ENVIROTECH SERVICES, INC.®

People Helping People Improve Their Environment

Winter Maintenance Best Practices – How to do More with Less

Presented by

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- Nine (9) years as the ADOT&PF Director of Statewide Maintenance and Operations
- Five (5) years as ADOT&PF Northern Region Maintenance and Operations Manager, oversaw arctic operations
- Currently a technical expert with EnviroTech Services
- Serve on the American Public Works Association (APWA) Winter Maintenance Committee. APWA instructor.

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Why You Do What You Do




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Winter Maintenance Goals

- Provide **safety** and **mobility** to road users
- Do this without negatively impacting the **environment**
- Do this within **budget**
- Provide the right **level of service**
- Address the **social expectations** of your community

- Has to be a systems based approach
- Needs cooperation and collaboration between all stakeholders
- Sustainability requires such cooperation to be effective

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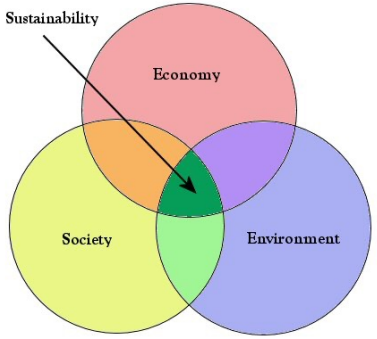
Sustainability Venn Diagram



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Liquids and Becoming Sustainable

- **Liquids, and Complex Chlorides**, if used as part of a proactive operations plan, can substantially reduce materials usage, wear and tear on maintenance equipment, and personal time
- Remember though, just because you are using liquids, does not mean you stop using solids – you are just going to use them differently
- There are a number of examples of real-world savings that have been documented from agencies that added liquids to their operations

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Winter Maintenance Best Practices

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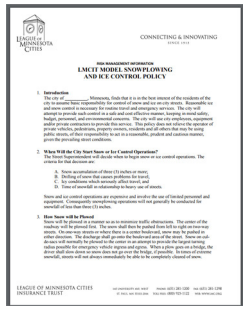
Snow and Ice Control Policy

Importance of having a snow and ice control plan

- Establishes Reason & Authority
- Identifies Responsibilities & Roles
- Stipulates Service the Agency Will Provide
- Outlines Strategies, Tactics & Resources
- Offers Protection from Liability
- Encourages the agency to study, develop, follow policies
- Communicates the policy to citizens and staff



CONNECTING & INNOVATING

LMCIT MODEL SNOWPLOWING AND ICE CONTROL POLICY

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It All Begins Here – Levels of Service

- They are at the center of winter maintenance and drive all our actions (ideally)
- Very location specific, what works in Sioux Falls would not work in Omaha, Juneau Alaska, or Georgia!
- Road type specific – residential streets should not receive the same efforts as interstates
- Possibly time of day specific – major commuter routes should have higher priority in the few hours leading up to rush hour
- Level of service determines what tools you will need for your winter maintenance

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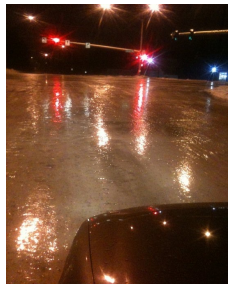
It's all about Providing Friction!



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How do we Provide Friction

- **Mechanical Methods**
- **Granular Materials**
  - Sand/Abrasives
  - Sand/Salt
  - Salt
  - Treated Salt
  - Complex Chlorides
- **Liquids**
  - Salt Brine/Enhanced Brine
  - Magnesium Chloride
  - Calcium Chloride
  - Potassium Acetate, Calcium Magnesium Acetate, Urea, etc.

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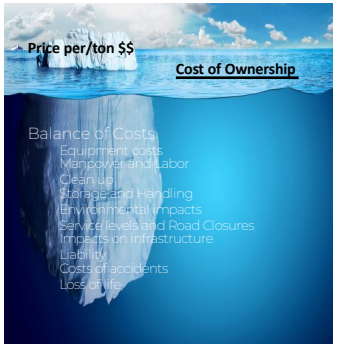
Evaluation of the Options – The True (Total) Cost of Providing Friction

- Price, Cost, and Value
- Performance
- Equipment and Infrastructure
- Corrosion and Concrete
- Environment and Toxicity
- Safety and Service Levels
- Handling and Storage

MUST CONSIDER LIFECYCLE COSTS!



