



COLORADO

Department of
Transportation



**LIQUID ONLY PLOW ROUTES
PACIFIC NORTHWEST SNOWFIGHTERS
June 5-6, 2018
Spokane, WA**



COLORADO
Department of
Transportation

Liquid Only Plow Routes: One Tool in the Tool Kit

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How are Liquid Deicer Materials Used?

Anti-Icers:

- **Preventative** Winter Road Treatments
 - Placed **before** icing occurs
 - **Prevent** the bond between frozen precipitation and pavement.
 - **Secondary function** is to melt snow and ice.
 - **Proactive.**
 - **Typically liquid.**



Deicers:

- **Reactive** Winter Road Treatment
 - Placed **after** precipitation occurs.
 - **Remove** the bond between frozen precipitation and pavement.
 - **Primary function** is to melt snow and ice.
 - **Reactive.**
 - **Can Be Both Liquids and/or Solids**





Anti-Icing Strategy

- ANTI-ICING (**preventive treatment**)
 - Applying liquid product directly onto the roadway pavement **before** the storm, before the snow or ice is sticking to the roadway surface; this prevents ice from forming or snow bonding to the pavement.
 - Applying liquid product **during** the storm immediately after plowing, prevents a hard-to-remove ice or snow pack from forming during the storm.





De-icing Strategy

- De-icing (**reactive treatment**)
 - Applying liquid product to the roadway pavement to break the bond of existing snow and ice by dissolving downward, penetrating the snow and ice to the pavement; the melted snow and ice can then be plowed from the roadway.





De-icing Strategy

- De-icing (**reactive treatment**)
 - De-icing requires considering many factors
 - Air and Pavement Temperature dependent
 - Moisture dependent
 - Product May dilute and Refreeze
 - Additional Storage May be Needed
 - And if goal is to maintain wet roads regardless, Cost will be a Factor





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - Report Date September 2010
 - Participating Agencies
 - Research funded by combined pool - Wisconsin DOT and USDOT
 - Clear Roads Technical Advisory Committee
 - Experience from Winter Maintenance Experts





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - Project Focus-
 - Project direction concentrated on during-storm direct liquid application (DLA)
 - Current best practices regarding during-storm liquid applications for snow and ice control
 - Why, Where, When, How
 - Determine and recommend field tests that are needed to help validate and improve best practices





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - What-
 - During-storm DLA is the technique of directly applying liquids to the roadway surface during storm event
 - Why
 - An additional tool that allows us to leverage the benefits of liquid chemicals during a wider range of storm event types
 - Require 50% of the material used by granular-only applications
 - Where
 - Benefits in mild, moderate and colder climates
 - When
 - Condition dependent – Rules-of-thumb





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - Rules-of-thumb for when to use DLA

*Rules-of-Thumb for During-Storm DLA
(For Illustration Only)*

Factor	Limits of Direct Liquid Applications ¹
Storm Intensity	Some use a rule-of-thumb that snowfall rates should be 0.5 inches/hour or below. Others use a slightly higher rule-of-thumb maximum value of 1 inch/hour and below
Pavement Temperature ²	All experts find 25°F and above favorable for during-storm DLA. Some consider during storm DLA when 20°F or above.
Moisture Content	Ordinary moisture content is most conducive to during-storm DLA. Wetter events produce higher dilution potential. Drier (ie powder) events may not need any chemical (plow only).
Cycle Times	Generally about 1.5 hours is a reasonable cycle time. Shorter cycle times help reduce refreeze potential. Caution should be used with this parameter because of variation in cycle times due to slow moving traffic, liquid loading, etc.

