LSiD™
Low Salt Solutions

Low Salt Design Guide

A guide to winter infrastructure design

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Low Salt Design Guide

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Disclosure

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Introduction

Low Salt Design has emerged to solve a problem and answer the question: how do we reduce the need for salt in winter maintenance? In cold climates, we are highly dependent on salt to improve winter pavement performance. Through changing our design approach, we can envision safer winter infrastructure that boasts faster pavement recovery and better control of blowing snow and meltwater sprawl. By considering winter in the design process as an equal partner to spring, summer, and fall, we have found an exciting new path forward — Low Salt Design.

Low Salt Solutions

Low Salt Solutions (LSiD™), an umbrella program housing Low Salt Design, was trademarked by Bolton & Menk, Inc. in 2022.

We hope Low Salt Design will improve the performance of our infrastructure throughout all four seasons. We trust the design team to use their best judgment on when and how to recommend Low Salt Design in cold climate projects, based on all requirements and performance goals influencing project design.

Learning from Winter Maintenance Professionals

Ask any winter maintenance professional what the five problem areas are on their route, and they can tell you. For decades, we have been teaching plow drivers how to integrate science into their industry to drive down the need for salt. For years, plow drivers have been telling us it's impossible to tackle this problem alone. We all acknowledge that winter maintenance professionals can improve their practices, but more importantly, the designed and built world needs to work *for them* in the winter, rather than *against them*. After listening to over 20,000 plow driver's challenges, we realize the answer, or at least part of the answer, lies in improved infrastructure design.

Learning from Civil Engineers and Design Teams

In 2022, Bolton & Menk acquired Fortin Consulting and since then, we have had the opportunity to bring advice from the winter maintenance industry to civil engineers, landscape architects, water resource professionals, CAD experts, technicians, and beyond. Typical designs rarely require any standards for winter performance. For example, designs may minimize the potential for ponding water and manage this risk, but sprawling meltwater was not a consideration. Stormwater designers are conditioned to find a way to treat and remove a pollutant, not prevent a pollutant.

Chloride source reduction goals for pollution prevention do not appear in design criteria. As a result of these discussions, we realized we had an opportunity to improve designs, and Low Salt Design emerged. Low Salt Design offers a set of winter considerations that, when integrated into design, will boost winter safety and drive down the need for salt.

The Need for Change

The reliance on deicers has skyrocketed to meet public demand for dry winter pavements. Years ago, people were comfortable driving slower, staying home on snowy days, putting snow tires on their vehicles, or wearing snow boots to get around. Today, many expect the commute to be the same in January as it is in July. Each year, Minnesota imports over 100 million dollars of salt for just city, county, and state operations. The private sector also uses salt. Chloride, specifically found in road salt, is a top pollutant of concern in Minnesota and in most cold climate regions and impacts the environment in the following ways:

- Every teaspoon of salt permanently pollutes about 5 gallons of water.
    - To the EPA aquatic life chronic cl standard of 230 mg/l.

    - To the drinking water cl standard of 250 mg/l.
- Every ton of salt applied creates infrastructure damage.
    - Costs to repair damages range from $1,700 – $17,000, as presented in the MPCA Smart Salting for Roads Manual. Rates are adjusted for inflation based off the 2014 report on The Real Cost of Salt Use for Winter Maintenance in the Twin Cities Metropolitan Area.
- Salt harms soil, vegetation, and wildlife.

The Minnesota Pollution Control Agency has integrated chloride reduction/awareness into:

- Twin Cities Metropolitan Area Chloride Management Plan
- Minnesota Statewide Chloride Management Plan
- MS4 General Permit

Benefits of Low Salt Design

As we design our saltable surfaces to perform better in the winter, they become safer and drive down the need for salt. Driving down the need for salt offers many benefits as described in Figure 1.

Figure 1. Benefits of Low Salt Design

Low Salt Design Goals

Low Salt Design creates safer winter surfaces. At the highest level, low salt design aims to improve winter pavement recovery and reduce the amount and frequency of blowing snow and meltwater that return to saltable surfaces.

Improve Winter Pavement Performance & Pavement Recovery

Pavement performance refers to how the pavement can provide good traction even under the stress of cold temperatures, snow, or freezing rain. Pavement recovery refers to how fast a saltable surface can recover from snow or freezing rain. Winter maintenance operations are geared up to do two things: 1) remove the snow and 2) melt the residual snow/ice with deicers.

From an infrastructure design perspective, we can improve performance by capitalizing on free resources: the sun and wind. We want to be mindful of topography and conveyances that influence the routing of meltwater. Consider pavement alternatives for those tough win situations. In general, we aim to speed up recovery of pavement friction. We believe our improved designs will achieve winter safety earlier, with less effort and less chemicals.

Stop Repeat Offenders

Winter maintenance professionals have the job of clearing the pavements, designers should prevent the snow or meltwater from returning to the pavements. The two big repeat offenders are meltwater sprawl and blowing snow.

Meltwater Sprawl

Thaw/freeze events are where meltwater sprawl and refreeze occur. The Twin Cities Metro Area gets about forty-eight of these events each winter, likely more if we consider pavement temperatures.

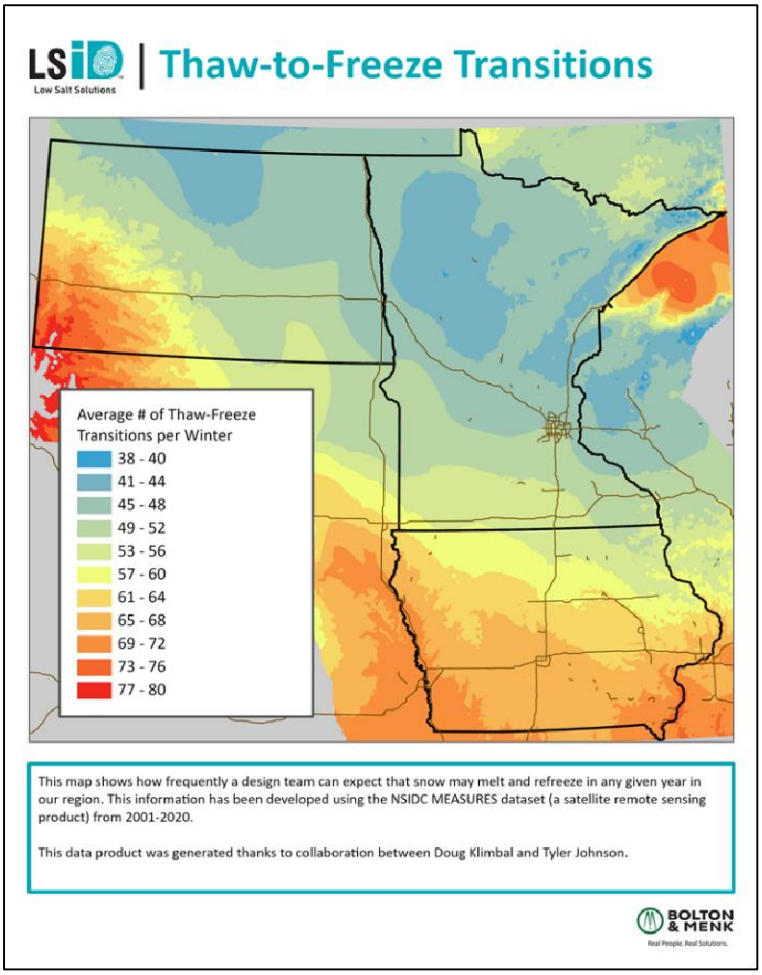

Figure 2. Thaw-to-Freeze Transitions

In Minnesota, statewide there are 38-60 thaw-to-freeze transitions, even more in Iowa, up to 72.

Not all temperature swings cause meltwater sprawl. Meltwater sprawl can only occur when snow is present and when the thawing cycle is long/strong enough.

When meltwater sprawls onto saltable surfaces it will likely refreeze, creating unsafe conditions and require salting. Meltwater sprawl can be reduced, and or eliminated through Low Salt Design.

Climate change is likely altering the number of thaw/freeze events in your area. Meltwater sprawl management can be a tool for climate adaptation.

Figure 3 shows a change in thaw/freeze events in an eighteen-year window.

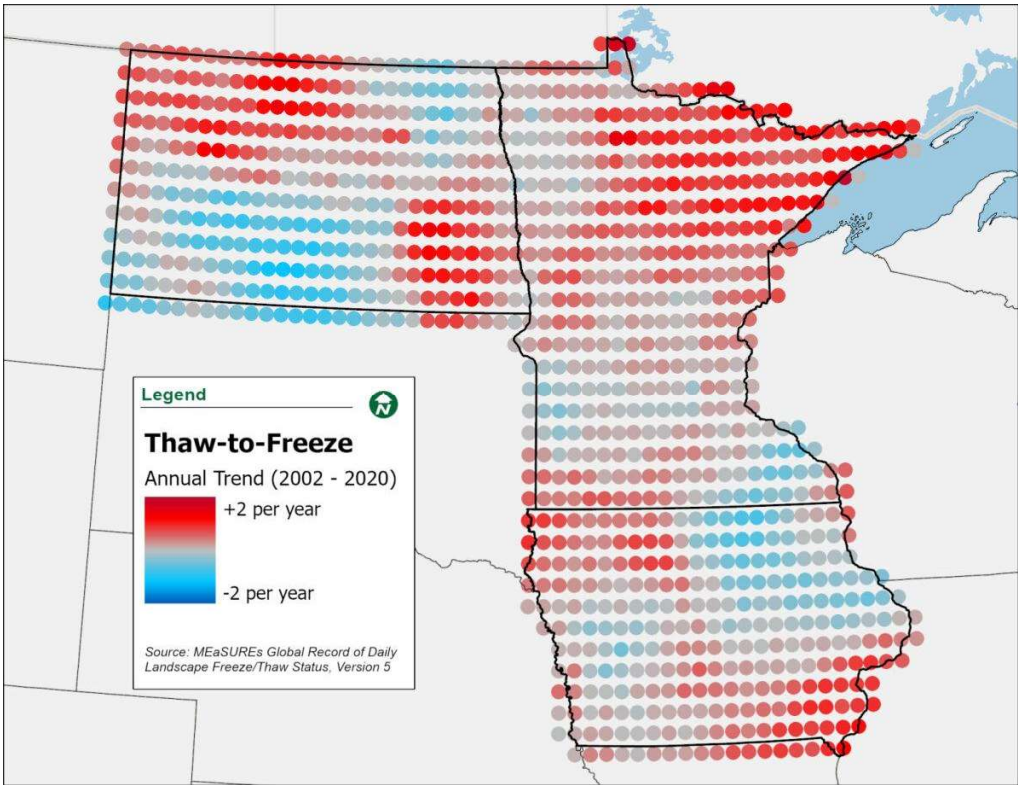

Figure 3. Thaw/Freeze Event Trends

Blowing Snow

We cannot change the type or amount of precipitation that falls from the sky, but we can reduce the amount and/or frequency of snow returning to our pavements. Blowing snow is a repeat offender and the section on Outsmarting the Wind is dedicated to gaining better control of blowing snow.

Apply Low Salt Design to Critical Areas for Best Return on Investment (ROI)

Critical areas are defined by the level of risk, salt, and effort needed to provide safe winter travel. Designing for superior winter performance in critical areas is the fastest way to increase public safety and drive down the need for salt. Critical areas may vary from site to site but are typically locations that require excellent pavement friction. Because of the need for excellent friction, these areas get the most repeat attention from winter maintenance crews. Some common critical areas are:

- ADA routes
- Braking and merging zones
    - Ramps

- Quick freeze areas
    - Bridges
- Shaded low areas
    - Underpasses
- High-speed or high-traffic areas for vehicles and pedestrians
    - Main building entrances
    - Interstates, freeways, and highways
- Significant hills or curves

Identify critical winter safety areas for any cold climate site that is being designed, renovated, or repaired and cross-check whether Low Salt Design strategies have been considered.

Low Salt Design Strategies

There are ten strategies of Low Salt Design detailed in the first release of this guidance. The ten strategies are represented with 8 unique icons as shown in Table 1.

	Use the Sun
	Outsmart the Wind
	Horizontal Drainage
	Vertical Drainage
	Snow Removal Made Easy (Plow Access)
	Snow Storage
	Salt Storage
	Minimize Footprint of Salted Surfaces
	Pavement Alternatives
	Vegetation

Table 1. Low Salt Design Strategies

Integrating the icons from Table 1 into a plan sheet will document Low Salt Design strategies. They are not necessary in a construction plan set but are a useful educational tool to provide awareness. They also provide an easy way to document adherence to MPCA's Statewide Chloride Management Plan or other initiatives requesting chloride reduction action.

