New York State | Department of Environmental Conservation | Department of Transportation

Adirondack Road Salt Reduction Task Force Assessment and Recommendations

2023

Basil Seggos, DEC Commissioner | Marie Therese Dominguez, DOT Commissioner

This is the report of the Adirondack Road Salt Reduction Task Force established by Chapter 313 of the Laws of 2020 (Randy Preston Road Salt Reduction Act), as amended by Chapter 67 of the Laws of 2021. It presents the findings, review, and recommendations of the Task Force with respect to road salt contamination and winter road management practices within the Adirondack Park. It also contains recommendations for an Adirondack Park Road Salt Reduction Pilot Program.

For questions or comments about the Adirondack Road Salt Reduction Task Force and this report, please contact: ADKSaltReductionTaskForce@nysemail.state.ny.us

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ACRONYMS AND TERMS			
AADT	Average Annual Daily Traffic	**EPA**	U.S. Environmental Protection Agency
ABP	Agricultural By-product	**LOS**	Level of Service
APA	Adirondack Park Agency	**MCL**	Maximum Contaminant Level
AVL	Automatic Vehicle Location	**MS4**	Municipal Separate Storm Sewer System
AWI	Adirondack Watershed Institute	**NaCl**	Sodium Chloride
BMP	Best Management Practice	**NPG**	Non-Agricultural Nonpoint Source Planning and MS4 Mapping Grants
BOD	Biochemical Oxygen Demand	**PESTLE**	Political, Economic, Social, Technological, Legal, and Environmental
COD	Chemical Oxygen Demand	**PWS**	Public Water Systems
DEC	Department of Environmental Conservation	**RWIS**	Road Weather Information Systems
DLA	Direct Liquids Applications	**SIMA**	Snow and Ice Management Association
DOH	Department of Health	**SSI**	Sustainable Salt Initiative
DOT	Department of Transportation	**WIIA**	Water Infrastructure Improvement Act
EFC	Environmental Facilities Corporation	**WQIP**	Water Quality Improvement Project
ENB	Environmental Notice Bulletin	**WSI**	Weather Severity Index

Executive Summary

Background

This is a report to the Governor and Legislature from the Adirondack Road Salt Reduction Task Force established by the Randy Preston Road Salt Reduction Act in 2020. The Task Force was charged with conducting a comprehensive review of road salt contamination and roadway, parking lot, driveway, and sidewalk management best practices within the Adirondack Park, and making recommendations for enhancements.

The legislation attempts to address the conflicting paradigms between the use of road salt and the protection of public health and the environment. On the one hand, the all-weather use of transportation corridors and privately owned paved surfaces is essential, and the application of road salt to roads and other surfaces to control ice and snow for the safety of the traveling public has become an established practice. On the other hand, the protection of public health and the environment from contaminants is also essential, and the migration of road salt onto nearby lands and waters has detrimental effects on natural resources, humans, property, and infrastructure. Long-term, successful balance of these objectives depends on engaging these competing tensions using the best available science and management practices.

The impacts from road salt application are pronounced within the 6-million acre Adirondack Park, which typically experiences a longer snow and ice season than other areas of the state. The Adirondack region of New York State is home to both permanent and seasonal residents, 2.6 million acres of forever wild Forest Preserve, and many unique and sensitive natural ecosystems, all of which rely on a healthy environment and clean drinking water.

This report provides the Task Force recommendations to reduce road salt usage and its impacts, while giving due consideration to public health, the environment, and the safety of the traveling public.

Solutions and Findings

The Task Force conducted a review of road salt use and impacts, current state, local, and commercial winter management practices, levels of service for roadways, and practices in other states with similar winter conditions.

The impacts from road salt on the environment can be long term. Once road salt dissolves in winter it can run off into surface waters through snow melt and stormwater or find its way onto surfaces where, even later in the year, it can continue to leach further into groundwaters. As a result, the road salt applied for public safety during the winter can elicit wide ranging impacts on both aquatic and terrestrial ecosystems and sources of drinking water. These impacts tend to be mostly associated with chloride, a primary component of NaCl (sodium-chloride, aka "salt"), which is the main component in common road salt, but high levels of sodium are known to be harmful to people on certain health-protective diets.

Through its investigations, the Task Force found that while most monitored waterbodies in the Adirondack Park met existing regulatory guidelines for contaminants typically found near road salt applications, a limited number of instances of regulatory guideline exceedances were identified which could result in impacts to human health and the environment. Task Force members with subject matter expertise also found that more recent scientific literature (see section on Sources and Impacts of Road Salt) may indicate existing water quality standards are not protective enough to prevent impacts to the Adirondack Park's sensitive natural resources and ecosystem. Therefore, more protective limitations specific to the Adirondack Park may be required to prevent further deterioration to the region's water quality, wildlife, and the environment.

In addition, primarily because of its corrosive characteristics, road salt also damages vehicles, plumbing pipes and fixtures, and public infrastructure such as bridges.

Finally, The Task Force found that state-of-the-art techniques for winter road management were continuously improving with new technologies and programs becoming available and being applied in various locations.

Recommendations

The Task Force's assessment addresses impacts from road salt on public health and the environment, reviews current winter road management practices, identifies training and public outreach practices to support road salt reduction targets, and provides recommendations to reduce the overall application of road salt through various best management practices. The Task Force work in these areas includes recommendations for:

- Road Salt Reduction Targets – including new water quality standards and environmental assessment and monitoring guidelines to help prevent and measure impacts to human health and the environment.
- Best Management Practices – focusing on proven snow and ice removal policies and practices that reduce the overall quantity and frequency of salt applications while maintaining levels of service.
- Snow and Ice Removal Training – providing awareness, information, and training to snow and ice removal practitioners, as well as the diversity of stakeholders who influence the rate and frequency of salt application, with a goal of broad implementation and adoption of recommended practices throughout the Adirondack Park.
- Funding – supporting and achieving the various road salt reductions strategies, best management practices, public outreach campaigns, and responding to potential contamination.
- Providing Public Access to Data and Information – informing the public and snow and ice removal practitioners on the usage of road salt across New York State to support decision-making and enhance transparency.
- Create Public Outreach and Education Campaigns – educating various target audiences on the impacts of road salt and the various strategies that can be implemented to reduce road salt usage while maintaining public safety.
- Examine Rapid Response to Surface and Groundwater Contamination – so the public will be assured there are clear mechanisms for investigations into potential contamination and a pathway to remediate identified contamination of their drinking water supplies.

The Task Force also reviewed potential pilot projects to evaluate and demonstrate the effectiveness of various road salt reduction strategies, while still ensuring the reasonable safety of the traveling public. These recommended pilots include:

- Comprehensive Analyses of Minimum Best Practices Implementation(s) within Existing Municipal Pilot(s). – To establish baseline standards for salt application policies and practices to serve as a model for all winter management operations at all levels of government to follow throughout the Adirondack Park.
- Comprehensive Analyses of Minimum Best Practice Implementation(s) within New Municipal Pilot Areas – To establish a baseline of application rates and the level(s) of service achieved when implementing current practices (a.k.a., "business as usual").
- Managing 'Cold Spots' on Roadways – To develop a documented 'Proof of Concept' model for managing roadway "cold spots" by implementing a selective vegetation management pilot as an additional alternative to the need for frequent and excess road salt application in certain locations.
- Chloride Free Zone(s) – To develop a 'Proof of Concept' model that achieving safety and level of service performance expectations can be met or exceeded when implementing chloride-free deicing alternatives.
- Seasonal Speed Warnings – To develop a 'Proof of Concept' that weather warning signage statements provide opportunities to reduce road salt rates and the frequency of application.
- Private Properties – To develop a baseline analysis of salt applied as a benchmark for future salt reduction.

Financial Support of Recommendations

In order to implement the recommendations included in this report, additional funding from federal, state, or local governments will be necessary. The implementation of best management practices will guide any necessary changes to current snow and ice removal operations, comprehensive planning to institute such changes, and purchasing of equipment for more efficient application of road salt. These actions will likely require the leveraging of existing, or creation of new, financial resources. Many of the recommendations within this report could help reduce road salt contamination at its sources which is typically the most cost-effective approach.

Purpose and Overview

The Adirondack Road Salt Reduction Task Force

In July of 2020, legislation was signed establishing the Adirondack Road Salt Reduction Task Force (Task Force). The legislation authorized the Task Force to complete a comprehensive review of road salt contamination and snow and ice removal best management practices on roadways, parking lots, driveways, and sidewalks within the Adirondack Park, and to provide recommendations to reduce salt usage and its impacts, while giving due consideration to public safety and the safety of travelers in the Adirondacks.

This report represents the results of that comprehensive review. It addresses: 1) the nature, scope, and magnitude of impacts from road salt on surface and groundwaters, public health, and infrastructure, 2) reviews current state, local, and commercial winter road management practices, 3) identifies methods for training and public outreach related to the wise use of road salt and its potential impacts, and 4) provides recommendations to reduce the overall application of road salt through various best management practices, thereby limiting its impact on the environment and public health.

Task Force Membership

The Task Force is co-chaired by the New York State Department of Environmental Conservation (DEC) and New York State Department of Transportation (DOT), with representation by the New York State Department of Health (DOH), Adirondack Park Agency (APA), and 10 additional Governor-appointed members. The appointed members represent various areas of expertise related to understanding environmental impacts, management, and the application of road salt. This includes representation of academia, law, private industry, county and local governments, and environmental advocacy.

Governor Appointees

- Brittany Christenson
- Chris Navitsky
- Dr. Daniel Kelting
- Gerald Delaney
- Joe Martens
- Kevin J. Hajos
- Dr. Kristine Stepenuck
- Phillip Sexton
- Robert J. Kafin
- Tracy J. Eldridge

New York State Agency Representation

- Department of Environmental Conservation
- Department of Transportation
- Department of Health
- Adirondack Park Agency

History of Snow and Ice Control in the Adirondack Park and New York State

The all-weather use of transportation corridors, including highways, streets, and privately-owned paved surfaces, is essential to the function of modern-day society and New York State's economy, which has necessitated snow and ice removal, along with control measures in the winter months to protect public safety. When the transportation system is closed or the capacity is reduced due to inclement weather, the traveling public, industry, and commerce are all affected. This is especially relevant in the Adirondack Park, which typically experiences a longer snow and ice season than other areas of the state.