Notes:

- Note that these are *rules-of-thumb*. In practice, all parameters will have to be considered together along with other factors such as traffic, equipment availability, timing, etc.
- Consider temperature trends (increasing/decreasing temperatures)





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - Project Results – Highlights from survey and interviews:
 - During storm Direct Liquid Application (DLA) can be done as liquid only however, often supplemented with lighter granular application

During-Storm DLA Benefits	
Benefit	Result
Reduced application rates	Savings and minimized negative side effects
Reduced loss of material	Savings and minimized negative side effects
Faster post-storm cleanup	<ul style="list-style-type: none"> • Crew gets to “go home earlier” (employee satisfaction) • Better post-storm LOS (faster regain) • Reduced accidents in safety critical post-storm period as drivers increase speeds • Savings from reduced labor
Quick (instantaneous) effect	Faster improvement of LOS
Prevention of bonding ¹	Improving LOS, reducing post-storm cleanup
Expanded toolbox	Expanded tool selection to best meet event conditions
Accurate low application rates	Liquids can be spread at very low application rates (ie 20 pplm) compared to granular. Thus allows the right amount of material to be used for light storms.
Reduced corrosion effects	Some experts have found that during-storm DLA has reduced corrosive effects on vehicles because of dilution compared to “undiluted” (ie granular) chemical on vehicles.
Leverage proven benefits of liquids	Leverage proven benefits of liquids (pre-storm and pre-wetting granular)
Notes	
1) Extends the concept (benefit) of pre-treatment through the storm	





Clear Roads Project

- Identifying the Parameters for Effective Implementation of Liquid-Only Plow Routes
 - Project Results cont –
 - Primary hurdles to overcome for successful implementation
 - Employee and management buy-in
 - Equipment Considerations
 - Slide-in Units
 - Combination Units
 - Liquid Only Snowplows
 - Liquid Only Applicators
 - Tankers
 - Quick Reference Guide
 - New Research – Training video to implement Liquid Only Plow Routes





Clear Roads Project

- Quick Reference Guide – Attached Quick Reference Guide for Direct Liquid Applications (DLA); A printed copy is available for you, and Can be found at: [WisDOT-0092-10-18-Quick-Reference-Guide](#)



Quick Reference Guide

During-Storm Direct Liquid Applications (DLA)
A New Tool for the Winter Maintenance Toolbox

For Clear Roads by EVS
9/17/2010

DLA Rules-of-Thumb

Parameter	Most Favorable For DLA	Consider DLA	Notes
Pavement Temperature ¹	25°F or above	20°F or above	
Storm Intensity (inches/hour)	0.5 inches/hour or below	1.0 inches/hour or below	
Moisture Content	Ordinary	Dryer Snowfall	Dry/powder snow - consider plow only Wet snow – can dilute chemical quickly “Ordinary” approx. 10:1 snow/liquid ratio

Notes:

- 1) Consider temperature trends (increasing/decreasing temperatures)
- 2) Note that these are *rules-of-thumb*. In practice, all parameters will have to be considered together along with other factors such as traffic, equipment availability, timing, etc.
- 3) 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. As cycle times increase, supplementing DLA with direct granular should be considered. Also, caution should be used if you are depending on a short cycle time for this parameter because of variations due to slow moving traffic, liquid loading, etc.



Clear Roads Project

- Training Video for Implementation of Liquid-Only Plow Routes
 - January 2017 to June 2018
 - Participating Agencies
 - Minnesota DOT
 - Clear Roads Technical Advisory Committee
 - Problem and Goal
 - Varying degrees of success with Liquid Only Plow Routes throughout DOT agencies;
 - Unable to secure the Buy-In needed to implement this practice;
 - Create Video to Improve communication and accelerate implementation of Liquid-Only Plow Routes.