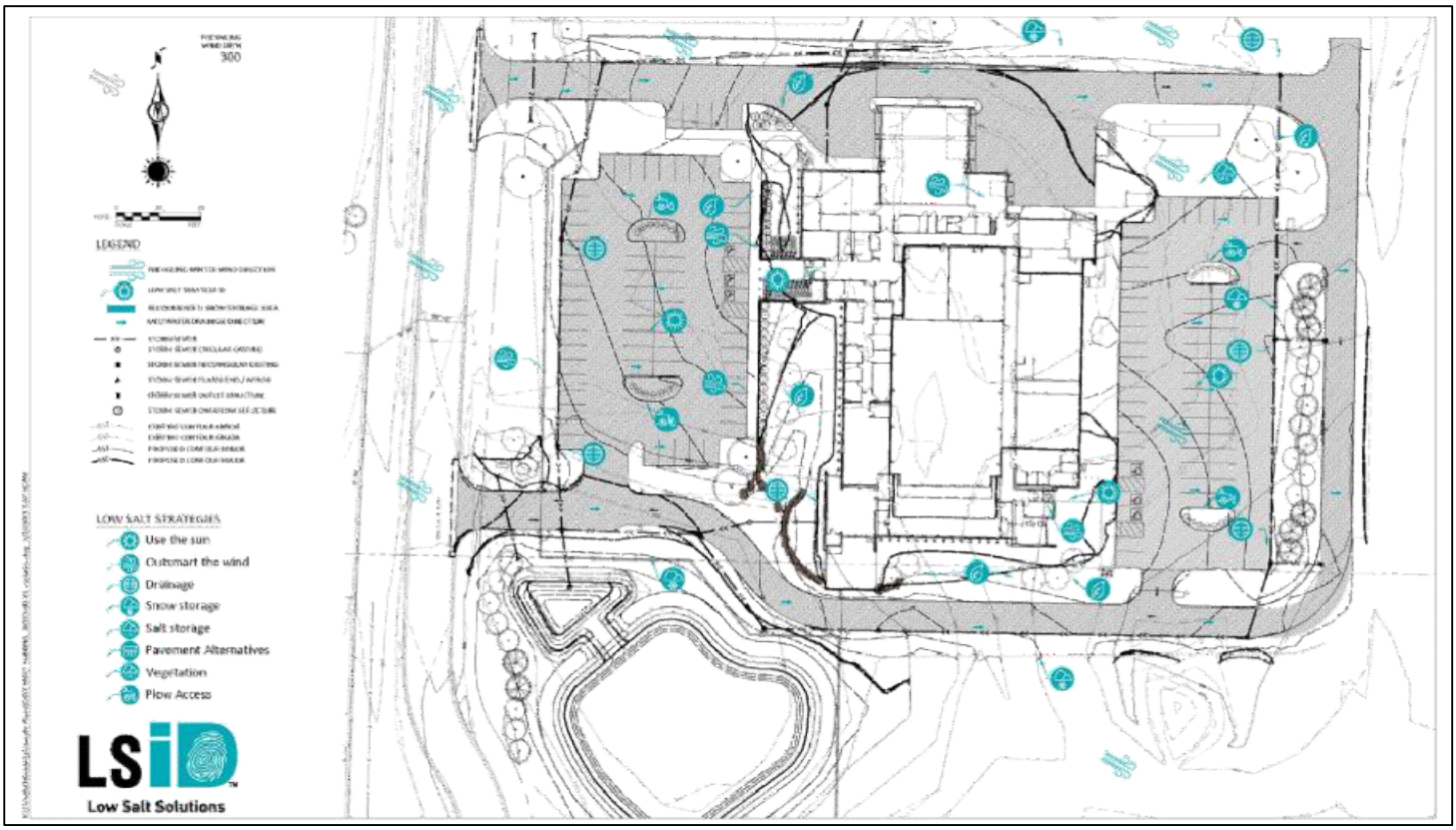

Figure 4. Example Plan Sheet

Use the Sun

The power of the sun to melt snow and ice is our first strategy and has the potential to trump the rest of our strategies. One of the biggest benefits of the sun is that it is FREE!

Position infrastructure so that the sun is directed onto critical areas. Where the sun shines, we use less salt which will create safer surfaces with less maintenance effort.

Take time to do a winter shadow cast evaluation of each site. Think about how many hours during the day the site's critical areas will be in the shade. Areas that are mostly shaded will likely be the more snowy/icy areas. In your design platform, add an image of the sun in the south as a friendly reminder to the designer to consider shading.

Landscape architects, ecologists, foresters, and land care specialists have a strong role to play in using the sun, as illustrated in Figure 5. For all of us concerned with climate change and heat islands, using the sun in the winter should be balanced with using the sun in the summer. As you can see below, we can still have shaded pavement in the summer, yet improve winter pavement recovery in the winter. Deciduous trees provide the double benefit we seek.

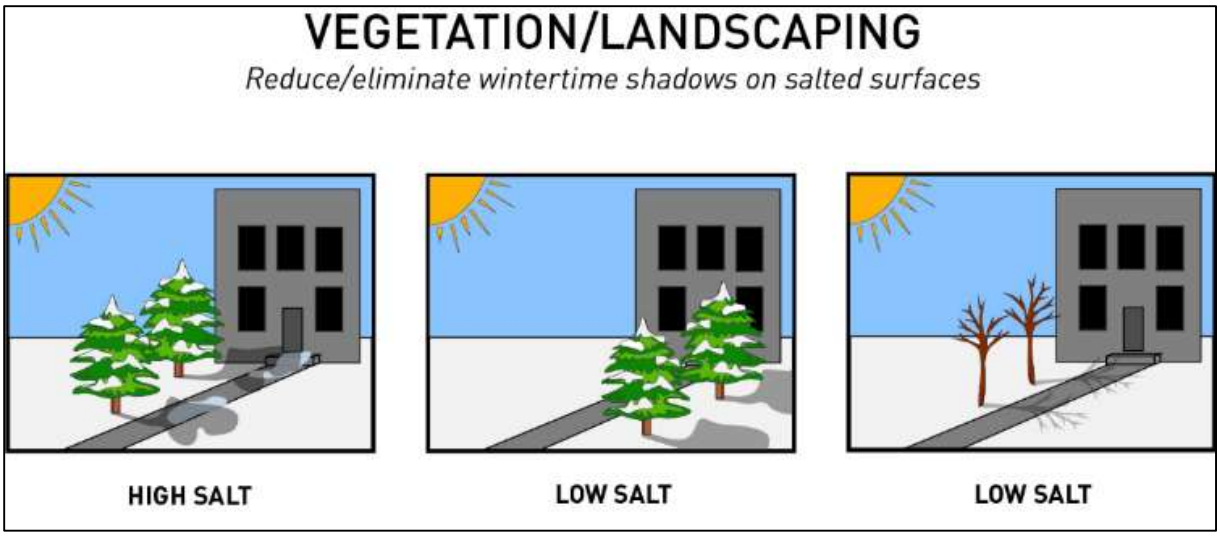

Figure 5. Use the Sun: Vegetation/Landscaping

In Figure 6, upfront cost savings would suggest a shorter bridge, but a slightly higher bridge with the low spot in the sun will be a safer winter underpass, requiring less salt and increasing the life expectancy of the bridge foundation. If we consider the lifecycle cost of this bridge versus the build cost of the bridge, we will discover a different path forward.

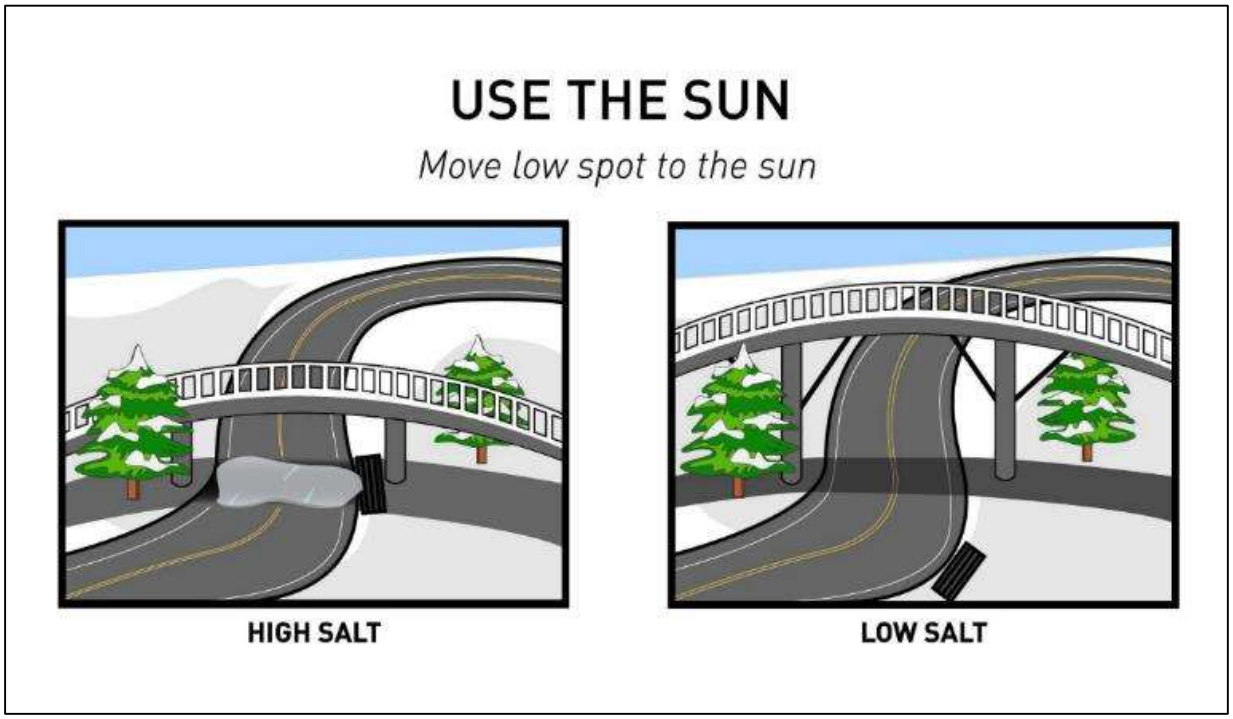

Figure 6. Use the Sun: Move Low Spot to the Sun

Don’t wait — as soon as possible, think about orientation of critical areas to take advantage of the sun. Figures 7 and 8 are a good example of this.

