Winter Parking Lot and Sidewalk Maintenance Manual

June 2006

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Produced by:

Minnesota Pollution Control Agency

FORTIN CONSULTING, INC. serving the environment

CTAP Circuit Training and Assistance Program

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UNIVERSITY OF MINNESOTA

MINNESOTA DEPARTMENT OF TRANSPORTATION

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LTAP MINNESOTA LOCAL TECHNICAL ASSISTANCE PROGRAM

ENVIROTECH SERVICES, INC.

MWMO Protect it. Pass it on. MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Cadwell Lawn Care & Landscaping Saving Our Customers And The Environment

GGP General Growth Properties, Inc.

Acknowledgments

This manual is dedicated to helping Minnesotans protect the environment. Whether you are the plow driver, the building manager or the traveling public, you have an important role to play in protecting our environment.

The *Winter Parking Lot and Sidewalk Maintenance Manual* is based on the *Minnesota Snow and Ice Control Field Handbook for Snowplow Operators* produced by the Minnesota Local Technical Assistance Program Center and on the training materials for the Minnesota Pollution Control Agency *Winter Maintenance of Parking Lots and Sidewalks* training class. Thanks to the following sponsors and participants for their valuable input in the production of this document.

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Technical Advisory Panel

Project Leaders:

Carolyn Dindorf – Fortin Consulting, Inc.
Connie Fortin – Fortin Consulting, Inc.
Andrew Ronchak – Minnesota Pollution Control Agency

Technical Expert Committee Members:

Tom Broadbent – Envirotech Services, Inc.
Charles Cadwell – Cadwell Lawn Care & Landscaping
Jeff Dubay – City of Minnetonka Public Works
Greg Felt – Scott County Public Works
Wendy Frederickson – Minnesota Department of Transportation
Rich Peterson – General Growth Properties, Inc.
Kathleen Schaefer – Minnesota Department of Transportation, University of Minnesota Circuit Training and Assistance Program
Jim Weber – University of Minnesota Facilities Management Landcare

Other Contributors:

Jim Grothaus – Minnesota Local Technical Assistance Program
Dave Redig – Minnesota Department of Transportation – District 6, Rochester
Brooke Asleson – Minnesota Pollution Control Agency

Writing:

Carolyn Dindorf – Fortin Consulting, Inc.
Connie Fortin – Fortin Consulting, Inc.

Cover Art:

Rod Whyte – Whyte Graphics

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Purpose of this Manual

The purpose of this manual is to deliver practical advice to those who manage parking lots and sidewalks. This manual will help you make better, proactive, cost-effective choices in winter parking lot and sidewalk management. It will give you knowledge to become a leader in your industry by operating more efficiently and reducing environmental impacts.

A blanket approach will not work for the range of conditions Minnesota experiences; different strategies are needed for different regions and different conditions. We encourage you to continue to test, document, and refine the practices from this manual.

Throughout the manual you will find environmental tips shown with a fish symbol. These tips will help you reduce environmental impacts from snow and ice control operations.

Throughout the manual you will find cost-saving tips shown with a dollar symbol.

Background Information

Good Business Choices

Customer service is the key to success. You can use Best Management Practices (BMP's) to keep parking lots and sidewalks safe and also reduce environmental impacts. By taking time to educate your customers on the proper methods of snow removal and ice control (and the value to them), you can create a good and long standing-relationship with them.

Your customers want reliable service. Providing a well-planned and executed winter maintenance program will leave a positive impact on your customer. By using the latest technologies, you will be more reliable. By providing a higher level of service, you are likely to reduce slip and fall exposures.

Your customers want someone educated on parking lot maintenance. You are educating yourself on best practices for winter maintenance, with this handbook.

$ ***If you use the right amount of material at the right time, you will save time and money.***

$ ***Certification in snow and ice control is a good reflection on you and your organization.***

Your customers and the public want safe parking lots and sidewalks. By understanding the materials, weather and application rates, you will have a head start on controlling icy, slippery parking lots and sidewalks.

Your customers want clean and neat parking lots and sidewalks. By using less material and increased winter sweeping, pedestrians will track less material into buildings, and there will be less damage to flooring. Proper snow storage makes debris removal in the spring easier. Covered storage of deicers looks better, will reduce loss of material and will protect water. By preventing vehicle leaks, cleaning up spills and using lower application rates, you will keep parking lots and sidewalks neat.

Your customers want affordable snow and ice control. By using more sophisticated chemicals, you might need a bigger budget up-front. Initially you may have to charge more for using liquids. However, these costs are likely recovered by reduced sweeping, reduced floor and rug maintenance, reduced parking lot striping and reduced snow and ice maintenance time. Companies are willing to pay to keep the dirt out.

Your customers want to protect our lakes and rivers. Educate your customers on the importance of responsible deicing applications.

 ***The best way to protect our lakes is to use less material. It is difficult to recover salt or sand once applied.***

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 the glaciers.

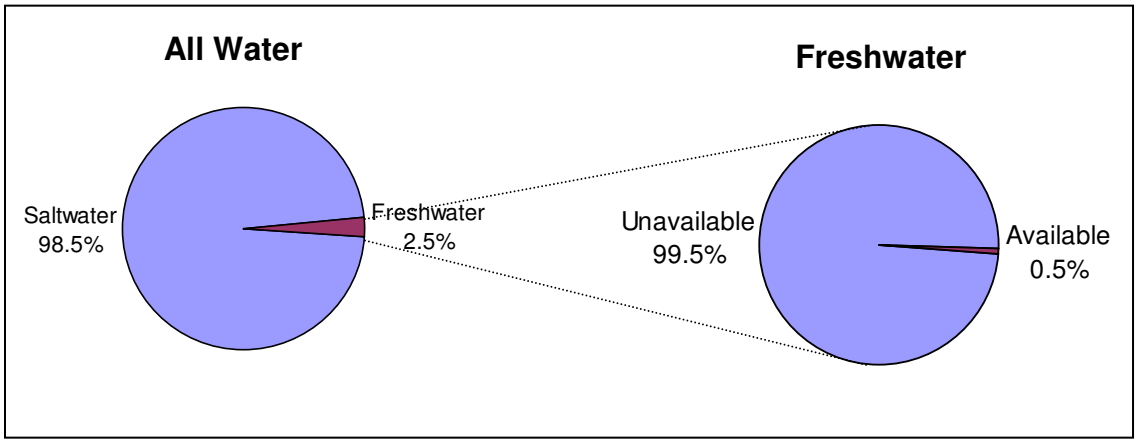

Figure 1. Available Water

- Water is recycled over long periods of time. We have a limited supply of water on this planet. Water is reused, recycled and dispersed as illustrated below from MnDNR "Healthy Rivers a Water Course" CD-Rom.

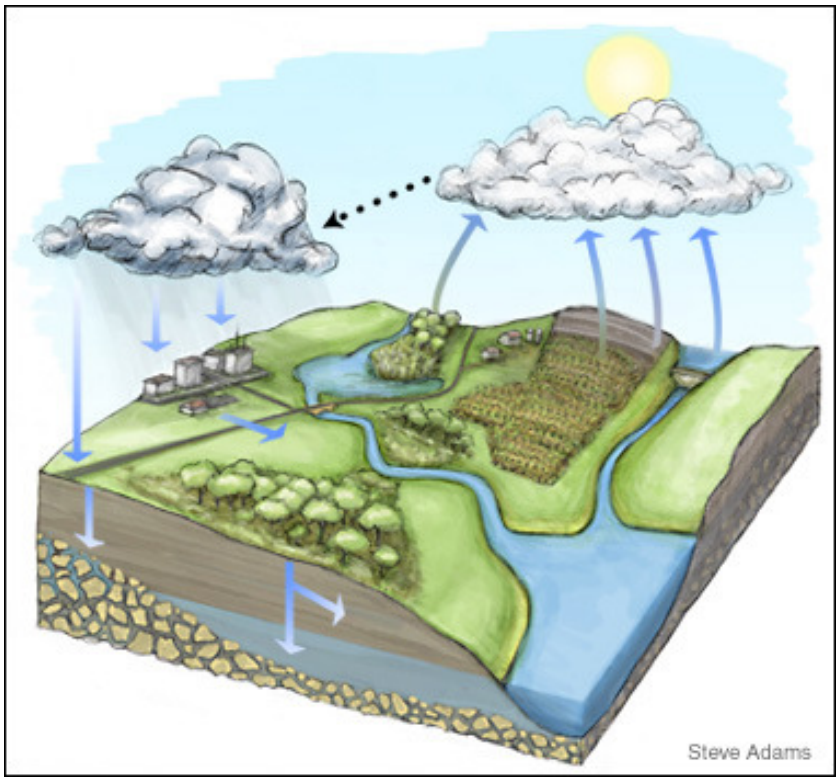

Figure 2. The Water Cycle

- Forty percent of Minnesota's tested lakes and rivers are polluted enough to be put on the federal list of impaired waters. For a list of impaired waters, including those impaired by chlorides, see www.pca.state.mn.us/water/tmdl/index.html
- A lot of salt is used in winter maintenance. The average salt use in the Twin Cities Metropolitan area is 350,000 tons per year (Sander et al. 2007).

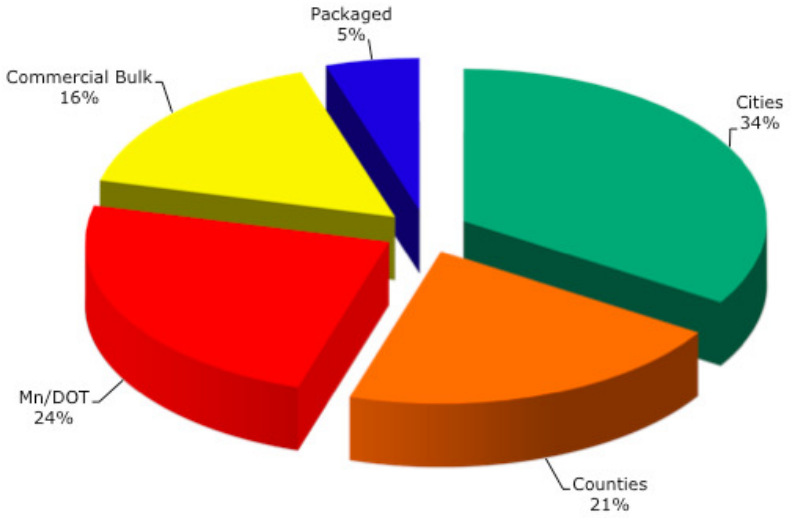

Figure 3. The Distribution of road salt use in the Twin Cities Metropolitan area.

