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Liquids Lessons Learned: Advice and Experiences from Chicago Area Waterways Chloride Workgroup Members with Liquids for Winter Operations

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The mission of the Chicago Area Waterways Chloride Workgroup (CAWCW) is to bring together a diverse coalition of stakeholders to work together to preserve and enhance water quality and stream resource quality in the Chicago Area Waterway System watershed and its tributaries. The CAWCW supports member organizations with their efforts to implement Best Management Practices (BMPs) to reduce chlorides to improve water quality while providing safe surfaces to the traveling public.

Many organizations use liquid deicers as a BMP in their Winter Operations to meet their service goals while reducing salt use. The "Liquids Lessons Learned" guide includes advice and experience from CAWCW members and combines the winter operations liquids advice into one living document.

Advice and experience related to communication, general winter operations, weather and pavement conditions, mixing brine, storage of liquids, blending liquid products, and equipment are all included in the guide.

Any other topics and advice are welcome additions to the guide. As your organization uses liquids or tries

something new and would like to add your experience or advice to the guide, please reach out to the Workgroup Coordinator.

"Try it. Liquids may seem complicated, but they aren't. Talk to nearby communities to get help and try to help other communities learn from your experiences when possible."



Key Terms for Liquids in Winter Operations

Liquids — General term for a deicing material in a liquid form, like salt brine.

Deicing — A reactive treatment of applying a deicer (like salt) to break the snow and ice bond with a paved surface after it has occurred either during or after a storm, either as a treatment by itself or to aid in mechanical clearing.

Direct Liquid Application (DLA) — The use of liquid only treatments before, during, or after a winter storm event for anti-icing and deicing.

Liquids as a Deicer — A reactive treatment that involves using only liquid treatments in a deicing capacity.

Liquid Only Route—A plow route on which only liquid treatments are used for anti-Icing (pre-treatment) and deicing when weather conditions fall within

appropriate usage parameters.

Anti-icing, aka Pre-Treatment with Liquids — A proactive treatment that involves the application of liquid deicer treatment prior to the onset of a winter weather event (snow, frost, etc.) that prevents the snow and ice from bonding to the road surface.

Pre-Wetting — Combining liquid and granular deicing materials at the spreader or auger as deicer is applied to road surface to wet the granular material before it reaches the road surface.



Treated Salt, aka Pre-Treated Salt — Combining liquid and granular deicing materials before loading onto spreading

equipment to wet the granular material. This may be done at the stockpile or purchased as treated salt from a supplier.

Salt Brine — A liquid solution comprised of sodium chloride (NaCl) and water that is mixed to a concentration of 23.3% Sodium Chloride by weight.

Magnesium Chloride — In the context of liquids, a liquid solution comprised of magnesium chloride (MgCl₂) and water (ratio varies). Magnesium chloride may also refer to granular deicer composed of magnesium chloride.

Calcium Chloride — In the context of liquids, A liquid solution comprised of calcium chloride (CaCl₂) and water (ratio varies). Calcium chloride may also refer to granular deicer composed of calcium chloride.

Organics, aka Carbohydrates—Carbohydrate additive to deicing materials (like salt brine), like Beet Juice or corn byproducts, to change the performance of the deicer. These products do not melt snow or ice, but instead disrupt the formation of ice crystals and help lower the freezing temperature of brine. Their sticky nature helps reduce bounce and scatter and keep deicing material on the pavement surface.

Experiences with Liquids as Part of Winter Operations

Our program has a goal of using all liquids (both pre-storm and during storm). We've learned liquids have a benefit to equipment maintenance and to reducing dry salt storage needs. Some of our routes are currently running all liquids and we are working on expanding it to other routes. This coming winter we are going to be experimenting with rates and blends to dial-in what works best in the conditions we commonly face. Right now, we are using about 50-60 gallons/lane mile on our all-liquids routes and that may change based on snow intensity, weather, and road conditions.

What happens if we find 80 gallons/lane mile is needed? Can our equipment handle that?

We need to experiment with cycle timing, plowing, how quickly the liquid treatments dilute with snow/precipitation, and how long it will work. We will be needing to expand our brine making operation to support an all-liquid program.





Liquid Application Rates that have worked well for various CAWCW organizations:

Anti-Icing Application Rates

Pavement Temp/Weather Conditions	Liquids Rate	Product
Frost Forecast, Above 32F pavement temp steady or rising, monitor temps and pre-treat	45-70 gallons/lane mile	100% brine
15F and above	40 gallons/lane mile	100% brine
15-10F	40 gallons/lane mile	90% brine/10% CaCl2
0-10F	40 gallons/lane mile	80% brine/20% CaCl2

Example from a recent storm: High 30s (°F) air temperature, but pavement temperature was high 20s (°F). Anti-icing (pre-treatment) was not used ahead of the storm. We used an all-liquid operation during storm and used only salt (sodium chloride) brine at about 27 gallons/lane mile. It was very effective and worked well. Trying the all-liquids operations helped with buy-in from staff, because they could see it worked. We wanted to try it to show staff that all liquids can work and get the buy-in. It was a good success story for our program.