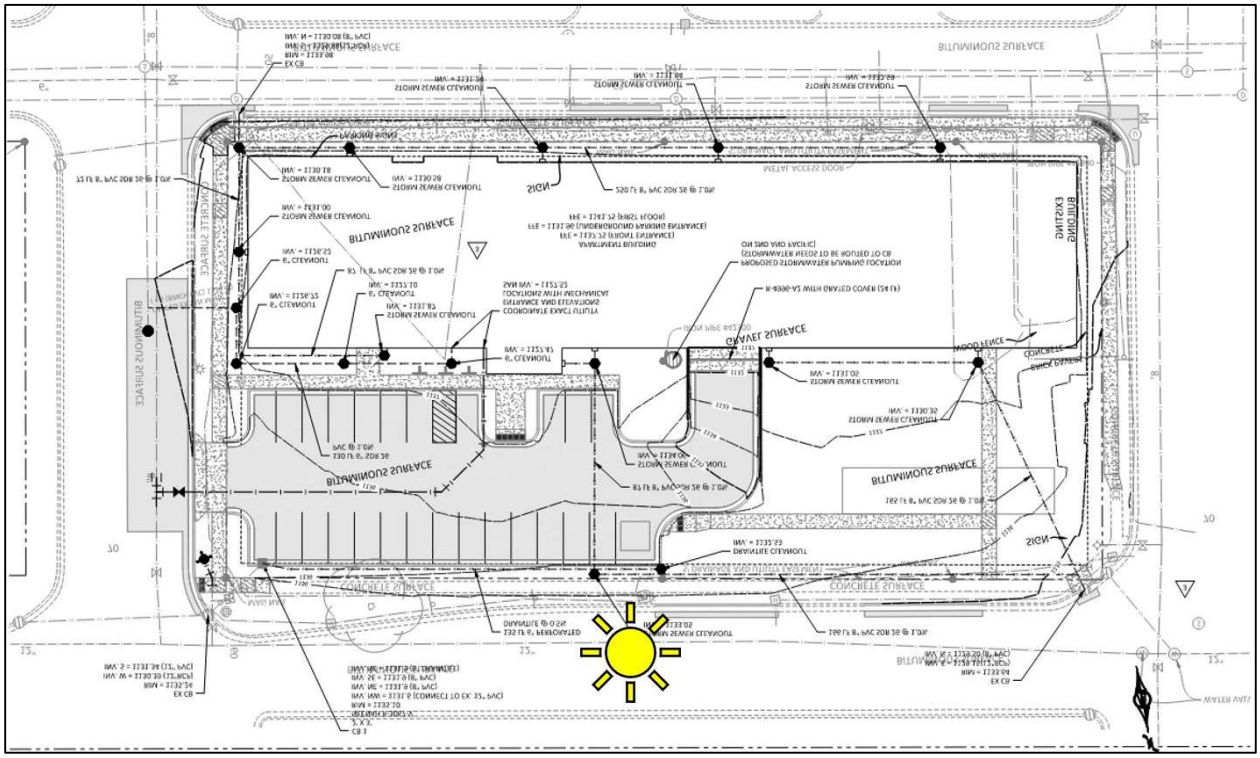

Figure 7. Building Shadow: Low Salt Example

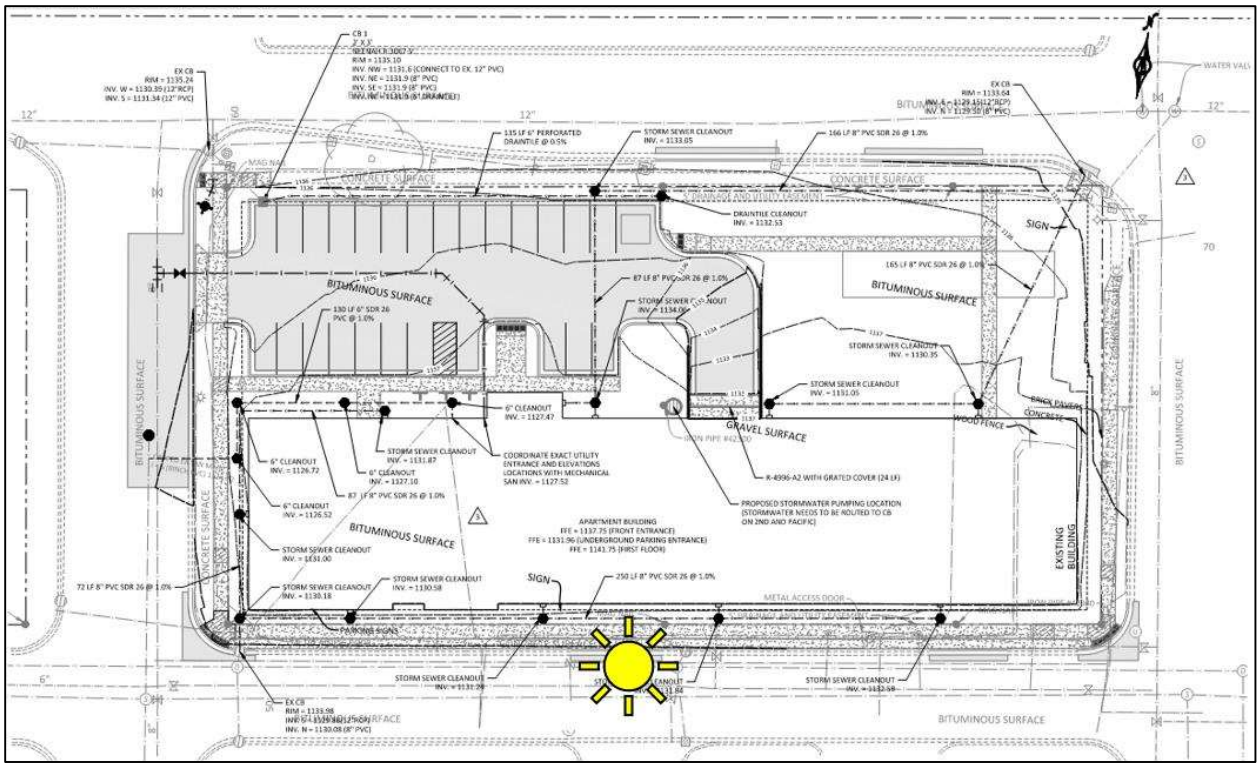

Figure 8. Building Shadow: High Salt Example

Figure 9 shows a very shaded urban corridor (dark color indicates heavy shade). This tells the design team the sun will not be helping us with pavement recovery on the roadways. A different strategy is needed to improve winter safety.

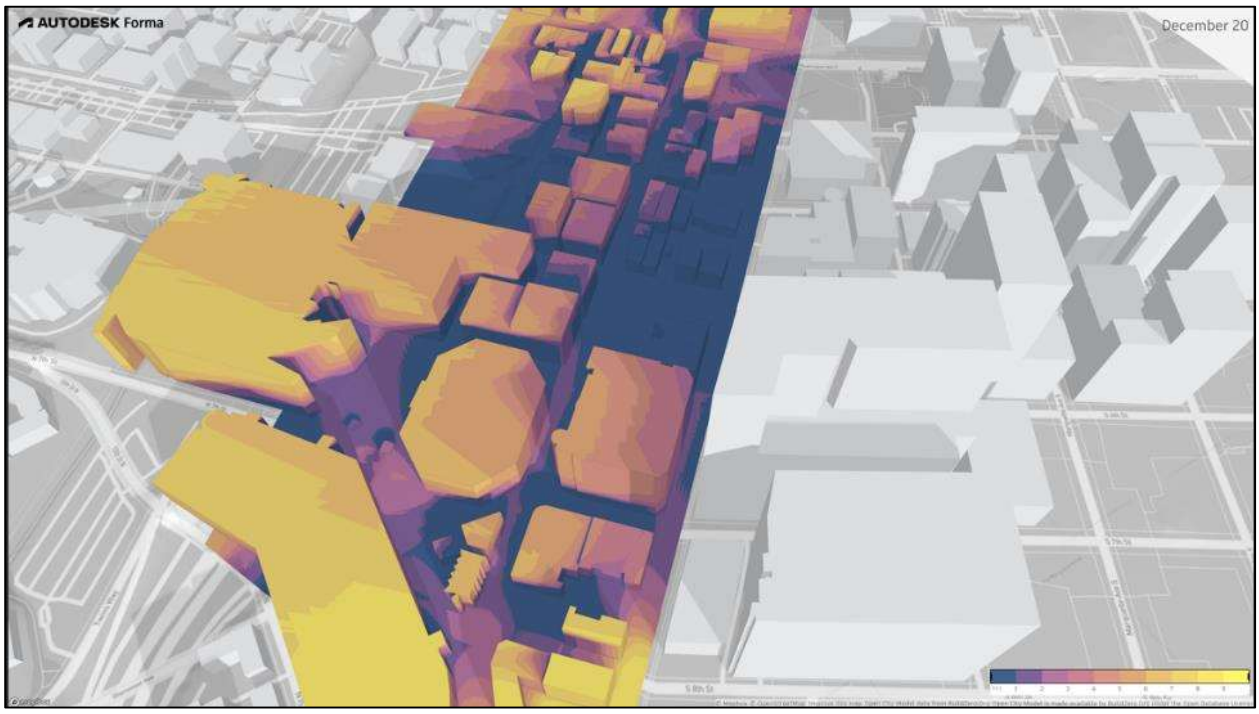

Figure 9. Use the Sun: Shade Analysis

Outsmart the Wind

Be aware of the direction of the prevailing winter wind at each site. For most of Minnesota, the winter wind blows from the Northwest. Prevailing winter winds may be different than prevailing summer winds. Show the winter wind direction in the design platform as a reminder to the designer to take advantage of the wind in design.

Wind is a major consideration in farming areas, near open water, wetlands, and prairies. It is also a factor in urban and suburban areas, around golf courses, athletic fields, and lakes.

Figure 10 illustrates the direction of the winter wind through arrows and hours of winter wind strong enough to displace resting snow through shading. If the site is being designed in any of the orange areas, make sure to give extra attention to outsmarting the wind.

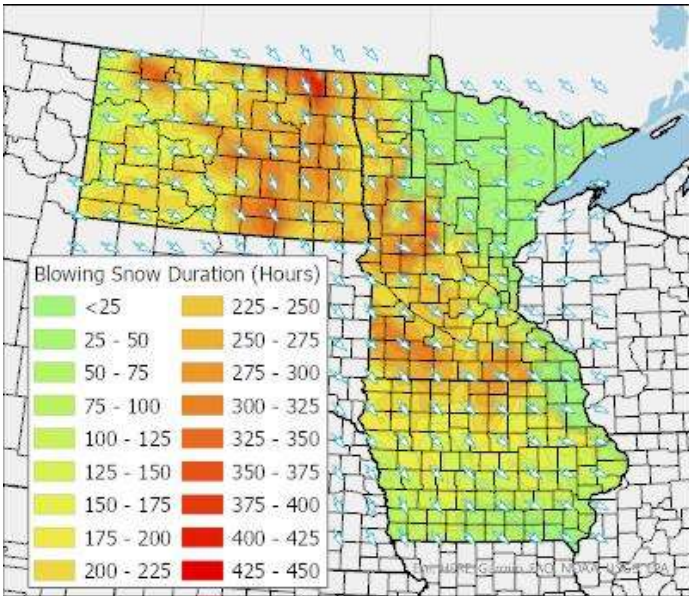

Figure 10. Prevailing Blowing Wind Directions Across MN, ND, and IA

Wind fetch is the distance the wind travels uninterrupted. If the fetch is greater than 1000 feet and if the site is in a snowy and windy area, it is time to outsmart the wind. Wind can be even trickier as it travels and bends around buildings and obstacles in urban corridors. Mapping the wind and snow drop will provide design insight.

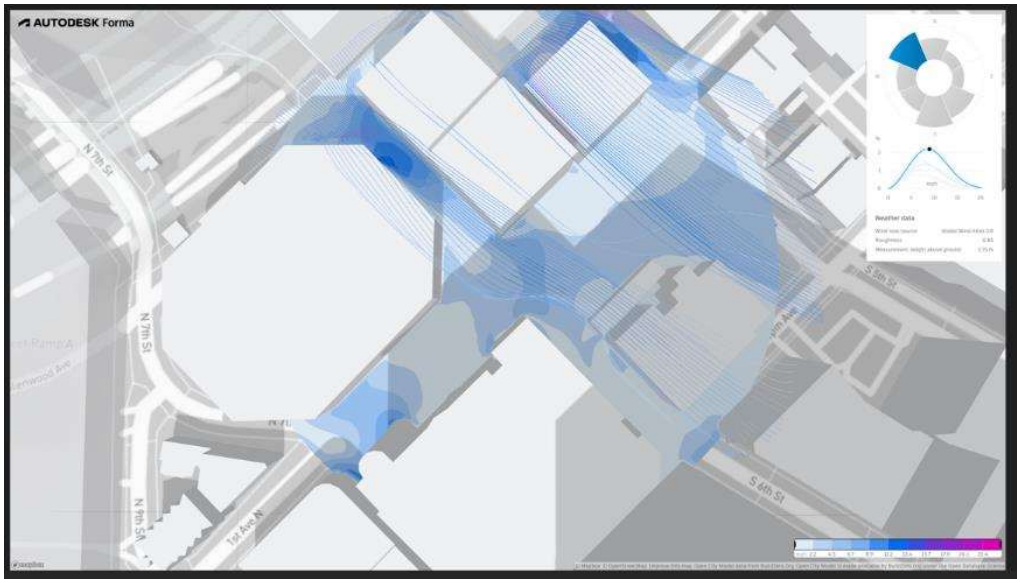

Figure 11. Outsmart the Wind: Wind Mapping

If we can outsmart the wind and direct snow deposit where we want it, we can reduce the effort needed by winter maintenance crews and thus salt use. The most common blowing snow control strategies are snow fence or drift-free road and ditch design. These are used primarily along roadways in rural areas. However, blowing snow control strategies may be useful along stretches of urban or suburban roadways. Often, blowing snow control strategies are not used in site design (i.e. schools, shopping centers, parks), but they should be. We have three basic strategies: create intentional snow fences, remove unintentional snow fences, and integrate other aspects of drift-free road and ditch design.

Intentional Snow Fences

Intentional snow fences intercept the wind and cause it to lose energy and drop the snow before reaching the pavement we intend to protect. Notice the direction of the wind and that the snow drop occurs after the wind loses energy. Designing a setback for the snow drop area will help protect our pavement.

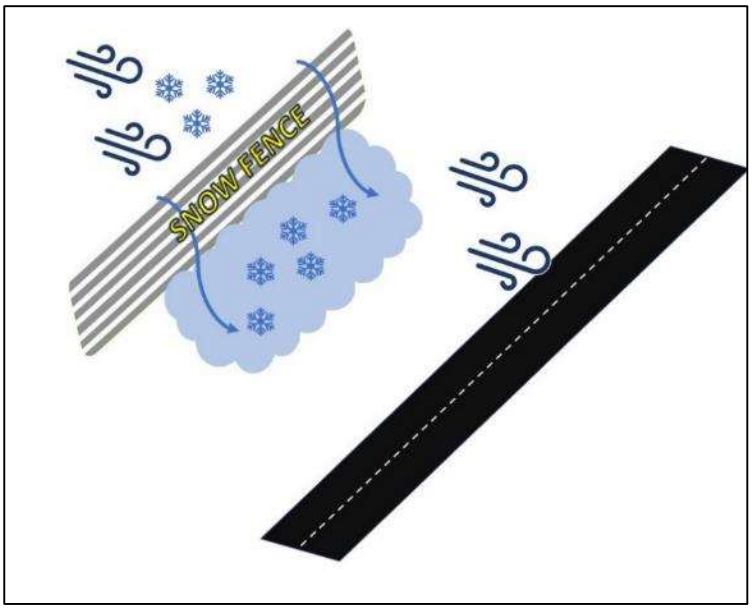

Figure 12. Outsmart the Wind: Intentional Snow Fence

Snow fencing comes in many shapes and forms, from standing row crops to structural or living snow fences. Some strategies provide double benefits:

- Installing solar panels on snow fences produces energy and drifting snow control (see Resources section for solar snow fences).
- Shelter belts outsmart the wind and provide habitat (see Resources section).
- Living snow fences provide beauty and snow control along roadway corridors.

Challenge yourself to outsmart the wind but also harvest as many benefits for the community as feasible in the process. The Minnesota Department of Transportation has excellent design tools for blowing snow control (see Resources section).

Unintentional Snow Fences

Do you have your landscape and park bench on the windward side of your pavement? That may serve as an unintentional snow fence and cause you trouble in the winter. Unintentional snow fences cause energy to be lost and snow to drop where we don't want it. An unintentional snow fence might be the tall grass near the roadway or the landscaping near a parking lot. One reason many mow ditches in the fall is to avoid this unintentional snow fence phenomenon where the roadside vegetation catches the blowing snow and creates a snow drift on the road. Fall maintenance of landscape beds on the windward side of a parking lot or sidewalk would also improve winter safety.