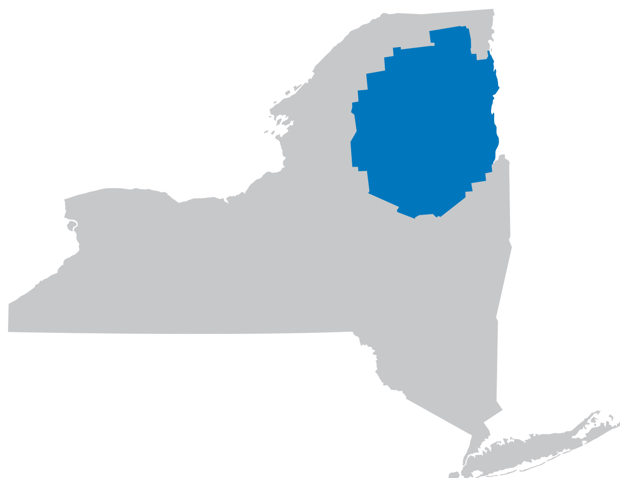
While advances in snow and ice removal have improved public safety and reduced vehicle and property damage, personal injury, and loss of human life, the use of salt and chloride de-icing agents has had adverse environmental, health, and property impacts in some areas of the Adirondack Park, primarily along transportation corridors. The overarching priority for transportation and environmental regulators is to balance public safety needs through snow and ice control practices on roads and paved surfaces with the need to reduce road salt related threats to environmental quality, public health, and property.

The Adirondack Park

A 6-million-acre State Park

The Adirondack Park was created in 1892 by New York State and today contains approximately six million acres (Figure 1) comprised of a blend of public and privately owned lands that are home to small towns and hamlets alongside mountains, forests, lakes, and rivers. In addition to being the largest publicly protected area in the contiguous United States and the largest area of publicly protected lands east of the Mississippi River, the Adirondack Park is greater in size than Yellowstone, Yosemite, Glacier, and Grand Canyon National Parks combined, and is the largest intact, temperate deciduous forest left in the world.

Figure 1. Map of the Adirondack Park in New York State



Within the Adirondack Park, nearly 2.6 million acres of State-owned lands are classified as Forest Preserve and protected as "forever wild." Article XIV, Section 1 of New York State's Constitution, provides in part:

"*The lands of the state, now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed...*"

This mountainous and undeveloped region of New York State is home to many unique and sensitive plants, fish, and wildlife, some found only within the Park. More than 130,000 permanent residents and 200,000 seasonal residents also call the Adirondack Park home. These residents rely heavily on the natural ecosystems of the Adirondack Park to support their local economies through forestry, agriculture, outdoor recreation, and tourism. More than 12 million people from all over the world visit the Adirondack Park each year to take advantage of various outdoor recreational activities, from hiking, skiing, and camping to fishing, hunting, and snowmobiling.

Table 1. Summary of surface water resources in the Adirondack Park by major watershed.

Watershed	Total Area	Lakes and Ponds				Rivers & Streams
		Number	Minimum	Maximum	Total	
	acres		--------------------acres --------------------			miles
Ausable	325,740	248	0.03	1,942	5,162	908
Black	685,135	2,705	0.02	5,842	33,122	1,921
Boquet	174,870	178	0.05	649	1,240	556
Chateaugay	95,760	136	0.02	2,564	3,361	215
Chazy	74,252	22	0.06	1,828	1,845	124
Grass	175,712	329	0.01	440	2,275	435
Minor Tribs to Lake Champlain	341,963	228	0.01	531	2,921	577
Lake George	167,036	148	0.02	28,524	29,452	295
Mohawk	380,366	783	0.03	1,693	11,864	818
Oswegatchie	298,334	867	0.01	6,795	12,847	738
Raquette	607,100	1,389	0.02	6,047	48,162	1,204
Sacandaga	633,334	862	0.02	20,740	38,559	1,228
Salmon	77,588	257	0.02	331	1,588	168
Saranac	361,583	505	0.02	4,844	21,961	861
St Regis	334,818	581	0.02	1,433	8,264	815
Upper Hudson	1,087,692	1,808	0.01	4,618	32,551	2,135
TOTAL	**5,821,283**	**11,046**			**255,174**	**12,998**

Water Resources

The Adirondack Park is also home to a diversity of freshwater ecosystems, with 16 major watersheds that collectively contain more than 11,000 lakes and ponds, and more than 30,000 (12,998 greater than one mile in length) miles of rivers and streams[1] (Table 1). These watersheds connect the Adirondack Park to many of the State's most significant surface waters, including Lake Ontario, Lake Champlain, and the St. Lawrence, Mohawk, and Hudson Rivers.

The Adirondack Park also contains a vast glacial aquifer system with more than 1 million acres of unconfined surficial aquifers. These aquifers are located throughout the Adirondack Park, except for the High Peaks Region where steep slopes and narrow valleys preclude their formation. In these more mountainous areas of the Adirondack Park, smaller valley-fill glacial aquifers dominate.

These surface and groundwaters, and their predominantly forested, naturally intact watersheds, boast thriving fisheries and varying dependent populations of birds and mammals because of exceptional water quality. As a result, these water resources support various forms of recreation, both in and on the water, and provide vitally important supplies of potable surface and groundwater to rural communities (Table 2). The exceptional and abundant water resources of the region also help attract millions of visitors to the Adirondack Park and support a thriving tourism industry.

The combination of shallow bedrock, thin soils, and mountainous terrain makes the Adirondack Park an area where the effects of road salt may be observed before other areas.

Table 2. Summary of uses supported by waters in the Adirondack Park.

Supported Uses	Classification	Lakes & Ponds	Rivers & Streams*
Water Supply Recreation (in and on), Fishing	A, AA, A-Special, AA-Special	557	2,983
Recreation (in and on), Fishing	B	100	522
Fishing	C	4,489	15,293
Fishing	D	693	2,664

* Classification is summarized by regulatory segment, not river/stream miles

1 https://www.dec.ny.gov/docs/lands_forests_pdf/adkmap.pdf

Sources and Impacts of Road Salt

Salt Production in New York State

New York State has a long history of producing mineral salt for use in various applications, dating back to the late 1800s. Historically, Central New York has been the hub for the state's salt production due to natural geologic formations of halite, extracted as both underground rock salt (used mostly for melting ice and snow) and brine (used for medicinal and chemical purposes).

Nationally, rock salt makes up the majority of types of salt produced (~44%), with most of it consumed through the deicing of roads[2]. New York State ranks third in rock salt production, providing approximately 16% (~7.7 million tons) of the total national output[3]. Today, rock salt is New York State's third leading valued mineral product, behind crushed stone and cement respectively, contributing approximately $560 million to the state's economy annually.

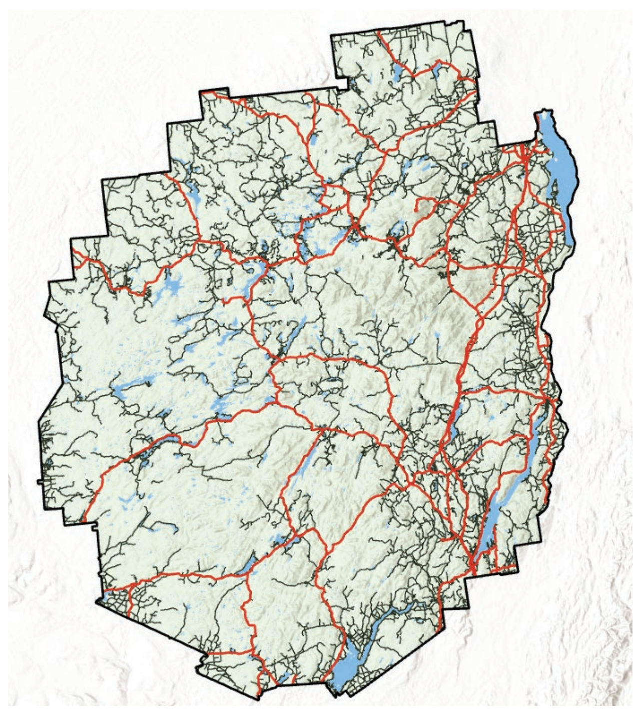
Sources of Road Salt in Surface and Groundwaters

Generally, road salt presence in surface and groundwaters results from its application on public and private roads, sidewalks, parking lots, and driveways (collectively known as impervious surfaces), and from its storage in large, sometimes inadequately covered, piles. Impervious surfaces all have the potential via runoff to contribute significant amounts of road salt and other contaminants to New York State's water resources. One of the more significant forms of impervious surface within the Adirondack Park is the estimated 8,830 total lane-miles[4] of paved roads (Figure 2), which require some form of management for safe winter road travel. Approximately 29% of paved roads in the Adirondack Park are maintained by DOT. These include, State and US highways and Interstate 87, with the remaining 71% maintained by local municipalities (i.e. county, town, and local roads). The State highways are generally higher classified roadways serving higher traffic volumes and higher speeds. According to the NYS Roadway Inventory System, State highways account for 71% of all vehicle-miles traveled in the Adirondack Park, compared to 29% for all other paved roadways.

An estimated 193,000 tons of road salt are applied annually to the road network of the Adirondack Park during the colder months of the year. Of this road salt, 44% is applied to the local road network and the remaining 56% is applied to the state road network. These application estimates equate to an average of 34 tons of road salt per lane-mile applied to state roads and 13 tons per lane-mile applied to local roads. This difference in application rates is supported by the differences in roadway classification, traffic volumes, and vehicle speeds that exist between the State and local road networks[5].

Once dissolved, about half the road salt applied to roads in winter runs off into surface waters through snow melt and stormwater[6]. The remainder finds its way onto surfaces where, even during warmer months of the year when road salt is not applied, it continues to leach farther into surface and groundwaters. At least an estimated 3,687 miles (28%) of rivers and streams and 820 (7%) lakes and ponds within the Adirondack Park have the potential to receive road salt-laden runoff from the paved road network[7].

Figure 2. Map of the Paved Road Network within Adirondack Park. Red lines represent DOT maintained roads and black lines represent locally maintained roads.