Liquids have worked well for our program. Our program started with salt brine during storms, using about 35-60 gallons/lane mile, and anti-icing ahead of storm (when conditions are right for antiicing). Having the capability and getting buy-in from staff is a huge first. It is also really important to get community buy in. Many in the community want the crunch of dry salt and don't always understand that liquids are working. We use all liquid routes in downtown areas. Only during heavy intensity snows, we may introduce carbohydrates/organics or use granular as needed. With liquids we are able to use less salt overall and not lose salt to bounce and scatter. We have been able to see a 40%

reduction in salt use. We have been able to double the use of brine each year as we are transitioning to more liquids.



We used to order up to 3,500 tons of salt each year, but since using liquids we have been able to reduce that to about 1,500 tons. This is a 50% reduction in what we're using each winter, and our program is still able to maintain roads and safety. We use anti-icing when possible. Liquids have helped reduce bounce and scatter of dry salt and we haven't changed our plowing method. We plow right away. Smaller snow amounts we use an underbody plow and don't let it build up. Our program has been using anti-icing for 5 years and we have found that if we can use anti-icing ahead of a light dusting, we may not have to call out.

This year we purchased a liquid spreader for the sidewalks. It has been a great tool to use in the public works yard to help build staff buy-in for liquids. The unit is a walk behind unit that we can control the spread rate on. Our goal is to avoid seeing salt lingering on sidewalks or surfaces days after storm and with liquids we are reaching that goal.



Liquids Application Guidance adapted from Clear Roads' "Liquid Roadway Treatments, Technical Reference Guide"

Source: Liquid Roadway Treatments, Technical Reference Guide for Clear Roads by Stonebrooke Engineering (9/12/2017) - https://www.clearroads.org/materials-liquid-materials/ and http://clearroads.org/download/technical-reference-guide-2/

Usage Parameters

Table 2: Recommended DLA Parameters During a Storm Event

Parameter	Most Favorable For Liquid Treatment	Consider Using Liquid Treatment	
Pavement Temperature ¹	15°F or above (salt brine) 0°F or above (magnesium chloride) ² 0°F or above (calcium chloride) ²	15°F or above (salt brine) 0°F or above (magnesium chloride) ² 0°F or above (calcium chloride) ²	
Storm Intensity (inches/hour)	Light Snow (less than 0.5 inch/hour)	Medium Snow (0.5 to 1.0 inch/hour)	
Moisture Content ³	Ordinary (approx. 10:1 snow/liquid ratio) ³	Dryer Snowfall	

Notes:

1. Consider temperature trends (increasing/decreasing temperatures)

2. Additives are available can reduce the freezing point of magnesium chloride. Similar temperature ranges are recommended for calcium chloride. Work with vendors to verify temperatures.

3. Wet snow can dilute liquid applications, which reduces their effectiveness

Direct Liquid Application Rates & Cycle Times

"Agencies have had success with direct liquid application rates generally from 20 gallons per lane mile (gplm) to 80 gplm, depending on conditions, timing, if granular is also being applied, level of service, and other local factors. Your local experience will allow you to fine-tune your application rates.

Cycle times will vary depending on location. Shorter cycle times help reduce refreeze potential, and longer cycle times increase dilution-refreeze potential. Generally about 1.5 or 2 hours is considered a preferred cycle time. Cycle time incudes the time needed to refill the truck tanks and the "dead head" time to the treatment route. As cycle times increase, supplementing liquids with granular should be considered."

Table 3: Suggested Liquid Roadway Treatments Application Rates (adjust based on local experience)
Application rates are in gallons of salt brine per lane mile (gplm)

Event Type	Pavement Temperature				
	32-30°F	29-27°F	26-24°F	23-15°F	
For 2-Hour (or less) Cycle Times					
Light Snow (less than 0.5 inch/hour)	20 gplm	35 gplm	40 gplm	55 gplm	
Medium Snow (0.5 to 1.0 inch/hour) ¹	35 gplm	45 gplm	55 gplm	Not Recommended	
For 3-Hour Cycle Times ³					
Light Snow (less than 0.5 inch/hour)	35 gplm	50 gplm	65 gplm	80 gplm	
Medium Snow (0.5 to 1.0 inch/hour) ¹	50 gplm	65 gplm	80 gplm	Not Recommended	

Notes:

1. For medium snow events, only consider using liquid treatments based on your experience, and when other factors are highly favorable, such as pavement temperature and moisture content.

2. It is suggested to generally supplement the liquid application with a light direct pre-wet granular application (70 pplm) when possible (especially as dilution-refreeze potential increases).