- Our lakes are becoming more saline with increase road salt use.
- 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.
- The concentration of chloride is increasing in our surface and groundwater. Salt water is heavier than freshwater and sinks to the bottom of the lakes. Eventually causing chemical stratification of the lake and loss of lake turn over.

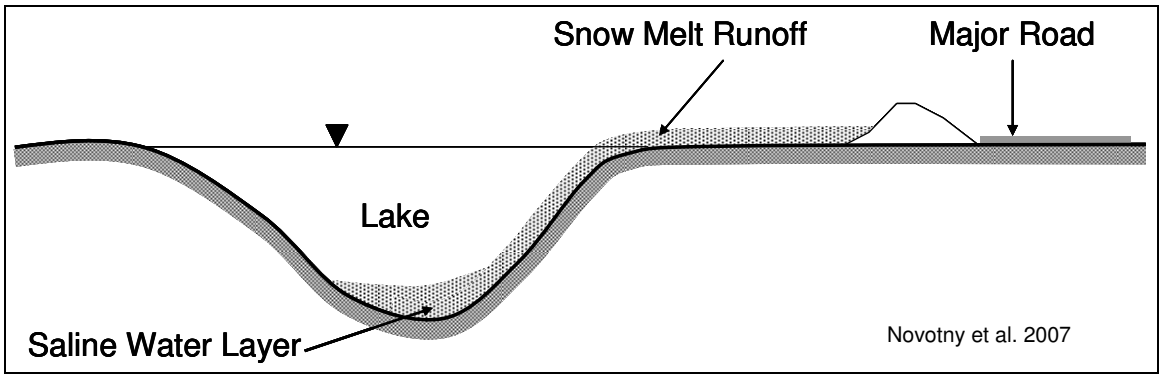

Figure 4. Schematic of a saline water intrusion into a lake

Reduced salt use equals reduced salt in lakes and streams.

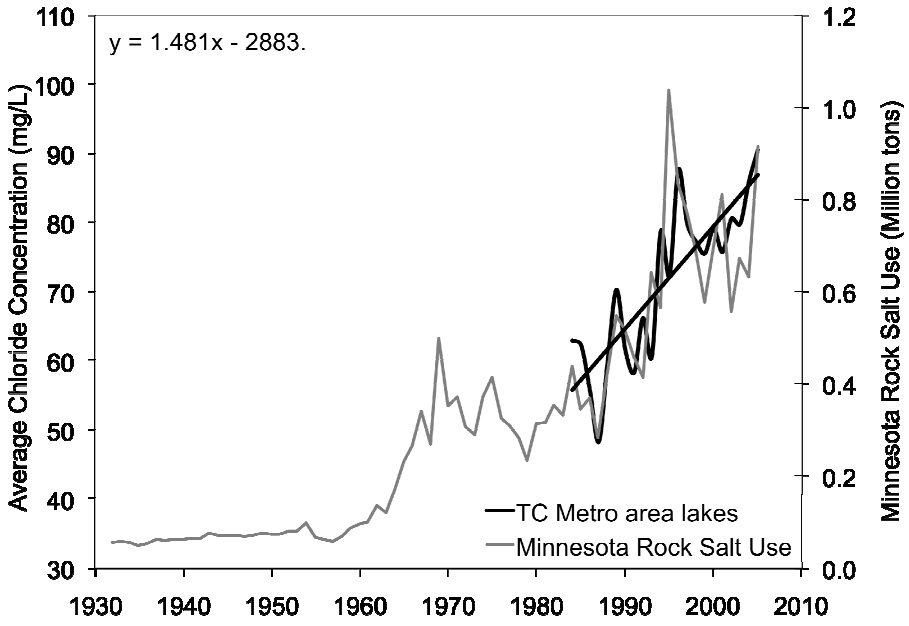

Figure 5. Lake chloride concentrations and rock salt use

Comparison of lake chloride concentrations in 39 Twin Cities lakes and rock salt purchases by the state of Minnesota.
(Novotny et al. 2007).

- Winter sand leaves parking lots and moves downhill with water to the nearest lake, pond or river. They fill in the bottoms of our lakes and rivers, accelerating the aging process of the water body and disrupting the food chain.
- In 2004-2005, the MPCA measured chloride concentrations in Minnesota's ground water. The results show that Minnesota's urban areas have the highest occurrence of chlorides (25-150 mg/L). (MPCA Minnesota's Ground Water Condition: A Statewide View 2007).
- To remove salt from water reverse osmosis is required. This is not practical for our lakes, rivers, groundwater and wetlands. Therefore prevention is important.

1 ton of rock salt ($50) causes greater than $1,450 in corrosion damage to bridges. (Sohanghpurwala 2008)

Fathead Minnows will die if exposed to chloride concentrations of 443 mg/l for more than 30 days
(http://duluthstreams.org/understanding/impact_salt_2.html)

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Prepare for Winter Operations

Policies

Start now! Develop a maintenance policy with your customer. A little planning and communication up-front can help you do a better job.

- To see example policies www.mnltap.umn.edu/ctap.
- Schedule training for you, your crew and customer. Check the MPCA website to find out about upcoming training opportunities: www.pca.state.mn.us/programs/roadsalt.html .
- Discuss the maintenance policy with your crew.
- Address customer expectations, the hours and use of the building, priority access points and environmental concerns in your policy.
- Inform your customers of any changes to your snow and ice maintenance program, and why you are making them.
- Include site monitoring in the policy.
- Plan for year round sweeping.
- Document any closed building entrances during the winter. If this is agreeable, it would reduce the amount of chemicals and maintenance time.
- Reduce your risk by having a solid written winter maintenance policy and training program that utilizes best management practices.

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

Reduce your liability. Establish a maintenance policy with the customer and follow it.

Storage

Storage areas often cause groundwater or surface water contamination.

Snow Piles

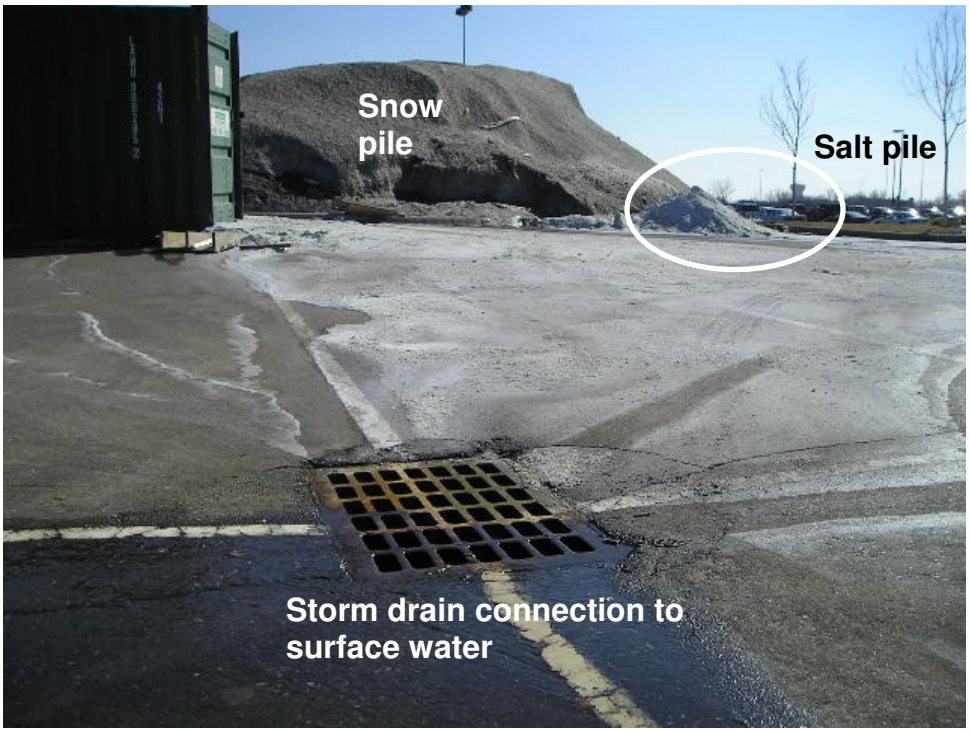
- Store in an area where you can recover the solids after the snow melts.
- Locate snow down-slope from salt and sand storage. Prevent snow melt from flowing through salt or sand storage area.
- Avoid pushing snow into lakes, ponds, wetlands, rivers or other natural areas. This will increase the amount of solids that can be recovered after the melt.
- Windrows of snow can be used to guide motorists in parking when they cannot see the parking lines.

Salt Piles

- Store salt where it is protected from rain, snow and melt water.
- Store on an impervious surface.
- Cover all piles, ideally indoors.

Improper storage of salts can lead to groundwater contamination.

- Sweep loading areas back into the pile to reduce leaching.
- Contoured pads (bowl-like) for pretreated salts, reduces runoff from the pile.
- Store away from lakes, rivers, ditches, storm drains and wetland edges.



A common mistake is storing a snow pile uphill of a salt pile.

Figure 6. Incorrect Salt Storage: uncovered and placed in path of melting snow pile

Salt storage areas are often a source of groundwater contamination. To reduce risk, have a covered storage area on an impervious pad. Take measures to keep salt or salt brine from leaving storage area.

Salt Bags

- Store away from rain or snow.
- Dispose of bags properly.
- Seal open bags.