2 https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-salt.pdf
3 https://d9-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/atoms/files/myb1-2017-salt.pdf
4 A lane-mile is a mile of roadway in a single driving lane, e.g. 1 mile of a two lane road would have 2 lane miles
5 These data were informally compiled through the work of the Task Force and has not been verified by NYS DOT or local municipal snow and ice removal operators at the time of publishing this report.
6 (Meriano et al. 2009)
7 (Regalado and Kelting 2015)

Impacts of Road Salt on the Environment and Public Health

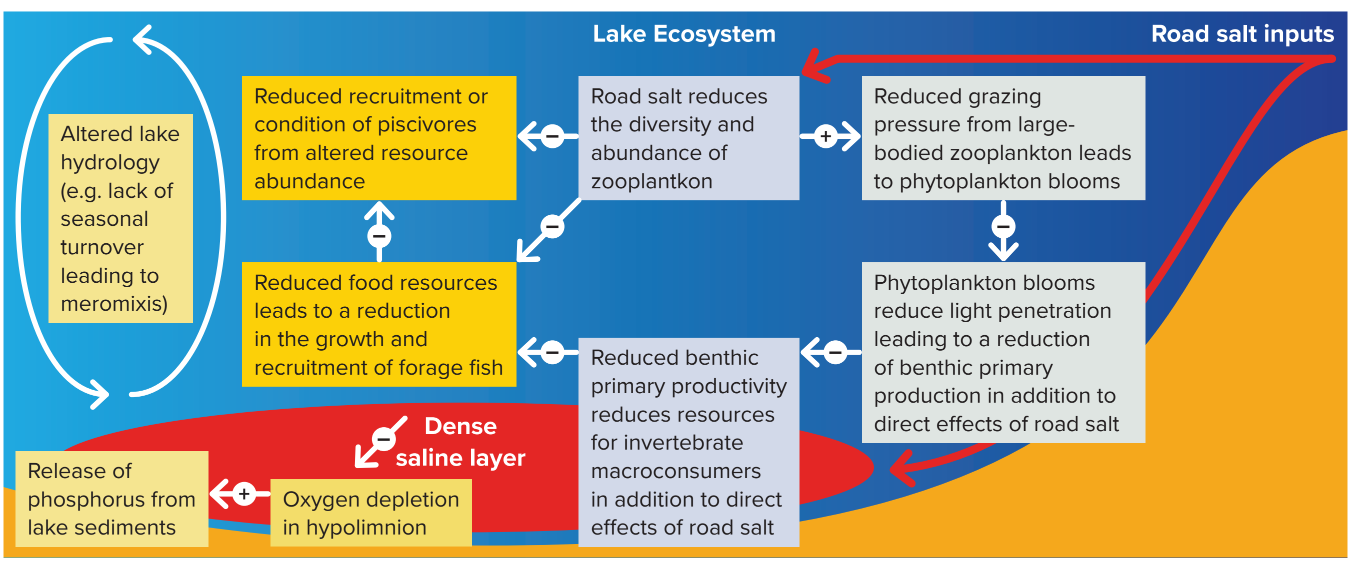
In general, the impacts of road salt on the environment are wide ranging and varied, and include alterations to both aquatic and terrestrial ecosystems. These impacts tend to be associated with chloride, a primary component of NaCl (sodium-chloride, aka "salt"), which is the main component in common road salt.

Once in natural surface waters such as rivers, streams, and lakes, road salt can cause changes in the natural structure and function of aquatic ecosystems and the communities of aquatic organisms that inhabit them (Figure 3). For example, species composition tends to shift toward more "salt-tolerant" species, altering the makeup of communities that form the basis of the aquatic food web, including phytoplankton, zooplankton, and benthic macroinvertebrates. In turn, chloride from road salt can lead to an overall decrease in the productivity of freshwater ecosystems, reducing the overall species abundance, or in cases where there are particularly high chloride concentrations, direct mortality of aquatic organisms. In some lakes, sodium and chloride concentrations can increase with depth and cause oxygen depletion in the hypolimnion (lower level of the water column), triggering the release of phosphorus from sediments, possibly exacerbating cyanobacteria blooms due to the loss of large-bodied zooplankton. Additionally, the presence of road salt in runoff is suggested to increase mobilization of trace metals (cadmium, lead, copper, iron, zinc, and others), which have been demonstrated to accumulate in fish[8].

After road salt is washed away from impervious surfaces to which it is applied, it begins to accumulate in roadside soils, where it not only leaches into surface and groundwater, but becomes available for uptake by plants, similar to other soil contaminants. As a result, road salt has been shown to impact the terrestrial environment by depleting soils of essential plant nutrients. Road salt also influences the mobilization of heavy metals, resulting in reduced plant vigor or even the death of plants along salted roads. These effects can be observed along roadsides where application of road salt is heaviest, with premature loss of leaves (defoliation), discoloration (yellowing), suppression of flowering, premature mortality, and poor regeneration. As a result, road salt encourages the establishment and expansion of non-native vegetation that possess higher salt tolerances than native vegetation, disrupting natural terrestrial ecosystems. These changes in plant communities can have cascading impacts, which in turn, increase stormwater runoff and erosion[9].

In addition to its impacts on aquatic and terrestrial ecosystems, once road salt enters groundwater, it can contaminate sources of drinking water supplies. Sodium and chloride can be naturally present at low levels in drinking water, especially if it is sourced from groundwater, due to their natural occurrence in certain rock and soil formations. However, high concentrations resulting from human activities such as the application of road salt can have adverse impacts on human health and property.

Figure 3. Generalized cascade of impacts from road salt contamination on freshwater lakes. From Hintz, W. D., & Relyea, R. A. (2019). A review of the species, community, and ecosystem impacts of road salt salinization in fresh waters. Freshwater biology, 64(6), 1081-1097



8 (Amrhein and Strong 1990, Qadir and Schubert 2002, Bäckström et al. 2004, Meland et al. 2010, Fay and Shi 2012, Hoomehr et al. 2018, Tiwari and Rachlin 2018, Hintz and Relyea 2019, Wiltse et al. 2020, Fournier et al. 2021)

9 (French 1959, Lacasse and Rich 1964, Anderson et al. 1966, Smith 1970, Hofstra and Hall 1971, Hall et al. 1972, Hofstra and Lumis 1975, Reznicek 1980, PM and SM 1980, Fleck et al. 1988, Viskari and Kärenlampi 2000, Richburg et al. 2001, Environment Canada 2001, Bryson and Barker 2002)

The impacts from high levels of sodium and chloride in drinking water vary. The presence of sodium is typically only problematic for individuals who have low-salt or limited-salt dietary restrictions. Because the majority of the salt humans consume comes from food, drinking water often plays a small role in the total daily amount of salt intake. However, for people with certain medical conditions (e.g., high blood pressure, heart diseases, kidney or liver diseases) that cause them to be on a sodium-restricted diet, the presence of elevated levels of sodium in their drinking water complicates the management of their health risks. In contrast, the impacts of chloride in drinking water are associated with its well-known corrosive properties, which are associated with increased risk of corrosion of metals, including lead, copper, iron, and steel, from pipes and other infrastructure[10]. Households using private wells and small unregulated water systems are at the greatest risk of negative impacts from corrosion. Regulated public water systems sample for lead and copper, and take actions to reduce corrosion when required.

Condition of Adirondack Waters and Levels of Road Salt Contamination

In general, when compared to levels of sodium and chloride elsewhere in New York State, water quality is typically better in the Adirondack Park, with concentrations of contaminants at lower levels. However, there are instances where exceedances of regulatory guidelines that were established to protect human health and the environment exist (Figures 4-6). Additionally, Task Force members with subject matter expertise found more recent scientific literature[9, 10, 11] indicating that certain water quality standards may not be protective enough to prevent impacts to the Adirondack Park's sensitive natural resources. Therefore, more protective limitations may be required to prevent further deterioration to Adirondack Park water quality, wildlife, and the environment.

The Task Force analyzed various sources of water quality data from both surface and groundwater to better understand their condition within the Adirondack Park and to determine potential impacts from road salt. The Task Force also conducted an extensive review of the scientific literature to provide context for the data analysis.

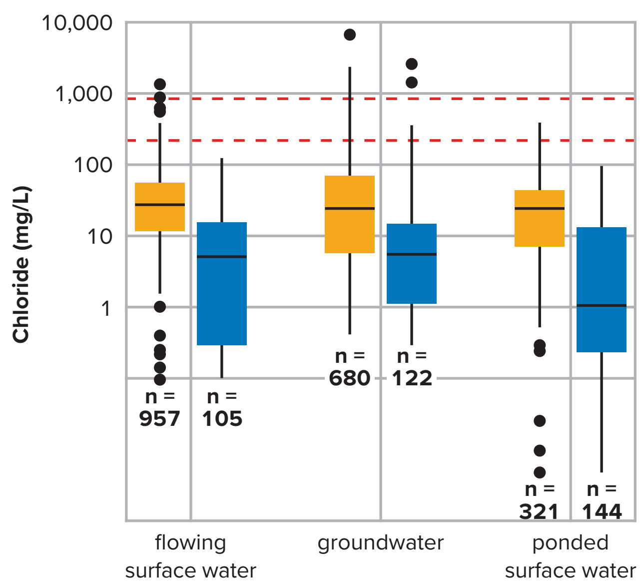
Public Health

The DEC's water quality monitoring programs collect chloride measurements from surface and groundwaters across the state, representing more than 20 years of data for groundwater, 30 years for ponded waters, and 40 years for flowing waters. In general, chloride concentrations are lower within the Adirondack Park compared to the rest of the state (Figure 4). This is true even for the subset of waters classified as drinking water sources (Figure 5), but the levels are potentially problematic, nonetheless.

Environmental regulatory agencies such as the United States Environmental Protection Agency (EPA), DEC, and DOH develop environmental standards that establish the concentration of a pollutant above which an unacceptable adverse effect may occur in the environment or to human health. As such, DEC has established water quality standards for the protection of human health in sources of water supplies, which include:

- 20 mg/L Sodium in groundwater (Class GA[11]); and
- 250 mg/L Chloride in groundwater (Class GA) and surface water (Class A, A-S, AA, AA-S).

Figure 4. Chloride concentrations in all surface and groundwaters of New York State (from DEC's water quality monitoring programs). Blue represents "within" and gold represents "outside" the Adirondack Park. The red dashed lines represent EPA's recommended chronic and acute criteria to protect aquatic life. The number of sites in each category are indicated by the n values in the plot.