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Clear Roads Project

- Start-Up Reference Guide (page one)
- Benefits of Liquid Roadway Treatments
- Definitions



Liquid Roadway Treatments Start-Up Reference Guide

For Clear Roads by Stonebrooke Engineering
08/28/2017

Benefits of Liquid Roadway Treatments

Liquid roadway treatments are:

- **Responsive:** Liquid treatments begin working immediately
- **Reliable:** Liquids work predictably and accurately
- **Straightforward:** Liquids are easy to control and apply
- **Effective:** Liquid treatments stick to the road better than solids
- **Efficient:** Reload times can be shorter for liquids than solids, depending on pump capacity
- **Controlled:** There is less waste with liquids due to the bounce rate of solids
- **Economical:** Most agencies decrease their salt usage by 25-50%



Definitions

- **Anti-Icing:** A proactive treatment (sometimes called pretreatment) that involves the application of a liquid treatment prior to the onset of a snow event that prevents snow and ice from bonding to the road surface.
- **De-Icing:** A reactive treatment for melting existing snow and ice from a surface, either as a treatment by itself, or to aid in mechanical removal.
- **Direct Liquid Application (DLA):** The use of liquid-only treatments before, during, and after a storm event for anti-icing and de-icing.
- **Liquid-Only Plow Route:** A plow route on which only liquid treatments are used for anti-icing and de-icing when weather conditions fall within appropriate usage parameters.
- **Salt Brine:** A solution comprised of 23.3% sodium chloride (NaCl) and 76.7% water by weight.
- **Magnesium Chloride:** A solution comprised of magnesium chloride (MgCl) and water (ratio varies).
- **Calcium Chloride:** A solution comprised of calcium chloride (CaCl₂) and water (ratio varies).
- **Granular:** Rock salt in solid form.





Clear Roads Project

- Start-Up Reference Guide (page two)
- Tips for Gaining Buy-In
- Equipment Recommendations

Tips for Gaining Buy-In

- **Start Slowly:** Consider supplementing existing granular applications with liquids. As success is observed and confidence increases, expand the liquid program and reduce granular rates.
- **Visit Other Shops:** Visiting facilities that already have a successful liquid program can accelerate team buy-in.
- **Partner:** If you do not have a brine maker, consider purchasing brine from a nearby agency while you start your program.
- **Contact Experts:** Utilize online resources to get contact information for liquid treatment experts, including the Clear Roads website at www.clearroads.org
- **Utilize Existing Equipment:** Consider converting or upgrading existing equipment to save on up-front costs.
- **Communicate Effectively:** Keep your team informed of all lessons learned, challenges, and success stories as you test the products. Keeping your team involved in the program can help turn critics into advocates
- **Know the Limitations:** Remember that liquid roadway treatments are just one tool in the toolbox, and they are only effective during certain weather conditions.



Equipment Recommendations

- **Applicator Loading Pump:** This pump will be pumping chemicals, so make sure it is designed for a specific gravity of approximately 1.5 (not a water pump). The minimum port size is 2", but many agencies prefer a 3" size for faster flow rates. The minimum flow rate should be 110 gallons per minute (gpm) at 20 psi. A preferred flow rate is 275 gpm at 20 psi. The discharge hose length should be as short as possible. When choosing the port size, consider the applicator tank inflow line size, outflow line size, and valve sizes. These should match the pump capacity. Most liquid delcers are corrosive, so you will need to select a pump that can resist corrosion. Rock salt also contains stone particles that can cause excessive wear on pump parts, which should be considered when selecting your equipment.
- **Applicator Discharge Pump and Plumbing:** Heavier snowfall with lower temperatures typically requires high application rates. Larger pumps will increase your speed and efficiency. The actual size will depend on your applicator spread width. In one case, an agency suggested 370 gpm pumps for agencies with heavy usage.
- **Applicator Spray Bars:** Spray bars either mount to the tank, the pump, a slide-in bar, or are attached to the truck like a hitch receiver. Many varieties are available, including single, two-lane, and three-lane assemblies.
- **Storage Tanks:** Storage tank size and material will vary, but most agencies have a minimum tank size of 5,000 gallons. The most common types are polyethylene or fiberglass vertical storage tanks. Before choosing a tank, check with your local environmental control agency to determine what your state requires for containment.
- **Loading Area:** Design your loading set-up to be as user-friendly as possible. This will help gain buy-in among the entire team, and will result in a more efficient operation. The number of pumps required for loading will vary depending on your number of trucks using liquids.