Liquids

- Understand the freezing point of your liquid. This will determine if it can be stored outdoors or if it must be stored indoors. Salt brine (NaCl) should be stored indoors.
- Storage tanks for liquids are regulated by the MPCA.
- Tanks should be double-walled or have secondary containment.
- Label the tank documenting its contents.
- Before installing tanks, check on local visual screening ordinances.
- Some above-ground storage tanks are exempt from regulations:
    - Those with a capacity of 500 gallons or less.
    - Those with a capacity of 1100 gallons or less and not located within 500 feet of Class 2 surface water (Class 2 surface water includes all

Minnesota waters that are or may be used for fishing, fish culture, bathing, or any other recreational purpose and where it may be necessary to protect water or plant life as well as the public health, safety, or welfare).

- For more information on storage tanks see www.pca.state.mn.us/cleanup/ast.html, Minnesota Rules Chapter 7151

Sand piles

- Winter sand is typically mixed with some deicer to prevent freeze-up of the pile. Therefore, sand pile storage should be the same as salt pile storage.
- Do not use leftover winter sand for other uses. Save it under cover for the next season.

Prevent groundwater contamination. Do not locate storage areas near wells. Limestone regions with fissures and sinkhole are very prone to groundwater contamination as are sandy soils.

Weather

Knowing existing and potential weather conditions is very important for a successful snow and ice control operation. Monitor the weather closely so that you are prepared to act early in storm situations. Check the National Weather Service (website http://www.noaa.gov) local TV station, or website weather. A Road Weather Information System (RWIS) is available on the Internet at www.rwis.dot.state.mn.us. RWIS provides information like pavement temperature from various locations around the state.

Pavement Temperature

You must know the pavement temperature to determine the proper amount and type of material to apply. Most weather stations report air temperature measured at a height of 30 feet above ground, which can differ from pavement temperatures. There is not a direct correlation between air temperature and pavement temperature.

Figure 7. Temperature Sensor

Pavement temperatures differ from sunny to shaded areas and concrete to asphalt surfaces. Similar surfaces constructed over different base materials hold temperatures differently. Seasonal differences also occur. The same air temperature in November and January will often show very different pavement temperatures.

Why guess. You can purchase hand-held temperature sensors from auto part stores for about $100. They are designed to measure engine temperature. Make Sure the one you buy has the appropriate temperature range and accuracy for cold weather work.

Be still and point pavement sensor at the ground to get a reading. Mirror-mounted temperature sensors are also available; they are less likely to be lost or stolen but do cost more and are generally not available at an auto parts store. A small investment in equipment will improve your performance.

Getting prepared for winter

- Calculate the area of your parking lots, service roads and sidewalks.
- Identify snow storage areas.
- Understand the properties of various deicers, and then select the type(s) to use.
- Estimate the amount of material you will need using the application rate charts. Order based on your estimate.
- Understand the environmental problems caused by snow, salt and sand storage. Determine where and how you can best store each item.
- Train your crew on proper application rates.
- Mark islands, fire hydrants and other landmarks obscured by snow.
- Note existing conditions of curbs and other items that might be damaged by winter maintenance.
- Note or mark all catch basins and manholes that may cause a hazard to the plow and the operator.

$ ***Knowing the pavement temperature will allow you to apply the proper amount of material for each situation.***

Drainage

Take time to inspect drainage ways and, remove obstructions to prepare for the spring melt. Never open frozen storm drains with high doses of salt. This is toxic to aquatic life in the receiving waters. Use other methods such as heat to open drains. Look for ways to capture any solids before they enter the storm drain system. Make sure your parking lot does not drain through your salt storage area.

Storm drains lead to the nearest lake, river, pond or wetland. They do not go to a treatment plant.

Calibration

Calibration is an essential procedure to measure the amount of material applied. No matter how sophisticated or simple your operations, always calibrate each piece of equipment yearly. The trend is to use less material. Purchase equipment that has the capability to deliver low application rates. You can calibrate any type of equipment. Just find a way to determine how many pounds of material per minute is landing on the pavement or sidewalk over a measured area or distance, and for differing speeds.

All good programs are based on calibration of equipment.

If you cannot or choose not to calibrate your equipment, you will need to calculate the size of the parking lot, the surface temperatures and the material you are using. The application rate chart and these three

parameters will tell you how many pounds of deicer to apply. Without calibration, it will be up to you to find a way to evenly distribute the recommended amount across your parking lot.

- Calibrate each piece of equipment
- Calibrate for every type of material you use.
- If you don't have different settings, you can change your application rate by adjusting the gate opening and truck speed.
- Place the calibration results, for each setting, in your truck or near the equipment.
- For specific calibration directions, contact the manufacturer.

Calibration tells you how much material will be applied at each setting or at each speed.

$ ***Calibration will allow you to more accurately use your deicers.***

Simple Calibration for Conveyor and Auger Spreaders

If your equipment has different settings, you will need to calibrate for each setting. It generally takes three people to calibrate equipment: one to run the truck, one to catch the material and one to count the auger revolutions. Repeat the calibration for different materials.

Best bet: Contact manufacturer for calibration instructions.

Step 1: Calculate discharge rate

- Mark the auger or conveyor shaft so you can tell when a revolution has been made.
- Determine how many pounds are discharged per auger/conveyor shaft revolution. Capture in a bucket or tarp the amount of material that comes out for one revolution and weigh it. For more reliable results, do this three times and average the results.
- Count the number of revolutions per minute.
- Lbs/revolution X number of revolutions/minute = discharge rate in lbs/minute.

Example: *5 lbs of dry salt was the average amount dropping in 1 revolution. 10 revolutions occurred in one minute. The discharge rate is 50 lbs/minute. We tested setting #1 using dry rock salt (NaCl). We were discharging 50 pounds/minute and at 15 mph the application rate is 200 lbs/mile.*

Step 2: Calculate application rate:

Speed	Time to drive 1 mile	Discharge rate Per setting*	Application rate (discharge x time)	Type of material
5 MPH	12 minutes			
10 MPH	6 minutes			
15 MPH	4 minutes			
20 MPH	3 minutes			
Example: 15 MPH	Example: 4 minutes	Example: 50 lbs from setting #1	Example: 200 lbs/mile	Example: Dry salt (NaCl)

Table 8. Calibration Chart for Auger Spreader

*This number is always the same for each setting

Simple Calibration for Gravity Flow Equipment

Gravity flow equipment is very difficult to calibrate and likewise very difficult to deliver products in a consistent manner. Look for ways to upgrade your equipment. This calibration procedure can also be adapted for use on sidewalk equipment.

Step 1: Calculate discharge rate

- Mark out a 10-foot stretch of road/parking lot.
- Sweep it clean of sand or any other material.
- Drive the truck and start applying material prior to the marked area. When you cross the start point, make sure your speed stays at the desired speed and remains consistent for the 10-foot stretch. Continue spreading material a short distance beyond your marked area.
- Record your vehicle speed.
- Measure the width the material is spread or bounces, in feet.
- Sweep up and weigh the material that is within your marked 10-foot stretch.
- Record the lever position/setting for the gate/chute. If there are no numbers for the positions, make your own permanent marks and numbers on the equipment to identify the positions.
- To improve accuracy, repeat this procedure two more times and calculate the average weight of material applied.

Step 2: Repeat step 1 for different speeds, settings and materials

Step 3: Create application rate chart to keep in your truck or near equipment

- Using the information gathered, make an application rate chart to indicate how much material is applied at each setting and speed.
- If you use more than one type of material, repeat the test for each material.
- Place the completed calibration chart in each truck. You can use it to compare to the recommended application rates.

Calculate application rate:

Vehicle: _____ Material:_____ Date:_____

		A	**B**	**C**	**D**	**E**
Speed	Lever position or gate setting	Lbs. Material recovered in 10 feet	Spread width in feet	Coverage area in sq/ft (**B x 10**)	Application rate in lbs/1000 ft^2 (**1000/C x A**)	Application rate in lbs/lane mile (12' width) (**D x 63.4**)
5 MPH						
10 MPH						
15 MPH						
20 MPH						
Example 20 MPH	*Setting 2 Half-closed*	*0.4 lbs*	*13 feet*	*130*	*3.1 lbs/1000 sq. feet*	*196 lbs/mile*

Table 9. Example Calibration Chart for Gravity Flow Equipment

Example:

- *Using sand, driving 20 mph, spreader position half closed.*
- *0.4 lbs of sand was recovered in the 10-foot length, spread out to a 13-foot width (the width the sand bounced to).*
- *Coverage area = 13 feet wide by 10 feet long or 130 square feet.*
- *Since the application rate tables are all in 1000 sq ft units, you can compare this test to the recommended application rate tables.*
- *To determine how much would be spread in 1000 square feet, divide 1000 by the coverage area and multiply by the lbs. of material recovered 1000/130 x 0.4 = 3.1.*
- *The application rate delivered is 3.1 pounds per 1000 square feet. If you want to convert it to lbs. per 12 foot lane mile, multiply by 63.4.*

Desirable Equipment Features

- Ability to calibrate
- Ability to deliver low application rates
- Control switch in cab

Some fish species are affected by concentrations of less than 1000 ppm sodium chloride, about 1 to 1.5 tablespoons of salt in 5 gallons of water.

Apply wisely. We will never have a chance to recover the chemicals applied.

Calibration Chart

Calibration Chart for Gravity Flow Equipment						
Vehicle or spreader number:					Date:	
Material Type:				Calibrated by:		
		A	**B**	**C**	**D**	**E**
Speed	Lever position or gate setting	Lbs. Material recovered in 10 feet	Spread width in feet	Square feet covered with material (**B x 10**)	Application rate in lbs/1000 ft^2 (**1000/C x A**)	Application rate in lbs/lane mile (12' width) (**D x 63.4**)

Table 10. Blank Calibration Chart for Gravity Flow Equipment

How Salt Works

- Salt is a deicer, it will melt snow and ice.
- Sand is an abrasive; it does not melt snow and ice.
- Abrasives provide traction on top of packed snow or ice.
- Abrasives and deicers do not work well mixed together.
- Salt lowers the freezing point of water from 32 ºF to a colder temperature.
- Salt must be in solution (brine) to work, it won't do anything until it begins to dissolve.
- Salt brine (NaCl) is most effective at a 23.3% solution.
- The melting power is reduced as more snow falls or melts and the brine becomes less than 23.3%.
- The melting power is reduced as more salt is applied making a stronger ("hotter") mix and the brine becomes more than 23.3%.
- A deicer (salt) will work until the freeze point of the brine equals the pavement temperature. At this point the salt will stop melting and you may experience refreeze if pavement temperatures are dropping.