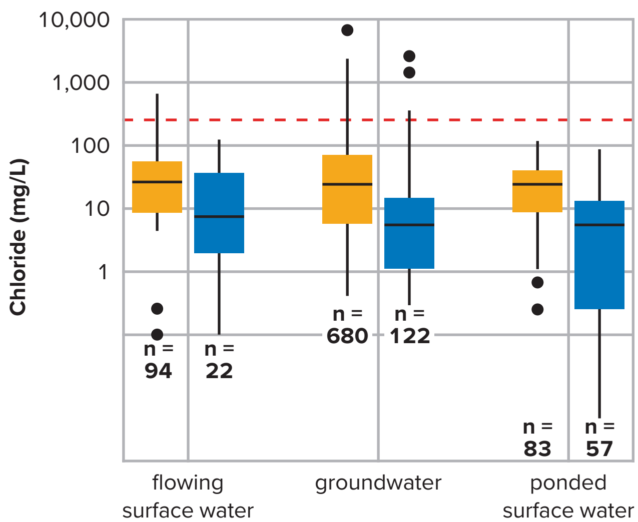


[10] (Edwards and Triantafyllidou 2007, Pieper et al. 2017, 2018, Stets et al. 2018)
[11] Classes defined on page 6 of the Background and Technical Appendix to the Adirondack Road Salt Reduction Task Force Assessment and Recommendations

Among the source water supplies in the Adirondack Park, 5% of the groundwater (Class GA) sampling locations and none of the surface water locations (Class A, A-S, AA, AA-S) exceeded the water quality standard for chloride (Figure 5).

Figure 5. Chloride concentrations in source water supplies of New York State (from DEC's water quality monitoring programs). Blue represents "within" and gold represents "outside" the Adirondack Park. The red dashed line represents DEC's water quality standard for the protection of human health in drinking water sources. The number of sites in each category are indicated by the n values in the plot.

Source Water Supplies Only

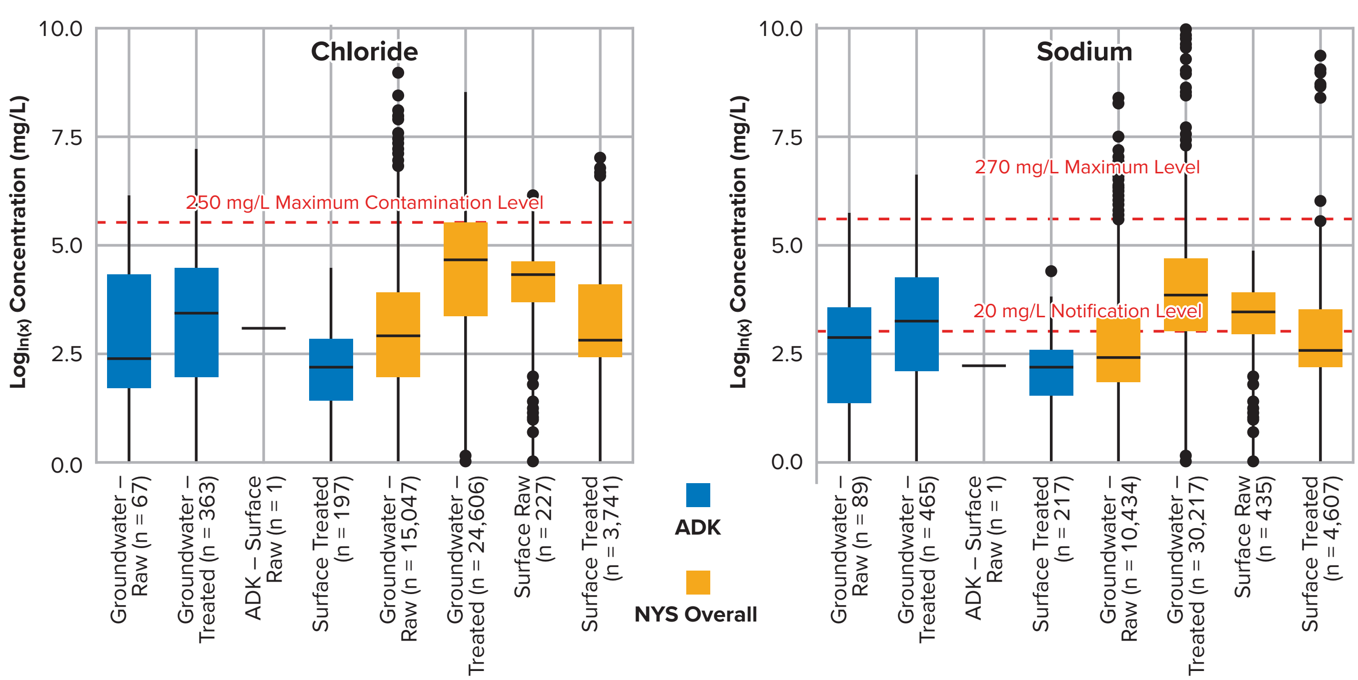


DOH, which provides regulatory oversight of public water systems (PWS), has established a maximum contaminant level (MCL) for chloride of 250 mg/L in finished (treated) drinking water. DOH also recommends that water containing more than 20 mg/L of sodium should not be used for drinking by people on severely restricted sodium diets, and water containing more than 270 mg/L of sodium should not be used for drinking by people on moderately restricted sodium diets. Monitoring for sodium and chloride for community and non-transient non-community water systems is at DOH's discretion, meaning that monitoring is required when there is reason to believe an MCL has been violated, the potential exists for an MCL violation, or the contaminant may present a risk to public health.

From DOH's PWS monitoring, the Task Force analyzed nearly 46,000 sodium measurements from more than 3,600 sampling points across New York State. These results represent approximately the last 20 years of monitoring data. Similar to results from DEC's ambient water quality monitoring programs, concentrations of sodium and chloride from PWS in the Adirondack Park are lower than in other areas of the state (Figure 6). No surface water systems within the Adirondack Park reported chloride concentrations greater than the 250 mg/L MCL. However, in Adirondack systems that use groundwater as their source, 9% exceeded the chloride MCL in raw water, and in treated groundwater, the MCL was exceeded in 7% of systems (Figure 6). With regard to sodium, approximately 40% of Adirondack Park groundwater

Figure 6. The distribution of chloride and sodium concentrations based on location, source, and point of sampling from drinking water systems in the Adirondack Park and New York State. The red dashed lines represent the 250 mg/L maximum contaminant level for chloride (left) and the 270 mg/L and 20 mg/L notification levels for moderately and severely restricted sodium diets, respectively (right). Blue represents "within" and gold represents "outside" the Adirondack Park. The number of samples collected in each category are indicated by the n values.

The Distribution of Chloride and Sodium Concentration based on Location, Source, and Point of Sampling



systems reported concentrations in both raw and treated water samples exceeding the 20 mg/L severely restricted sodium diet notification level. Only 6% of reported raw or finished (treated) water concentrations exceeded the 270 mg/L moderately restricted sodium diet notification level.

Aquatic Life

Although not currently a New York State regulatory standard such as those established by DEC and DOH, the EPA recommends 230 mg/L and 860 mg/L of chloride in surface waters is protective of aquatic life from chronic and acute exposure respectively[12]. Within the Adirondack Park, none of the surface waters sampled by DEC exceeded EPA's recommended chronic and acute toxicity criteria protective of aquatic life (Figure 4).

However, more recent scientific studies indicate an array of impacts to aquatic life at lower concentrations than existing EPA guidance. These impacts have been observed at chloride concentrations below 230 mg/L. For example, some studies suggest changes in aquatic ecosystems occur with chloride concentrations between 5 - 90 mg/L [13] [14], and in oligotrophic, soft water systems with low amounts of calcium, such as those common in the Adirondack Park, impacts have been observed at concentrations less than 5 mg/L[15]. Therefore, 10 mg/L of chloride, which is near the lower limit of impacts to aquatic life, is likely a reasonable threshold below which impacts are unlikely (i.e., protective). This threshold of 10 mg/L is also 20 times higher than the baseline concentration in Adirondack Park waterbodies. Similarly, slightly higher concentrations (closer to 40 mg/L of chloride) have been observed as causing further stress to aquatic life, with additional shifts in ecosystem structure and function at this concentration[16]. This literature-based threshold also aligns with DEC's existing Consolidated Assessment and Listing Methodology[17] values of 42.7 mg/L for flowing waters and 30.9 mg/L for ponded waters.

As described earlier, the primary pathway for road salt to enter the environment is through its routine application to impervious surfaces. Within the Adirondack Park there is a high degree of connectivity between the paved road network and surface and groundwater resources by virtue of road runoff. An estimated 820 lakes and ponds, 3,687 miles of rivers and streams, and 43,273 private residential wells are on properties adjacent to paved roads. As a result, data analyzed by the Task Force suggests water quality in surface and groundwaters associated with the state road network, is being impacted by road salt use (Figures 7 and 8), for example:

- The median chloride concentration in lakes and ponds not receiving any runoff from paved roads was 0.3 mg/L. Lakes and ponds receiving runoff from local roads had a median chloride concentration of 0.9 mg/L, while lakes and ponds receiving runoff from state roads had a significantly higher chloride concentration at 18.7 mg/L. Lakes and ponds that receive runoff from both local and state roads fell in between at 9.9 mg/L.
- The median chloride concentration in rivers and streams not receiving any runoff from paved roads was also 0.3 mg/L. Rivers and streams receiving runoff from local roads had a median chloride concentration of 2.0 mg/L, while rivers and streams receiving runoff from state roads had a higher median chloride concentration at 24.6 mg/L. As with lakes and ponds, rivers and streams receiving runoff from both local and state roads fell in between at 14.4 mg/L.
- Groundwater data, mostly collected from private wells located downslope of state roads, exceeded the 20 mg/L sodium guidance value for people on severely restricted sodium diets.

[12] EPA Nationally recommended criteria are expected to protect aquatic organisms from unacceptable effects assuming the default exposures. Acute, means exposure to a 1-hour average concentration of the chemical does not exceed the criterion more than once every 3 years on average. Chronic, means exposure to a 4-day average concentration of the chemical does not exceed the criterion more than once every 3 years on average. https://www.epa.gov/wqs-tech/supplemental-module-aquatic-life-criteria
[13] (Hintz and Relyea 2019)
[14] (Arnott et al. 2020)
[15] (Palmer and Yan 2013)
[16] (Arnott et al. 2020, Hébert et al. 2022, Hintz et al. 2022)
[17] https://www.dec.ny.gov/docs/water_pdf/calmmay2021.pdf

Figure 7. Median Chloride Concentrations in Lakes and Ponds and Rivers and Streams by Road Runoff Type in the Adirondack Park. Vertical bars represent 95% confidence intervals on the median. The number of sites in each category are indicated by the n values in the plot.