Clear Roads Project

- Technical Reference Guide (page one)
- Definitions
- Usage Parameters



Liquid Roadway Treatments Technical Reference Guide

For Clear Roads by Stonebrooke Engineering
09/12/2017

Definitions

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Usage Parameters

Table 1: Recommended Anti-Icing Parameters Prior to a Storm Event

Parameter	Salt Brine	Magnesium Chloride	Calcium Chloride
Pavement Temperature ¹	15°F or above	0°F or above ²	0°F or above ²
Time Remaining Until Storm	Within 24 hours ³	Within 48 hours ³	Within 48 hours ³
Precipitation	None ⁴	None ⁴	None ⁴

Notes:

1. Consider temperature trends (increasing/decreasing temperatures)
2. Additives are available can reduce the freezing point of magnesium chloride. Magnesium chloride and calcium chloride are not recommended at pavement temperatures above 40°. Work with vendors to verify temperatures.
3. Applying anti-icing closer to the storm reduces the chances of traffic pushing the treatment off the roadway.
4. Rainfall prior to a snow storm event dilutes liquid applications, which reduces their effectiveness

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

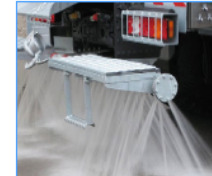


Clear Roads Project

- Technical Reference Guide (page two)
- Direct Liquid Application Rates & Cycle Times
- General Tips

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 includes the time needed to refill the truck tanks and the "dead head" time to the treatment route. As cycle times increase, supplementing liquids with direct 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)

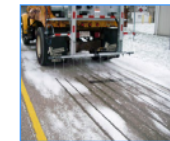
Event Type	Pavement Temperature			
	32-30°F	29-27°F	26-24°F	23-15°F
For 2-Hour (or less) Cycle Times				
Light Snow (less than 0.5 inch/hour)	20 gplm	35 gplm	40 gplm	55 gplm
Medium Snow (0.5 to 1.0 inch/hour) ¹	35 gplm	45 gplm	55 gplm	Not Recommended
For 3-Hour Cycle Times²				
Light Snow (less than 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.

General Tips

- Supplementing liquid treatments with granular can achieve a "best of both worlds" solution by producing the full road liquid coating (to prevent bonding), some traction (granular), and also allowing the granular to slow down the dilution of the liquid treatment.
- If the storm is severe, consider using only mechanical snow removal until the severity lessens, and then resume liquid treatments.
- Liquid treatments can be used on hard packed snow to loosen it for plowing.
- Magnesium chloride and calcium chloride are typically 2-5 times the cost of brine, depending on location and vendor. The application rates of magnesium chloride and calcium chloride are typically 30% lower than salt brine.





CDOT History

History of Liquid Deicers

- In winter of 1988-1990, CDOT began using mag chloride in Glenwood Canyon to avoid using sodium chloride.
- In the early 1990's, use expanded to the Denver Metro area to reduce air pollution caused by sand.
- In the winter of 1995-96, CDOT started using mag chloride on I-70 after 42 long-term road closures occurred the previous year.





CDOT History

Additional Positives using Liquid Deicers:

❖ Mobility

❖ Safety

❖ Air Quality

❖ Water Quality

❖ Cost Benefits





CDOT History

Why Use Liquid Deicers

- Excessive sand use contributed to poor air quality in Denver area...called “The Brown Cloud effect”.
 - In the 1080’s EPA cited PM-10 violation (Particulate Matter)
 - Passed Regulation 16 to reduce amount of sand used on the roads in 1989





CDOT History

Additional Positives using Liquid Deicers:

- ❖ Air Quality – Studies by CDPHE establish acceptable PM Level





CDOT History

Additional Positives using Liquid Deicers:

- ❖ Air Quality – NOT





CDOT History

In Colorado, using Liquid Deicer Products results in:

- Decrease in salt/sand applied to roads:
 - CDOT has reduced its sand use by an average of 50% on I70;
- Sediment from sand in streams has been significantly reduced over time
- Fewer cracked windshields and chipped paint on vehicles
- Statewide decrease in number of accidents due to snow and ice



