McHenry County

Snow & Ice Control Handbook for Sidewalks and Parking Lots

Reducing the Environmental Impacts of Chlorides

Acknowledgments

This field handbook is dedicated to the plow operators who keep our roads safe all winter long. It is based on the *Manual of Practice for an Effective Anti-icing Program,* produced by the Utah LTAP Center, the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual, and the McHenry County Snow and Ice Control Removal Handbook..

McHenry County

Snow & Ice Control Handbook

for Sidewalks and Parking Lots

Field Handbook for Snowplow Operators

OCTOBER 2010

Based on a Guide Originally Published by:
Minnesota Local Road Research Board (LRRB) www.lrrb.org

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Contents

Purpose of this Handbook

The purpose of this field handbook is to help promote an understanding of the tools, best practices, and limitations for snow and ice control on parking lots and sidewalks.

This manual is designed to encourage environmentally responsible methods for snow and ice control that will help you reduce salt/sand use and mitigate environmental impacts while meeting the safety and mobility needs of sidewalk and parking lot users. Although it is less obvious than for roads, sidewalks and parking lots are also significant sources of salt and other contaminants that can harm water resources.

The handbook will help you understand the best snow and ice management practices. Improved practices such as anti-icing, pre-wetting, and pre-treating are emphasized in this field handbook. Also included are standard best practices expected in a quality snow and ice control program.

A blanket approach will not work for the broad range of, pavement, concrete, and weather conditions that plow operators encounter. This handbook teaches how to apply different strategies in different regions and under different conditions. We encourage you to continue to test, document, and refine the practices from this field handbook. We also encourage you to attend a winter snow and ice removal workshop and obtain certification for snow and ice removal operations.

Throughout the field book you will find environmental tips shown with this fish symbol:  These tips are provided to help you reduce environmental impacts from snow and ice control operations.

Using smaller amounts of deicers and abrasives means fewer pollutants will end up in our streams, lakes, and drinking water.

Background

Water and Environmental Impacts

- Only 2.5 percent of all of the water on this planet is freshwater (not saltwater). Of that, less than 1 percent is available to us. The majority of our freshwater is frozen in glaciers.

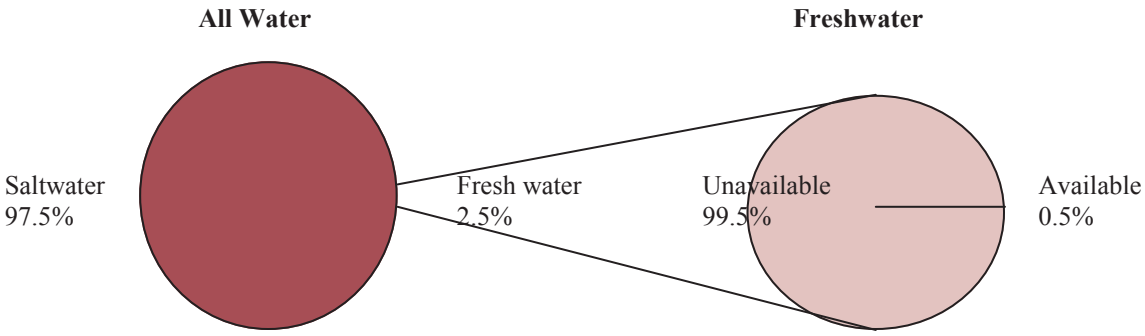


Figure 1. Available water

- The earth has a limited supply of water, which is recycled over long periods of time. Water is reused, recycled and dispersed as illustrated below from the MN Department of Natural Resources' "Healthy Rivers a Water Course" CD-Rom.

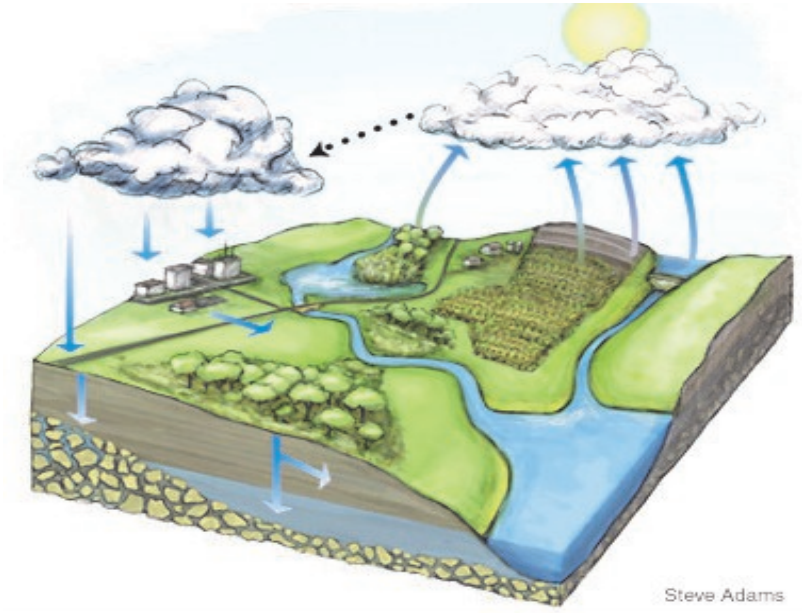


Figure 2. The water cycle

Road Salt Contributes to Water Pollution

- Salts dissolve and move downhill with the water to the nearest lake, river, or pond. They do not settle out; they stay in our water cycle virtually forever.
- Salt water is heavier than freshwater and sinks to the bottom of lakes. This eventually causes chemical stratification of the lake and loss of lake turnover.
- In Illinois, about 6,000 stream miles and 12,400 acres of lake have been placed on the federal list of impaired waters for aquatic life. For a list of impaired surface waters, including those affected by chloride, see http://www.epa.state.il.us/water/tmdl/303d-list.html.
- Chloride in groundwater has been increasing in the Chicago metropolitan area as the region has become more urbanized. Especially high concentrations of chloride (up to 1,000 mg/L) have been found in groundwater near Interstate 94 (Kelly 2008).