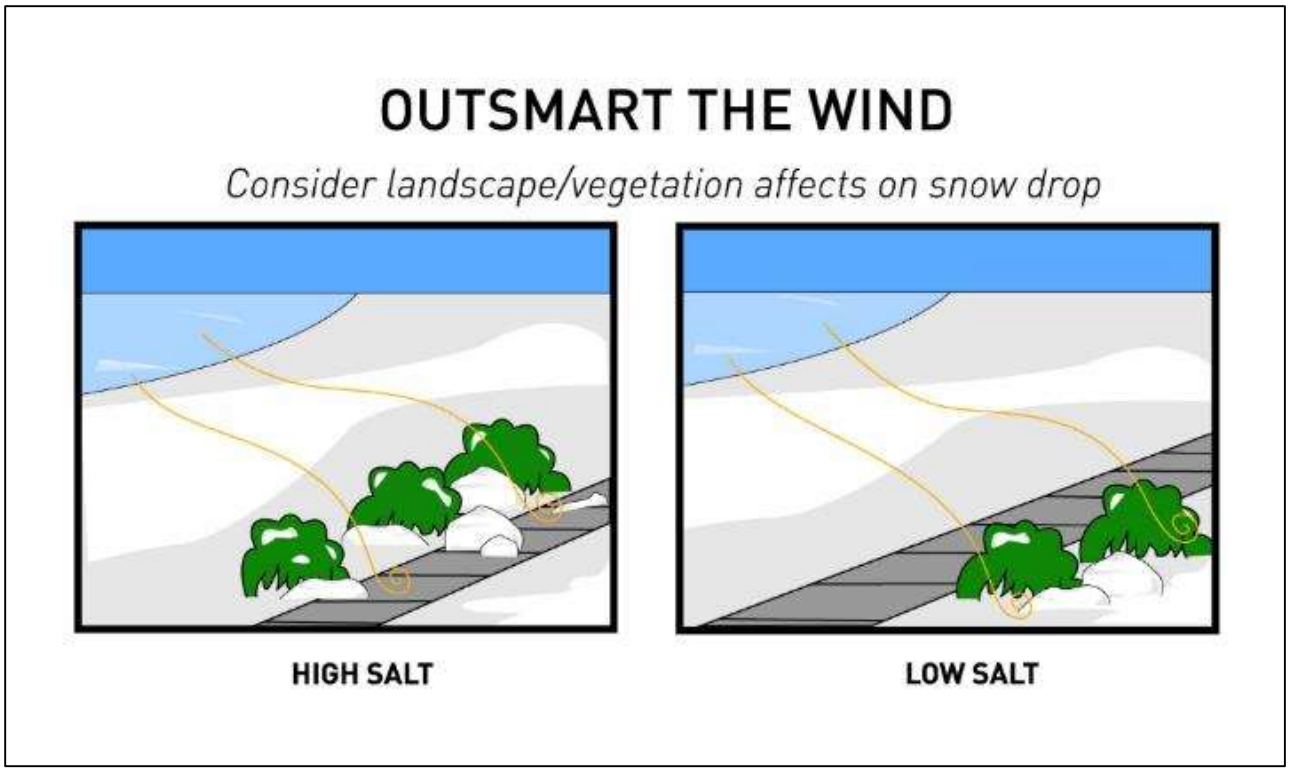

Figure 13. Outsmart the Wind: Unintentional Snow Fence

Drift-Free Road and Ditch Design

Drift-free road and ditch design should be used to take advantage of road and ditch geometry. Consider using the opportunity of new road design to better control blowing and drifting snow (see Resources section).

Horizontal Drainage

Where the meltwater goes, so does the hazard, followed by the salt. Try to eliminate the meltwater footprint on salted surfaces. If it cannot be eliminated, work to reduce the footprint. Design to prevent meltwater from draining into critical areas. Sheet flow is more important to control than ponding, as a winter hazard and salt reduction strategy. To experience this phenomenon for yourselves, visit existing sites on a warm winter day and observe the meltwater sprawl. Notice how much of the saltable surface it covers. Make sure your next design has less meltwater sprawl.

Design the Shortest Path for Meltwater

Intercept meltwater to not let it flow onto a saltable surface. Avoid directing meltwater from a salted sidewalk to a salted parking lot to a salted road. Stop the flow across these salted surfaces.

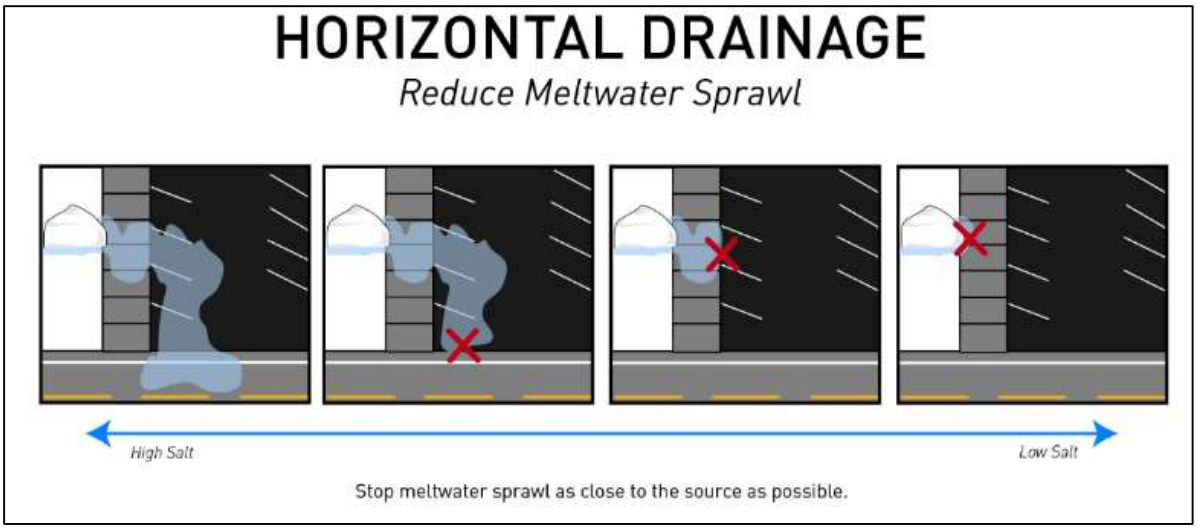

Figure 14. Horizontal Drainage: Intercept Meltwater Sprawl

Figure 15. Horizontal Drainage: Low vs. High Salt Design

The left image of Figure 15 shows meltwater's interception prior to reaching the sidewalk — this is an example of low salt design. The right side of Figure 15 shows no meltwater control, resulting in a high salt design.

With Figure 16, be aware that rain follows the contours of the land much nicer than snowmelt does. Do not be outsmarted by the snowmelt. Count on the need to exaggerate the contours as snow is three-dimensional and the melting and movement of it may not occur at the ground level.

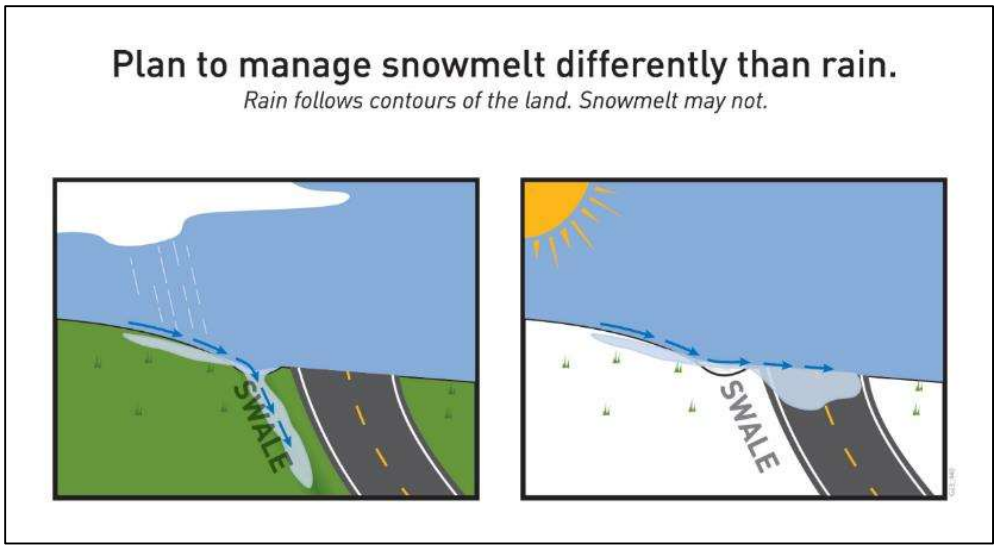

Figure 16. Horizontal Drainage: Rain vs. Snowmelt Contours

Pay close attention to the supers. Superelevated surfaces are known for meltwater sprawl.

Figure 17. Super Elevated Surfaces Known for Meltwater Sprawl

Avoid locating critical areas in the low spot, such as front entrances, crosswalks, and ADA parking stalls. Figure 18 shows a design that directs meltwater to the storm drain. The storm drain is located in a critical safety area, thus creating a winter safety hazard.

Figure 18. Horizontal Drainage: Avoid putting Critical Areas in the Low Spot

Reduce/eliminate meltwater sprawl onto stopping, merging, and turning areas. Understand the stopping distance where brakes will be applied. Route meltwater away from this zone.

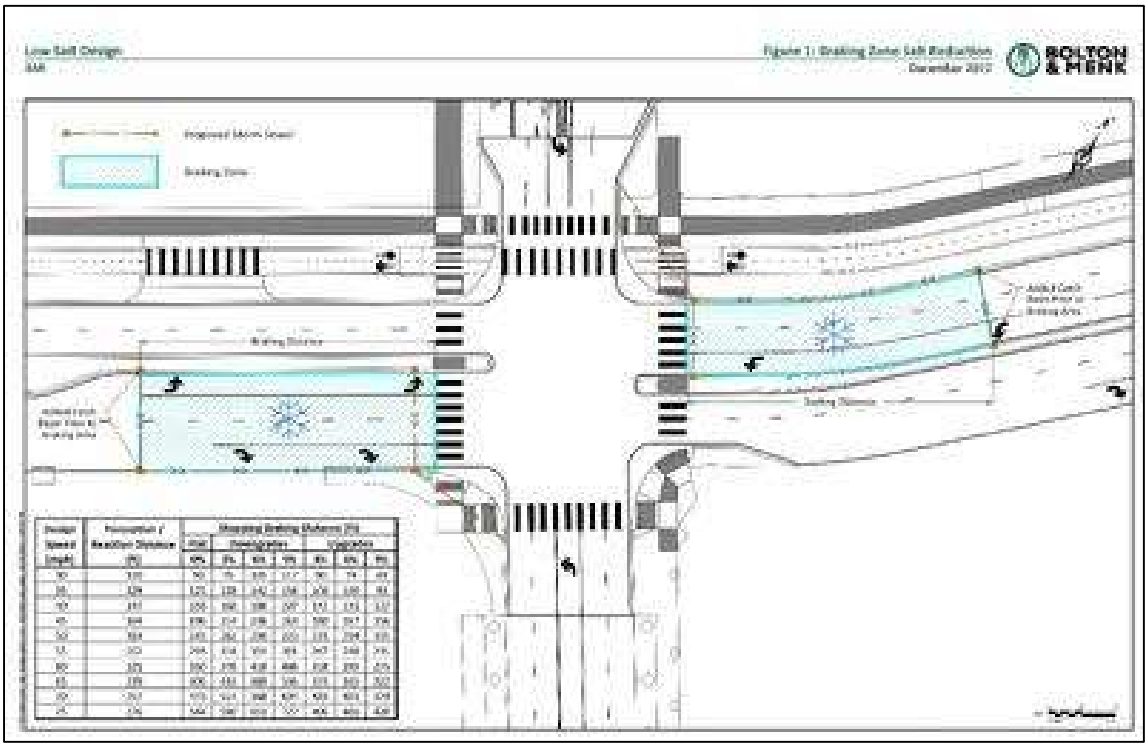

Figure 19. Horizontal Drainage: Route Meltwater Away from Braking Zone

Vertical Drainage

Look up and pay attention to the snowmelt drainage from the buildings, medians, parking lot islands, bridges, decks, awnings, lawns, and raised structures that will not be plowed. Be a step ahead of winter and route meltwater away from saltable surfaces.

Look for decks, canopies, or other areas where snow will catch and drip onto salted surfaces. Route sidewalks around these obstacles, not under them, or devise a system to catch and control meltwater.

Figure 20. Vertical Drainage: Avoid Discharge from Higher Elevations to Saltable Surfaces

The dripping of snowmelt on the front steps creates as much hazard as a downspout directed to the sidewalk. All of it turns to ice, reduces safety, and calls out for salt.

Anticipate the snowmelt from snow collection areas and keep it off the saltable surfaces. Figure 21 is a diagram that shows snow resting on rooftop, awning, balcony, planter box, and raised median of an office building. Other snow collection areas are lawns, gardens, and natural areas.