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Mechanical Methods

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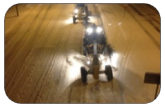
Snow Removal Equipment Platforms





Trucks Light Trucks Graders



Loaders Snow Blowers Packers

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Various Plow Options



One Way Plow Two-Way or Reversible Plows Expandable Plows




V-plows Underbody Plow Wing Plow Finger Plow

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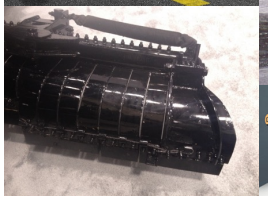
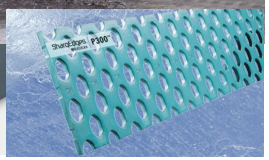
Plow Blade Technology





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Sand and/or Sand and Salt Mix

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But isn't Sand Cheaper?

- To Buy? – Probably Yes
- To put in Place? – Probably Not
  - We apply at a higher rate and need to refill more often
  - **Cleanup** – A significant cost that most do not consider – ***But You Should***
  - **Environmental Costs** – A significant cost that most do not consider – ***But You Should***

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Temporary Friction Improvement (SAND)

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True Cost of Sand – Cleanup?

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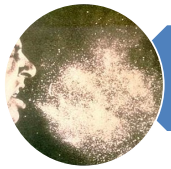
Environmental Issues with Abrasives (Sand)

Siltation & Build-up
- Lakes, Rivers & Streams
- Drainage Watercourses (Ditches)
- Shoulders
- Drainage Structures
- Vegetation



Air Quality
- Fine Dust
- Adverse Human Impacts
- Contributes to Air Pollution

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True Cost of Sand – Environmental?

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True Cost of Sand – PM 10 (PM 2.5) ?

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What About Salt-Sand Mixes?

The material used should be geared to your level of service goals.
A 50/50 salt/sand mix is confused on its goals.

Suppose you are using a 50/50 salt sand mix → You want to apply 200 lbs. per lane mile of salt so you need to apply 400 lbs. per lane mile of sand-salt mix → If you have a 5-ton capacity (10,000 lbs.) you can cover 50 lane miles with straight salt, but only 25 lane miles with a mix

The mix means more refilling, more time in the shop, less time on the road –
And there are minimal benefits to the added sand.

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Gravel Road Sanding

- Avoid excessive sanding on Gravel Surfaces
  - Too many fine soil materials will create a “greasy” condition
  - Too many coarse materials won’t provide enough traction
  - Both will increase:
    - potholes,
    - wash boarding,
    - soil erosion,
    - shoulder berming,
    - ditch/culvert clogging,
    - and outfall sedimentation

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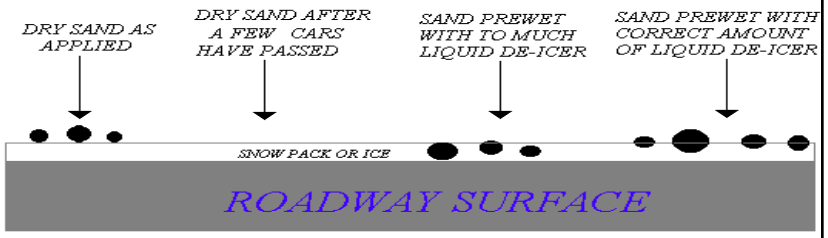
Benefits of Pre-wetting Sand



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Sand and Sand/Salt Mixes

Benefits of Sand/Salt Mixes

- Most common, readily available product used
- Works in all types of weather and storm events
- Lower initial costs
- Good choice during extreme cold, gravel roads, and steep grades
- Good choice on low volume roads with defined low level of service

Negatives of Sand/Salt Mixes

- Is not an active deicing material
- Traction is temporary
- Reduces lane miles per/truck
- Clogs sewers and drains
- Environmental issues (water and air quality)
- Windshield damage
- Cost of clean-up
- Higher overall life-cycle cost
- Bicycle accidents