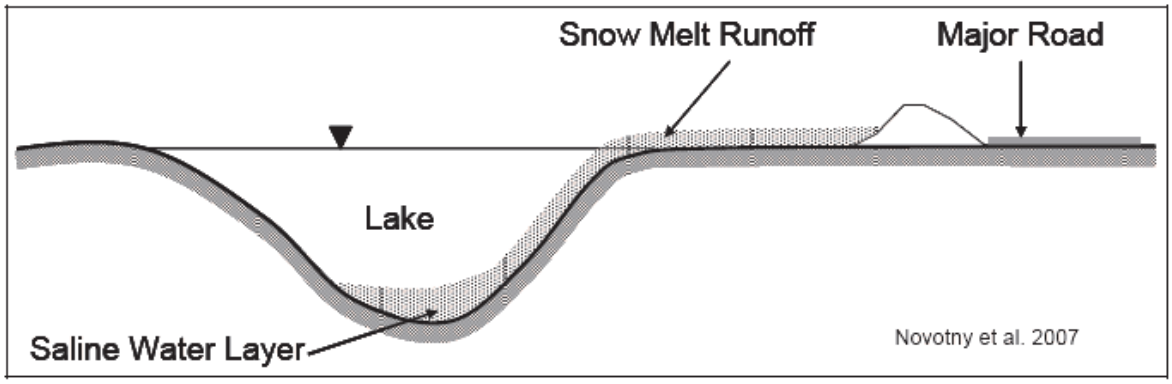


Figure 3. Schematic of a saline water intrusion into a lake

Fathead minnows will die if exposed to chloride concentrations of 443 mg/L for more than 30 days. (http://duluthstreams.org/understandingimpact_salt_2.html).

How Your Ice Fighting Arsenal Works

Salts and sand are the two most common products used on sidewalks and parking lots. They work by very different mechanisms. Salts are chemical deicers. They use chemical pathways to influence the melting behavior of ice. Sand is an abrasive. It works physically to add traction on top of snow and ice. Except in rare instances, using salt and sand together is a not efficient because they are working at cross purposes.

Note:
The best way to remove snow and ice is mechanically.
It takes four times more salt to remove ice than to prevent it.

Chemical Deicers

- Chemical deicers melt snow and ice by lowering the freezing point of water below the normal freezing point of 32°F.
    - This effect is called freezing point depression.
    - The freezing point is depressed because the presence of ions (such as Na^+ and Cl^-) in water make it harder for water molecules to join together form ice crystals. The solution must have a lower energy (a colder temperature) before the forces attracting ions to each other can overcome the dispersive forces of the ions in solution.
- The amount of freezing point depression depends on the concentration of the solution.
- The rate of melting depends on the pavement temperature (See “Before the Storm:” Pg. 21 for more information).

Three Classes of Chemical Deicers

Chlorides

- NaCl (rock salt)
- $CaCl_2$
- $MgCl_2$

$CaCl_2$ and $MgCl_2$ are more effective at melting ice for two reasons. First, they dissolve into three ions (One Ca^{2+} or Mg^{2+} ion and two Cl^- ions) as opposed to two for rock salt (Na^+ and Cl^-). More ions makes it more difficult for water molecules to come together to form ice crystals. Second, the process of dissolving $CaCl_2$ and $MgCl_2$ release heat.

Acetates

- Potassium acetate
- Calcium Magnesium acetate (CMA)

Alternative Plant-Derived Deicing Compounds

- Beet juice from sugar production
- Beer brewing mash
- Sugar cane
- Corn syrup

Additional products exist and can be found on the Pacific Snow Fighters Web site.

Physical Abrasives

These substances work to add traction. They are often used on corners, intersections, and steep grades where additional traction may be needed. Types of physical abrasives include:

- Sand and gravel
- Cinders
- Slag & bottom ash

Snowmelt can carry salt to the nearest lake, river, pond, or wetland through storm drains

Why Use of Deicers and Abrasives is Important

Deicers and abrasives allow us to continue our daily activities even in the face of winter weather. They provide both safety and economic benefits by allowing us to continue our jobs, transport goods, and deliver services even when winter weather is not cooperating.

Safety

- Clearing and deicing freeways and highways can reduce traffic accidents by as much as 87%.
- Clearing parking lots can also dramatically reduce accidents in these areas.

Costs

- While snow clearing and de-icing is expensive, the cost of a full season of snow management still costs less than a single day of lost economic activity due to a snowstorm
- The costs associated with a broken arm are typically $12,000-$20,000. The costs associated with a single broken hip can exceed $40,000.

Downsides to Deicers and Abrasives

No deicers or abrasives are environmentally friendly, no matter what the package may say. Operators and clients must weight the benefits of deicers with their environmental impacts and use these tools responsibly.

Chlorides

- Cannot be removed or recovered from the environment easily.
- Do not leave once they are in the water.
- Can only be removed from water through reverse osmosis, which is expensive and not practical for remediating large amounts of water.
- Damage roadside vegetation.
- Damage the soil structure by reducing permeability.
- Reduce nutrients available for uptake in the soil, weakening vegetation.
- Harm aquatic life.
- Are corrosive to infrastructure; $MgCl_2$ can contribute to the flaking of concrete
- Often have toxic anti-corrosion agents added to them.
- Sodium can contribute to or cause cardiovascular, kidney, and liver diseases, and is directly linked to high blood pressure. Elevated sodium levels in sources of drinking water could be an area of concern.

Acetates

- Are organic, non-chloride substances.
- Compete with aquatic life for oxygen.
- Contribute nutrients that can promote algal blooms.
- Are less corrosive than chlorides and can be treated by holding ponds.
- Are safer for vegetation.