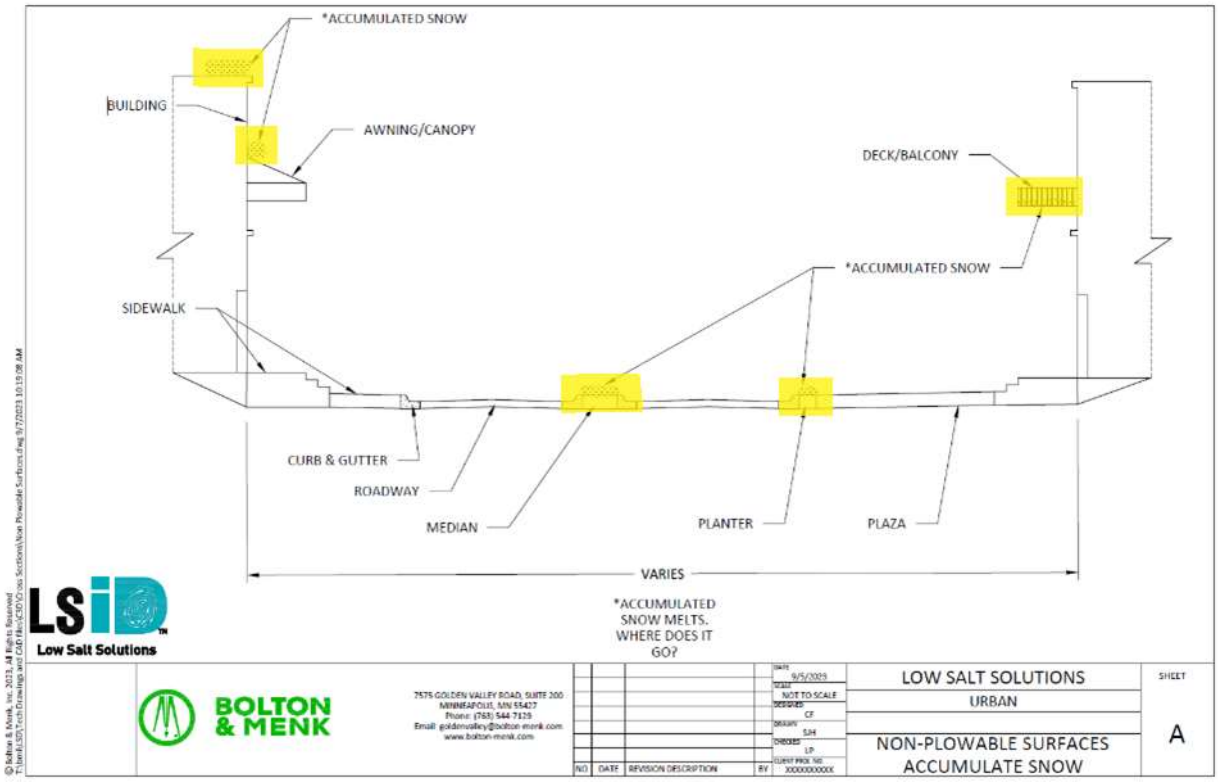

Figure 21. Vertical Drainage: Urban Area, Look Up for Snow Accumulation

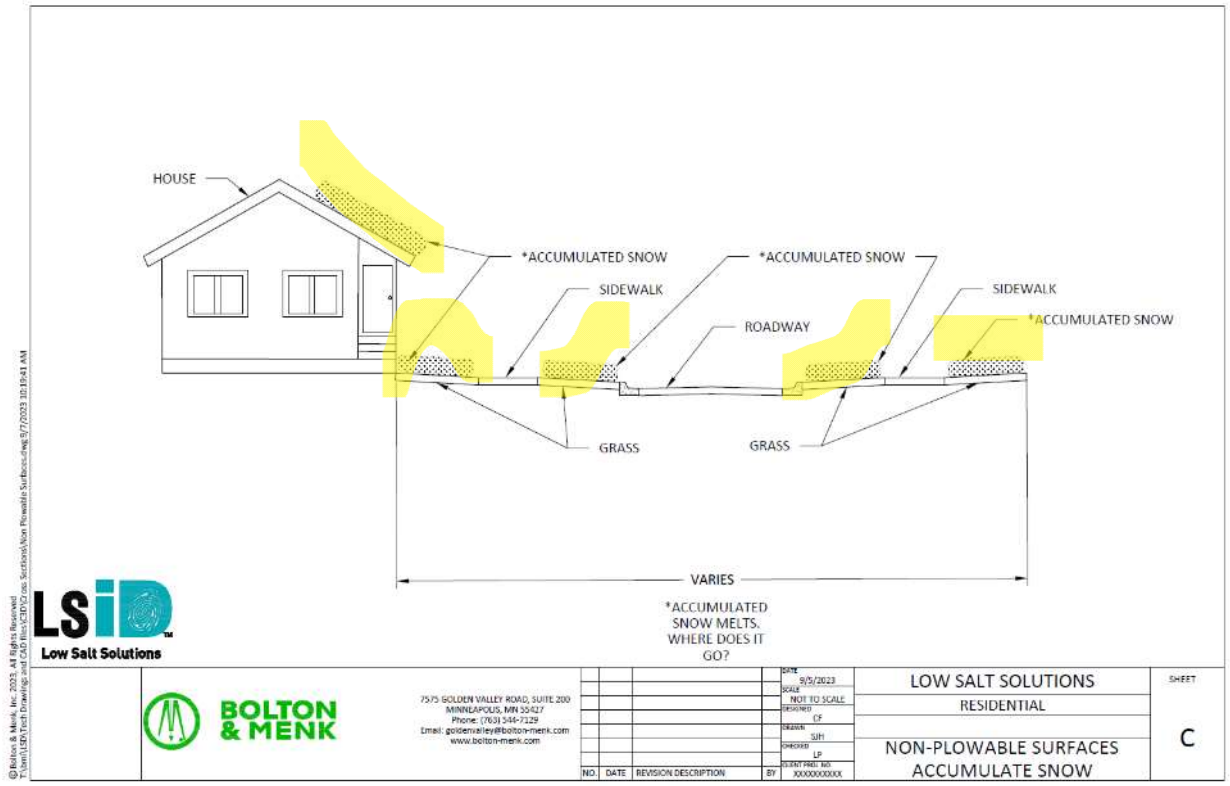

Figure 22. Residential Area, Non-Plowable Surfaces Accumulate Snow

Figure 23 illustrates that what seems safe for summer design has winter safety implications.

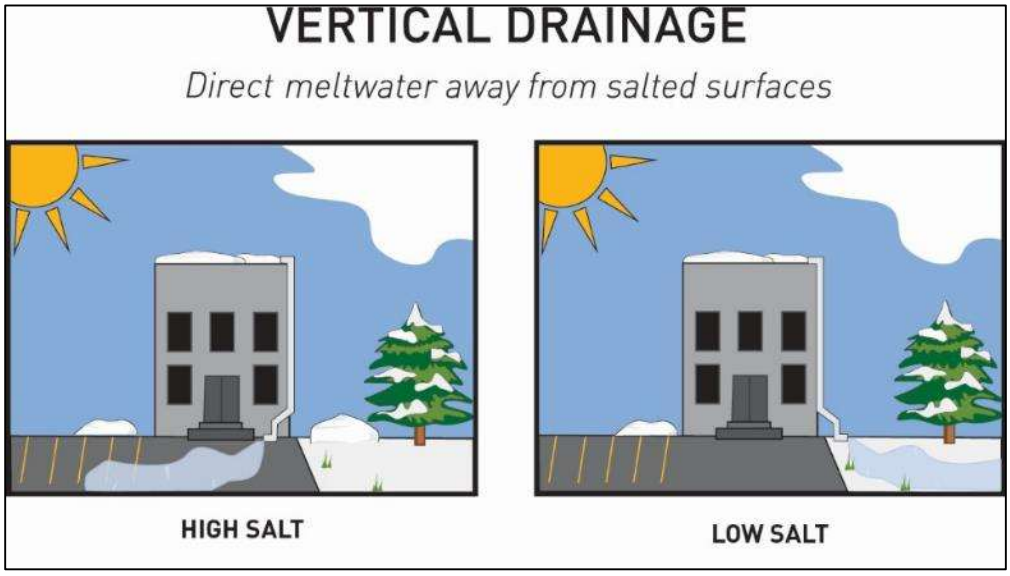

Figure 23. Vertical Drainage: Direct Meltwater Away from Salted Surfaces

Snow Removal Made Easy

Understand the contours of a plow, then design for easy snow removal. If it is difficult to plow around obstacles and in nooks and crannies, we end up with more chemical snow removal. No one wants to get out of the truck and shovel — this is true for UTVs and sidewalk clearing equipment too. If designs allow for automated snow removal, we will reduce the need for deicers.

Tips for making it easier to plow:

- Reduce back up maneuvers. They are a time sink, dangerous for the driver, parked cars, infrastructure, and anyone nearby, whether they are walking, biking, skiing, or driving.
- Eliminate obstacle courses. Design straight pushes into well-designed snow storage areas. Snow removal obstacle courses can occur on sidewalks, roads, and parking lots. They are comprised of raised medians, especially those with in and out contours, and raised islands, tight turning radius, a mix of light poles, utilities, islands, curb stops, mailboxes, benches, planter boxes, fire hydrants, shopping cart bays, gores, and the list goes on.
    - If the site needs many of these plow obstacles, attempt to group them together with a plowable perimeter, see Figures 24 and 25. Consider if some of the snow removal obstacles can be removed for wintertime (e.g., picnic tables).

Figure 24. Reduction of Plow Obstacles by Combining Light Post, Street Sign, and Parking Notice

Snowplows need to be able to turn around, move back and forth, and navigate within your space while pushing snow. Think like a plow driver — design areas that are easy to plow.

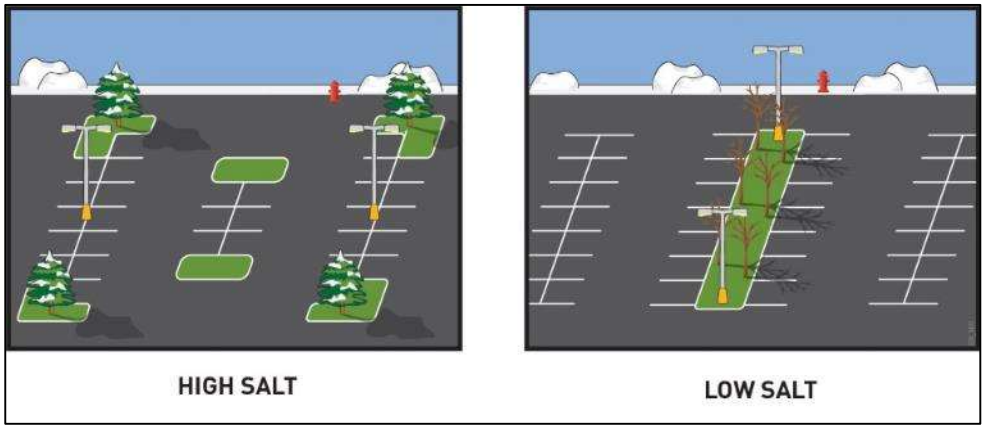

Figure 25. Snow Removal Made Easy: Large vs. Small Parking Lot Islands

Plow blades are rigid and cannot flex to remove snow from a contoured surface. Therefore, consider the width of maintenance equipment in your design. Many complaints have been heard about clearing pedestrian ramps — the width and the angles pose a challenge for the blades on snow removal equipment. ADA is about improved mobility, but without the ability to easily clear snow and ice, these areas will be less safe than others.

In the next section, we discuss snow storage. Ease of plowing and snow storage go hand in hand. In Figure 26, we see our good intentions for a well-performing snow storage area but located in an area that may not be a favorite of the plow driver. If you work with maintenance staff during design, the final designs are likely to be easier to maintain.

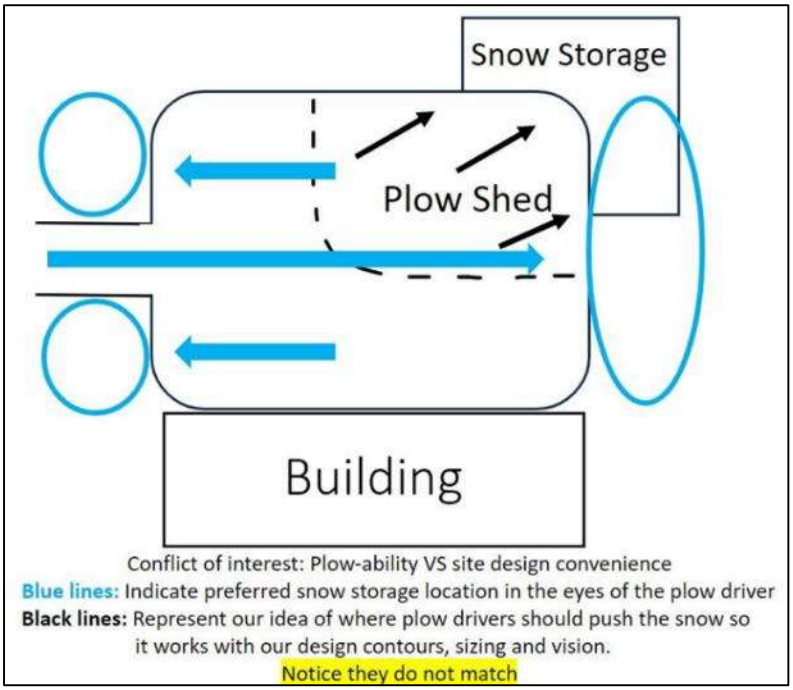

Figure 26. Snow Removal Made Easy: Plow-ability vs. Site Design Convenience

Advice from a maintenance expert:

> *"The parking lots of the past are the easiest to plow… This enables equipment to make repetitive, even movements, and plow the most efficiently. Most parking lot designs these days follow local codes that require lots of tree islands. I think…only allowed fourteen spots to be in a row before another tree island needed to be installed. These are very tedious to plow around. Trees add more shade; great for people, heat island, etc., bad for trying to melt ice. Although usually these trees are pretty unhealthy and really not creating all that much shade I suppose.*
>
> *The more nooks and crannies there are, the harder it is to plow, and the more likely it is a contractor will attempt to salt off the remaining snow that can't quickly/easily be plowed or have to make multiple salt passes to try and reach odd curves and corners."*
>
> - Josh Dix, former City of Roseville Maintenance Supervisor, now Cook County MN Highway Maintenance Technician

Snow Storage

Create space for snow storage. Winter maintenance professionals have a difficult job of finding enough space to push snow to. To have good winter performance, we need well-designed snow storage areas.

Figure 27. Snow Storage Should be Free of Obstacles like Trees and Shrubs

Control the meltwater footprint. This is easiest to do by creating snow storage on the low side of saltable surfaces. Wherever snow storage is located, take control of the meltwater sprawl. Figure 28 shows the result of storing snow on the high side of the parking lot with meltwater draining across the length of the lot to the catch basin and accessible parking spots at the low end.