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Salt (Rock Salt, Road Salt) – Sodium Chloride (NaCl)

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If You Use Salt – You Are Already Using Liquids

Salt Doesn't Melt Anything

Until in Solution

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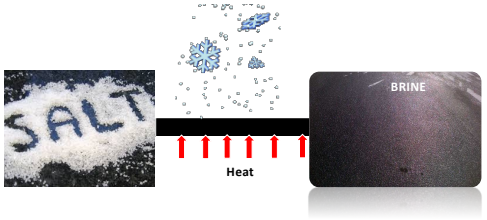
Snow/Moisture



Salt needs heat and moisture to turn into a liquid.
Too little of either and the transformation will take longer or may not occur.

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Pounds of Ice Melted Per Pounds of Salt

Sodium Chloride Limitations

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

It is not cost-efficient to apply salt (sodium chloride)
at pavement temperatures less than 15 degrees (20 F)

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It's all about the pavement temperature

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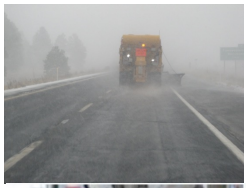
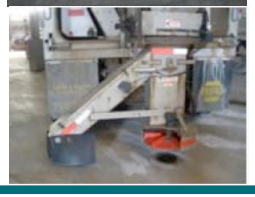
Salt Application

- 150-500 lbs. per lane mile
- Limited to 15 degrees – 20 degrees
- Bounce and scatter is an issue
- **Highly Recommend Pre-Wet!!!**
- Requires no clean-up
- Use the crown of the road to your advantage
- Chutes can help deliver material low and on target
- **Watch your speed**





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Salt Options/Enhancements

- **Sodium Chloride Salt -** Is typically white evaporative or mined rock salt and is the most commonly used anti-icer/deicer.
- **Treated Salt** – Typically road salt treated with magnesium and/or calcium chlorides. Treated salt can be purchased from vendor already treated or can be treated in the stockpile.
- **Complex Chloride** - A complex chloride is a naturally derived, homogenous blend of the 4 main chloride salts. Solid complex chlorides™ are mined from ancient sea deposits and also contain other naturally occurring minerals.

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Treated Salt Considerations

- Lower effective temperature than straight road salt
- Salt is pretreated before allied to road
- Leeching potential
- Salt only treated on exterior – once melted, working only with NaCl

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Complex Chlorides

- Complex Chlorides 92% – 96% (Magnesium, Calcium, Sodium, & Potassium Chloride)
- Complex Chlorides contain all-natural corrosion inhibitors and environmental buffers crystallized *within* each granular – not just sprayed on the surface
- Typical application 30% - 40% less with true complex chloride than traditional white road salt
- Typical application 100 – 350 lbs./lane mile

- The following rates are estimates based on temperature. Other conditions will affect the amount needed and should be taken into consideration.

Temperature	Lbs./Lane Mile
25F	125
20F	175
15F	200
10F	250
5F	300
0F	350

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Granular Salt Thoughts and Takeaways

- White salt should not be applied at pavement temperatures below 15-20 degrees F
- Complex Chlorides have been applied to pavement temperatures down to 0 degrees F
- **Remember, more salt does not speed up melting**
- **Solids should be applied pre-wet or pre-treated**
- Solids are excellent choice for snowpack (deicing) & freezing rain events
- Granular salt may bounce, scatter or be displaced by traffic (just like sand), therefore it may not be best for anti-icing or early de-icing
- Solids will take longer to dilute than liquids – when applying a liquid product, you are applying 24%-32% and 68%-76% water

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Liquids – Application Techniques/Methods

- **Deicing** – traditional approach to snow and ice control sometimes referred to as direct liquid application.
- **Anti-icing** – sometimes referred to as pre-treating
  - Typically with liquids
  - Pre-wet solids
- **Pre-wetting** – applying liquids to solids before placement on the surface or roadway
  - In stockpile (sand or salt)
  - At discharge
  - On truckload (not recommended)
- **High volume output**
  - High amounts of liquids combined with some solids
  - Direct liquid application for de-icing – high amounts of liquids

We DO NOT use chemicals to "burn off" the snow

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What's the difference?