Plant-Based Deicers

- Act as fertilizers in the water.
- Increase algal growth and use oxygen as they decompose.
- Impacts are serious, but not as long-lasting as chlorides.

The U.S. EPA recommends that drinking water not exceed 250 mg/L of chloride.

Abrasives

- Can create air quality and dust problems when crushed.
- Fine particles can decrease water clarity.
- Slag and bottom ash release heavy metals to the environment.
- Contribute to the silting and shallowing of lakes and marshes.

Why is this important to McHenry County?

McHenry Country has an average annual snowfall of 38" and we need deicers but:

- We are solely dependant on ground water for our drinking water.
- Our groundwater is very vulnerable to contamination.
- 3/4 of McHenry County ground water is drawn from within 100ft of the surface.
- Records show trend towards increasing salinity of ground water in McHenry County.
- More than half of the wells in McHenry County have chlorides rising at a rate of 1 mg/L/yr or more.
- Deicers are difficult and costly to remove from water.

Population growth is likely to add additional burden to the water supply.

Salt Use Statistics

Note: The following are road statistics. Information regarding private applicator rates and amounts is difficult to obtain.

- The Great Lakes region (Illinois, Wisconsin, Michigan, Indiana, and Ohio) uses the most road salt of all the regions in the country. The Chicago area alone (six counties including McHenry County) uses over 270,000 tons of road salt (primarily NaCl) in an average winter.
- The City of Chicago uses an average of 400 tons of salt per year.
- The average annual Illinois State Bid is 1.4 million tons of salt. The actual use in Illinois is higher as this does not represent all the entities that purchase salt on their own.
- In 2009, the state of Illinois spent $52,184,919.52 on road salt, and budgeting for road salt is one of the top priorities for local governments in the state.

McHenry County has already worked hard to reduce salt use on roads! Reducing salt use on parking lots and sidewalks can help use further reduce our salt consumption and the subsequent impacts on the environment and our sole source of drinking water—groundwater!

Before the Winter

Planning out a strategy for winter before the snow falls is the first step in reducing salt and sand use while maintaining a high level of service and safety.

Talk with your customers

- Develop a plan with your customer. You both want the same thing: safe, navigable parking lots and sidewalks.
    - Your customers will appreciate the reduced cleaning and sweeping costs as less salt and abrasives are tracked into stores and homes.
    - You will appreciate the cost savings of using less deicers and abrasives.
- Your plan should outline priority areas the customer wants cleared. Discuss if there are entrances that can be closed for the winter or if there are preferred access paths. Less area to clear means less chemicals and abrasives used.
- Discuss whether all of the parking lot needs to be cleared or if it only needs to be cleared at certain times (extra parking lots at malls may only need to be cleared during the holiday shopping season). Windrows of snow can also be used to guide cars through unplowed portions of parking lots.
- Identify all specialized surfaces: pervious asphalt, concrete, and pavers as well as heated surfaces. These areas will need reduced (or no) deicing or abrasives. If these areas need to be cleared, make sure that your strategy will not harm the surface.
- Identify areas where snow and ice can be stored on site, if needed. Avoid plowing into streams, ponds, and marshes.

Our waters are threatened by policies that are based on fees for material use. This encourages overuse of materials.

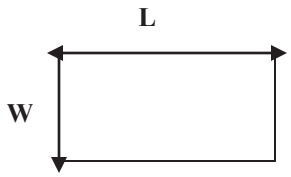
Determine the area of your parking lots

The amount of deicer or abrasive needed depends on many factors including the size of the area.

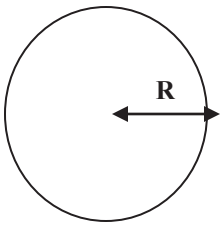
To determine area, you can:
- Ask your client for a to-scale map or plan of the area.
- Go out and measure.

Formulas for area:

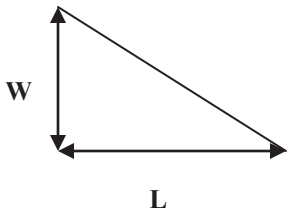
The area of a rectangle is length x width.



The area of a circle is 3.14 x radius x radius. The radius is the distance from the center of the circle to the edge of the circle.



The area of a triangle is length x width divided by 2.



Get to know your materials

Not every deicer is equally desirable for every job. Take time to learn about your materials before the season begins.

Speed of melting

- Different deicers take different amounts of time to melt one pound of ice. This amount of time also varies with temperature. Learn when it is no longer effective to use certain deicers. See the Appendix (page 30) for a chart of melting speeds.

Cost and Availability

- Some deicers cost more than others. Learn when it is financially advantageous to use different deicers (for example, an expensive deicer might be more economical at lower temperatures if you need to use less volume)

- Some deicers may not be available for resupply. You may have to ration your stock over the entire season.

Practical melting temperature

- This is the lowest temperature at which the deicer will have a noticeable impact. While the deicer will melt ice and snow at lower temperatures, it would take far too long to have any practical use. This lowest temperature at which a deicer will melt snow and ice is called the eutectic melting temperature. It is often listed on labels because it is lower than the practical melting temperature and therefore looks more impressive. Don't use the eutectic melting temperature. When in doubt, contact the manufacture or supplier.

Ideal Concentration

- Different de-icers work when applied in a different ways. Some work best as brines. See the anti-icing section (page 22) and the Appendix (page 30) for further information.

Environmental and infrastructural impacts

- Different deicers have different negative consequences for the environment (see pages 11 and 12). Are there any special considerations that call for the use of a specific deicer?

Know the properties of the different chemicals to make the best selection for your conditions.

Test your materials

- Verify the manufacturer's claims.
- Apply small amount of deicers to test areas under different weather conditions and see if they act as the manufacturer states.
- Record if any products are under or over performing. If products are not behaving as anticipated, contact the manufacturer to see if they have any suggestions.
- If you are using new products, this can help you become familiar with how they look and how they work.