After One Season







CDOT Present

Colorado, using Liquid Deicer Products results in:

- Use liquid and granular products for anti-icing and de-icing
- All products must be on the Colorado Approved Product List (APL)
- Granular Products
 - DriRox (Compass Minerals) – brining salt (8A-B), road salt (8A-R)
 - Kiln Dry Medium (SaltWorx, LLC) – road salt (8C-R)
 - Rocanville Standard (GMCO) – road salt (8C-R)
 - Ice Slicer RS (Envirotech) – wet salt(8B)
 - IceKicker (SaltWorx, LLC) – wet salt (8B)
 - Qwik Salt (Compass Minerals) – wet salt (8B)
 - Rapid Thaw (GMCO) – wet salt (8B)





CDOT Present

Colorado, using Liquid Deicer Products results in:

- Liquid Products
 - Ice Ban 305 (GMCO) – liquid mag (Cat 1)
 - Meltdown APEX (Envirotech) – liquid mag (Cat 1)
 - Meltdown Inhibited (Envirotech) – liquid mag (Cat 1)
 - Nex Gen Torch (GMCO) – liquid mag (Cat 1)
- Corrosion Inhibitor
 - Sheild GLT Plus (Paradigm Group) – brine inhibitor (A-1)
 - AMP (Envirotech) – brine inhibitor (A-3)

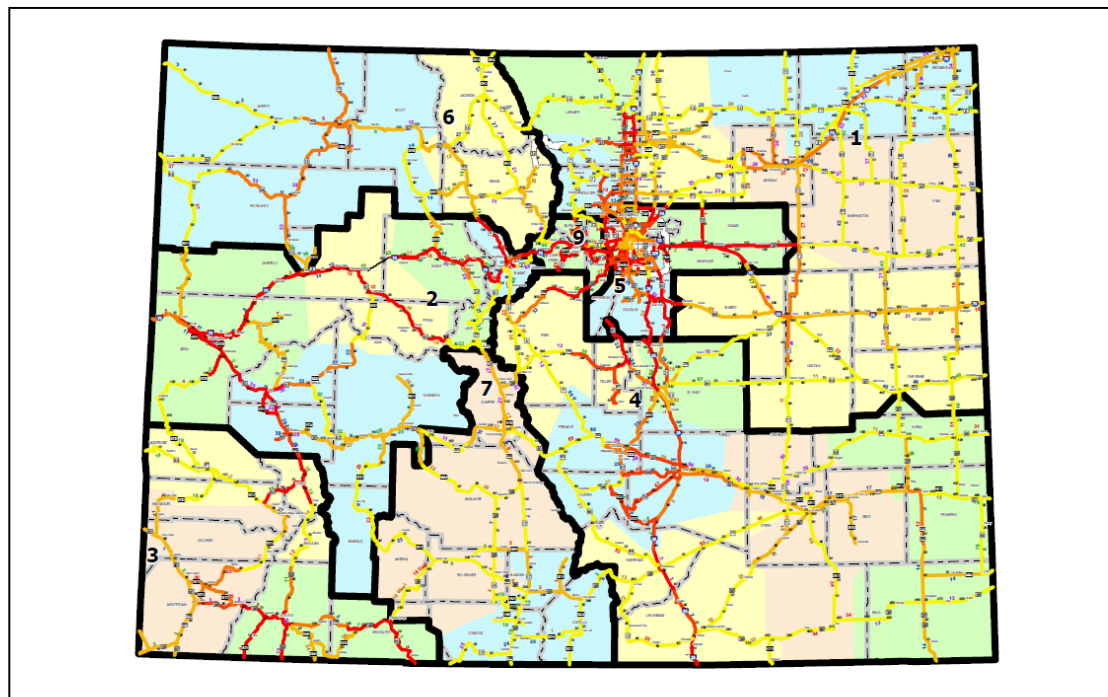




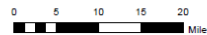
CDOT Present

Colorado Liquid Routes - usage

Statewide Historic Liquid Material Usage



The information contained in this map is based on the most currently available data and has been checked for accuracy. CDOT does not guarantee the accuracy of any information presented, is not liable in any respect for any errors or omissions, and is not responsible for determining "fitness for use".