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DEALING WITH THE BOND

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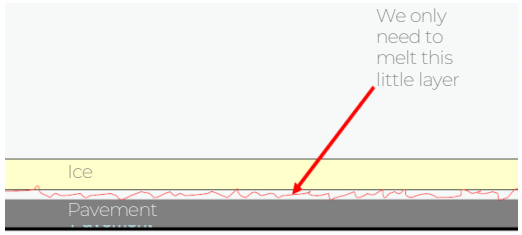
Anti-icing

The goal of applying anti-icing chemicals is to **prevent the bond** from forming between the pavement and the snow & ice. We are not trying to melt all the snow & ice



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Liquid Possibilities

Pro-Active treatment prior to an event

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Various Application Equipment

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Anti-icing

- Anti-icing is a **proactive** strategy, accomplished by applying a chemical freezing point depressant (typically liquid or pre-wet solids) directly to the road surface
- Anti-icing **prevents** snow from freezing and bonding to the road surface
- Generally used in advance of an event
- Often anti-icing focuses on hills, curves, intersections, bridges & major roads
- Benefits:
  - Better pavement conditions
  - Less chemical needed – less cost
  - Applications can last for days

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De-icing

- De-icing is a **reactive** snow and ice control strategy in which chemicals are applied to the top of an accumulation of snow, ice, or frost that is already bonded to the pavement surface
- Chemical must work its way through snow/ice to the road surface where bond can be broken and snow/ice plowed off
- Plowing is still the best method of removing snow
- **DO Not try to burn off snow with chemicals**

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Pre-Treating/Pre-Wetting

Want Your Material to Work? → **Get It Wet!**

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Why Pre-treat/Pre-wet?

- Jump starts brine process
- Minimize scatter during application
- Keeps 20%-30% more on road
- Sticks sand to the road surface
- Reduces working temperature of salt (if pre-wetting with mag, calcium chloride, or enhanced brine)
- Reduces environmental impacts
- Saves money
- **Allows you to DO MORE WITH LESS**

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How to Minimize Salt/Sand Bounce and Scatter (MDOT Study)

- Just because your truck can put salt out at 50 mph does not mean you should!!!!
- Speed is the biggest factor effecting salt bounce and scatter
- **Maximum application speed should be 35 MPH**
- **25 mph speeds retain the most salt in target zone by far**
- Treated salt/sand scatters less than untreated salt - reduces bounce and scatter by as much as 30%

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Liquid Pre-Treating Stockpile

Is Done Prior to Stockpiling

- Salt:
  - 6-10 Gallon / Ton
- Sand:
  - 4-6 Gallon/Ton

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On-board Pre-Wetting Application Rates

- Typical application rates have historically been 8-12 gallons per ton
- Recent research and field experience indicates that application rates of 20-30 gallons per ton have been very successful
- Higher liquid rates can allow lower granular application rates
- Best results are with magnesium and calcium chlorides as the pre-wetting liquid.

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Pre-Wetting Benefits and Takeaways

- **Reduce bounce and scatter by as much as 30% and keeps the material on the road which also means**:
  - Less sand in the ditch, under guardrails, in storm drains
  - Less spring sweeping
- **Improve granular performance**
  - It instantly starts the brine making process by introducing moisture
  - It can reduce the effective temperature of the salt
- **Reduce granular application rates**

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Choosing Your Liquid Chemicals

Most commonly used liquids

- Salt brine
- Enhanced salt brine
- Magnesium chloride
- Calcium chloride

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Choosing Your Chemicals

Which Chemical/ Material should you use?			
A Major Difference is in Operating Temperature	Salt Brine is Good to 15°F/20°F Generally Less Expensive	Calcium Chloride & Magnesium Chloride Will work at Lower Temperatures	Calcium Chloride & Magnesium Chloride Application Rates are Considerably Lower