Store your materials properly

Proper storage of deicers and abrasives can cut down on loss of materials due to wind, rain, or leaching, reducing unnecessary environmental impact and saving money.

- Cover any deicers and store them on an impervious surface.
- Avoid the setback zones of potable wells (see IEPA Title 35, Part 616, Subpart L for setback distances).
- Store deicers indoors when possible. This cuts down on contact with water and loss from wind.
- Do not store deicers near storm drains or surface waters or downhill from melting snow piles.
- Inspect your trucks and other equipment to see if there are any leaks that can be repaired.
- See if there is anyway to reduce spillage of material from trucks and equipment.
- Determine if deicing liquid can be stored outside without freezing (NaCl brine should be stored indoors).
- Liquid storage tanks should be double-walled or have secondary containment.

Don't let your investment wash away. Store your purchases out of the rain and the wind.

Calibrate your equipment

Calibration involves finding out how much chemical or abrasive is being applied over a given time to a given area for different equipment settings.

Calibrating your equipment allows you to know exactly how much deicer or abrasive you are using. If you don't know how much you are using, you can't know if there is room to reduce the amount applied.

- Calibrate *each piece of equipment annually*. It is recommended that you recalibrate your equipment with each new shipment of salt as the consistency of it may change.
- Because of wear and tear, each truck, spreader, or other piece of equipment will behave differently.
- Keep the calibration records with each piece of equipment.
- When purchasing new equipment, look for equipment that can be calibrated easily and that can deliver small amount of material. It is hard to use less if your equipment wants to use more.
- Any piece of equipment can be calibrated. Just find a way to determine how many pounds of material per minute is landing on the pavement or sidewalk over a measured area and at different speeds.

Once materials are applied, they cannot be recovered.

General Calibration Tips

- Follow the manufacturer's guidelines for calibration. If you don't have your owner's manual handy, look on the manufacturer's website or contact the manufacturer for training.
- For manual sander controls, calibration directions can be found at: http://www.saltinstitute.org/snowfighting/6-calib.html, in the "US" section.
- Calibrate salt/sand mix vs. salt or sand only separately. Each substance will flow differently!
- Remember: The auger plate must be in place during calibration. You are not calibrating the truck properly if the material is gravity-flowing.
- Keep of a copy of the calibrated application rate chart handy with each piece of equipment.

Basic Calibration Procedure for Auger or Conveyor Systems

If manufacture-specific calibration directions are not available, these generic steps can be used.

1. Measure the amount of deicer or abrasive that is released over a given amount of time.

    - To do this, attach a bucket or bag to the auger or run the equipment over a tarp for a short period (usually 15 seconds to a minute).
    - Collect the amount of material discharged and weigh.
    - For more accurate results, repeat this several times and average the results.

2. Divide the amount discharged by the time in minutes (Remember, there are 60 seconds in a minute. So if you ran the equipment for 15 seconds, divide the quantity discharged by (15/60)). The result is the discharge rate in lbs/min.

3. Repeat for each equipment setting.

Alternatively:

Determine how much material is released in one auger revolution by catching the material in a bucket or tarp and weighing it. Count the number of auger revolutions per minute. Multiply the two numbers to get the discharge rate in lbs/min. For best results, do three measurements and average the results.

Below is a sample calibration chart for an auger spreader at different travel speeds, showing discharge in lbs/ 1,000 ft^2. "W" is the width of the discharge area or lane.

Table 1. Sample Calibration Chart for Auger Spreader

				Discharge Rate (lbs/1,000 sq. ft.)			
	A	B	C	Travel Speed and Computational Multiplier			
Control Setting	Shaft (RPM)	Discharge per Revolution (lbs)	Discharge per Minute (lbs/min) (A x B)	5 mph C/W x 2.27	10 mph C/W x 1.14	15 mph C/W x 0.76	20 mph C/W x 0.45

To Calibrate a Hand Spreader

1. Walk with the spreader at your normal walking speed for a 10 foot stretch.

2. Record the width of the strip the over which the material was applied.

3. Sweep up all of the material and weigh it.

4. Repeat several times and average for better results.

5. Calculate the area the over which the material was released by multiplying the horizontal spread of the material by the length of the test zone (10ft).

6. To find the application rate in pounds per 1,000 square feet, divide 1,000 by the area of the test zone (step #5), then multiply by the amount of material released (#3).

Basic Calibration Procedure for Gravity Flow Systems

Gravity flow systems are hard to calibrate. Think about upgrading your equipment if possible. The following are general steps for calibrating gravity flow equipment.

1. Find an open parking lot. Mark a 10 foot stretch of parking lot with a start and finish line.
2. Clean the 10ft area between the lines
3. Choose a setting for your truck. Drive over the area. Have someone standing outside the area cue the operator to open the gate shortly before the start line and close it shortly after the finish line. Drive at a constant speed.
4. Record the width of the strip the over which the material was applied.
5. Sweep up all of the material and weigh it.
6. Repeat several times and average for better results.
7. Calculate the area the over which the material was released by multiplying the horizontal spread of the material by the length of the test zone (10ft).
8. To find the application rate in pounds per 1,000 square feet, divide 1,000 by the area of the test zone (step #7), then multiply by the amount of material released (#5).
9. Repeat for each setting.

Below is a sample calibration chart for gravity flow equipment.

Table 2. Sample Gravity Flow Calibration Chart

Calculate application rate:
Vehicle: _____ Material:_____ Date:_____

		A	B	C	D
Speed (MPH)	Lever position or gate setting	Lbs. material recovered in 10 feet	Spread width (ft)	Coverage area in sq/ft (Bx10)	Application rate in lbs/1000ft² (1000/CxA)
5 MPH					
10 MPH					
15 MPH					
20 MPH					
Example: 20 MPH	Setting 2 Half-closed	0.4 lbs	13 ft	130	3.1 lbs/1000²ft

Before the Storm

MONITOR THE WEATHER

It is essential to be aware of existing and potential weather conditions. Resources for weather monitoring include the National Weather Service (http://www.noaa.gov), local TV and radio stations, and the Internet.

