet

SSAt – Smart Salting Assessment tool

UTV – Utility Task Vehicle

WISDOT – Wisconsin Department of Transportation

Appendix 3: Glossary

Abrasives – products such as sand or grit used to give traction on top of snow or ice

Air temperature – the temperature reading in the air. Most weather forecasts use air temperature.

Anti-icing – the process of applying a liquid to the pavement before the storm to reduce the bonding of snow and ice to the pavement

Application rate – the amount of product (deicer) put down per area, usually given as lbs./1,000 square feet or gallons/1,000 sq. ft. in this manual

Brine – liquid deicer made of a 23.3 percent concentration of rock salt (NaCl) in water

Calibration – the practice of measuring how much product comes out of a piece of equipment at each setting

Catch test – running a spreader for a timed interval, usually one minute, and collecting the material discharged. The material is then weighed and the data is used for calibration of the spreader. This test can be performed with any material granular or liquid.

Chloride – a chemical component occurring in most common deicers. It is considered a pollutant and it is very difficult and expensive to remove from the environment.

Concentration – the amount (in percentage) of active ingredient in a liquid, e.g. 23.3 percent sodium chloride in brine

Deicers – products that will melt snow and ice (e.g. chlorides or acetates)

Deicing – the process of applying a deicer during or after the storm to melt snow or ice

Direct Liquid Application (DLA) – applying only a liquid deicer. The term is most commonly used to refer to application of deicer during or after the storm, but anti-icing is also a DLA practice.

Eutectic temperature – the temperature at which a deicer solution will freeze, also known as the freeze point

Ground speed controls – equipment that can automatically adjust discharge rate as your speed changes to achieve a consistent application rate

Hydrometer – a device used to determine the density of a liquid. When making brine, you will be using a hydrometer to measure the salinity (saltiness) of the mixture

Ice melt capacity – the total amount of ice a fixed amount of deicer can melt given unlimited time

Ice melt speed – how quickly a fixed amount of deicer can melt ice at a given temperature

Leaching – deicer runoff from a pile of salt which if not contained may make its way into surface water or groundwater

- Level of Service** – the goal you are trying to achieve for a maintenance area. Level of service targets can range from bare pavement to snow covered pavement and often a time period is associated with level of service. (e.g. bare pavement in 12 hours after it has stopped snowing)
- Manual controls** – equipment that uses a manual setting such as a dial or lever to control gate opening. The discharge rate for manual controls will depend on gate opening and speed of travel
- Non-chloride Deicer** –refers to an acetate, formate, urea or any deicer that does not contain chloride
- Organic additive** – sometimes called “organics,” organic additive refers to a sugar, carbohydrate or plant by-product used as additive to deicers
- Pavement temperature** – the temperature reading at the pavement surface. More important for winter maintenance operations than air temperature
- Practical melting temperature** – the temperature at which a deicer will melt snow and ice to give results within a reasonable timeframe (approximately one hour)
- Prewetting** – adding liquid deicer or additives to granular deicers as it leaves the equipment or truck
- Pretreated salt** – liquid deicer or additives added to granular deicers in a stockpile or bagged product
- Sodium chloride (NaCl)** – also known as rock salt or road salt. Sodium chloride is the most commonly used deicer
- Spread Pattern** – is what the deicer, liquid or granular, looks like on the pavement. Spread patterns vary with application rate.
- Winter sand** – sand with a little salt mixed into it to keep the pile from freezing
- Wisconsin Salt Wise** – a coalition of organizations from across Dane County working together to reduce salt pollution in our lakes, streams and drinking water

Appendix 4: Resources

This section contains the web addresses for resources. These were compiled in June 2019 and may change over time.

Wisconsin Salt Wise Resources

Official Salt Wise Website

<https://www.wisaltwise.com/>

Training Schedule

<https://www.cityofmadison.com/live-work/sustainability/winter-salt-certification/get-certified>

List of Certified Individuals and Businesses

<https://www.cityofmadison.com/live-work/sustainability/winter-salt-certification/find-certified-applicators>