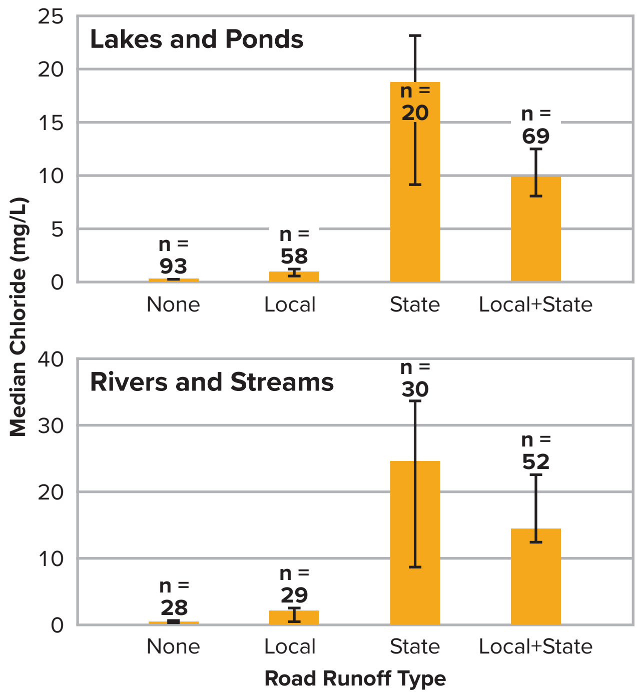
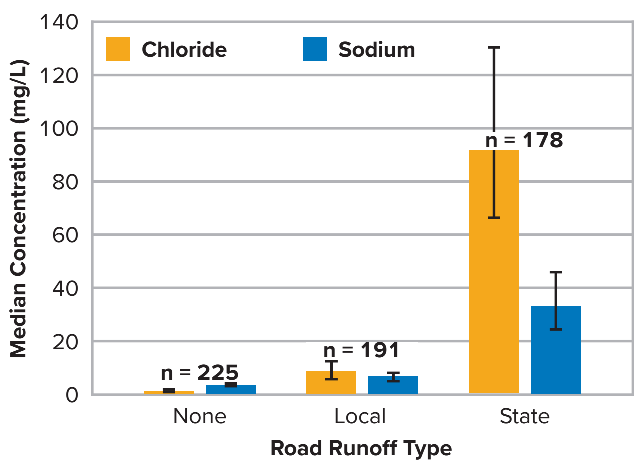


Figure 8. Median Chloride Concentrations in Private Wells by Road Runoff Type in the Adirondack Park. The number of sites in each category are indicated by the n values in the plot.



Task Force Recommendations for Road Salt Reduction Targets

The following recommendations are meant to provide protection of public-health, aquatic life, and the recreation-based economy of the Adirondack Park. However, a detailed evaluation of certain relevant recommendations must be performed based on public safety, the safety of the traveling public, and economic factors before widescale adoption and implementation.

Based on the data and information reviewed related to the impacts of road salt on the environment and public health, the Task Force recommends:

1. Adopt, in regulation, both the Aquatic (Chronic) and Aquatic (Acute) chloride water quality criteria set forth currently by EPA at 230 mg/L and 860 mg/L, respectively. These criteria will help establish a minimum level for protection from salt contamination from various regulated sources.

2. Establish, for the purposes of water quality assessment, clean water planning, and a targeted road salt reduction level for pilots, a surface water chloride goal within the Adirondack Park of 40 mg/L for stress to aquatic life, and 10 mg/L as protective of any change to aquatic life.

3. Set road salt application reduction goals, to be verified by the pilots, in an effort to reduce the chloride level to fall at or below the 40 mg/L goal (Table 3) in most lakes, noting the need for reliable current application data for local and state roads, parking lots, driveways, and sidewalks. This will allow the development of actual load/rate reduction targets (as well as parking lot, driveway, and sidewalk coverage by watershed). In order to set these reduction goals, a comprehensive cost-benefit analysis, with consideration of impacts to public safety, should be undertaken to determine the efficacy of achieving them.

4. Establish sentinel, long-term water quality monitoring stations that are integrated with existing DEC and DOH networks, to monitor road salt impacts over time in both surface and groundwater in the Adirondack Park. Implement road salt reduction pilot programs and associated surface and groundwater monitoring, which will continue as long as necessary to collect meaningful data.

Table 3. Road Salt Reduction Scenarios and Predicted Outcomes Based on Equilibrium (in = out)

Percent Salt Reduction	Lakes Below 230 mg/L	Lakes Below 40 mg/L	Lakes Below 10 mg/L
90	all	50 (100%)	50 (100%)
80	all	50 (100%)	44 (88%)
70	all	50 (100%)	37 (74%)
60	all	50 (100%)	34 (68%)
50	all	49 (98%)	28 (56%)
40	all	48 (96%)	20 (40%)
30	all	47 (94%)	16 (32%)
20	all	44 (88%)	8 (16%)
10	all	43 (86%)	4 (8%)

Road Salt Impacts on Property and Infrastructure

The negative impacts of road salt on property and infrastructure stem primarily from its well-known corrosive properties. The corrosivity of chloride is associated with increased risk of corrosion of plumbing infrastructure and the contamination of drinking water by chemicals mobilized by that corrosion. Based on analysis conducted by the Task Force, using well water data along with real property statistics, an estimated 16,985 or 31 percent of homeowners across the Adirondack Park may be experiencing corrosive damage to plumbing, fixtures, and connected appliances from their well water. An estimated 12,436 or 73%, of these homes were constructed before the 1986 amendment to the Safe Drinking Water Act, which prohibited lead in plumbing and fixtures. Similar to other surface and groundwater data reviewed by the Task Force, corrosivity appears higher in watersheds receiving road runoff, and varies by dominant road type (Table 4). The drinking water well construction details of these older homes is largely unknown, so it cannot be readily determined whether road salt is being introduced to these wells from surface runoff, groundwater, or a combination. Additional studies should be performed to further identify the dominant pathway of the introduction of road salt contamination in these systems.

Table 4. Corrosivity of private well water in the Adirondack Park by road runoff type based on the Larson-Skold Index

Road Runoff Type	Non-Corrosive	Corrosive	Highly Corrosive
None	203 (95%)	4 (2%)	6 (3%)
Local	102 (71%)	12 (8%)	29 (20%)
State	54 (32%)	11 (6%)	106 (62%)

Impacts to human health, the environment, property, and infrastructure (including corrosivity) may be reduced through the use of alternative de-icing materials. Some alternatives for traditional road salt (sodium chloride – NaCl) have more and/or different corrosive properties than NaCl, and most alternatives have other environmental and/or economic (or performance) drawbacks (Table 5). Therefore, selection of an alternative to traditional road salt should not be made without consideration of the application setting, the frequency of use, and the extent of application. For example, many abrasives can perform as a short-term solution to provide traction, but will break down and become less angular over time with traffic. They also impact water quality and aquatic life differently because they do not dissolve and can build up in surface waters and alter stream and waterbody bottoms and flows. Other materials can adversely affect water chemistry in different ways than chloride-based deicers.

Table 5. Some common de-icer alternatives to road salt, and their impacts to infrastructure and the environmental. From National Winter Service Research Group, 2019. Practical Guidance Documents, Section 3, De-Icer Types. https://nwsrg.org/de-icer-types.

De-icer Infrastructure and Environmental Impacts		
De-icer	**Infrastructure**	**Insoluble Content (%)**
Sodium Chloride	Corrosive to steel, aluminum, and reinforced concrete	Harms vegetation, relatively low impact on water quality
De-icers containing agricultural by-product (ABP)	Similar to sodium chloride, potentially less corrosion of spreaders	Similar to sodium chloride. Service providers should contact the DEC to verify their use
Calcium Chloride	Corrosive to steel, aluminum, and reinforced concrete	Damages vegetation, relatively low impact on water quality
Magnesium Chloride	Corrosive to steel and aluminum, damages weak concrete	Damages vegetation, relatively low impact on water quality
Calcium Magnesium Acetate	Non-corrosive to most metals, moderately corrosive to galvanized steel	Benign – least harmful de-icer
Potassium Formate	Non-corrosive to most metals, moderately corrosive to galvanized steel	Slightly lower biochemical oxygen demand (BOD) than potassium acetate so less impact on water quality
Ethylene Glycol	Non-corrosive	High BOD and chemical oxygen demand (COD) so damages ecosystems, toxic to mammals
Propylene Glycol	Non-corrosive	High BOD (higher than ethylene glycol) and COD, damages water systems
Urea	Non-corrosive	High BOD and COD, damages water resources by releasing ammonia and nitrates, toxic to aquatic life.

Notes:
Factors highlighted in red are high impact
Factors highlighted in green are low impact

Best Management Practices to Reduce Road Salt Applications

What Influences Salt Application

Understanding how to achieve reductions in the application of road salt within the Adirondack Park requires an understanding of the intentions behind salt application. These include protecting public safety, meeting user expectations, reducing liability, managing budgets, and operating efficiently.

Across the spectrum of state, municipal, commercial, and private property owners that apply road salt to impervious surfaces, the intent is the same: to clear surfaces of snow and ice to provide safe travel that reduces the potential for injuries and damage related to crashes.

Properly maintained roadways can reduce the amount of salt needed to adequately maintain them free of snow and ice during the winter season. With smooth surface conditions free of potholes, rutting, and delamination, roads are more easily cleared of snow and frozen precipitation by snowplows than a poor road with a high frequency of surface distresses and deficiencies. Additionally, roadside maintenance including shoulder grading, ditching, brush cutting and tree clearing may allow for snow storage off the paved surface, provides positive drainage of surface runoff away from the pavement and lets sunlight onto pavement to increase surface temperatures. Improving these elements directly leads to more effective snow and ice clearing operations with less reliance on road salt.