MONITOR PAVEMENT TEMPERATURE

In order to plan the amount and type of material to apply, you will need to know the pavement temperature. The temperature of the air, as measured by weather stations, can be quite different from the temperature of the pavement. Pavement temperatures can vary widely depending on the time of year, the exposure (how sunny or shady the area is), the surface materials, and the type of base materials underlying the pavement.

Hand-held temperature sensors, available for sale at auto-parts stores, allow you to directly measure the pavement temperature. Be sure that your sensor has the appropriate temperature range and accuracy for your purposes. More sophisticated mirror-mounted temperature sensors are another option.

In addition, a partnership of the Federal Highway Administration (FHWA) is working to develop a Road Weather Information System (RWIS) — an online service for highway condition information, including surface temperature (go to http://www.clarus-system.com). This other RWIS services only provide information for state highways; however, if you don't have a sensor, they can give you a general idea of conditions in your area.

Figure 4. Hand-held temperature sensor

ANTI-ICING

Anti-icing involves applying materials before an event to prevent snow and ice from bonding to the pavement surface. It is a proactive approach that is more cost-effective and environmentally safe than deicing after a storm. In fact, anti-icing increases safety with about 1/4 of the material and about 1/10 of the overall cost. It also saves time — depending on its size, a parking lot can be treated in a few minutes, saving time up front and later on. Depending on weather conditions, anti-icing materials can be applied well in advance of an event and can remain effective for several days.

Anti-icing works best when combined with accurate weather and surface temperature information.

Equipment

Equipment needed for anti-icing includes two main components:

- An anti-icing unit (a transport vehicle with a tank, or a hand-held pump sprayer or backpack sprayer). Pick-up trucks or ATVs can be retrofitted with a tank and boom and/or a hose reel with a sprayer.

- Stream nozzles, which can be purchased or constructed. A solid stream helps to avoid slippery conditions better than fan spray. Stream nozzles should have at least 8 holes, 8-inch spacing, with a bar height of 12 to 14 inches from the surface, and a pressure of 30 to 35 psi at the bar. If you must use fan nozzles, apply the material very lightly to try to avoid creating slippery surfaces.

Anti-Icing Tips

What to do:

- Less is more; over-application of anti-icers and granular material leads to slippery surfaces. Maintain dry areas between treated areas, and always follow product application recommendations.
- Use the Anti-Icing Application Rate Guidelines chart (on page 33) as a starting point.
- Use liquids, which are more effective than solids, including pre-treated or pre-wetted materials. When you use solids, you need more material, and the solids don't track as well.
- Liquids can also be dispersed by foot and vehicle traffic. If traffic lanes are treated, material will be transferred to parking areas. For the same reason, you may want to avoid treating areas directly in front of buildings — this can reduce the amount of material tracked inside and avoid over-application in high-traffic zones.
- Apply early — early application is particularly important for frost or light freezing drizzle.

What not to do:

- Don't reapply if there is still residue on the surface. Residue can remain for several days after application if precipitation or traffic wear-off does not dilute the original application.
- Don't apply liquids before a predicted rain or significant freezing rain — they will wash away.
- Don't apply $MgCl_2$ or $CaCl_2$ to a surface above 35º F pavement temperature. The surface can become slippery.
- Don't anti-ice under blowing conditions and be aware of areas that are prone to wind issues.
- Don't overuse $MgCl_2$ or $CaCl_2$ —this can lead to slippery surfaces. Too much granular material can also make a surface slippery.

Anti-icing can reduce airborne dust and salt particles.

PRE-WETTING AND PRE-TREATING

Pre-wetting and pre-treating have two main advantages:

- Salt does not melt snow and ice unless it is dissolved in a solution. Because of this, pre-wetting and pre-treating help to jump-start the melting process and penetrate built-up snow and ice.

- Wet materials stick to surface better than dry materials — they are less likely to blow or bounce out of the desired application area. This means that pre-wetting and pre-treating allow you to use less material (20% to 30% less), saving money and reducing environmental impacts.

When using pre-treated or pre-wetted materials, be sure to adjust the application rate! You will need about 1/3 less material compared to using a dry product.

Pre-Treating

Pre-treating means mixing a liquid deicer into a stockpile of sand or salt before it is applied. It does not require equipment changes or any new capital investment for equipment. Pre-treated materials can be purchased, or materials can be mixed on site. Brine is a common liquid deicer, but $CaCl_2$, $MgCl_2$, and acetates may also be used when pre-treating.

When pre-treating salt stockpiles, apply liquid deicer at a rate of 6 to 8 gallons/ton. For $MgCl_2$, avoid using rates greater than 6 gallons/ton.

When pre-treating sand stockpiles, apply salt brine at a rate of 4 to 6 gallons/ton.

After pre-treating, the leach risk is increased, so be sure to cover the stockpile and store it on an impervious pad.

Pre-Wetting

Pre-wetting means adding a liquid to the salt as it is being applied, either at the spinner or through a soaker pipe in the auger box. Unlike pre-treating, this does require equipment changes. However, it allows for more flexibility because you can switch the chemical makeup depending on conditions. Salt brine, $CaCl_2$, $MgCl_2$, and acetates may be used as pre-wetting agents.

The optimal application rate is 8 to 14 gallons/ton for salt brine and 6 to 8 gallons/ton for $MgCl_2$. Below 15º F, salt brine is less effective than other liquids and it might result in frozen hoses and valves.