One application rate will not fit all storms; how long an application lasts depends on:

- Pavement temperature
- Application rate
- Precipitation
- Beginning concentration of the brine

Speed of Melting

Will the road salt you apply have time to work or is it time to switch to a different deicer? This chart will aid you in making that decision.

Pavement Temp. ºF	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	

Table 11. Speed of Melting

$ ***Don't use road salt below 15º F . You are wasting money and time.***

Selection and Use of Materials

Factors to consider

- Environmental impacts
- Practical melting temperature
- Testing
- Cost and availability

Human drinking water cannot exceed 250 mg/l chloride

Environmental Impacts

Deicers are not environmentally safe no matter what the bag says. Do not buy a product based on this claim.

Chlorides:

- Are less effective if applied in concentrations that are too high. The correct concentration is crucial, just like anti-freeze in your car.
- Are corrosive to steel unless they have a corrosion inhibitor added.
- Have corrosion inhibitors and anti-caking agents that are often toxic substances.
- Damage plants through direct toxicity or by interfering with water uptake.
- Change the soil structure.
- Are often the least expensive and most available deicer.
- Are not removed by holding ponds or rain gardens.
- Can be removed by water by reverse osmosis, a very slow and expensive process

About 1 teaspoon of salt can pollute 5 gallons of water forever. This applies to all chlorides.

Acetates:

- Are non-chloride compounds. They have different melting characteristics than chlorides.
- Are an organic substance.
- When added to water, compete with aquatic life for oxygen.
- Contribute nutrients which promote algal blooms in lakes and ponds.
- Cause problems in our waters but tend to be less persistent than the problems introduced by chlorides.
- Are usually safer for vegetation.
- Have less corrosion potential and are often used at airports or in areas with expensive infrastructure such as bridges.
- Have the potential to be treated by holding ponds.

Acetates can have a high biological oxygen demand (BOD), and can contribute to oxygen depletion in soil and water. Use carefully.

Plant-based additives:

- Often corn, beet, molasses or other organic additives are added to salts to improve performance. Increased performance allows for lower application rates.
- These additives do not contribute chlorides to the water but contribute nutrients (fertilizer) to the water. The impact they have is to increase aquatic plant and algae growth. They also use oxygen as they decompose.
- The impacts are serious but not as long-lasting as chlorides.

One lb. of phosphorus encourages growth of up to 500 lbs of algae. Phosphorus is in plant-based products.

Vegetation:

- Deicers can be very damaging to both soil and vegetation.
- Our efforts should be to keep salt off of vegetation: Drive slower when applying deicers, turn down spinner speed to reduce spread pattern, use drop spreaders on sidewalks, store snow piles on hard surfaces, and reduce application rates.
- One source of information about salt-tolerant plants is the MnDOT plant selector tool ***http://plantselector.dot.state.mn.us.***

Figure 12. "Witches Broom" Branching from Salt Spray

Salt spray damages budding and branching of trees.

Salt changes the soil structure. It reduces its permeability and reduces the nutrients in the soil available for the plant uptake.

Practical Melting Temperature

Be careful when reading the melting temperature on bags of deicers. They often list the eutectic temperature, which is the lowest possible melting temperature. At this temperature it would take a very long time to melt ice. Instead, use the lowest practical melting temperatures in the chart below or ask your supplier for the practical melting temperature and the time it takes to melt ice at that temperature. Remember, use pavement temperature, not air temperature.

Chemical	Lowest Practical Melting Temp.	Eutectic Temp.	Optimal Concen-tration
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.	15º F	-6º F	23%
$MgCl_2$ (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.	-10º F	-28º F	27 to 30%
$CaCl_2$ (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.	-20º F	-60º F	30%
CMA (Calcium Magnesium Acetate)—Delivered as a powder, crystals, pellets, or liquid. Liquid CMA is used mainly on automated bridge deicing systems. Non-corrosive, biodegradable. Sometimes added to sodium chloride as a corrosion inhibiter. Alternative for areas where chloride use must be limited. Often higher cost.	20º F	-18º F	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.	-15º F	-76º F	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.			
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		

Table 13. Lowest Practical Melting Temperature

Testing

The best way to reduce impacts, save money and maintain customer satisfaction is to:

- Know what is in your product.
- Know how and when to use it.
- Use the minimum amount needed to get the job done.
- Seek out products that allow for smaller application rates.

Take time to test your materials to ensure that they perform as expected. Do not rely solely on the bag or on the manufacturer's literature. There are no labeling requirements so manufacturers can choose to label products in their own way. Labeling can be confusing; some list the eutectic temperature while others list the lowest practical melting temperature. The list of ingredients may or may not be included. Often the percentage of each ingredient is not included. Research your product, understand the practical melting temperature and get a list of the ingredients.

An area of special concern is the transition to liquids. Anti-icing liquids if over applied can become slimy or slippery. Test your application rates and your spray pattern so you can become confident in preventing the bonding of ice without creating a slimy or slippery situation.

For pre-treating stockpiles, add liquids conservatively. The dry material can only hold so much liquid before leaching occurs. Keep a close eye on your storage area to make sure it can contain the wet salt pile. Test your liquid application rates and your storage facility on a small stockpile before doing this on a large scale.

Cost and Availability

Sodium Chloride (Road Salt) is typically the cheapest and easiest to find of the deicers. Because of this it is widely used and overused. Sodium Chloride is only effective at pavement temperatures above 15 degrees. Because it doesn't work well at colder temperatures it is often over applied in attempts to get it to work better. At temperatures lower than 15 degrees switch to a different deicer.

Non-chloride deicers are more difficult to find and often cost more. If you are concerned about the long term effects of chlorides on our lakes and rivers, take time to find a source for alternate products and give them a try. As the demand for non-chloride deicers increases, the cost will drop and the products will be easier to find. All deicers have environmental impacts but the impacts of chloride based deicers are very long term.

Salt and sand mixes are commonly used to stretch the salt budget. This is an ineffective practice. Salt and sand work against each other. To save money use deicers when you need to melt and sand when you need temporary traction. Mixing them decreases the effectiveness of both products and increases the cost.

$ If you use a 50/50 salt/sand mix, you're generally either half right or half wrong. Using a salt/sand mix leads to over application of both materials.

Sidewalk Tips

Always remove snow prior to applying deicers. If you plow, blow or sweep first, the chances of refreeze diminish and slush build-up is minimized.

- Sidewalks are over-salted areas in winter maintenance.
- Use drop spreaders, not rotary spreaders, for sidewalks. If you are using a rotary spreader, adjust the opening to limit dispersion of deicers to the sidewalk or install shields to restrict the spread pattern. This minimizes your application rate and protects the vegetation.
- Many slip and fall incidents occur within ten feet of the curb lines. Adjust practices to include proactive measures like anti-icing.
- If you are not responsible for sidewalk maintenance, consider providing this information to the building occupants to educate them on these best practices for winter maintenance.
- Focus on aggressive mechanical removal of snow. The less snow, the less deicer required. This will lend to a safer walking surface.
- Deicers can harm heated sidewalks.
- Products such as heated or textured mats, placed on sidewalks or steps, may work for small problem areas. Test these, as you would, any new product or deicer.

$ ***Salt only needs to melt 1/16 inch to prevent the bond between the pavement and the ice. Save money by applying salt before the ice bonds so you don't need to melt through it.***

Building Entrances

Steps are often the most over-salted area in all of winter maintenance. This overabundance of deicer causes damage to floors inside the building with salt and/or sand being tracked in. It causes problems outside of the building with deterioration of concrete and metal structures. It costs more money than necessary, pollutes our water and does not provide any additional safety. The right amount of deicer and proper mechanical removal of snow and ice will serve you and your customer much better.

A free short video for small site winter maintenance is available at www.pca.state.mn.us/programs/roadsalt.html. It is designed for those that do winter maintenance of small sites such as stairs, curb cuts, and handicap ramps. The video is a visual instruction tool useful for those who apply granular deicer to small areas outside building entrances. It covers these key points:

- Always remove snow prior to applying deicers. The less snow, the less deicer required for a safer walking surface.
- Use the proper tool for snow and ice removal
    - Push shovel (no sides) for pushing snow
    - Scoop shovel (sides) for lifting snow.
    - Broom for small amounts of light fluffy snow.

    - Ice scraper for use under ice and compaction
    - Ice chisel for breaking open compaction, or under ice and compaction.
- Use hand-held spreaders to disperse deicers. Spreaders:
    - Provide more even distribution
    - Reduce amount needed
    - Reduce tracking into buildings
    - Save money with reduced salt application
    - Save infrastructure, less salt, less corrosion
- Look for opportunities to close extra building entrances during the winter. High maintenance, non-essential entrances are perfect candidates.

To determine the amount of deicer needed for steps, stairs and small sites:

- Refer to the application rate chart.
- For those who do maintenance as a small part of their job, it is unlikely they will ever use an application rate chart. Here are some guidelines to get them closer to the proper rates. The goal should be:
    - Even spread pattern with granules no farther than 3 inches apart
    - Even spread pattern with no granules touching each other
    - No piles of deicer
    - No deicer on dry pavement
    - No deicer in vegetation

$ ***Handheld spreaders not scoops should be used to apply deicer to steps and building entrances. You will save at least 50% of the salt you normally use in a winter without reducing the level of safety.***

Parking Lot Tips

- It is hard to walk and push shopping carts through salt and sand accumulations in parking lots. Sand is ineffective once it is on the pavement. Sweep it up to prevent a slippery situation.
- Handicap parking spots are often over salted and over sanded. They should get the same amount of salt or sand as other areas.
- Sand/salt mix isn't advised however it may help in freezing rain situations.
- Always plow before applying chemical.
- You may be able to use a lower rate in high traffic areas. Traffic tends to help mix and melt.
- Store snow downhill from any salt storage areas. Avoid water running through salt storage.