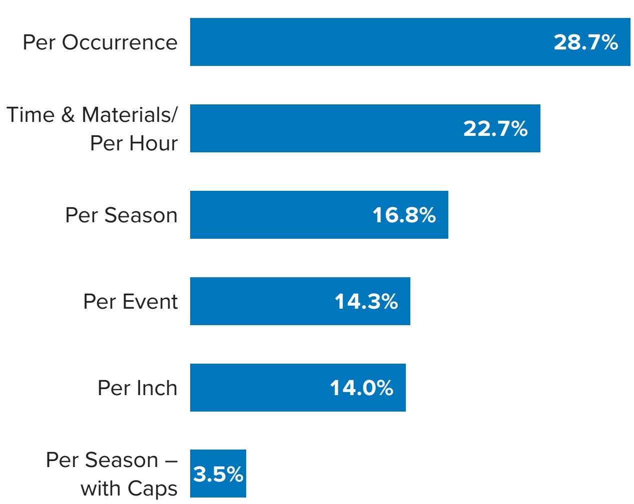
Local and state government officials, residents, property owners and managers, and visitors to the Adirondack Park who drive on the roads all have service expectations for traveling on public roads and private facilities that allow public access in winter conditions.

The State, local governments, and private entities have a duty to protect public safety, maintain surfaces in alignment with that legal duty, and may incur liability for not doing so.

In addition to service level expectations and liability concerns, there are practical economic factors at play related to government and industry budgets, profits, and operational efficiency, which also drive the use of road salt. For some smaller local municipalities, it has been reported that annual snow and ice removal budgets are at the risk of a “use or lose” attitude of appropriators, or require minimum salt deliveries regardless of actual need, which could influence higher rates of road salt application. Many private sector snow and ice removal contracts are based on the frequency and amount (time and materials) of road salt applied. Other contracts are based on an overall seasonal cost, which also can also result in excessive road salt application because it becomes a tool of efficiency over mechanical methods of snow and ice removal. Applying road salt is generally less expensive compared to other winter road management methods and materials, and when coupled with the above-described service contracts, results in salting as a service and profit center (Figure 9) because the unintended adverse consequences are not usually quantified in dollars.

Therefore, salt reduction strategies must recognize the intentions behind road salt use. Salt reduction strategies should work to manage these intentions, and service level expectations, to keep each within reasonable bounds, establish priorities and balance among them, and reduce conflicts, while optimizing public health and safety and environmentally desirable outcomes.

Figure 9. The Top Five Snow and Ice Removal Contract Models, adapted from Wolf, 2016



Review of Best Management Practices

The implementation of best management practices (BMPs) affords an opportunity to reduce road salt application throughout the Adirondack Park, while still meeting a high level of service expectation and providing safe winter travel. While DOT and several municipalities have currently established BMPs that are being utilized in the Adirondack Park and across the state, other state agencies and local governments, and private organizations in the snow and ice removal industry in the Adirondack Park can be challenged with developing and implementing their own standardized BMPs.

The Task Force reviewed, prioritized, and verified a comprehensive list of existing BMPs using existing industry standards already being implemented to reduce road salt applications in the Lake George watershed and other areas of New York State and North America. The BMPs outlined below are intended to improve upon existing practices, and to be easily adopted by private, state, and local snow and ice removal practitioners. The BMPs listed below were categorized based on their intended use in the process of snow and ice removal. The BMPs identified can be incorporated into existing BMPs, and broadly include measurement, calibration, prevention, analysis, improvements, and optimizations.

Measurement

This includes the measurement of the universe of application areas (e.g., road lane miles, parking lot sq. ft. or acres, and sidewalk square feet) to pre-determine reasonable application rates and the output of equipment per application to facilitate calibration. The adequate measurement and recordkeeping of application areas, materials used, application effectiveness (level of service achieved), and various weather and environmental conditions provides the needed information for applicators to effectively refine their snow and ice removal operations to reduce road salt usage and maintain an adequate level of service.

Calibration

This refers to the calibration of road salt application equipment. As with any instrumentation used in various industries, equipment calibration is an important element of maintaining consistent measures of accuracy, precision, and quality control.

Prevention

In the case of road salt application BMPs, among others, prevention means limiting the initial bonding of snow and ice on paved surfaces through a myriad of anti-icing application measures, disincentivizing service contracts that promote higher rates of salt application (described above), and managing road salt storage and other materials to prevent inadvertent loss and runoff.

Analysis

This refers to the analysis of data and information collected during snow- and ice-removal activities to identify and characterize operational anomalies and inconsistencies of salt rate outputs. Directly connected to measurement BMPs, analysis of salt output rates, how well applications are achieving levels of service, and the conditions surrounding them, provide the opportunity to then make improvements and optimize operations.

Improvements

Measuring, calibrating, and analysis provide opportunities for adaptive management to reduce the amount of road salt, meet target levels of snow and ice removal, and provide a reasonable degree of safety for the traveling public.

Optimizations

This includes the use of various methods and technologies that continuously improve and sustain the implementation of reductions in road salt output, while maintaining the safety of the traveling public. For example, applying alternative treatments such as salt mixes and other alternatives, using Direct Liquid Applications such as brine solutions to prevent initial surface bonding of snow and ice, and the installation of segmented plow-blades and other technologies to improve mechanical removal.

Task Force Recommendations for Best Management Practices

In order to implement these recommendations, additional funding from federal, state, or local governments will be necessary. These actions will likely require the leveraging of existing, or creation of new, financial resources.

Recommended minimum measurement practices include:

1. Setting policy for consistently measuring and recording resulting outputs (materials, time, level of service) to enable benchmarking future improvements.

2. Setting standards for measuring and documenting the size of areas where targeted salt applications are to be applied, including roads, parking lots, and sidewalks.

3. Establishing that salt/material (salt sand mix) outputs be consistently and accurately measured and recorded with GPS enabled/automated vehicle location (AVL) salt tracking technology.

4. Adopting a consistent material inventory tracking process that reconciles material (salt/sand) application after each event compared to materials in storage (piles).

5. Setting a policy for consistently measuring and comparing level of service (LOS) performance by event, route, and/or site. Furthermore, it is recommended measuring LOS be automated using a cloud-based road weather information systems (RWIS/Cameras).

6. Establishing a method(s) for comparing salt applications per event compared with categories of weather severity, commonly measured by the weather severity index (WSI).

7. Establishing that surface (pavement) temperatures be measured and assessed before salt application decisions are made.

Recommended minimum calibration practices include:

8. Establishing that salt/material (salt or sand or mix) application output is calibrated to ensure accurate measuring.

9. Adopting a standardized storm dispatching process to include a pre-storm response to perform pre-snow accumulation anti-icing applications to prevent the bond of snow and ice on paved surfaces.

10. Establishing minimum calibration policies that decision-makers (managers/supervisors) and operators (salt truck drivers) may implement, including training and a minimum monthly recalibration practice for all spreader and sprayer equipment.

11. Setting a scheduled cadence of calibration training and practice pre-season, during the season, and anytime a change to spreader/sprayer technology has been made due to repairs or a change in material(s).

12. Establishing minimum and maximum salt inventory and equipment resource allocations based on quantities of lane miles compared with the estimated numbers of trips (laps/cycles) determined from historical weather data information.

13. Establishing minimum and maximum workforce/staffing and equipment capacity thresholds to minimize the use of salt being used as an efficiency tool due to shortages of plow operators or equipment breakdowns.

Recommended minimum prevention practices include:

14. Establishing that public and private snow and ice management service contracts are performance-based agreements that incentivize for efficiency rather than compensate for the quantity or frequency of salt and other materials applied.

15. Setting an anti-icing policy to enable the prevention of snow and ice from bonding to paved surfaces. The use of salt brine (liquid application) being the most efficient material compared to spreading granular (solid application) salt.

16. Establishing that salt and materials be stored on an impervious surface that is covered and self-contained to prevent salt/material storage runoff and leaching.

17. Establishing environmentally sensitive area designations to encourage minimal or no salt use where possible, without compromising safety.

18. Establishing seasonal speed warnings to include inclement weather warning statements that recommend reducing the speed of travel.

Recommended minimum analysis practices include:

19. Establishing that salt and other material (sand) output rates are analyzed on a per application and per event basis to identify anomalies and variances of salt rates that can be reduced and still achieve the same level(s) of service.

20. Setting minimum LOS performance expectations to be achieved.

21. Establishing standard production rates, including time, quantities of material (salt/sand/mix), and LOS expectations, to assess with actual measured materials and monitored LOS achieved.

22. Adopting a consistent dataset and method for assessing weather occurrences and the winter severity index (WSI).

23. Establishing that training curriculum/content development and delivery for winter management operations assess their own sets of data and identify opportunities for production and salt application improvements.

Recommended minimum improvement practices include:

24. Setting a policy standard requiring salt application improvement standards of practice (methods) that are implemented and measured, and provide training to drive forward road salt reduction.
25. Establishing cost- and salt reduction targets based on assessed and observed anomalies and variances, including application rates, application frequencies, and production times.
26. Adopting salt application rate guidelines to benchmark with reputable industry research (i.e., Clear Roads, Snow and Ice Management Association (SIMA), Sustainable Salt Initiative (SSI)).
27. Setting standard communication processes that managers and operators follow for pre-storm, during storm, and post-storm salt application decision-making.

Recommended minimum optimization practices include:

28. Setting a policy for reviewing and updating salt application techniques (methods) and equipment on an annual basis.
29. Creating an annual winter management (including salt application) optimization investment schedule for purchasing and updating assets (equipment) and training (managers and operators).
30. Adopting segmented and other plow optimization technologies (continuously improving options).
31. Implementing Direct Liquids Applications (DLA) anti-icing and deicing methods.
32. Establishing DLA only routes, based on appropriate roadway classification, where vehicle and pedestrian traffic volumes and topography are favorable for piloting (i.e., flat roads vs hills).
33. Establishing chloride-free routes and areas as an alternative to the use of chloride salts, when deemed safe for the traveling public, based on appropriate roadway classification, where vehicle and pedestrian traffic volumes and topography are favorable for piloting.

Training Programs for Snow and Ice Removal

To optimize snow and ice removal practices and to ensure implementation of recommended BMPs, training will be necessary for all applicators working in the Adirondack Park. Targeting state and municipal winter road maintenance workers and commercial and private applicators, training can provide snow and ice removal professionals with the information they need to reduce their use of road salt while maintaining a high level of service.