3. For cycle times greater than 2 hours, supplementing liquids with direct granular is strongly suggested.

4. For magnesium chloride, calcium chloride, additives, and blends, work with vendors to verify application rates.

Communication

Email communication ahead of winter weather can help manage expectations and keep key departments, staff, and other organizations informed of your operations and plan. A detailed internal email to key personnel like the city/village manager, property maintenance, communications, or other key personnel with important winter operations and weather information keeps everyone on the same page. An email to other key community members, like business, park, and school districts (including universities) and city employees with winter weather information and needed winter operation information can keep these key community members and partners informed.



Driver/Operator Communication

It is very important to communicate with plow drivers on how to refill trucks correctly with how much product, what blend needs to be used, and what setting to use. We find that on a 200-gallon saddle tank, using about 50 gallons less helps avoid overfilling or foaming.

We want to minimize the ability to change what mixes are being used in trucks by drivers. A good system can lock this down to avoid driver changes and reduce issues with blends or products. What doesn't work – not communicating with the public ahead of time. Tints in organics/ carbohydrates have caused issues if we did not communicate well. People complained about the color being tracked into buildings, stains on cars, scared about impacts to dog paws, and even "Is it gluten-free?". We learned communicating with the public really helps save on headaches!



Meetings ahead of winter with local police are very beneficial to winter operations. The police get to ask questions and learn about the winter operations program. This reduces the number of calls back to public works from local police about conditions and if plow trucks need to be called out or salt needs to be spread. Inter-department communication really makes a positive difference in winter operations and helps manage expectations.

Sharing Knowledge and Liquids Resources

Not everyone has the ability to make brine (such as DIYing brine makers or purchasing a brine maker or space to make brine). To help improve access to brine, we sell brine at close to cost to local school districts, universities, and park districts. This can be a good way to share knowledge and resources to help others use liquids.

Weather and Pavement Conditions to Consider when using Liquids

Shading and slush – sometimes our plow drivers call back with reports of slush when using liquids, especially on routes with less direct sun and more shading from buildings or trees. The liquids are breaking the bond between the snow and pavement surface, so we are seeing slushy surfaces instead of frozen surfaces.

If you need to anti-ice (pretreat roads with salt brine), you should understand what is going to happen with the weather for success. It is important not to anti-ice if rain is called for during a winter storm as it can wash the anti-icing (pretreatment) off the road surfaces.







It is important to pay attention to pavement temperatures. Depending on the temperature, blending in a product like calcium chloride can help in very cold temperatures. If it is too warm, calcium chloride can cause slick surfaces and is best when pavement temperatures are very cold. Our program uses blends with at most 20% calcium chloride for very cold temperatures. Calcium chloride is best used in blends instead of on its own to avoid slippery roads.

Mixing Brine, Storage, Blending Advice



When blending, it is really important to get concentrations and ratios correct to avoid icing up streets.

Organics can cause foaming and you really need to pay attention to how much is used. Our limit is 10% at most for a mix. Most frequent mix when using organics is about 5%. Anti-foaming agents also help and are available.

When using liquids, you need to consider tanks and appropriate sizing for the tanks. It can feel like you are a "mad scientist" as you figure it out. It is important to take the time to figure out mix ratio, especially if blending multiple liquid products together (like salt brine with calcium chloride or organics/ carbohydrate). Assign 1-2 key staff members to be your liquids "mad scientist", so that all your staff is not responsible for maintaining the liquids or making brine.





You need to check tanks and products every year ahead of winter. Evaporation can happen in the off season (summer especially). The concentration of the product will change, and you will need to readjust the concentration to be at the optimal concentration. Some products may settle out and recirculating the product in the tank to help re-mix the product may also be needed.

Liquids Equipment



If using stack blending, saddle tanks can fill unevenly. If you want a blend of 50 gallons of Product A and 10 gallons of Product B, if you're not paying attention loading the products, it can push more of one product into one tank versus the other tank. It is important to isolate the tanks with valves instead of filling the tanks together to get the same blend in both tanks. Another option is to mix in a separate tank and pump out of that tank only to load trucks with the pre-mixed product to avoid issues. Start thinking of the future when ordering equipment. If you want to use more liquids in the future, start factoring that in equipment orders now instead of waiting. Add liquids equipment to as many pieces of new equipment as possible to keep liquids as an option for your program. This could also include thinking about trucks with slurry capabilities (like the "Shake and Bake" technique or 90% liquids and 10% granular presented at the Salt Conference this year) or other liquid innovations so you keep your options open.





Not all saddle tanks have the appropriate connections for pumping/loading. It is important to make sure you get the correct sized hose to avoid issues. Some equipment can share key information with decision makers or supervisors about what and how much of a liquid product was loaded onto which truck by individual driver/ operator. This can help programs track and evaluate. We have found that we can evaluate better if drivers are coming back frequently to the yard for refills and are overusing product. This allows us to address it and creates a system of checks and balances so we can better evaluate our program during the winter rather than only at the end of the season.

Filter screens on equipment may clog, especially when using organics. You need to find the right screen size (typically a larger hole size with organics). Using a prefilter can help avoid clogging.