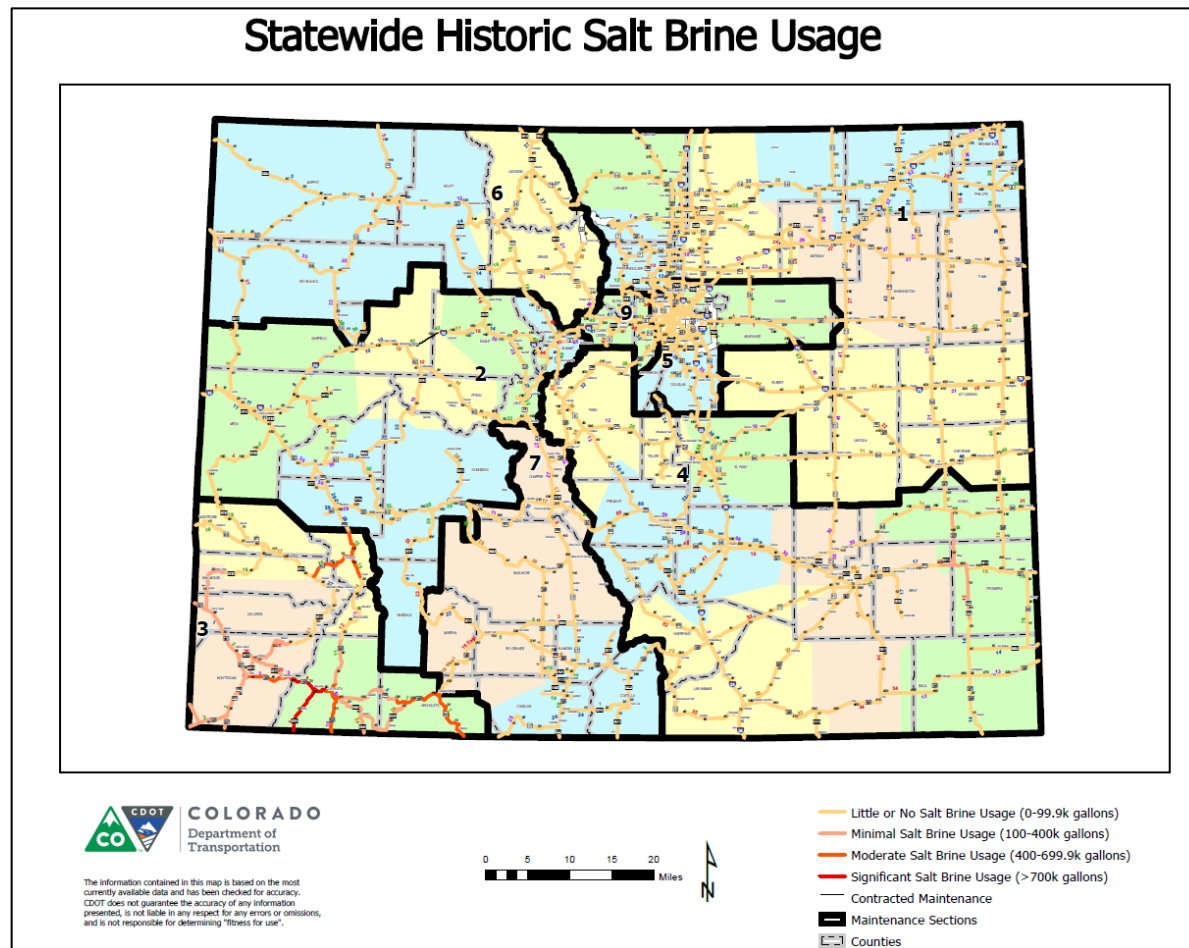


- Significantly Below Average Usage (<24%)
- Below Average Usage (25 - 74%)
- Average Usage (75 - 125%)
- Above Average Usage (126-175%)
- Significantly Above Average Usage (>175%)
- Contracted Maintenance
- Maintenance Sections
- Counties