Thoughtful selection of who develops training materials and provides the actual training will be critical to an effective training program. Train-the-trainer models have proven successful in disseminating new ideas and methodologies to audiences similar to those that apply road salt. In the instance of road salt application, the train-the-trainer concept enables a portion of the winter snow and ice management workforce to receive training from their peers, who are likely to be trusted messengers or "opinion leaders." Using such a model may increase the willingness of snow and ice removal professionals to adopt new strategies.

Absent a mandatory requirement for snow and ice removal professionals to engage in training, incentivizing participation may be necessary. This could be accomplished by providing a professional certification program as a way to deliver training. Salt applicators in the private sector who obtain education and demonstrate a sufficient level of proficiency in the subjects taught could receive a credential. Some incentive may induce workers to seek such certification. Offering limited liability protection to trained and certified practitioners who follow prescribed reduced salt best practices could be one tool to incentivize participation.

Task Force Recommendations for Snow and Ice Removal Training

Recommendations for training of snow and ice removal professionals include:

1. Establishing training programs for state and local winter road maintenance workers and commercial and private property applicators of road salt. The program should focus on optimizing implementation of snow and ice removal practices, and include topics such as BMPs, salt reduction targets and reasons to achieve them, types of equipment and their purposes, and the financial implications of salt use. To the extent DOT's existing training programs contain appropriate information and methods, those materials should be a convenient reference.

2. Establishing that in-person training opportunities provide experience with new technologies and specialized equipment, and instruction on calibration, use, and maintenance of such equipment.

3. Instituting a Train-the-Trainer model so that providers of training include peers of winter snow and ice management workers. Additional, more advanced and specialized training should be provided for those trainers.

4. Creating a certification program associated with the training program for salt applicators who obtain training and demonstrate a sufficient level of proficiency. Incentivize acquiring certification and participation in training by providing a system of benefits to certified individuals; for example reduced liability.

5. Developing instructional materials and guides to BMPs that can be informative to policy- and decision-makers such as elected officials and government regulators. Individuals whose positions influence how road salt is applied should receive instruction to facilitate informed decisions about budgeting, contracting, purchasing, and risk management.

6. Reassessing the salt purchasing mechanisms for local governments and making adjustments to allow road salt acquisition, use, and storage to be more efficient and flexible.

Funding

In order to advance many of the recommendations included in this report, funding from federal, state, and/or local governments will be necessary to ensure the effective implementation of control and response strategies. For many of the small communities in the Adirondack Park, additional financial resources will help advance public education, worker training, recordkeeping, equipment and material purchases, and the implementation of BMPs. In addition to the recommendations outlined below, several sections of this report discuss specific areas where funding is needed to achieve road salt reduction targets.

Implementation of BMPs will inevitably require changes to current snow and ice removal operations, comprehensive planning to institute such changes, and purchasing of equipment for more efficient application of road salt. Various funding mechanisms should be established to ensure BMPs are integrated into current and future operations.

There are currently several programs through DEC and the Environmental Facilities Corporation (EFC), such as DEC's Water Quality Improvement Project Program (WQIP) grants, Non-Agricultural Nonpoint Source Planning, and Municipal Separate Storm Sewer System (MS4) Mapping Grants (NPG), and EFC's Water Infrastructure Improvement Act (WIIA), which could be leveraged to further advance the recommendations of this report. These programs can help reduce road salt contamination at its sources and help protect drinking water supplies. Fundable examples include construction of, and improvements to, deicing material storage facilities, equipment upgrades for measuring salt output (salt spreaders and AVLs), brine making and application equipment, and land acquisition for source water protection.

Recommendations on Funding to Achieve Road Salt Reduction Targets

To reduce sources of road salt contamination, enhance protections of water supplies from road salt contamination, and remediate impacted surface and groundwaters, the Task Force recommends increasing available funding by creating new, or leveraging existing, funding programs. More specifically, the Task Force recommends:

1. Providing funding to incentivize local governments' adoption of technology and equipment to reduce salt use while continuing to have safe winter roads for their communities. Funding levels should remain stable or grow for a 10-year period, and be based on highway miles owned and maintained by the municipality and/or the average annual daily traffic (AADT).

2. Providing funding to incentivize organizations (public and private) to follow the recommended snow and ice removal BMPs.

3. Establishing funding program(s) or expand existing programs, to include road salt reduction BMPs. For example, funding of advanced technology salt and plow trucks or upgraded equipment and expanding the list of eligible projects in the WQIP that target reducing road salt impacts.

4. Funding water quality testing of private wells that would focus on baseline water quality, in addition to testing for emerging contaminants and salt/chlorides. The funding program could potentially be administered by state, county, or local departments/agencies. Funding should also accommodate the remediation and/or relocation of private drinking water wells contaminated by road salt or other deicing agents. Information about this funding should be available at the time of home sales so that both buyers and sellers have access to any available remediation/relocation funding.

5. Providing funding to support a winter road maintenance planning report category in NPG. These reports would require the outline of proposed road salt reducing practices at the municipal level, and would identify current practices, environmentally sensitive areas, and proposed best management practices to reduce road salt application. These plans could then become requirements for applications under other recommended funding programs focused on best management practice implementation.

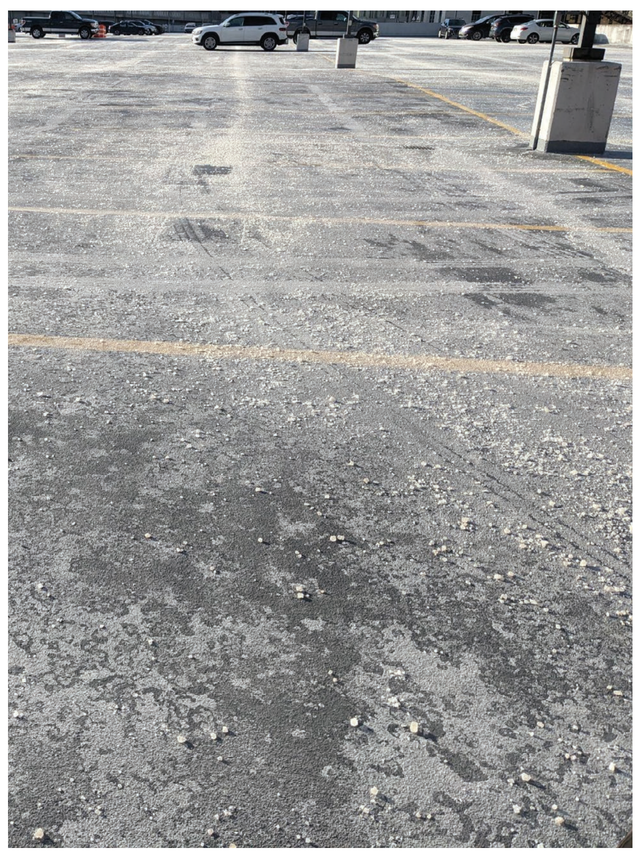
Public Outreach, Education, and Transparency

Providing Public Access to Data and Information

Publicly accessible record-keeping of road salt deicing materials, including purchasing information, and where, when, and how much is applied, will be essential to providing transparency about the use of road salt and its related costs and impacts.

In order to ensure that information on road salt usage and other deicing materials is as comprehensive as possible, data and information on road salt usage should be collected and reported by the primary applicators. Recognizing the difficulty of such reporting, a phased roll-out of required reporting may be necessary.

Similar approaches already exist for various New York State sources of data and are maintained by Open Data NY (https://data.ny.gov/). Therefore, it is possible that this same public data repository could be updated to provide this type of reporting on road salt usage to meet the emerging demand for information.



Recommendations on Providing Public Access to Data and Information

To provide access to data and information about road salt and its application in New York State, the Task Force recommends:

1. Requiring the reporting of road salt usage data and information by the primary entities involved in snow and ice removal operations (both public and commercial). Reporting should include, at a minimum, dates, sources, concentrations (as relevant), and quantities of anti-icing and deicing product purchases; types of materials used; where, when, and how much was applied; application rates; frequency of use; lane miles or area treated; costs; and storm weather statistics.

2. Implementing a phased-in approach to road salt data use reporting. For example, phase-1 should require reporting by state government, phase-2 local governments, and phase-3 the private (commercial) sector.

3. Creating a comprehensive, publicly accessible online database to collect and store road salt usage information. All salt applicators should have the responsibility of self-reporting information, but the database should be created and maintained by a State agency. The database should be updated at least once a year.

4. Establishing a publicly accessible, online reporting dashboard connected to the salt usage database that provides compilations of easily-understood, nontechnical information about winter salt use.

5. Expanding upon existing systems used for reporting water quality data to provide publicly available information on the fate and transport of road salt into surface and ground waters, especially those used for public drinking water supplies.

Public Education and Outreach

In order to effectively reduce the impacts of road salt on public health and the environment, an understanding among targeted audiences that use and have the potential to be impacted by the use of road salt should be established. To this end, a suite of targeted public education and outreach campaigns could be an effective tool. The goals should be to instill a shared understanding of the need for an effective winter maintenance program, the impacts of excessive road salt applications, bolstering support for road salt reduction measures and alternative removal approaches from a wide set of targeted public audiences, fostering a willingness among the public to support salt management, and garnering support from elected officials to facilitate implementation of best practices, while also considering public safety.

The overarching message of such an initiative should be to establish the clear need for an effective winter maintenance program to ensure public safety, while at the same time limiting the impacts to the environment and public health.

Recommendations on Creating Public Education and Outreach Campaigns

To develop public support for and adopt improved winter maintenance and road salt reduction practices, the Task Force recommends that New York:

1. Creating public education and outreach campaigns regarding salt use, salt impacts, the need to effectively and safely manage salt use, and actionable steps various target audiences can take to reduce salt use. These campaigns should be developed under the leadership of the Task Force co-chairs and should include participation by state agencies, members of the Task Force, and relevant public and private stakeholders as identified by the Task Force co-chairs.

2. Developing outreach materials targeting various specific audiences to garner support for and adoption of reduced salt practices by the many different sectors of the population. For example, the campaigns should target materials toward specific audiences that use, benefit from, and/or are impacted by use of road salt, such as homeowners, renters, private contractor clients, drivers, wintertime tourists, policymakers, roadway maintenance operators, business owners, and property managers.