During the Storm

DEICING

Deicing is the traditional approach to snow and ice management. It is a reactive approach; deicer is applied on top of snow, ice, or frost that has already bonded to the pavement and cannot be removed by mechanical means. The purpose of deicing is to break the bond between the ice and snow and the underlying surface. This requires the use of more deicing materials than would be needed for anti-icing. Because of this, deicing generally costs more than anti-icing in terms of materials, time, equipment, and environmental damage.

Overuse of deicers is a common problem. However, most over salting can be avoided by using correctly calibrated spreaders and good judgment in selecting application rates. See the Deicing Application Rates Guidelines chart on page 33.

There are two common reasons for overuse of deicers:

- Applying to already wet surfaces. This requires less salt.
- Not giving the material enough time to work before applying more.

Remember to keep records of how much deicer is being used, what types of deicers are in use, and where the deicers are being applied.

USING ABRASIVES

Sand and other abrasives (such as cinders) do not melt ice. They provide temporary traction on top of snow or ice, especially in areas of slow-moving traffic. They can be used when temperatures are too cold for deicing chemicals to be effective.

However, abrasives have several disadvantages. They will be tracked into buildings and other areas. They can cause air quality concerns after being group up by traffic, and they cannot be used on pervious or permeable pavements.

Sweeping

Abrasives are no longer effective when they are in direct contact with the pavement. In addition, sand on dry pavement can cause skidding. Abrasives should be swept up as frequently as possible and disposed of properly. Used sand is contaminated with pollutants and should not be used for sandboxes or beaches, or dumped in any water body or natural area. Some industries may be able to reuse sweepings after they have been screened, for example with 3/4-inch mesh.

For sweeping parking lots, trailer-type power sweepers can be haled behind a pickup truck. Smaller power brooms or sweepers can be used on sidewalks. Remember to wear a dust mask to avoid breathing in fine particles.

Best Practices for Sidewalks

Sidewalks are often the most over salted of all areas when it comes to snow and ice removal.

- Focus on mechanical snow removal. Always remove snow mechanically first. This reduces the chances of refreeze and slush build-up. This also allows you to better identify and selectively address problem areas.
- Use drop spreaders, not rotary spreaders. If you must use a rotary spreader, adjust the opening to limit dispersion or install shields to restrict the spread pattern.
- Using heated or textured mats on sidewalks or steps can reduce the need for deicers in small problem areas. Be sure to test them, and avoid using deicers on heated sidewalks.
- Look for opportunities to close extra entrances during the winter.
- Remember that many slip and fall incidents happen within ten feet of the curb. Anti-icing and aggressive mechanical snow removal can create a safer walking surface.
- Keep in mind that salt and sand on sidewalks get tracked into buildings. This leads to slippery areas inside the building.
- Consider using alternative, plant-based deicers. These may be effective for you, depending on your situation, and they have reduced environmental impacts when compared to salt. As with any new material or strategy, be sure to test any alternative deicers first and follow manufacturers' application guidelines.

Best Practices for Parking Lots

- As with sidewalks, always plow before applying deicing materials.
- Traffic tends to help mix and melt snow and ice. This means you may be able to use a lower application rate in higher-traffic areas.
- When using a truck, turn off the auger when stopped (even for short periods). Don't overfill the truck, because excess material will spill out.
- Sweep frequently — if possible, after each snow event. Sand and salt accumulations in parking lots make things difficult for pedestrians and can lead to slippery situations.
- Do not allow children to play on sand or salt piles.
- Be sure to store deicers up-gradient of any existing or planned snow piles.
- Consider using alternative deicers.

After the Storm

CLEANUP, STORAGE, AND MAINTENANCE

After an event, sweep up excess sand and salt (see page 25 for more information).

Snow piles may need to be trucked from parking lots and other areas. Ensure that all new and existing snow storage areas are down-gradient from deicer storage areas. Sand and salt should be placed on an impervious pad and covered.

At the end of the season, be sure to clean and maintain trucks, tanks, brine-making systems, pumps, and any other equipment according the manufacturers' specifications. Extra salt and sand can generally be stored and used next season. Don't apply extra materials just to get rid of them.

EVALUATING EFFECTIVENESS

When snow and ice control operations have ended after a storm, it is important to evaluate what was done, how well it worked, and what could be changed to improve operations in the future.

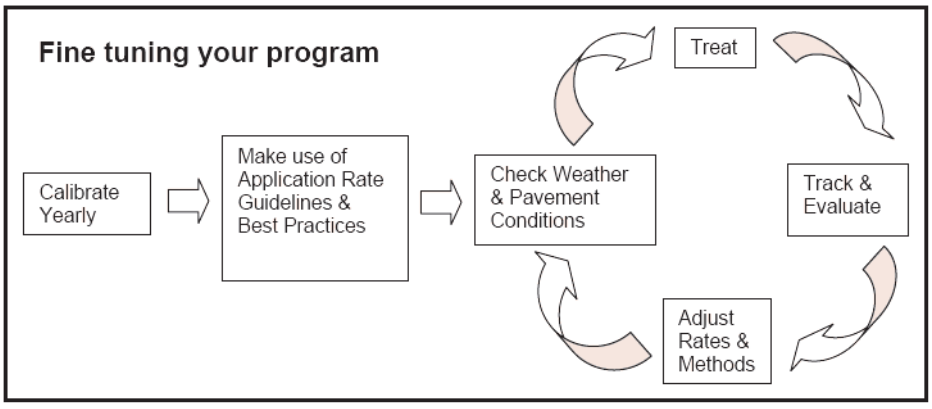
After-storm meetings with property managers and/or the maintenance crew are a good way to evaluate your operations and determine ways to improve your practices.

Documenting and Charting

Documenting and charting help you to use less material, reduce costs and environmental impacts, and have a more efficient and effective program overall.

Accurately record materials use at the end of each shift, including what was applied, how much was applied, and where it was applied.

Forms like the ones on pages 36 and 37 can be used to record and track observations. Share these observations with your team and use them to learn from each other.