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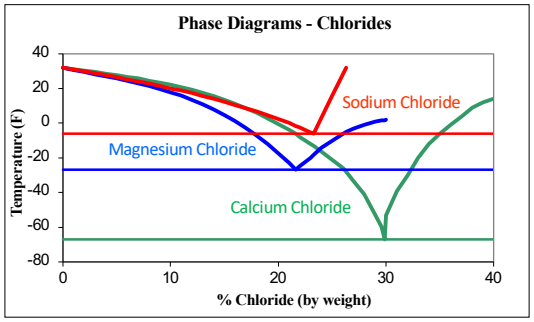
Ice Control Materials



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Eutectic Temperature vs. Effective Temperature

Effective Freeze Points 1:1 with Water

$CaCl_2$	8 °F
Enhanced $CaCl_2$	-2 °F
$MgCl_2$	4 °F
Enhanced $MgCl_2$	-8 °F
NaCl (23.3%)	16 °F
Enhanced NaCl	11 °F

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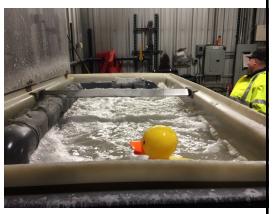
Salt Brine Basics

- Probably most common liquid anti-icer and typically lowest price
- Sodium chloride brine is a solution comprised of 23.3% sodium chloride (NaCl) and 76.7% water by weight
- Sodium chlorides eutectic temperature is -6° F at 23.3% salt (eutectic concentration)
- Sodium chloride is not hygroscopic.
- Can be blended with additional enhancers



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Salt Brine Basics

The "Basic" Liquid Is Salt Brine
Sodium Chloride (Salt) Plus Water

Easily Made,
Easily Stored,
Easily Handled,
Easily Used

Possibilities with Blending Using Other Chemicals

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Salt Brine Basics

The "Basic" Liquid Is Salt Brine
Sodium Chloride (Salt) Plus Water

23.3%

Is the Magic Number In the Brine World

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Making Liquids Doesn't Have to be a Multimillion Dollar Project

However, Automation is Nice

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Modern Brine Making/Equipment Storage

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Fairbanks Alaska

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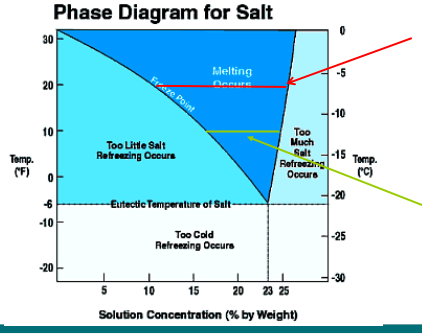
Eutectic Temperature vs. Effective Temperature



At **20** degrees (F) salt is effective at a wide range of concentrations

At **10** degrees (F) salt range of concentrations narrows

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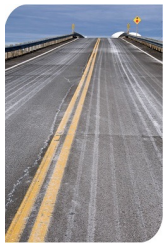
Salt Brine Performance Limitations

- Is prone to drying out and being blown from the surface by the wind
- Requires frequent reapplication
- The melting point of salt brine is often not low enough to be effective in many storms
- Salt brine alone is among the worst options in terms of the corrosion it will cause



What's the answer? – Salt brine enhancers

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Salt Brine/Enhanced Salt Brine Application Rates

- Approximate Range of 20 - 90 Gallons per Lane Mile
- Average about 30 – 50 Gallons per Lane Mile
- Do not shoot and run!
- Watch for signs of change
- Be proactive
- **Most importantly – use application rates that work best for you!!**

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Calcium Chloride and Magnesium Chloride Application Rates

- Rates range from 15-60 gal lane-mile depending on temperature and precipitation type - 20-30 gal per lane mile-*normal* start point
- Requires constant monitoring of precipitation rate, temperature, traffic, and dilution of the product
- Do not shoot and run!
- Watch for signs of change
- Be proactive
- **Most importantly – use application rates that work best for you!!**

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Application Rate Guidance for Salt Brine Blends for Direct Liqu... 3 / 8 198%