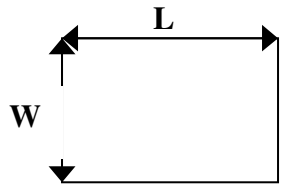
Sand fills in lake bottoms, accelerating the aging process of lakes. Lakes get shallower as they age, some eventually becoming wetlands.

Calculating Parking Lot or Sidewalk Area

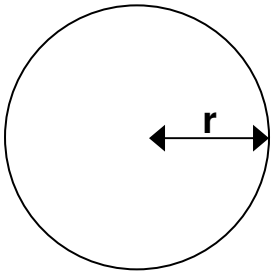
The amount of deicer needed is based on the size of the parking lot. Here are simple ways to calculate the area of your parking lot.

- Ask the property owner for a scaled map of the facility so you can calculate areas.
- Ask the property owner for the size of the area they want you to treat.
- Go out and measure the parking lot.

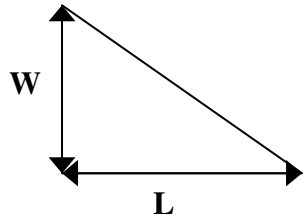
The area or square feet of a square or rectangle is
Length (L) X Width (W)



The area or square feet of a circle is **πr^2**
Or **3.14 x (r x r)** where **r** is half of the distance across the circle.



The area or square feet of a right triangle is
Length (L) X Width (W) divided by 2



Measuring your area along with knowing the pavement temperature will allow you to use the application rate charts. This will help you reduce the amount of chemicals you apply.

Surfaces such as pervious asphalt, pervious concrete and pervious pavers do not experience refreeze. All melted snow and ice travel to the storage layer below the surface. Salt is generally not needed on these surfaces and sand should be avoided.

Take Action to Keep Parking Lots Clear

Snow Removal Basics

It is best to apply sand or deicers after the storm. Materials applied during the storm are wasted.

All application rates are based on thoroughly plowed surfaces.

- Plow first before applying deicers to avoid dilution of the salt.
- Place deicers in high traffic areas as you plow. Leave other areas until plowing is complete.
- Limit use of salt and sand during the storm; use only to reduce bonding.
- Do not use salt to burn off snow.
- Use application rate chart.
- Understand the melting properties of your deicers. Do not use them unless you understand how they work.
- Plan and look for ways to anti-ice or use wetted materials.
- Check conditions and formulate the best strategy for those conditions.
- Don't apply dry salt (sodium chloride) below 15º F pavement temperature. It will not melt fast enough to help and it will blow off the surface onto nearby vegetation.
- Below 15º F, use a salt wetted with magnesium or calcium chloride or other low temperature deicers. For extreme cold, skip melting and use sand.
- Turn off auger when stopped, even briefly.
- Clean up spills.
- Track material use and effectiveness with an in-cab deicing data form.
- Use only what is needed based on proper application rates for the conditions. Put extra back in salt pile.
- Never plow or blow snow into bodies of water, wetlands, traffic or into streets.
- Remove snow from surfaces as quickly as possible to reduce compaction. Plow during off-peak hours or prior to the facility opening to increase efficiency and reduce conflicts with vehicles and pedestrians.
- Minimize back-up maneuvers to reduce chance of accidents.

About 1 tsp of salt will pollute 5 gallons of water…forever! (Federal Chloride standard is 230 mg/l).

Because it uses less materials, mechanical snow and ice removal is the best strategy for protecting our water.

Loading/hauling

- Don't overfill the vehicle: material will spill out as you drive around corners.
- Fill in side gaps in tailgates or equipment with spill shields where materials can escape and spill out.
- Large snow piles may need to be loaded out and removed to another site. Schedule this work when the mall or facility is closed to minimize conflicts with vehicles and pedestrians.

Deicing/Anti-Icing Information

Anti-icing

Anti-icing is the most cost-effective and environmentally safe practice in winter maintenance. You should be heading in this direction.

Anti-icing—a proactive approach—should be first in a series of strategies for each winter storm. By applying a small and strategic amount of liquid or pre-wet deicer before a storm, you can prevent snow and ice from bonding to the pavement.

Anti-icing is like preparing a frying pan. If you add a small amount of a liquid before cooking, the food will not bond to the pan. This reduces the amount of soap needed; scrubbing and time spent trying to clean the pan.

Anti-icing requires about ¼ the material and 1/10 the overall cost of deicing. It can increase safety at the lowest cost, and is effective and cost-efficient when correctly used and approached with realistic expectations.

Anti-icing prevents formation of ice from frost. It can be effective for up to several days depending on the weather conditions.

Anti-icing is quick. You can treat your parking lot in a matter of minutes. It is an excellent strategy for saving time. Charging by the hour is not a desired practice when you move into anti-icing.

Get started in anti-icing
The basic equipment you will need includes: Pavement temperature sensor, storage tank, spray truck system, transfer pump, hoses and fittings.

Guidelines for anti-icing

- Liquids are the more efficient than solids and may be applied days in advance of an event.
- It is better to use less than more. Over-application can cause slippery conditions.
- Anti-icing is often effective for heavy frosts.
- Liquids are dispersed by the traffic. If you spray the traffic lanes, liquid will migrate with the tires to the parking areas.
- Some users advise against spraying the service road in front of buildings and instead spray traffic lanes and back service roads to allow the traffic to spread the liquids near the building where foot traffic is higher. This can reduce tracking into the building and over-application in a high-traffic area.
- For service roads on hills, some users recommend applying to only the top half of the hill, relying on traffic to carry it down the hill, to avoid a slippery situation at the bottom of the hill.

- Anti-icing works best when combined with accurate surface weather information.
- Early application is particularly important for frost or light freezing drizzle.
- Pretreated or prewet materials are not as efficient as liquids for anti-icing; you need more material and they don't track as well. They will work if applied at very low application rates immediately before the snow event.
- See the Anti-Icing Application Rate Chart in this manual.

Stream nozzles prevent slippery conditions better than fan spray.

Anti-icing requires less material, and less material means less water pollution.

What to do

- Apply with stream nozzles to maintain dry areas between sprayed areas to reduce slipperiness. Stream nozzles work the best for anti-icing.
- If using fan nozzles apply extra light to reduce chance of causing a slimy/slippery situation.
- Try anti-icing in a low traffic area until you feel confident about its properties.
- Read some of anti-icing guidelines in the reference section of this manual.

What not to do

- Don't re-apply if there is still residue. The residue can remain many days after application if precipitation or traffic wear-off does not dilute the initial application.
- Don't apply $MgCl_2$ or $CaCl_2$ to a warm surface (above 35º F pavement temp.). It can become slippery.
- Do not apply liquids before predicted rain or significant freezing rain. They will wash away.
- Don't apply too much or the surface may become slippery.
- Less is better. Always follow application recommendations.

Too little $MgCl_2$ is safer than too much.

Using less salt doesn't have to reduce safety, but it does protect our lakes, streams and groundwater.

Equipment

- Anti-icing unit, i.e., transport vehicle with tank.
- Stream nozzles, minimum 8 holes, 8-inch spacing, bar height 12 to 14 inches from surface, 30 to 35 psi at the bar. These can be purchased or constructed.
- Solid stream. Fan spray is more apt to make slippery conditions.
- A hand held pump sprayer or backpack sprayer can be used for sidewalks. Remember to leave a pattern of wet and dry to reduce the chance of creating slippery conditions.

- There are many ways to retrofit your pick-up truck or ATV with a tank and boom and/or hose reel with sprayer.
- A shutoff switch in the cab is recommended.

Prewetting and Pretreating salt and sand

Prewetting and pretreating both mean getting dry material wet. Salt only melts snow and ice when it is in solution (dissolved). Dry salt does nothing until it is dissolved. Liquids applied to dry salt jump-start the melting process and penetrate ice and snow pack faster. Wet materials stick to the pavement and are less likely to end up in the nearby vegetation.

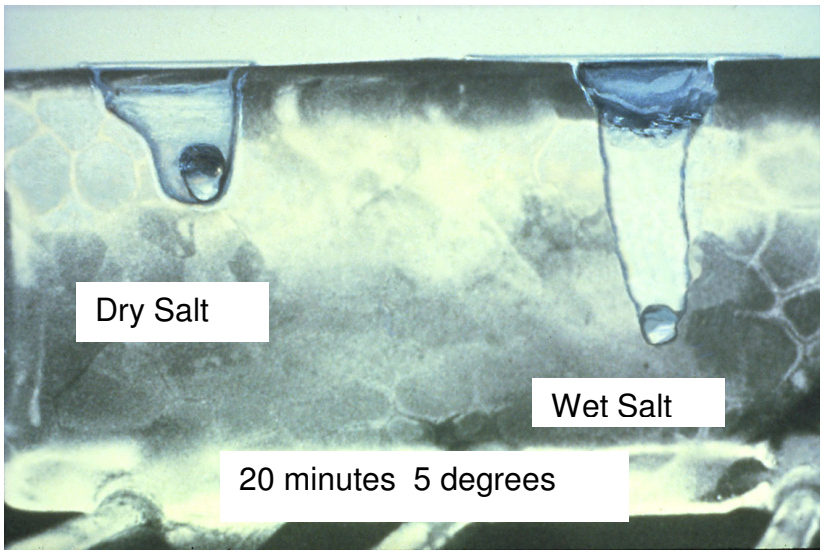


Photo courtesy of Wisconsin DOT transportation bulletin #22

Figure 14. Dry Salt vs. Wet Salt

- There are many types of liquid deicers.
- Brine is a common liquid deicer made from water and rock salt (NaCl).
- Prewetting (truck treatment) is the process of adding liquid to solids as they come off the truck onto the parking lot.
- Pretreating (stockpile treatment) is the process of adding liquid to solids in the stockpile.
- If you add sodium chloride (NaCl) liquid (brine) to dry salt, it will work faster.
- If you use magnesium chloride ($MgCl_2$) or calcium chloride ($CaCl_2$) liquid to dry salt, it will work faster and at lower temperatures.
- Prewetting or pretreating a sand stockpile is an alternative to adding dry salt to keep it flowing.
- Wet material sticks to the surface. Less is wasted by bounce and scatter.