NOTES:

Appendix

CHEMICAL DEICER INFORMATION
- **Speed of Melting**
- **Practical Melting Temperature**

APPLICATION RATES
- **Application Rates for Reduced Environmental Impacts**
    - **Application Rates for Anti-Icing**
    - **Application Rates for Deicing**

DOCUMENTATION FORMS
- **Sample Documentation Forms**

CONVERSIONS
- **Material Conversions**
- **Application Rate Conversions**
- **Units and Common Conversions**

Chemical Deicer Information

SPEED OF MELTING

This table will help you determine if the salt you apply will have time to work, or if it is time to switch to a different deicer. The table is from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

Table 3. Melt Times and Amounts

Pavement Temp ˚F	One Pound of Ice 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	

The table on the next page provides more information on the usefulness of different chemical deicers at different temperatures.

PRACTICAL MELTING TEMPERATURE

This table provides information on deicing chemicals' properties, eutectic temperatures, lowest practical melting temperatures, and optimal concentrations. A discussion of these terms and concepts can be found on page 15. Remember to use pavement, not air, temperatures. The table is from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

Table 4. Practical Melting Temperatures **Chemical and Description**	**Lowest Practical Melting Temp (˚F)**	**Eutectic Temp. (˚F)**	**Optimal Concentration**
NaCl (Sodium Chloride) Delivered as solid rock salt, also can be made into a brine. The basis of most deicing materials. Very corrosive. Inexpensive. Very available. Rarely has a corrosion inhibitor added.	15	-6	23%
MgCl2 (Magnesium Chloride) Delivered as a liquid. Often used to wet NaCl crystals to increase adherence to surface and reduce melting points. Corrosive. Higher cost. Often has a corrosion inhibitor added.	-10	-28	27-30%
CaCl2 (Calcium Chloride) Delivered as flakes, pellets, or liquid. Powerful deicer but extremely corrosive. Sometimes used incorrectly to open storm drains. Higher cost. Often has a corrosion inhibitor added.	-20	-60	30%
CMA (Calcium Magnesium Acetate) Delivered as a powder, crystals, pellets, or liquid. Liquid CMA is used mainly on automated bridge deicing systems. Noncorrosive, biodegradable. Sometimes added to sodium chloride as a corrosion inhibiter. Alternative for areas where chloride use must be limited. Often higher cost.	20	-18	32%
KAc (Potassium Acetate) Delivered as a liquid. Often used on automated bridge deicing systems and airports. Use for anti-icing, deicing, and prewetting. Non-corrosive, biodegradable. Alternative for areas where chloride use must be limited. Higher cost.	-15	-76	50%
Blends Both chlorides and acetates exist in blends. Talk to your supplier and determine the lowest practical melting temperature, the optimal concentration and the basic components in the blend. Most blends are centered on rock salt since it is cheap.	Varies	Varies	Varies
Winter Sand/Abrasives Winter sand has some salt mixed in it to keep it from freezing. Abrasives should be used for cold temperatures when deicers are not effective. They provide temporary traction but only work when they are on top of the ice.	Never melts; provides traction only		

Application Rates

APPLICATION RATES FOR REDUCED ENVIRONMENTAL IMPACTS

To determine effective application rates, you must take into account a variety of factors, such as type and rate of precipitation, air and pavement temperature, weather forecast, temperature trend, humidity, dew point, type of surface and subsurface material, and sun exposure.

These application rates should be used as a starting point for your operations. They should be modified over time to best fit your needs. The tables are from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

Application Rates for Anti-Icing

Table 5. Anti-Icing Application Rate Guidelines

These are a starting point only. Adjust based on your own experience.

Condition	Gallons per 1,000 sq. ft.		Other Products
	$MgCl_2$	Salt Brine (NaCl)	
1. Regularly scheduled applications	0.1-0.2	0.25-0.3	Follow manufacturer's recommendations.
2. Prior to frost or black ice event	0.1-0.2	0.25-0.3	
3. Prior to light or moderate snow	0.1-0.2	0.2-0.4	

CAUTION: Too high an application rate may result in slippery conditions or tracking.

To use this table:

1. Determine your parking lot or sidewalk area in square feet and divide that area by 1,000 square feet. This number is your size factor.
2. Choose your condition in the first column and move to the right to the appropriate deicer.
3. Multiply the application rate by your size factor.
4. To convert from gallons to ounces, multiply the result from step 4 by 128.

Application Rates for Deicing

These application rates are based on application guidelines for roads. As with the previous table, use these rates as a starting point and adjust to fit your needs. When temperature categories overlap, choose the one most applicable to your situation. The table is from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

Table 5. Deicing Application Rate Guidelines

Pavement Temp. (˚F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Salt Pre-wetted/ Pre-treated with Salt Brine (lbs/1,000 sq. ft.)	Salt Pre-wetted/ Pre-treated with Other Blends (lbs/1,000 sq. ft.)	Dry Salt (lbs/1,000 sq. ft.)	Winter Sand Abrasives (lbs/1,000 sq. ft.)
>30˚ ↑	Snow	Plow, treat intersections	0.75	0.5	0.75	not recommended
	Frz. Rain	Apply chemical	1.25	1	1.5	not recommended
30˚ ↓	Snow	Plow & apply chemical	1.25	1	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75	not recommended
25-30˚ ↑	Snow	Plow & apply chemical	1.25	1	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75	not recommended
25-30˚ ↓	Snow	Plow & apply chemical	1.25	1	1.5	not recommended
	Frz. Rain	Apply chemical	1.75	1.5	2.25	3.25
20-25˚↑	Snow or Frz. Rain	Plow & apply chemical	1.75	1.5	2.25	3.25 for frz. rain
20-25˚↓	Snow	Plow & apply chemical	2	2	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2	3	3.25