Application Guidelines and Calculator

<https://www.wisaltwise.com/Tools/Application-Guidelines-Calculator>

Calibration Resources

<https://www.wisaltwise.com/Tools/Calibration-Examples>

Case Studies

<https://www.wisaltwise.com/Case-Studies>

Certification Training Resources

<https://www.wisaltwise.com/Winter-Salt-Certification-Training-Resources>

Model Contracts

<https://www.wisaltwise.com/Tools/Model-Contracts>

Snow and Ice Policy

<https://www.wisaltwise.com/Tools/Model-Snow-and-Ice-Policies>

Post Storm Debriefing Form

<https://wisaltwise.com/documents/PDFs/Evaluation%20form.pdf>

Madison Resources

Dane County interactive Mapping

<https://dcimap.countyofdane.com/>

MMSD Grants

<https://www.madsewer.org/Programs-Initiatives/Chloride-Reduction/Chloride-Grants>

Purchase brine from City of Madison

<https://www.cityofmadison.com/streets/Seasonal/SaltwaterBrine.cfm>

Minnesota Pollution Control Agency Resources

MPCA's Chloride Page

<https://www.pca.state.mn.us/water/chloride-salts>

Smart Salting Assessment tool

<https://smartsaltingtool.com/>

Smart Salting Trainings

<https://www.pca.state.mn.us/water/salt-applicators>

Weather Resources

Wisconsin RWIS

Not currently available

MesoWest Weather Data, University of Utah

<https://mesowest.utah.edu/>

Other Resources

Clear Roads Research

<http://clearroads.org/>

Fortin Consulting, Inc.: Training Services

<https://fortinconsulting.com/>

Minnesota Local Road Research Board

<https://lrrb.org/>

Mississippi Watershed Management Organization "Small Sites Video"

<https://www.youtube.com/watch?v=-xMt1kyzlcg>

Snow and Ice Management Association (SIMA)

<https://www.sima.org/>

Wisconsin DNR's Impaired Water Search

<https://dnr.wi.gov/water/impairedsearch.aspx>

Wisconsin DNR Storm Water County Contacts

<https://dnr.wi.gov/topic/stormwater/contacts.html>

Wisconsin DNR's Surface Water Data Viewer

<https://dnrmaps.wi.gov/H5/?Viewer=SWDV>

Wisconsin DOT Road Salt Storage and Salt Bid Information (TRANS 277)

<https://wisconsin.gov/Pages/doing-bus/local-gov/hwy-mnt/winter-maintenance/rd-slt-strg.aspx>

Conversion Charts:

Gallon/Ton	Ounces/50 Lbs.	Oz./Lb.	Gallon/50 lbs.	Gallon/100 lbs.
5	16	0.32	0.125	0.25
6	19	0.38	0.15	0.3
7	22	0.45	0.175	0.35
8	26	0.51	0.2	0.4
9	29	0.58	0.225	0.45
10	32	0.64	0.25	0.5
11	35	0.70	0.275	0.55
12	38	0.77	0.3	0.6
13	42	0.83	0.325	0.65
14	45	0.90	0.35	0.7
15	48	0.96	0.375	0.75
16	51	1.02	0.4	0.8
17	54	1.09	0.425	0.85
18	58	1.15	0.45	0.9
19	61	1.22	0.475	0.95
20	64	1.28	0.5	1
21	67	1.34	0.525	1.05
22	70	1.41	0.55	1.1
23	74	1.47	0.575	1.15
24	77	1.54	0.6	1.2
25	80	1.60	0.625	1.25
26	83	1.66	0.65	1.3
27	86	1.73	0.675	1.35
28	90	1.79	0.7	1.4
29	93	1.86	0.725	1.45
30	96	1.92	0.75	1.5

Figure 14: Prewet ratio conversion chart for smaller quantities

Sand		Salt	
Yards	Tons	Yards	Tons
1	1.4	1	1.1
2	2.8	2	2.2
3	4.2	3	3.2
4	5.6	4	4.3
5	7.0	5	5.4
6	8.4	6	6.5
7	9.8	7	7.6
8	11.2	8	8.6
9	12.6	9	9.7
10	14.0	10	10.8

Figure 15: Yards to tons conversion chart²⁰

Field sheet for calibrating a push spreader

Test area length = 10 ft* *if your test area is longer than 10 feet use that number in your calculation for column E (e.g. if your test area is 20 feet long, the calculation for column E would be (Dx20).*

Equipment: _____

Calibrated by: _____

Date: _____

Material: _____

A	B	C	D	E	F	G
Speed (mph)	Lever position or gate setting	Weight of material spread in test area	Spread width (feet)	Coverage area (sq. ft.) (Dx10)*	Application rate (lbs/1,000 sq. ft.) C÷E x 1,000	Application rate (lbs/ lane mile) (12 ft width) F x 63
2						
3						
4						
5						
6						
7						
8						
9						
10						

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