Figure 28. Meltwater Sprawl from Snow Storage, soon a Sheet of Ice

Snow storage has many challenges. Consider all of these factors when designing snow storage:

- Appropriately sized
    - Our preliminary estimates for Minnesota range from 13- 30% of the plowshed surface area to be needed for snow storage on an average winter.
    - We welcome your snow storage observation data to improve our calculations.
- Meltwater control
- Easy snow push for plow
    - If there are options for where to push the snow, label the location for the plow drivers so the snow ends up in your high-performance area.
- Well-marked for snowplow operators
- Salt tolerant plant species
- Salt tolerant soils
- Salt tolerant infrastructure
- Ease of debris clean up (after spring melt)
- Winter use of this area does not ruin summer use of this area
- Summer use of this area does not ruin winter use of this area
- Sightline safety
- Kid magnet safety
- Snow dump landing area safety
- Aesthetic appropriateness
- Snow storage does not create a dam and block drainage

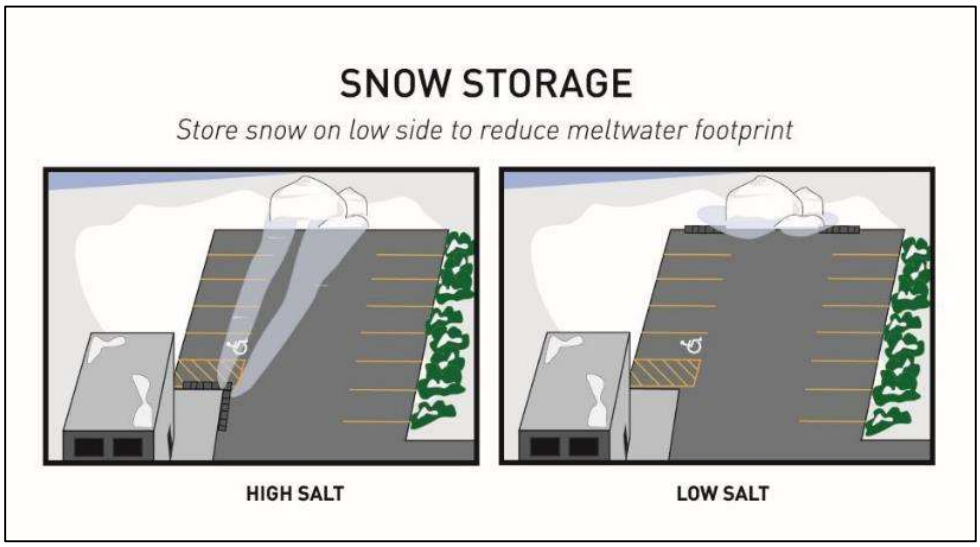

Figure 29. Snow Storage: Store in Low Areas for Easiest Meltwater Control

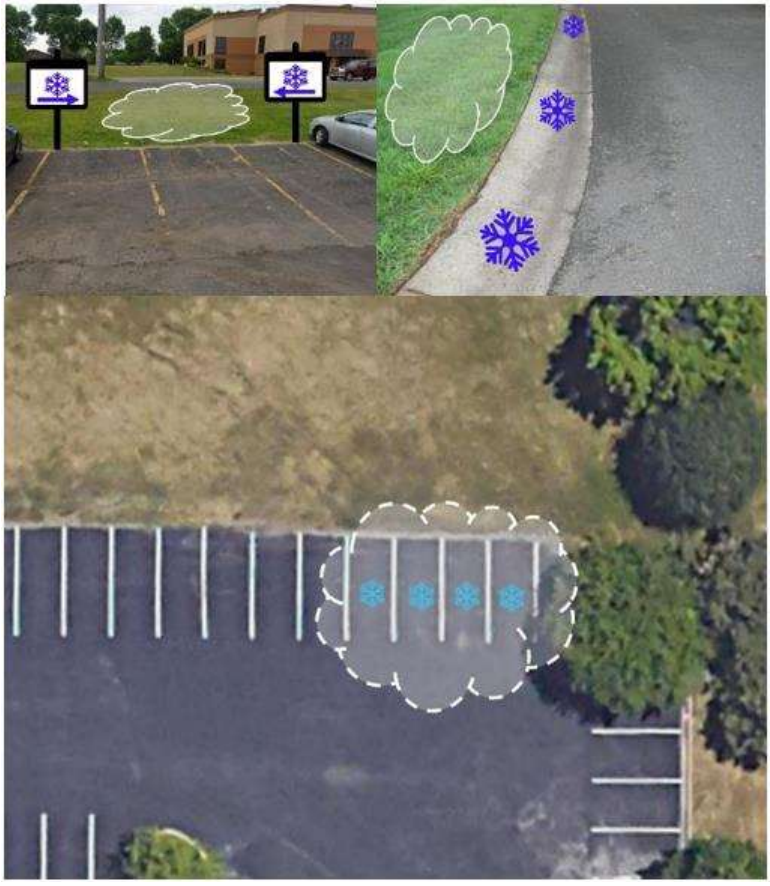

Figure 30. Label Snow Storage Locations

Figure 31. Snow Pile Inhibits Sightlines

Figure 32. Snow Storage Areas May Attract Recreation

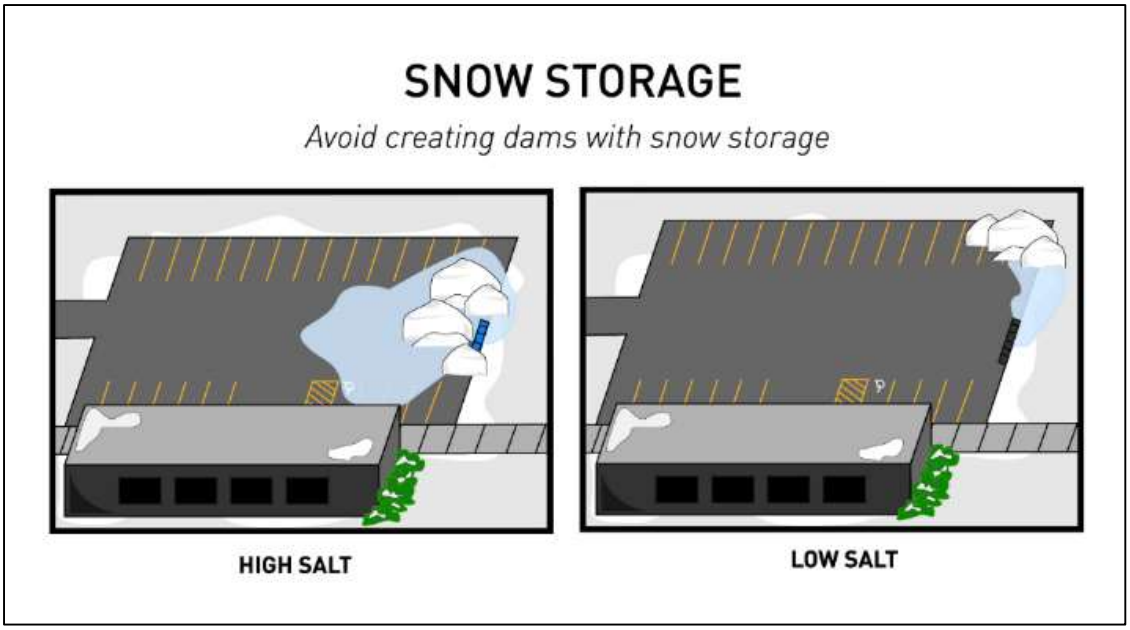

Figure 33. Snow Storage: Create Path for Meltwater and Stormwater to Drain

For superior four-season performance in managing stormwater and meltwater, we have invented snow gardens. Snow gardens can be designed for winter-only control of precipitation (snow) or for four-season functionality that manage both rain and snow.

Our early work categorizes snow gardens in ten basic forms (See Resources Section for Snow Garden Guide).

In road design, above-ground utilities and tree-free boulevards offer more snow storage, less damage to infrastructure, and winter snow benching opportunities.

Figure 34. Obstacle-Free Boulevards Allow More Snow Storage

Salt Storage

Salt storage is known for groundwater contamination. Most government entities in cold climate states have bulk salt storage facilities. Many large parking lots, malls, and business complexes will also seasonally store salt on their site. For site design, ask the client if there is a possibility for future bulk granular or liquid storage on site, the proper location, orientation, and drainage can be designed to minimize risk.

Salt storage can be permanent or temporary.

Figure 35. Salt Storage: Permanent vs. Temporary Placement

Liquid storage should be designed into modern salt sheds, or at least a good discussion should be held about it. It is gaining popularity and is a valuable tool in driving down the overall salt use.

Figure 36. Salt Storage: Granular vs. Liquid

Granular Storage:

- Place salt storage at a higher elevation than snow storage to keep meltwater out of the salt pile.
- Salt should be on an impermeable surface.
- Salt should be protected from snow, rain, and runoff.
- Face salt storage away from the prevailing winter wind direction.
- Salt piles should not drain into storm sewer (illicit discharge).
- Avoid salt storage near lakes, rivers, wetlands, and ponds.
- Avoid salt storage near areas of groundwater sensitivity such as wellhead protection areas.

Design Tips:

- Control snow, rain, and meltwater from entering storage area.
- Face salt loading side of storage in opposite direction of prevailing winter wind.
- A sealed entrance to salt storage offers best protection.
- Slope external area away from salt storage.
- Slope internal salt storage away from the door or create a birdbath collection area inside of storage. This way you have control of where the salty water goes if you get water in your shed.

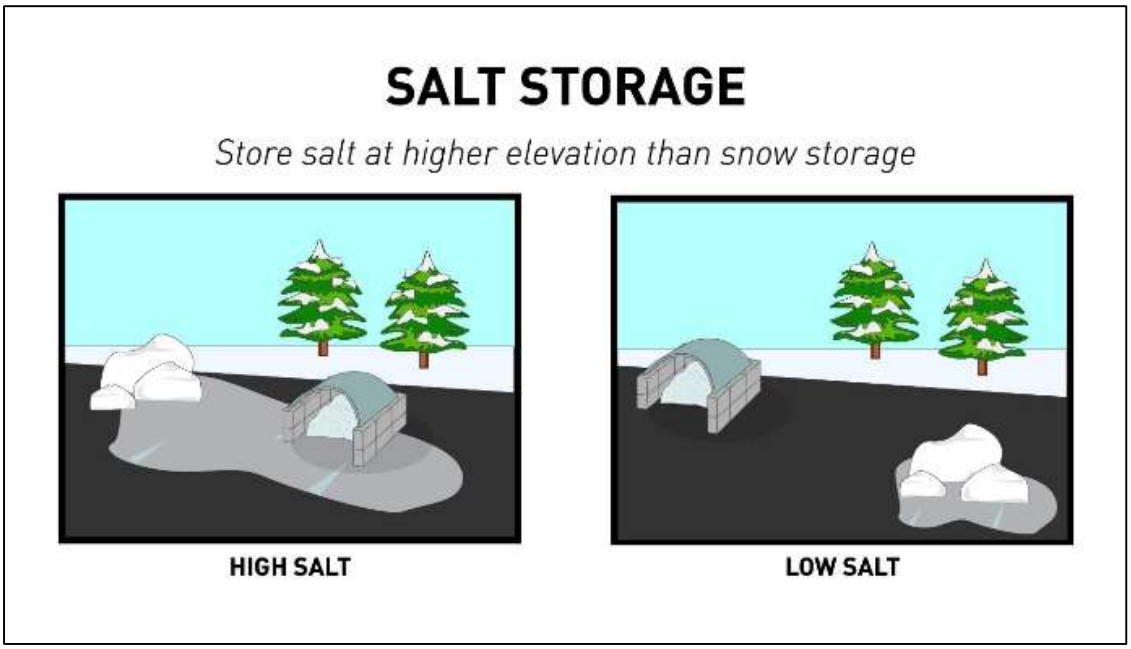

Figure 37. Granular Salt Storage: Store at Higher Elevation than Snow

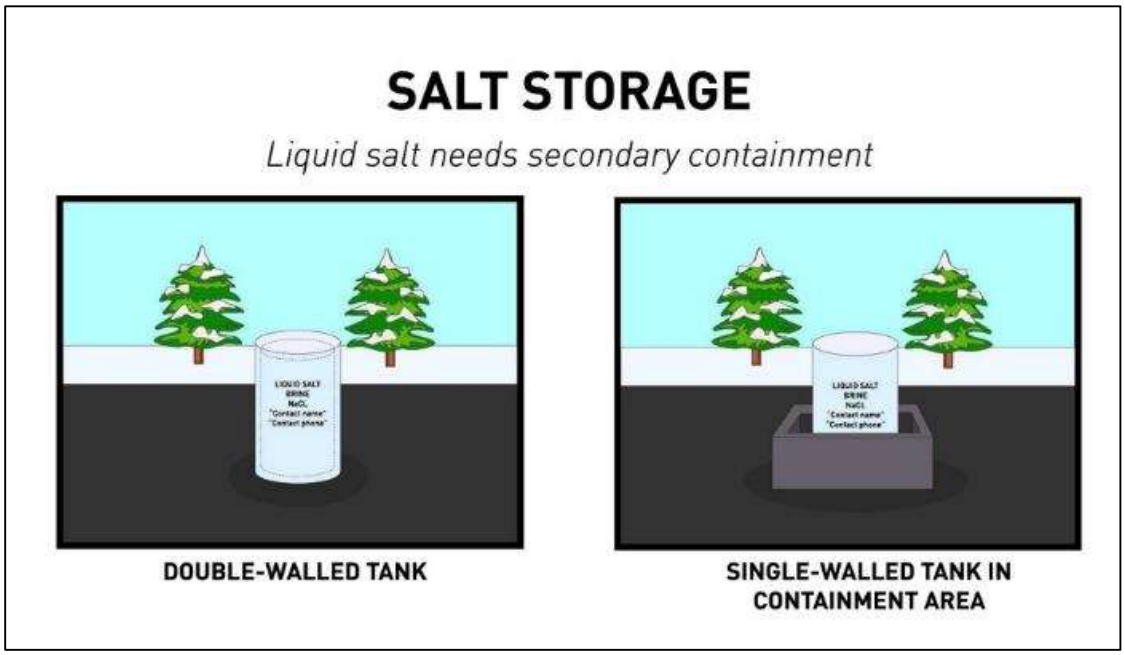

Figure 38. Liquid Salt Storage: Secondary Containment Area

Liquid deicer use is rapidly growing as it works faster, stays on target better, costs less, and creates less chloride pollution. Winter maintenance operations are increasing their use of liquid deicers. Designers, don't forget to ask if liquid deicer is to be stored on site. Each state has its own rules governing deicer storage and for liquids, they often follow the state's above-ground storage tank rules for less hazardous compounds.