Pavement Temperature	Trend	Road Surface Condition	Liquid (gal/ln-mi)			Solid (lb/ln-mi)	
			NaCl	$MgCl_2$	$CaCl_2$	Dry Salt	Pre-wet salt
32°F	Steady or rising	Dry	NR			NR	
		Icy patches	20-40	15-35	15-35	120-160	110-150
32°F	Below is imminent	Dry (snow forecast)	20-40	15-35	15-35	NR	75-125
		Slush or light snow	30-40	15-30	15-30	140-180	100-150
25-32°F	Remaining in range	Dry (snow forecast)	30-50	20-40	20-40	NR	100-125
		Light snow cover	40-60	20-40	20-40	160-200	125-175
20-25°F	Remaining in range	Dry (snow forecast)	40-60	30-50	30-50	NR	125-175
		Light snow cover	50-80	20-40	20-40	200-250	175-225
15-20°F	Remaining in range	Dry (snow forecast)	NR	40-60	45-65	NR	175-225
		Light snow cover	NR	45-65	45-65	250-300	200-250
0-15°F	Steady or falling	Dry (snow forecast)	NR			NR	200-250
		Light snow cover	NR			NR	200-250
Below 0°F	Steady or falling	Light snow cover	NR			NR	NR

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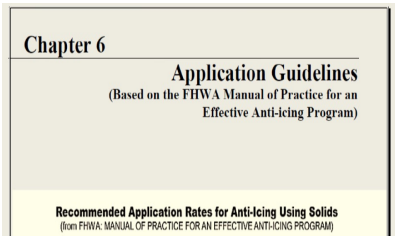
Application Rate Guidelines



https://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm

CLEAR ROADS
research for winter highway maintenance

https://clearroads.org/

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General Tips – Only use what is needed

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General Tips – Only use what is needed

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General Tips – Only apply to driving lanes

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Liquids – Great for Frost Management

Instant Results with Minimal Material

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General Tips – When not to anti-ice

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General Tips – Give Chemical Time to Work

- Give the product time to work no matter what product you are using.

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General Tips – Plow Only in Severe Storm

- If the storm is severe, consider using only mechanical snow removal until the severity lessens, and then resume liquid treatments

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General Tips – Anti-icing

Anti-icing applications with magnesium or calcium chloride should occur after the road has turned wet, but prior to an accumulation of snow or ice crystals

It is essential that the pavement be cleared of loose snow and ice before applying liquid chemicals to reduce the dilution that would result

PLOW FIRST!

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Early Fall Applications

Be careful of road surface contaminants when there has not been moisture for extended periods of time.

They can cause the surface to become slick with minimum application rates of de-icers

- Anti-freeze
- Motor oil
- Diesel fuel
- Gasoline
- Rubber

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General Tips

Apply with pencil/streamer nozzles (not fan spray) to maintain some bare pavement between sprayed areas to reduce slipperiness

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General Tips – Minimize Liquid Dispersal

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Calibration

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Calibration

- Know how much Product is being applied per Lane Mile
- ALL Trucks and Liquid Units must be Calibrated
- Do not Trust the Computer readouts on your Equipment
- Perform actual tests between Computer read outs and the amount of Product that is Actually Applied

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Liquid Benefits

- Reduced salt/chloride usage – less chlorides in the environment!!!
- Liquids are used to **prevent the formation of the bond between snow (or ice) & the pavement, and/or to break that bond.**
- Goal is to allow easier removal by snowplows and graders
- Excellent for pre-treatments, especially for frost management
- Liquid chemicals begin working almost instantaneously

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Liquid Benefits Continued

- Pre-wet sand will refreeze quickly to the road surface and creates a sandpaper-type surface and stays on the road longer
- Reduces sand and/or salt usage by up to 30% and therefore results in reduced environmental impacts
- Reduced cost of roadway sweeping and storm drain cleaning because we are using less sand
- Anti-icing application can last for days

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Thank you! – Questions?

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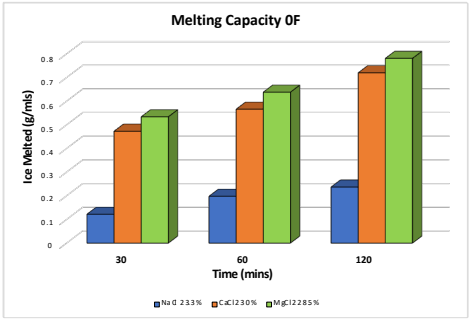
Melting Capacity – NDOT Mechanical Rocker Method



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