Guidelines for pretreating stockpiles

Pretreating is mixing a liquid deicer into the stockpile of salt or sand. Salt brine, calcium or magnesium chloride or acetates may be used as pretreating agents.

Treated Stockpile Application

- You can apply pretreated salt with a pickup truck, a dump truck, a drop or rotary spreader or almost any type of equipment used for dry salt.
- No equipment changes are required.
- Remember to turn down the application rate; you will need 1/3 less material than dry salt.

Cover salt and salt/sand piles and place them on an impervious pad to limit runoff and infiltration of chlorides.

Treated salt stockpile

- Spray the salt stockpile with a liquid deicing chemical. Salt may be purchased pretreated or mixed on site by you or the vendor.
- When treating the stockpile, apply at 6 to 8 gallons/ton. For $MgCl_2$, rates greater than 6 gallons/ton tend to leach out.
- Because leach risk at a stockpile is increased, proper storage is even more important.
- Be careful not add too much liquid. Follow guidelines.

Covering your stockpile protects the salt from wind, rain and snow and reduces waste.

Treated sand stockpile

- Spray the sand stockpile with a liquid deicing chemical.
- Apply to stockpile at 4 to 6 gallons of salt brine/ton sand.
- Because leach risk at a stockpile is increased, proper storage is even more important.

Generally you can use 1/3 less material if you prewet or pretreat and it works faster than dry salt!

Guidelines for prewetting

Prewetting is adding a liquid to the salt as it comes off of the truck. This can happen either at the spinner or through a soaker pipe in the auger box. While prewetting requires some equipment changes, it provides flexibility to switch the chemical makeup depending on conditions. Salt brine, calcium or magnesium chloride, or acetates may be used as prewetting agents.

Tips

- Remember to turn down the application rate; you will need 1/3 less than dry salt.
- Requires tanks and hoses on your truck.
- Best if you can turn on/off the liquid from inside the cab.
- Best if you can regulate the flow of liquids to be synchronized with the flow of solids so you are getting the proper mix.
- The optimal application rate is 8 to 14 gallons/ton for salt brine, 6-8 gallons/ton for $MgCl_2$.

- Prewetting with a chemical other than salt brine can reduce the application rate even further.
- Below 15º F, salt brine is less effective than other liquids and has the potential of freezing hoses and valves. Verify it is mixed at 23.3% to reduce freezing risk.
- Prewetting is most practical with a dump truck. Use of a pickup truck may be limited due to material weight.
- Think twice before mixing chemicals to form "hotter" brine. This is where problems often occur.

Use cautiously. Many deicers contain trace metals including cyanide, arsenic, lead, and mercury.

Two common overuses of salt are applying to already wet surfaces and not giving the material enough time to work, but adding more on top of existing salt.

Deicing/Traction

Deicing is a reactive operation where a deicer is applied to the top of an accumulation of snow, ice, or frost that has already bonded to the pavement surface and can no longer be physically removed. Deicing costs more than anti-icing in materials, time, equipment, and environmental damage. Deicing is the "traditional" approach to winter maintenance.

The goal is not to melt everything. The goal is to penetrate through the ice and snow and break the bond so the pavement can be plowed.

Deicing

Removing ice that has already bonded to the pavement is difficult. Removing it mechanically can damage equipment and surfaces. Generally, enough ice must be melted chemically to break the bond between the ice and the pavement. This requires larger amounts of chemical, making deicing much less efficient than anti-icing.

Use the application rate table to help you with deicing. Using recommended rates will help you with these common problems:

- Over-salting. Most over-salting can be prevented by using calibrated spreaders and good judgment in selecting application rates based on pavement temperatures.
- Trying to melt everything. Don't try to melt all the snow or ice on the surface with salt. This is an overuse of materials. Apply just enough to loosen the bond between the surface and the ice so it can be plowed off.

Using abrasives

Use winter sand and other abrasives when temperatures are too cold for deicing chemicals to be effective. But be aware that sand does not melt anything. It provides temporary traction, and only when it is on top. As a result, avoid sand use as much as possible. When sand is in contact with the pavement, sweep it up. It is no longer useful to you and can only harm the environment. Sand on dry pavement can cause skidding.

Advantages of sand (abrasives)

- Short-term traction: Abrasives can be helpful in areas of slow moving traffic, such as intersections.
- Useful in very cold temperatures when chemicals will not work.

Disadvantages of sand

- Sand is not cheap when you consider handling, clean-up, and disposal costs.
- Sand will be tracked into your lots or buildings. Sweep this up as often as possible and dispose of it properly.
- Used sand is contaminated with various pollutants such as oil, grease, metal and rubber and should not be used for clean fill unless screened, should not be used for sandboxes or beaches, and should not be dumped in wetlands, fields or any natural area.
- Once sand is driven over many times, the particles are much finer and can cause air quality concerns.
- Cannot be used over pervious asphalt, pervious concrete, or pervious pavers.

Sweeping

Sweep the sand from the parking lot areas midwinter as well as in the spring. Trailer-type power sweepers are available that can be hauled behind a pickup truck. Smaller power brooms or sweepers may be used on sidewalks. Workers should wear a dust mask to avoid inhalation of the fine dust particles.

- Used sand is contaminated with pollutants such as oil, grease, metal and rubber.
- Sweepings often can be brought to a landfill. Inform landfill operator in advance.
- Keep children from playing on the sweeping piles.
- Sweepings may be reused by some industries.
- Before reusing sweepings, trash, leaves and other debris should be removed from them. This is often accomplished by screening. When screening sweepings for reuse, use a small mesh for the final screening to ensure that all of the larger debris has been removed. (A 3/4-inch mesh will screen out much of the debris.) Dispose of trash and debris removed from the sweepings by recycling it (*e.g.,* aluminum cans), composting it (*e.g.,* leaves) or sending it to a sanitary landfill.

For more information on sweeping refer to the MPCA website: www.pca.state.mn.us.

Sweep up sand frequently, after each event if possible. Sand that washes into a stream or lake increases water turbidity, clogs fish gills, inhibits plant growth, and may kill small aquatic organisms due to smothering.

Sand clogs storm sewers, ponds, ditches and is expensive to clean up.

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Evaluate the effectiveness of your actions

After the Storm

When snow and ice control operations have ended after the storm, evaluate what was done, what worked, and what could be changed to improve operations.

- Have an after-the-storm discussion with the maintenance crew.
- Have an after-the-storm discussion with the property manager.
- Consider the environmental impacts caused by your deicer/abrasive use.
- Based on all aspects of the storm fighting experience, look for ways to improve your practices.
- Accurately record your material use at each site.
- Clean and check all equipment.
- At the end of the season, clean and maintain the truck, tanks, brine-making systems, and pumps according to manufacturer specifications.
- Do not use deicers at the end of the season just to use them up. Save them for next year. Place all piles on an impervious pad and cover them. This includes salt and salt/sand mixes.

Save extra salt at the end of the season. Do not apply just to get rid of it.

Winter abrasives are an air pollution concern. They get crushed by tires and the tiny dust can become airborne. Sweep up after the storm.

Documenting and charting

Good documentation leads to reduced use of materials, more effective snow and ice control, reduced environmental impacts, and cost savings.

- Unless you document and chart, you can't measure what you are doing.
- Track your material use. Learn to record what and how much you apply at each site, each time you visit. Be prepared to analyze and make adjustments to your process based on what you learn.
- Use forms like those shown in the appendix of this manual to record and track your work and observations.

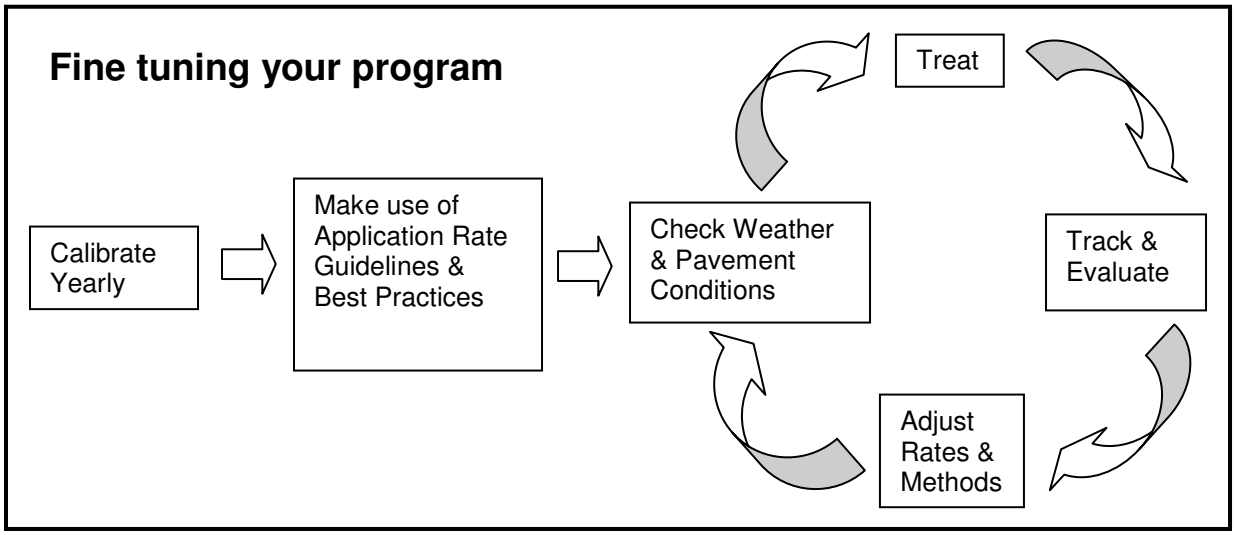

Figure 15. Fine Tuning Your Program

$ ***You can't manage what you don't measure.***

$ ***Following Best Practices and documenting your actions will help prove you are doing the best job possible and may reduce your liability.***

Documentation Form For Anti-Icing

Anti-icing Data Form				
Location: Date:				
Air Temp.	Pavement Temp.	RH	Dew	Sky
Reason for applying: Location: Chemical: Application Time: Application Amount: Observation (1st day): Observation (After event): Observation (Before next application): Name:				

Table 16. Documentation Form for Anti-Icing

RH- relative humidity
Dew- dew point
Sky- sunny to cloudy

Documentation Form for Deicing

Deicing Data Form			
Operator:			
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:			

Table 17. Documentation Form for Deicing

Application Rates for Reduced Environmental Impacts

Effective application rates are based on many factors, including type and rate of precipitation, air and pavement temperature, forecast and temperature trend, humidity, dew point, type of surface and subsurface material and sun exposure. The application rate tables used in this book have been taken from the Mn Snow & Ice Control Field Handbook, Manual 2005-1. These application rates are not perfect but are to be used as a stepping stone to improve your performance. Develop your own application rates using the guidelines included in this handbook as a starting point. Modify your practices incrementally over time to fit your needs. Make it a goal to reduce application rates and keep surfaces safe.