CDOT Present

Colorado NaCl Brine Routes - usage

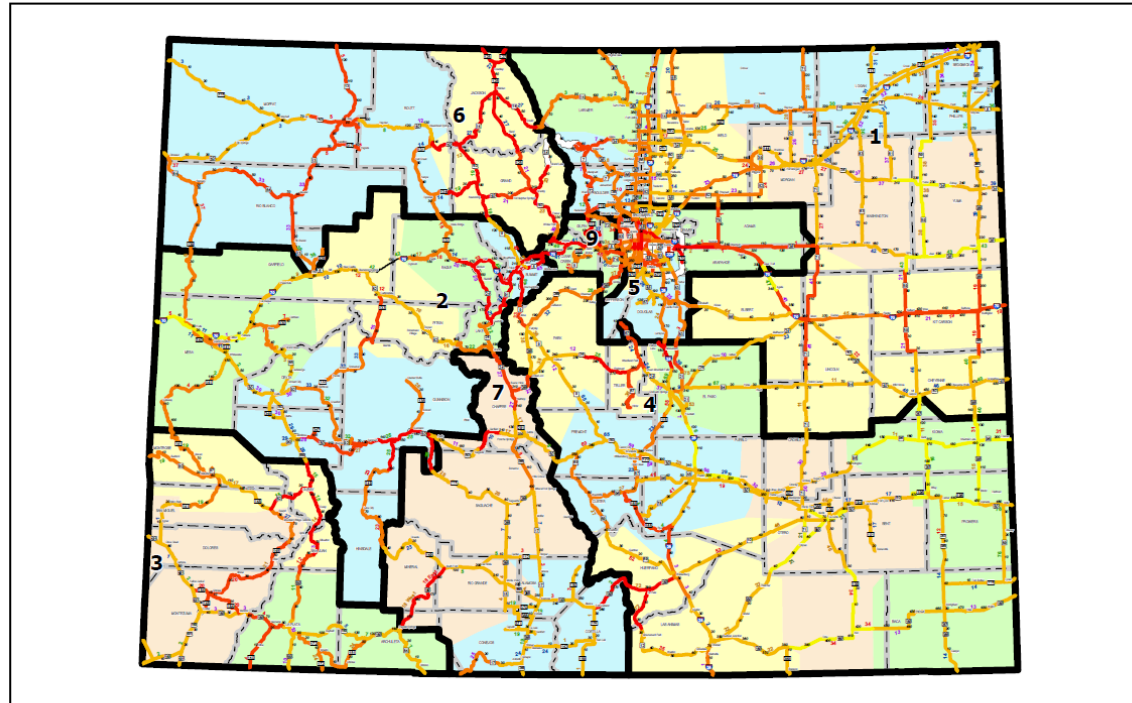




CDOT Present

Colorado Granular Routes - usage

Statewide Historic Solid Material Usage



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- Below Average Usage (25 - 74%)
- Average Usage (75 - 125%)
- Above Average Usage (126-175%)
- Significantly Above Average Usage (>175%)
- Contracted Maintenance
- Maintenance Sections
- Counties





CDOT Present

Colorado – Jeff can discuss his experience with liquid deicers, his role with the first report DLA and experience, maybe add a couple of slides here