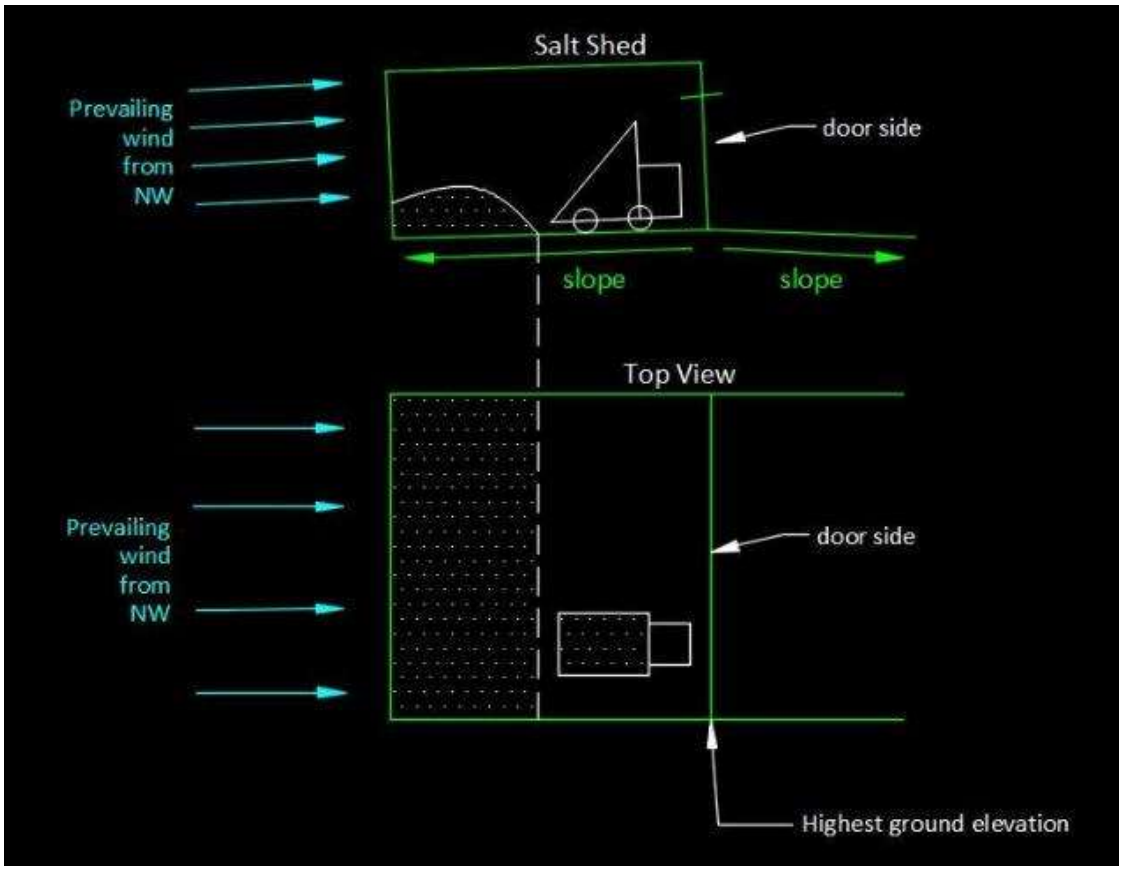

Figure 39. Salt Storage: Slope Internal Floor Away from Door

Figure 40 is an interesting example of good and bad practices:

- Good containment: Waterproof floor, no access to rain or snow.
- Poor housekeeping: The salt left in front of the storage bunkers should have been pushed or swept back into the storage container.
- Poor Placement: The snow piles all around the salt storage will wash the salt into the nearest water resource. Salt should be placed at a higher elevation than snow or if that is not possible, perimeter protection by intercepting melt water is needed.

Figure 40. Salt Storage: Good Containment, Poor Location, Poor Housekeeping

Salt storage regulations vary by state:

- Minnesota 2024: Salt storage is in the MS4 Permit and the Above Ground Storage Tank (AST) rules. For anyone in an MS4 community (including private sector), there is salt storage guidance that must be followed.
- Iowa 2024: No known salt storage requirements.
- North Dakota 2024: No known salt storage requirement.

See Resources Section for specific language on salt storage regulations.

Stay current on regulations for both liquid and granular salt storage. These regulations seem to be changing more frequently and are becoming more rigorous as chloride contamination awareness increases.

Minimize Footprint of Salted Surfaces

For every inch of pavement (sidewalk, parking lot, roadway, steps, ramps, bridge, path) we design, we open ourselves up to the likelihood that it will be salted. It won't be salted just once, it will be salted many times during the year and for many years in a row. Looking at it this way, we can see that if we make the sidewalk one inch narrower, make the cul-de-sac the minimum size for emergency vehicles, make the path to the dumpster six feet wide instead of twenty feet wide, we will have salt reduction potential to last the years.

Is this always possible or desirable, no, but is it always worth considering? Yes!

Road diets have often been discussed but primarily concepted with images and benefits that depict the growing season. Figures 41 and 42 show a reworked version of road diets that illustrate a 12-month benefit.

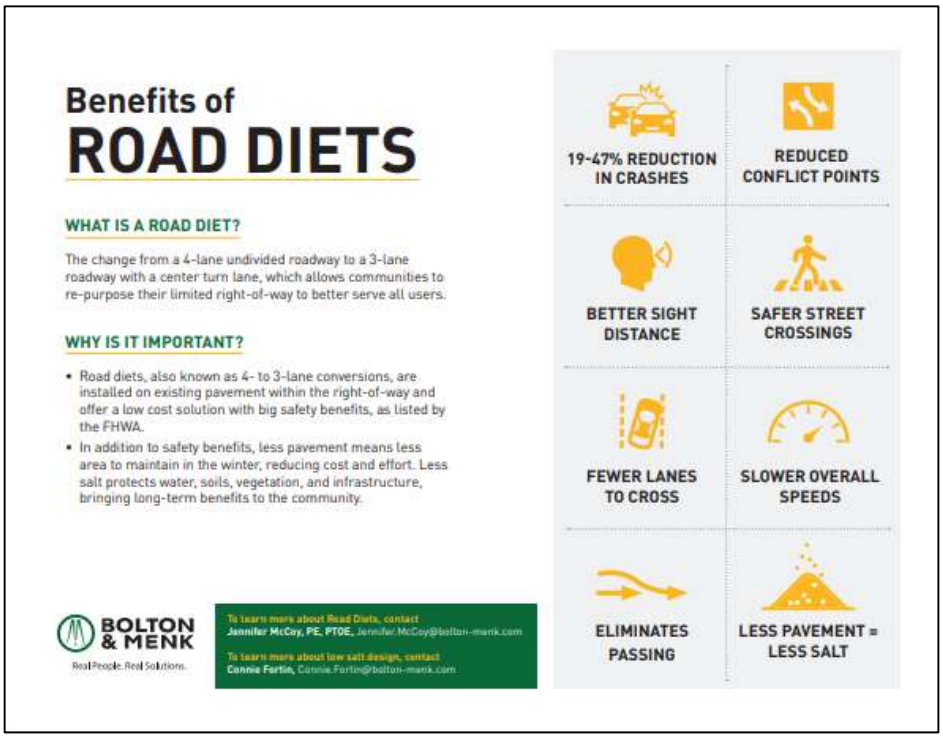

Figure 41. Benefits of Road Diets

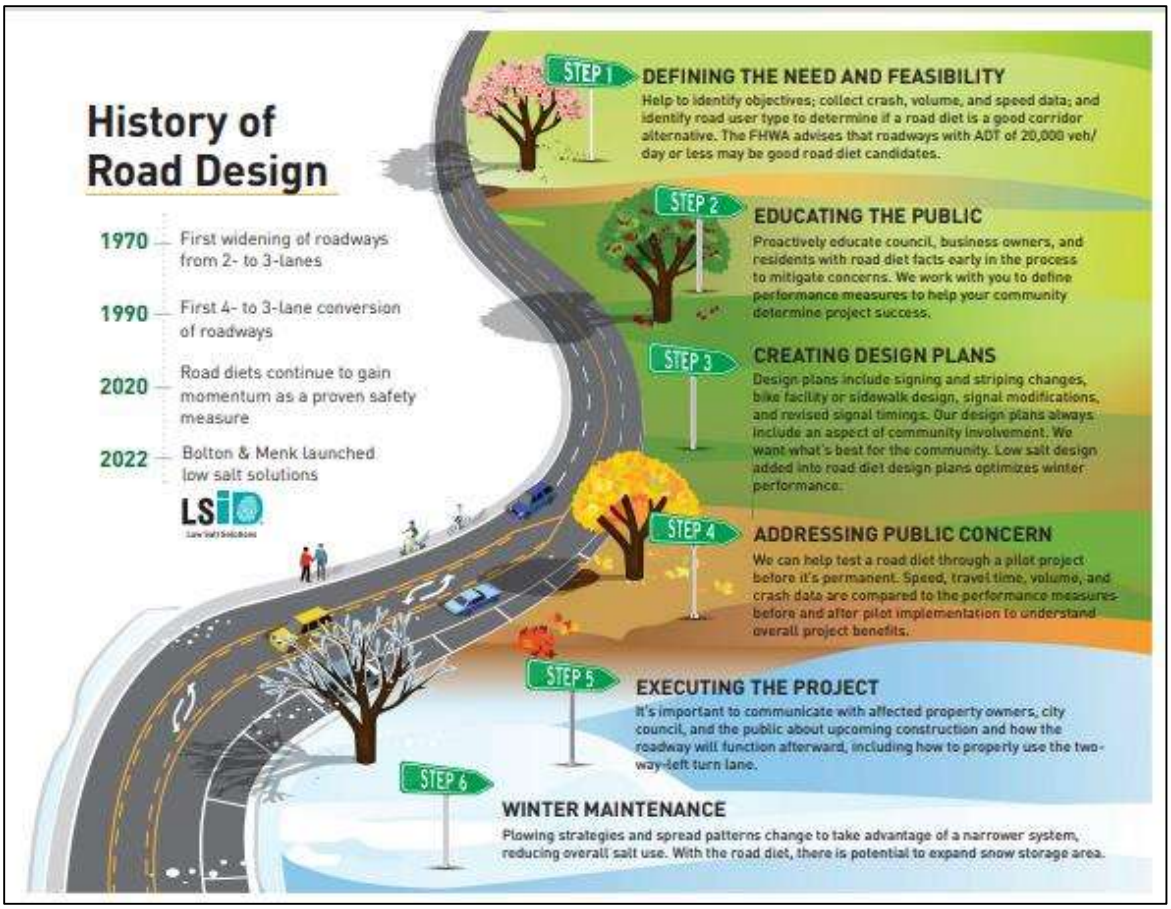

Figure 42. History of Road Design

Pavement Alternatives

We are not recommending pavement alternatives as our top Low Salt Design strategy, but it is a fine one to consider after less expensive strategies have been exhausted.

If the design has a critical area located in the low spot and in the shade, pavement alternatives may be the answer to gain acceptable winter performance.

Alternative pavement considerations include:

- Heated pavements: There are several options, we encourage the re-use of waste energy if possible.