Anti-Icing Application Rate Guidelines **These are a starting point only. Adjust based on your experience.**			
Condition	**Gallons/1000 sq. ft.**		**Other Products**
	$MgCl_2$	**Salt Brine(NaCl)**	
1. Regularly scheduled applications	0.2 - 0.4	0.3 – 0.6	Follow manufacturers' recommendations
2. Prior to frost or black ice event	0.2 - 0.4	0.3 – 0.6	
3. Prior to light or moderate snow	0.2 - 0.4	0.3 – 0.8	
CAUTION: Too high an application rate may result in slippery conditions or tracking.			

Table 18. Anti-Icing Application Rates

***How to use the anti-icing rate table above*:**

1. Determine your parking lot or sidewalk area in square feet.
2. Calculate size factor: Divide that area by 1000 (chart is based on a 1000 square foot area).
3. Find the application rate: Choose your condition in the first column of the table and follow sideways, stopping at the anti-icing chemical you are using.
4. Determine how many gallons you need: Multiply the application rate by your size factor.

Tip: To convert from gallons to ounces: multiply result from #4 by 128.

One 50 lb. bag of salt can contaminate over 10,000 gallons of water.

Deicing Application Rate Guidelines for Parking Lots and Sidewalks

These rates are based on road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates by adjusting your current rates incrementally downward toward these guidelines. Where temperature categories overlap, select the rate most applicable to your situation.

Pavement Temp. (ºF) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate in lbs/per 1000 square foot area			
			Salt Prewetted/ Pretreated With Salt Brine	Salt Prewetted/ Pretreated With Other Blends	Dry Salt	Winter Sand (abrasives)
>30º↑	Snow	Plow, treat intersections only	0.75	0.5	0.75	not recommended
	Frz. Rain	Apply chemical	1.25	1.0	1.5	not recommended
30º↓	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75.	not recommended
25 - 30º ↑	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75	not recommended
25 - 30º ↓	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.75	1.5	2.25	3.25
20 - 25º ↑	Snow or Frz. Rain	Plow & apply chemical	1.75	1.5	2.25	3.25 for frz. rain
20 - 25º ↓	Snow	Plow & apply chemical	2.0	2.0	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2.0	3.0	3.25
15º to 20º↑	Snow	Plow & apply chemical	2.0	2.0	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2.0	3.0	3.25
15º to 20º↓	Snow or Frz. Rain	Plow & apply chemical	2.5	2.0	3.0	3.25 for frz. rain
0 to 15º ↑ ↓	Snow	Plow, treat with blends, sand hazardous areas	not recommended	3.0	not recommended	5.0 spot treat as needed
< 0º	Snow	Plow, treat with blends, sand hazardous areas	not recommended	4.5	not recommended	5.0 spot treat as needed

Table 19. Application Rates for Deicing

Instructions for using application rate table if you calibrate your spreaders

1. Using Deicing Application Rate Guidelines for Parking Lots and Sidewalks. Select the row with the appropriate pavement temperature, temperature trend, and weather conditions.➔
2. Select the column that has the type of material you are using.🡻
3. Find the box where the row and columns intersect to find the application rate. ➔🡻
4. Compare those values to the calibration chart for your truck.*
5. Dial the correct setting for the rate calculated.

*If your spreader is calibrated in lbs/lane mile refer to Table 21 for conversion to lbs/1000 square feet.

Example:

1. Temperature: 22ºF and falling. It has finished snowing. Parking Lot: 54,000 sq. ft. ➔
2. Deicer: salt pretreated with salt brine. 🡻
3. Find the 20 – 25º ↓ box. Follow it to the right under the column labeled "Salt Prewetted/pretreated with salt brine." Read the rate in the box.

The box where the column and row intersect shows a rate of 2.0 /1000 square feet. ➔🡻

4. Refer to the calibration chart in your vehicle and set the spreader to the setting that most closely matches the 2.0 lbs/1000 square feet.

How much material will be applied in this example?

a. Calculate parking lot size factor: Divide parking lot size (54,000 sq. ft.) by 1,000 sq. ft. 54,000/1,000 = 54 The size factor is 54.

c. Use the size factor multiplied by the rate from step 3 above to find the amount of material to use for the 54,000 square foot lot.
Multiply 2.0 by 54 = 108.

The application amount for the entire lot is 108 lbs. prewetted/pretreated salt brine.

Instructions for using application rate table if you DO NOT calibrate your spreaders

Follow steps 1 – 3 above and the following instructions:

4. Calculate parking lot size factor: Divide parking lot size by 1,000 square feet.
5. Use the size factor (step 4) multiplied by the application rate (from step 3) to find the amount of material to use. Spread this amount evenly over your parking lot.

Once chlorides enter the ground or surface water, they never go away.

Results

The first winter maintenance training and certification workshops were held in 2005. After holding several classes, it was determined that a training manual was needed. The Winter Parking Lot and Sidewalk Maintenance Manual was written in 2006 and the training classes using the manual started in the winter of 2006-2007. In order to evaluate the effectiveness of the training, three class exercises were created. These exercises show potential rate reductions, potential change in practices and evaluate the training program. The results from the in class exercises were compiled at the end of the 2007-2008 winter season and are shown below.

Potential Changes

In 2007-2008, 345 people attended 14 Winter Parking Lot and Sidewalk Maintenance Workshops and filled out the forms used to evaluate the course. The summary of all the exercises is given below.

Rate Reduction:

- **95%** of attendees found that they need to either reduce the amount of material that they use, or not use that material at all.
- **96%** of attendees who used rock salt found that they need to reduce their application rates.
- **24%** of all attendees used sand or salt/sand mix. They found that they are using the wrong material.
- **62%** Average potential reduction in salt application rates
- **20% - 89%** Range of potential reduction

Best Management Practices (BMP):

Attendees were given a survey about their BMP practices. Out of 19 recommended practices listed:

- Before training: **31%** of BMPs were already being used
- After training: **76%** BMPs will be used in the future (as stated by participants)

Evaluation:

- Recommend class to colleagues? **93% yes**
- Was this class useful to you? **87% yes**
- Do you think you will be able to reduce the environmental impacts of the winter maintenance activities as a result of attending this class? **79% yes**

Comments from those attending class:

"*It's about time people got concerned about our water. Thanks for your work"*
"Real world examples by people using these methods brings integrity to the presentation"
"Awesome job! I can see the wheels turning in people's heads"
"Spread the word fast. This information is too important"!
"I am very surprised to learn so much about a subject that I thought I knew. "

Actual Changes

Following the winter season, follow up interviews were conducted to learn more about the winter maintenance changes made since training. The individuals interviewed had attended the training and volunteered to be part of our follow up research on the effectiveness of the training class. Several examples of these interviews are included below.

School District of Superior Wisconsin
Michael Soderlund - Maintenance Worker

Michael Soderlund attended the Parking Lot Training in October, 2007. After the training, many new successful changes were implemented. Overall, the District of Superior reduced their total use of deicers. One of the biggest steps forward was the production of their own brine. Michael said that everything is currently working well and there is no marked reduction in quality. Many District of Superior workers were initially hesitant about the new practices, but after a few tries they realized that the new methods work just as well or even better. The material application rates were greatly reduced, especially in the middle school and high school. The actual reduction rates are given below.

Rates:

2006-2007
The district used 294 bags of ice melt (50 lb bags)
The total was $2,320.48.

2007-2008
The district used 196 bags of ice melt.
The total was $1,552.32

Reduction in ice melt use: 33.3%
Reduction in cost: 33.1%

University of Minnesota Twin Cities campus
Jim Weber - U of M Facilities Management

Over the past few years, the U of M recognized the need to become much more environmentally conscious with winter maintenance, storm water management and the campus environment. They made many changes in their snow removal program; two key areas were employee training and calibration of equipment. By increasing awareness of proper application rates, they were able to significantly decrease the amount of de icing chemical we used. They started an aggressive anti-icing program with Liquid Magnesium Chloride for their sidewalks and salt brine for the streets and loading docks. Pre-storm applications were extremely successful in reducing the bond of snow and ice to walks as well as giving them more response time on the front end of snow events. They focused on mechanical removal of snow as their first line of defense and they have changed the main deicer for walks from a blended material to straight Magnesium Chloride. They dramatically reduced the sand in their sidewalk and street program which has saved them time and money in spring clean up and long term savings are expected in storm sewer maintenance. Small amounts of sand are still used as pattern indicators for their sidewalk trucks and for use during extreme cold weather. The numbers speak for themselves:

Material # 1 – Rock Salt
1997 - 2005 average: 775 tons of salt
2006 - 2008 average: 462 tons of salt

Net Average Reduction: 313 tons
% Reduction: 41%
Material Cost: $48.53/ton
Amount Saved: $15,193 average per year (2006 – 2008)

Material #2 – Ice Melt (Magnesium Chloride - $MgCl_2$)
1997 - 2005 average: 131 tons
2006 - 2008 average: 64 tons

Net Average Reduction: 67 tons
% Reduction: 51%
Material Cost: $410/ton
Amount Saved: $27,470 average per year (2006 – 2008)

Material #3 – Sand
1997 - 2005 average: 1965 tons
2006 - 2008 average: 18 tons

Net Average Reduction: 1947 tons
% Reduction: 99%
Material Cost: $8.30/ton
Amount Saved: $16,160 average per year (2006 – 2008)

Net-Work Services Company
Bob Rush – Director of Operations

NSC is a national facility management company that services commercial properties in 22 states. NSC's responsibility is to manage all building services which include hiring and managing winter maintenance contractors. While working in his prior role as Regional Manager for Minnesota and North Dakota, Bob Rush required all of his Minnesota winter maintenance contractors to be trained and certified on the best practices. As Director of Operations he has implemented a regional training program based on the Minnesota program. This allowed NSC to expand the training based on the best practices to all winter maintenance contractors in cold weather states. Bob has taken many steps to reduce the impacts of winter maintenance and to improve the safety of his operations

Bob required all Suppliers in the seven county Metro area to switch to a standardized treated salt for parking areas. He helped calibrate all truck mounted spreading equipment to insure they were not over applying the deicer.