CDOT Future

Colorado – Where are we going with winter maintenance





CDOT Future

TOW PLOWS – New snow-clearing equipment





CDOT Future

TOW PLOWS Cover more than twice the width of a traditional snow plow



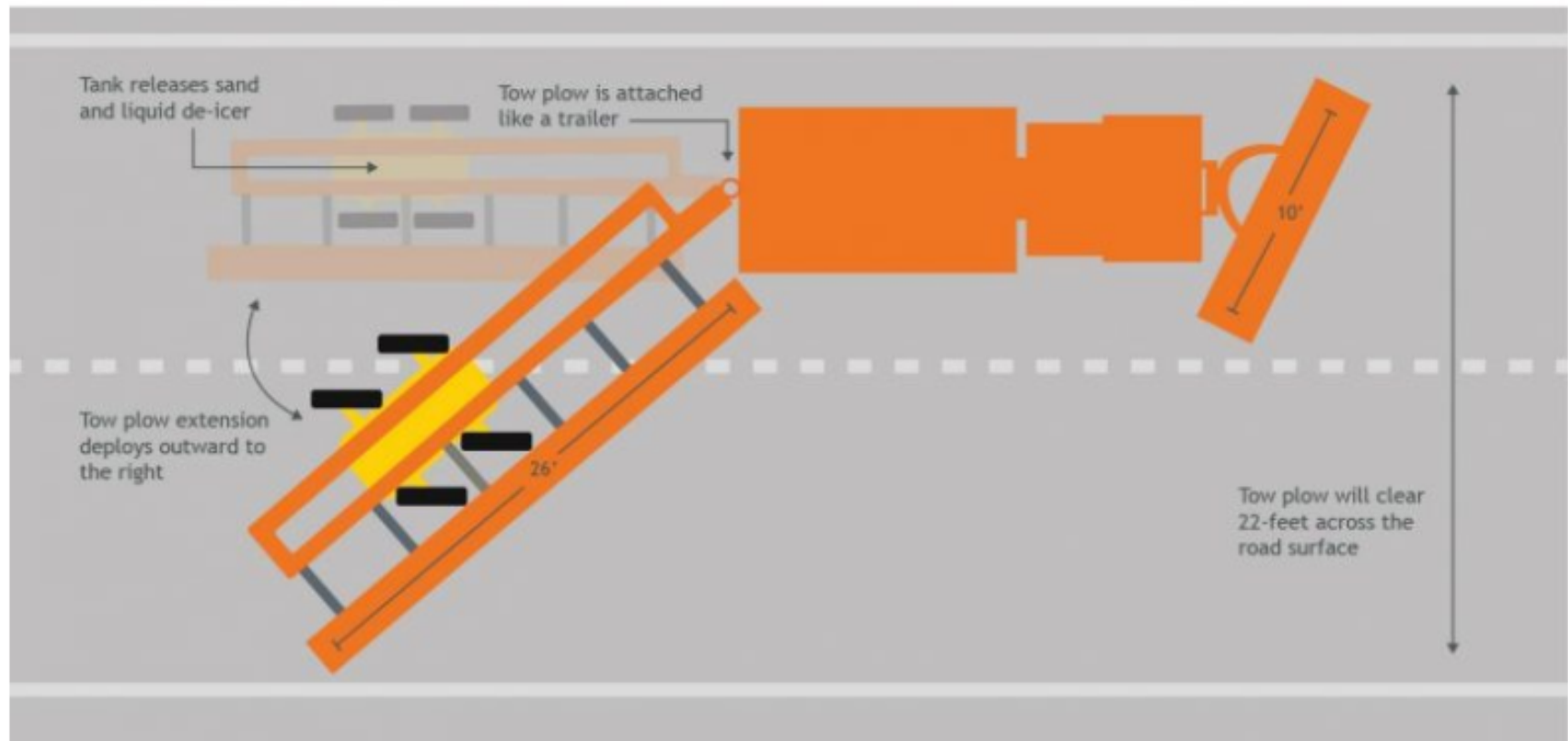


CDOT Future

TOW PLOW Will Clear 22 feet across the road surface



Tow Plow





CDOT Future

TOW PLOWS – Truck and Trailer combined are 70 feet long



TRULY, BOW TO THE PLOW....



Additional DOT's Tow Plow

Tow Plow is here at the conference...take a look..