Table 5, continued. Deicing Application Rate Guidelines

Pavement Temp. (˚F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Salt Pre-wetted/ Pre-treated with Salt Brine (lbs/1,000 sq. ft.)	Salt Pre-wetted/ Pre-treated with Other Blends (lbs/1,000 sq. ft.)	Dry Salt (lbs/1,000 sq. ft.)	Winter Sand Abrasives (lbs/1,000 sq. ft.)
15-20˚ ↑	Snow	Plow & apply chemical	2	2	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2	3	3.25
15-20˚ ↓	Snow or Frz. Rain	Plow & apply chemical	2.5	2	3	3.25 for frz. rain
0-15˚ ↑↓	Snow	Plow, treat with blends, sand hazard-	not recommended	3	not recommended	5.0 spot treat as needed
<0˚	Snow	Plow, treat with blends, sand hazard-	not recommended	4.5	not recommended	5.0 spot treat as needed

To use this table if you calibrate your spreaders:

1. Select the row with the appropriate pavement temperature, temperature trend, and conditions.
2. Select the column with the type of material you are using.
3. Find the cell where your rows and columns intersect.
4. Compare these values to the calibration chart for your truck. If your spreader is calibrated in lanes/mile, refer to Table 10 to convert to lbs/1,000 square feet.
5. Dial the correct setting for the rate calculated.

To use this table if you do not calibrate your spreaders:

1. Follow steps 1-3 above.
2. Determine your parking lot or sidewalk area in square feet and divide that area by 1,000 square feet. This number is your size factor.
3. Multiply the size factor (from step 2) by the application rate from step 3 in the previous set of instructions. This is the amount of material to use.
4. Spread the amount of material evenly over the area to be treated.

Documentation Forms

SAMPLE DOCUMENTATION FORMS

These sample documentation forms can be used to record observations and information about snow and ice control activities. See page 28 for more information on documentation and charting. The forms are adapted from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

Table 6. Anti-icing Data Form

Location:				
Date:				
Name:				
Air Temp.	Pavement Temp.	Relative Humidity	Dew Point	Sky/Conditions
Reason for applying:				
Location:				
Chemical:				
Application Time:				
Application Amount:				
Observation (1st day):				
Observation (After event):				
Observation (Before next application):				

Table 7. Deicing Data Form			
Name:			
Location:			
Event Began:	Date	Time	
Event Ended:	Date	Time	
Event type:	Snow	Rain	Both
Total precipitation:			
Pavement Temp:		Air Temp:	
Dew Point:			
Temperature Trend:			
Material used:			
Amount used:			
Application rate:			
Observations:			

Conversions

The following tables are adapted from the Minnesota Winter Parking Lot and Sidewalk Maintenance Manual.

MATERIAL CONVERSIONS

The conversions in Table 8 and Table 9 can be used to convert between tons and cubic yards. Note that weights will vary depending on the moisture content of the material.

Table 8. Material Conversions—Quick Reference

Sand		Salt	
Cubic Yards	**Tons**	**Cubic 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	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	10	10.8
11	15.4	11	11.9
12	16.8	12	13
13	18.2	13	14
14	19.6	14	15.1
15	21	15	16.2
16	22.4	16	17.3
17	23.8	17	18.4
18	25.2	18	19.4
19	26.6	19	20.5
20	28	20	21.6

These formulas, along with Table 8, can be used to convert between tons and cubic yards. Note that weights will vary depending on the moisture content of the material.

Table 9. Material Conversion Formulas

To convert...	Take...	And...
Tons of clean sand to cubic yards	Tons	Divide by 1.4
Cubic yards of clean sand to tons	Cubic yards	Multiply by 1.4
Tons of winter sand to cubic yards	Tons	Divide by 1.37
Cubic yards of winter sand to tons	Cubic yards	Multiply by 1.37
Tons of straight salt to cubic yards	Tons	Divide by 1.08
Cubic yards of straight salt to tons	Cubic yards	Multiply by 1.08

APPLICATION RATE CONVERSIONS

Use this table to convert between pounds per lane mile and pounds per 1,000 square feet.

Table 10. Application Rate Conversions

Pounds/ Lane Mile	Pounds/ 1,000 sq. ft.	Pounds/ Lane Mile	Pounds/ 1,000 sq. ft.	Pounds/ 1,000 sq. ft.	Pounds/ Lane Mile	Pounds/ 1,000 sq. ft.	Pounds/ Lane Mile
25	0.4	200	3.2	0.5	32	2.25	143
50	0.8	225	3.5	0.75	48	2.5	159
75	1.2	250	3.9	1	63	2.75	174
100	1.6	275	4.3	1.25	79	3	190
125	2	300	4.7	1.5	95	3.25	206
150	2.4	350	5.5	1.75	111	5	317
175	2.8			2	127		

CONVERSIONS BETWEEN COMMON UNITS

- 1 lane mile (12 ft x 5280 ft) = 63,360 square feet
- Average size parking spot: 9 x 20 feet or 10 x 20 feet = 180–200 square feet
- Driving isles (two-way) = About 25 feet wide
- 1 acre = 43,560 square feet
- 1 ton = 2,000 lbs
- 1 cup of salt (NaCl) = 0.6 lbs
- Salt (NaCl) weighs 72–84 lbs/ft^3 depending upon moisture and granule size
- 1 gallon = 128 ounces
- 1 cubic yard of salt = 1.1 ton
- 1 cubic yard of sand = 1.4 tons
- 1 cubic yard = 27 cubic feet
- 1 square yard = 9 square feet

ACRONYMS AND ABBREVIATIONS

- **°C** – degrees Celsius
- **°F** – degrees Fahrenheit
- **ft** – feet
- **lbs** – pounds
- **mg/L** – milligrams per liter
- **mph** – miles per hour
- **ppm** – parts per million
- **psi** – pounds per square inch

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- Plant selector tool. Allows you to select plants for many conditions including high salt areas. Minnesota Department of Transportation. http://plantselector.dot.state.mn.us.
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