Bob required all Twin City Metro and Duluth area suppliers to switch to a mag/hex for sidewalks. This standardized the deicer which helped the suppliers determine the correct application rates per sq. ft. based on temperature and location of the sidewalk.

He requested that all Twin City Metro suppliers attend the MPCA snow training program. He rewarded the suppliers that were able to show their certifications.

NSC held regional training sessions with all contractors, reviewed best practice for snow removal, and discussed the proper techniques and timing for deicer application.

He expanded the material that was developed by the MPCA and trained his Regional Managers that covered 14 States on best practices, impact on the environment and the need for continual training. They in turn introduced the training material in the larger markets like Salt Lake City, Denver, Omaha, Boise and others.

Bob requires preseason re-training of large suppliers to refresh them on the best practices.

They eliminated sand use in Minneapolis and Denver and continue to educate the maintenance contractors on the impact that sand has on the environment.

Net-Work Services reduced deicer use on parking lots by 15-20% in the first year of the program and on sidewalks by 20-25%. They hope to see additional reductions in the amounts of wasted material by continuing to help the teams understand the use of technology and best practices. Bob developed a working group to continue to research better practices and material with the goal of reducing deicer use and our impact on the environment.

Cadwell Lawn and Landscaping
Charles Cadwell – Owner

After attending the Parking Lot Training in 2005, Charles Cadwell's company examined their procedures for applying salt and deicing chemicals at Ridgedale Center and found some areas that were candidates for improvement. Practices in previous years included using salt rather carelessly and applying it to attempt to keep snow from accumulating during a storm. As such, it was quite common to apply twelve to fourteen tons of salt during a given storm. Since training, they examined their practices and have taken the following measures to reduce usage of salt products:

They reduced the speed setting on our auger to slow the feed rate of salt to the wheel. At the same time, we maintained the speed of the wheel and that made for better dispersion of the salt (more even dispersion of salt and greater coverage in a given load).

They inspected the truck tailgate because in previous years, they had a problem with spillage that resulted in "piles" of salt being dropped at random during turns or when hitting potholes or speed bumps. They found gaps between the tailgate sander and the truck bed that they filled with weather stripping. That forced all salt to be fed through the auger and baffle so that the spillage was eliminated. That further increased the coverage per given load that was achieved.

Based on the lectures provided in training, they no longer apply salt chemical during a storm. Salt is applied after the snow has been mechanically removed. The one exception to this is where some material might be needed to permit traffic safety at stop signs or on slopes and then it is used very sparingly after plowing the areas and then applying the chemical to facilitate traction. (That has occurred twice during this current year, to date.)

Average salt usage for a given snow event is now five to six tons. That is based on the number of loader buckets put in the truck where one bucket is considered to be one ton (Ridgedale does not have a scale). That form of measurement is standard for what we did in previous years and from one contractor to another.

They were able to further reduce salt applications the winter of 2007 -2008 by educating the customer on the mechanical removal being the major step and only when that is complete, applying salt to the pavement. They did use some salt during snowfalls that were extended to maintain traffic traction and safety, however the mall was very receptive to only using salt when absolutely necessary.

They were also able to maintain good performance in terms of the number of slip-and-fall incidents that occurred due to ice or snow. That supported our premises of using mechanical removal - then salt application as a process.

Resources and Bibliography

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Minnesota Department of Transportation
Field Chemical Testing: Anti-icing and De-icing Liquids. www.dot.state.mn.us/maint/research/chemical/The Field Book.pdf.

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University of New Hampshire Technology Transfer Center. *Manual of Practice.* www.t2.unh.edu/pubs/manofpractice_1.pdf.

Additional Resources

Training and technical assistance

- Winter Maintenance Voluntary Certification Program.
- Minnesota Pollution Control Agency www.pca.state.mn.us/programs/roadsalt.html.
    - Training schedule
    - List of those certified
    - Printable version of the training manuals
    - Video of small site winter maintenance
    - Other technical information on winter maintenance
- The Circuit Training and Assistance Program (CTAP), a joint program of Mn/DOT and the Minnesota Local Technical Assistance Program (LTAP), brings training to cities, counties and townships 651-282-2160 or www.mnltap.umn.edu/ctap.
- Mn/DOT Winter Maintenance Coordinator: 651-366-3586.
- Winter parking lot and sidewalk training, Winter road training. Fortin Consulting Inc. 763-478-3606. connie@fortinconsulting.com www.fortinconsulting.com.
- Storage tank regulation questions – MPCA Customer Assistance Center 651-297-2274 or 800-646-6247.

Other Web resources

- Minnesota Snow and Ice Control Field Handbook for Snowplow Operators. August 2005. www.lrrb.org.
- RWIS – Road Weather and Information System. www.rwis.dot.state.mn.us is an Internet weather service provided by Mn/DOT. It gets its information from sensors embedded in the state highways.
- The Minnesota Stormwater Manual. November 2005. http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html.
- Iowa Department of Transportation. *Anti-icing Equipment Manual* (with drawings for shop-made equipment). www.dot.iowa.gov/maintenance/internetpages/chemicals/ManualAntiicingEquipment.pdf.
- Minimizing De-icing Salt Damage to Trees http://www.extension.umn.edu:80/distribution/naturalresources/DD1413.html.
- Minnesota Department of Transportation. *Guide to Field-Testing Deicing and Anti-Icing Chemicals.* www.dot.state.mn.us/maint/research/chemical/chem_evaluation_guide.pdf.
- MPCA fact sheet "Managing Street Sweepings" (Fact Sheet #4.54 September 1997) available at www.pca.state.mn.us.
- 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.

- Protecting Water Quality in Urban Areas — A Manual, Chapter 7 – Pollution Prevention, http://www.pca.state.mn.us/water/pubs/sw-bmpmanual.html. pages 7.27-1 – 7.27-2 street sweeping and the reuse of sweepings
- Assessment of Stormwater Best Management Practices http://wrc.umn.edu/outreach/stormwater/bmpassessment/assessmentmanual/index.html , Chapter 7 – Source Reduction, pages 17 and 21-24 street sweeping and its effectiveness.
- Snow and Ice Management Association (SIMA) www.sima.org.
- Pacific Northwest Snowfighters. www.wsdot.wa.gov/partners/pns/default.htm.
- Salt Institute. *Practical Guide for Storing and Handling Deicing Salt.* www.saltinstitute.org/snowfighting.
- Salt Institute. *Calibration Instructions* (with downloadable Excel worksheet) www.saltinstitute.org/snowfighting/6-calib.html.
- Lake Superior Duluth Streams. "How much salt is a problem" http://duluthstreams.org/understanding/impact_salt_2.html].
- Salt Institute. Snow and Ice List Serve: www.sicop.net.
- Transportation Association of Canada. Syntheses of Best Practices-Road Salt Management:

  www.tac-atc.ca/english/informationservices/readingroom.cfm#syntheses.

Material Conversions

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
11	15.4		11	11.9
12	16.8		12	13.0
13	18.2		13	14.0
14	19.6		14	15.1
15	21.0		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	28.0		20	21.6

Table 20. Material Conversions

The following formulas and the above quick reference table will help you convert between tons and cubic yards. Weights will vary depending upon moisture content.

1. To convert tons of clean sand to cubic yards: # tons divided by 1.4 = cubic yards
2. To convert cubic yards of clean sand to tons: # cubic yards multiplied by 1.4 = tons
3. To convert tons of winter sand to cubic yards: # tons divided by 1.37 = cubic yards
4. To convert cubic yards of winter sand to tons: # cubic yards multiplied by 1.37 = tons
5. To convert tons of straight salt to cubic yards: # tons divided by 1.08 = cubic yards
6. To convert cubic yards of straight salt to tons: # cubic yards multiplied by 1.08 = tons

Use these tables to convert application rates between pounds per lane mile and pounds per 1000 square feet.

lbs/ lane mile*	lbs/1000 square feet
25	0.4
50	0.8
75	1.2
100	1.6
125	2.0
150	2.4
175	2.8
200	3.2
225	3.5
250	3.9
275	4.3
300	4.7
350	5.5

lbs/1000 square feet	lbs/ lane mile*
0.5	32
0.75	48
1	63
1.25	79
1.5	95
1.75	111
2	127
2.25	143
2.5	159
2.75	174
3	190
3.25	206
5	317

*12 foot lane width

Table 21. Application Rate Conversion Charts

Common Conversions

- 1 lane mile (12' x5280 ft.) = 63360 square feet
- Average size parking spot: 9 x 20 feet or 10 x 20 feet = 180 – 200 square feet
- Driving isles (2-way) = About 25 feet wide
- 1 acre = 43,560 square feet
- 1 ton = 2000 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

Definitions

°C – degrees Celsius
°F – degrees Fahrenheit
brine – liquid deicer made from water and rock salt (NaCl)
lbs. – pounds
LTAP – Local Technical Assistance Program
mg/l – milligrams per liter
Mn/DOT or MnDOT – Minnesota Department of Transportation
MPCA – Minnesota Pollution Control Agency
mph – miles per hour
ppm – parts per million
psi – pounds per square inch
sq. ft. – square feet