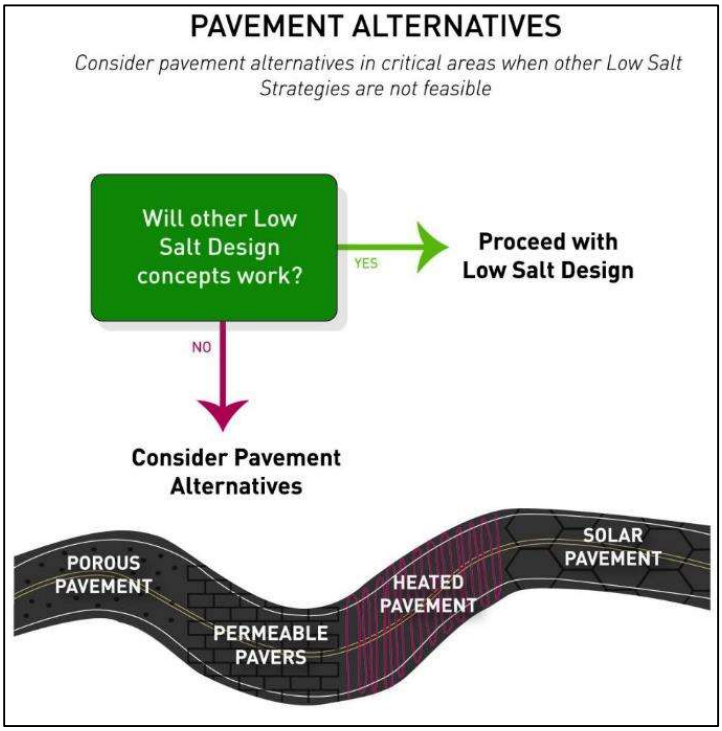

Figure 43. Pavement Alternatives

    - Energy reuse (see Holland Michigan Resource section)
    - Energy creation (see Solar Roads in Resource Section)
    - New energy use (many of our traditional pavement heating systems)
    - Consider the interface of heated and non-heated pavements and potential for ice dams; intercept meltwater before it hits unheated pavement
- Porous pavements & permeable pavers: Install porous pavement in the sun for improved four season performance
- Conductive pavement
- Different texture or material that offers better friction
- Different color that provides better melting (albedo), however, be sure to consider the summer heat island problems
- Pavement overlays that offer superior winter performance
- Pavements that secrete micro melting that can eliminate heavy salting

Figure 44. Heated Pavement: Entryway

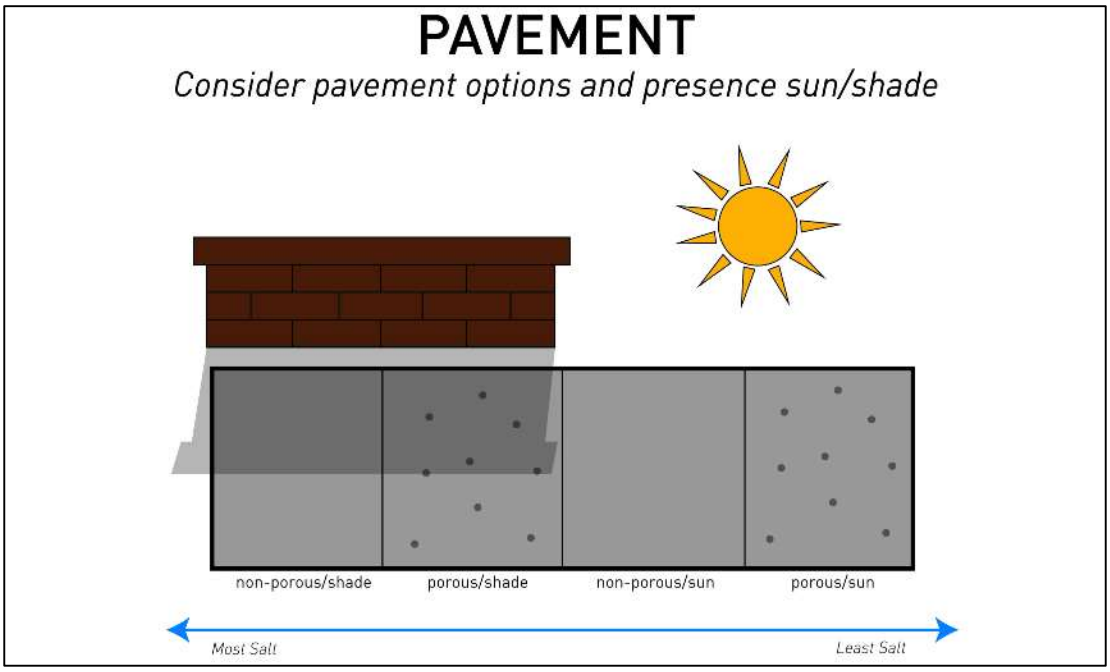

Figure 45. Sunlight and Permeable Paver Performance

Perhaps you are using porous pavement to meet infiltration requirements. Placement in a sunny location vs. a shady location could increase your year-round benefits and speed up pavement recovery.

Figure 46. Permeable Pavers: Intercept Meltwater Where Asphalt Conveys It

The ability of any pavers to withstand salt should be considered in the decision-making process. It is our hope that by using Low Salt Design, we reduce the need for salt and increase the paver lifespan. Salt will likely still be used, but some pavers and pavements have had a tough time standing up to direct salting or the salt tracked over them by vehicles or dropped on them by parked cars.

Figure 47. Salt Erodes Many Surfaces, Including Pavers

Figure 48. Alternative Materials, No Salt Needed

Vegetation

In this section, we have grouped concepts shared in other sections to make it quicker and easier for a forester, landscape architect, or those focused primarily on vegetation to take a glance at how plant materials and their placement will influence winter performance of saltable surfaces. It is recommended to visit the sections of interest to learn more about vegetations role in winter performance.

1. Snow storage: No woody species. Salt tolerance species.
2. Outsmart the wind: Standing row crops or living snow fences for intentional snow fencing. Location of wind break plantings on downwind side of saltable surfaces will avoid the unintentional snow fence. Mowing or pruning on the windward side of the landscape is suggested in the late fall to allow blowing snow to move across pavements.
3. Use the sun: Look at the placement of vegetation and the shadow it will create in the winter. Deciduous trees cast a weaker shadow than coniferous trees. All trees/shrubs to south of saltable surfaces create slower pavement recovery than trees/shrubs on north side of saltable surfaces.
4. Ease of Plowing: Vegetated islands and vegetated swales within a parking lot make it difficult to plow. Design for smooth contours that complement the plow blade. Vegetation in these swales and islands should be salt tolerant. Depending on how much salt is used in a parking lot, the destruction of the flora can be immediate or delayed.

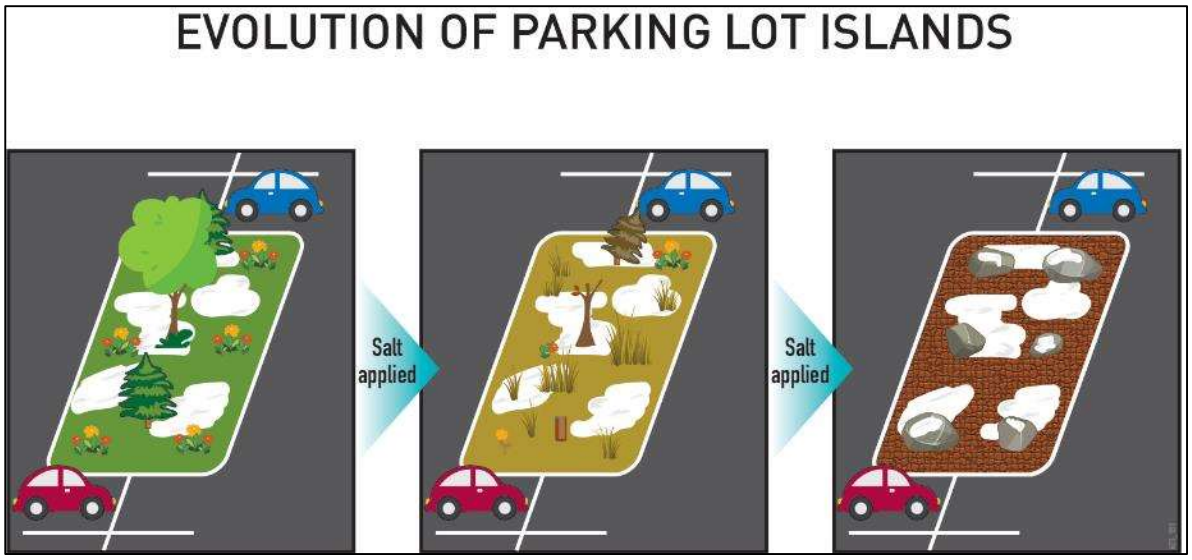

Figure 49. Fate of Vegetation in Cold Climate Parking Lot Islands

Conclusion

Cold climate regions struggle with winter safety and chloride pollution. We hope that Low Salt Design will increase winter performance of our saltable surfaces, thus increasing safety and driving down the need for salt. As we drive down the need for salt, we will increase the life of the vegetation and infrastructure, better protect freshwater resources, and reduce the stress on winter maintenance crews. It is our vision that Low Salt Design will increase safety and create cost savings wherever it is used.

We would like to share the energy and enthusiasm brought to this project by the engineers, landscape architects and water resources specialists at Bolton & Menk. We feel honored to be able to deliver a new path forward to our industry. We encourage you to give Low Salt Design a try and to contribute to the guidance surrounding it. Please submit your suggestions to lowsalt@bolton-menk.com

Definition of Terms

ADA: Americans with Disabilities Act

Critical Areas: Areas that require excellent winter friction. The volume of traffic and speed of traffic also help to influence critical areas for a site. Examples of critical areas are front steps, high traffic sidewalks, braking zones, bridges, underpasses, ramps, curves, hills, ADA routes.

EPA: Environmental Protection Agency

Fetch: The distance (winter) wind travels uninterrupted before it hits your site.

Gore: A triangular plot of land as designated when a road forks at the intersection with second road, or merges on and off from a larger one.

Horizontal Drainage: Drainage from snow piles or other adjacent sources of water onto surfaces that require salting.

Intentional Snow Fence: A temporary or permanent structure or row(s) of vegetation that intercept wind and cause it to lose energy and drop snow before reaching a road, sidewalk, or other surface.

LSiD™: Low Salt Solutions, a trademarked initiative of Bolton & Menk, which is predicted to house many initiatives, the first being Low Salt Design.

Low Salt Design: A series of design concepts aimed to create safer winter surfaces by improving pavement recovery and reducing the re-entry of snow and melt water to saltable surfaces. Safer surfaces reduce the need for salt.

Meltwater: Liquid snow

Meltwater Footprint: The wet surface area created on a dry pavement from the movement of snowmelt water.

Example 1. Not a meltwater footprint as this pavement is still recovering from a snow event.

Example 2. This is a meltwater footprint as the pavement was dry and the meltwater moved across the pavement.

Meltwater Sprawl: The movement of meltwater onto a saltable surface.

Pavement Friction: The amount of friction (could think of traction) under foot or under tire. The higher the friction value, the higher control the person or vehicle has while moving on across the pavement.

Pavement Performance: How the pavement can provide good traction even under the stress of cold temperatures, snow, or freezing rain.

Pavement Recovery: How fast a saltable surface can recover from snow or freezing rain.

Plowshed: The surface area plowed into a particular location.

Rain Garden: Vegetated infiltration area

Repeat Offenders: Meltwater sprawl and blowing snow

ROI: Return on investment — The higher the return on investment, the more you benefit.

Salt: Chloride-based product used for deicing.

Saltable Surfaces: Any hard surface that is likely to be salted in the winter (i.e. road, parking lot, sidewalk, trail, steps).

Snow Benching: A technique to move back snow ridges further from the roadway during high snow years to create capacity for snow storage for the next plowing event.

Snow Garden: A snow storage area, intentionally designed to reduce the meltwater footprint on "saltable" surfaces.

Unintentional Snow Fence: A temporary or permanent structure or row(s) of vegetation that unintentionally acts as a snow fence and drops snow in unwanted areas. Some examples are tall grasses near a roadway or landscaping near a parking lot.

UTV: Utility task vehicle

Vertical Drainage: Drainage from higher elevated sources such as buildings, bridges, awnings, and other tall structures that drain onto surfaces that require salting.

Resources

Podcasts on Low Salt Design:

- Designing in Salt Reduction https://sicop.transportation.org/episode-72-designing-in-salt-reduction/
- Innovating Winter Maintenance: Reducing Salt Use and Protecting the Environment https://www.thepublicworksnerds.com/2197993/12998912
- Designing for a Low-Salt Future with Connie Fortin https://youtu.be/OHsYCMN2qlw

Low Salt Design Publications:

- BMI Snow Garden Guide 2024

Winter Maintenance Podcasts:

- Episode 3: Innovating Winter Maintenance: Reducing Salt Use and Protecting the Environment with Connie Fortin. The Public Works Nerds. https://www.buzzsprout.com/2197993/12998912-innovating-winter-maintenance-reducing-salt-use-and-protecting-the-environment-with-connie-fortin

Low Salt Design Journal Articles:

- Designing to Achieve a Lower Salt Future. Environmental Connection. IECA. https://associationpublications.com/flipbook/ieca/2024/Quarter1/14/index.html
- Site Design: Rethinking infrastructure Performance to Reduce Salt Use. Snow Business Magazine. SIMA. https://www.sima.snowbusinessmagazine.com/snowbusiness/september_2023/MobilePagedReplica.action?pm=2&folio=44#pg51
- On the Road to Less Salt Use in Minnesota Cities. Minnesota Cities Magazine. League of Minnesota Cities. https://www.lmc.org/news-publications/magazine/mar-apr-2023/less-road-salt/
- Designing a Low Salt Future. Roads & Bridges. https://www.roadsbridges.com/winter-maintenance/article/33009904/designing-a-low-salt-future
- Designing a Lower Salt Future. Stormwater Solutions. https://www.stormwater.com/home/article/33043034/designing-a-lower-salt-future

Low Salt Design Videos:

- Bolton & Menk – Low Salt Design, Corridor Consideration (youtube.com)

Outsmart the Wind:

- Blowing Snow Control Tools. University of Minnesota. https://snowcontroltools.umn.edu/
- Drift-free Road and Ditch Design https://snowcontroltools.umn.edu/design-tool
- Designing Guidelines for the Control of Blowing and Drifting Snow. Strategic Highway Research Program. onlinepubs.trb.org/onlinepubs/shrp/SHRP-H-381.pdf
- Using Noise Barriers and Snow Fencing to Capture Solar Energy. Minnesota Department of Transportation. https://mdl.mndot.gov/_flysystem/fedora/2023-02/202120ts.pdf
- Effective Shelterbelt Design. Agriculture Victoria. https://agriculture.vic.gov.au/farm-management/soil/erosion/effective-shelterbelt-design

Examples of Heated Pavements:

- Holland Snow Melt Weather Channel Story. City of Holland. https://www.youtube.com/watch?v=mq-1m-zvPus
- Solar Roadways. https://solarroadways.com/

Example of Surface Overlay:

- SafeLane® Surface Overlay. Cargill. https://www.cargill.com/industrial/winter-road-maintenance/safelane-surface-overlay

Salt Storage:

- 2020 MS4 General Permit. Minnesota Pollution Control Agency. https://www.pca.state.mn.us/business-with-us/2020-ms4-general-permit
- Liquid Salt Storage Guidance and Regulations. Minnesota Pollution Control Agency. https://www.pca.state.mn.us/sites/default/files/p-tr1-12.pdf

To