3. Utilizing a wide variety of messaging methods, such as public service announcements (PSAs), pamphlets, tip sheets, social media, webinars, op-eds, road signage and messaging, etc., as relevant to each target audience.

4. Evaluating the campaigns' effectiveness, which may include before and after surveys, and observations of control and treatment groups.

Rapid Response to Surface and Groundwater Contamination by Road Salt

Addressing road salt contamination of surface and groundwater, whether as a result of past practices or arising from the continued use of road salt, is important to ensure protection of the environment and public health. This is especially true with regard to remediating public and private water supplies that provide drinking water to the residents and visitors of the Adirondack Park. Unfortunately, it can be difficult for property owners and others in the general public to clearly understand the process by which information on road salt contamination is transferred from problem identification through to remediation. Therefore, it is necessary to create a rapid and efficient process by which information about road salt contamination is conveyed to those impacted by it, and to the government agencies responsible for minimizing the impact.

Recommendations on Rapid Response to Surface and Groundwater Contamination

To ensure a rapid and complete response to surface and groundwater contamination from road salt, the Task Force recommends:

1. Developing an appropriate mechanism or agreement to coordinate between DEC, DOH, and DOT, which is consistent with law, which outlines opportunities to respond to and remediate surface and groundwater contamination, including public and private drinking water supplies.
2. Providing information for landowners on how to test water at certified labs, how to determine likely cause(s) of contamination, recommended protective and remediation actions, the availability of financial or technical support, and other available assistance.
3. Publishing a clear, transparent, and user-friendly process for landowners to file a complaint in the event that their private well is discovered to be contaminated with road salt. This documentation should detail how to file such a complaint, the functions of involved agencies, and a reasonable timeframe that the landowner will be contacted by the agency with jurisdiction to assist in rapid response.
4. Creating a funding mechanism to provide economic support to cover the costs of reasonable remedies to restore drinking water quality for households whose water exceeds New York State guidance for drinking water supplies, including sodium and or chloride, in cases where road salt is determined to be one of the sources of contamination. Qualifying low-income households should receive financial support for reasonable remediation. It is further recommended that a cost study be conducted to determine the size and scope of impacted private wells.
5. Examining the existing statutes of limitation for making a landowner claim of contamination from road salt and other drinking water contaminants to ascertain if sufficient time exists for a reasonable determination as to the existence of contamination, the potential source of contamination, and the effectiveness of any responsive actions.
6. Reviewing the feasibility of establishing a legal requirement that a seller of a home with a private drinking water supply disclose the sodium and chloride content of the home’s water supply. This recommendation is contingent upon the creation of a funding mechanism so that homeowners have access to economic relief when sodium and/or chloride contamination is identified.
7. Conducting a feasibility study to determine if the use of DEC and DOH’s joint Drinking Water Source Protection Program, or similar programs, would be of utility in the creation and implementation of plans to reduce road salt concentrations in surface waters used for drinking water. The application processes for the appropriate existing program(s) should be reviewed to ensure that the applicant’s burden is minimized. It is further recommended that case studies of impacted water supplies, such as Butternut Pond in Chesterfield, NY, be included in the feasibility study.

Recommendations for Road Salt Reduction Pilot Studies

The Task Force recommendations for establishing and implementing road salt reduction pilot studies in the Adirondack Park include the following:

1. Pilot framework
2. Pilot categories and location candidates
3. Pilot implementation recommendations
4. Pilot operational planning, monitoring, and management recommendations
5. Potential pilot implementation challenges and constraints

Pilot Framework

Pilot recommendations combine the need to measure and assess salt application data along side implementation of best management practices so that we can begin to compare salt application rates, develop benchmarks, identify anomalies, and establish variables to compare through a diverse set of pilots.

Recommended Hypotheses

The recommended hypotheses to include for developing pilot recommendations:

1. Current rates of salt applications used in public and private operations, including roadways, parking lots, sidewalks, and private roadways, may be higher than they need to be for achieving a safe and acceptable level of service.
2. Less salt is applied when a comprehensive set of minimum winter management guidelines are consistently followed.
3. The rates and frequencies of salt application rates increase when levels of service or perceived levels of quality for snow and ice control are increased by policymakers or their constituents/ clients.
4. The amount of salt applied is higher when municipalities, property owners, or contractors are liable for slip and fall claims.

Specific Aims

The pilot recommendations may support the need for a broad range of contextual analyses of current winter maintenance practices that are then benchmarked with interventions of methods and technologies that are introduced and implemented over the period of the pilot, and could address these specific aims:

1. Determine if salt and/or other materials can safely be reduced, such as by comparing salt application rates applied against the existing guidelines established by DOT and other winter maintenance research groups (e.g., Clear Roads).
2. Identify existing salt application rate guidelines to be utilized as a model for furthering the development of a Park-wide standard. Develop a comparative analysis overlay of salt application rates to show where the opportunities for standardization exist.
3. Evaluate and summarize the current state of how winter maintenance is being practiced throughout the Adirondack Park. Some Task Force members suggested this could be accomplished through a survey and political, economic, social, technological, legal, and environmental (PESTLE) analysis methods for categorizing the PESTLE issues that impact the current practices and sustainability of each operation that applies salt throughout the Park. They also recommended that a comparative review of current studies and surveys will be beneficial to include a) ADK Action Clean Water, Safe Roads Partnership, b) Ausable River Association AsRA Salt Use Survey, c) Lake Champlain Sea Grant survey, d) salt output and level of service data collection for the Lake George Salt Reduction.
4. Investigate the primary drivers and variables that influence the amount of salt used in each pilot. Develop a weighted scale of the variables identified in the collaborative survey and analyses processes.
5. Discover the practical constraints, implications, and anomalies from the analyses of the diverse pilots to provide a foundation for the development of future salt reduction guidelines to be implemented throughout the Adirondack Park. It is expected that further discoveries will result in the need for future research and salt application rate standards. Furthermore, it is anticipated there will be a significant need for the development and enforcement of new policies, standards of practice, government regulation/ legislation, training, and certification.

Pilot Categories and Location Candidate Recommendations

By law, the Road Salt Task Force report is to include recommendations for an Adirondack Park Road Salt Reduction Pilot program. It is with this charge in mind that the members of the Task Force thought it would be beneficial to suggest specific potential pilot locations for consideration as part of DOT's assessment of where and how to implement a possible pilot program based on the findings of this report. While these locations are not guaranteed for pilot programs, the Task Force recommends the development of six pilot categories to be reviewed by the agencies/entities responsible for the development of said pilots with the appropriate resources and funding.

Public safety and the safety of the traveling public must be duly considered by the municipality or other responsible party before implementing or continuing any pilot. Adjustments to the recommendations below may be needed to ensure the pilot can be implemented, while still maintaining the roadway in a reasonably safe condition.

Pilot Category 1: Comprehensive Analyses of Minimum Best Practices Implementation(s) within Existing Municipal Pilot(s)

Collaborate and financially support (fund) the ongoing DOT pilots and Lake George proof case models.

Goal

Establish minimum standards for salt application policies and practices that all municipal winter management operations (state, county, town, village) should follow throughout the Park.

Objectives

1. Season 1: Establish a baseline of salt application practices and rates being followed in each pilot location, which will allow for benchmarking when salt reduction interventions are introduced or expanded in season 2.
2. Season 2: Determine the minimum standard of salt application practices and rates, and recommend that winter management operations Parkwide adopt these standards.

Location Candidates

1. Route 86 – DOT
2. Route 9N – DOT
3. Warren County
4. Town of Hague

Pilot Category 2: Comprehensive Analyses of Minimum Best Practices Implementation(s) within New Municipal Pilot Areas

A pilot of new locations, with the primary purpose of establishing a confident baseline of the amounts of salt being applied to the paved road network within the Park, and to also assess surface water responses to reduced salt application. This pilot should help inform how different lakes and watersheds will respond to reduced salt loads, and will test assumptions regarding steady state and accumulated salt storage in watersheds.

Goals

- Season 1 Goal: Establish a baseline of application rates and level(s) of service achieved when implementing current practices (a.k.a., "business as usual").
- Season 2 Goal: Document a comparative analysis of salt outputs when interventions of best practices are introduced and implemented.

Objectives

1. Measure salt application outputs consistently with GPS-enabled salt tracking technology.
2. Monitor the LOS being achieved using a consistent method and technology.
3. Develop a detailed list of salt reduction interventions to implement in season 2.
4. Document LOS achieved per storm event within Winter Severity Index (WSI) categories including, at minimum, air and road surface temperatures.
5. Measure and analyze chloride loading levels in adjacent soils and waterbodies utilizing current and ongoing research data.
6. Develop a broad stakeholder engagement plan that identifies and addresses barriers to discovery and implementation of best practices among winter maintenance practitioners and their constituents.

Pilot Category 2 Location Candidates

1. St. Regis/Lake Clear/Rt. 30 DOT and local town(s) routes

2. Mirror Lake – Village of Lake Placid, Town of North Elba

Pilot Category 3: Managing 'Cold Spots' on Roadways

Vegetation along State travel corridors within the Adirondack Park plays a variety of important functions, including control of runoff, screening, and maintenance of a natural, park setting. Vegetation can also create safety problems, clog drainage structures, and impair visibility. Vegetation, particularly coniferous trees, can also shade road corridors during the winter months and create "cold spots" where snow and ice accumulate. Road maintenance crews often apply significantly greater amounts of road salt to these shady road corridors to provide safer driving conditions. The Final Generic Environmental Impact Statement/Master Travel Corridor Unit Management Plan for State Highway Corridors in the Adirondack Park acknowledges and describes this problem as follows:

> Tree canopy cover and the shade it provides has maintenance implications even when no hazard trees are present. Portions of corridors with a more open canopy and/or greater tree set back (from the highway), especially on the prevailing sunny side, benefit from higher pavement temperatures during winter maintenance periods. Excessive shade can produce "cold spots" and the rapid formation and persistence of ice in the roadway. The judicious management of roadsides could directly result in smaller and/or fewer cold spots and, secondarily, reduced salt use. Management activities can include preventing new conifer growth, pruning and selective tree removals, and canopy thinning, balanced with other considerations (e.g. aesthetics, forest preserve).[18]

There are "cold spots" along Adirondack Road corridors, many of which are proximate to sensitive water resources such as lakes, ponds, streams, and wetlands.

The thinning or cutting of coniferous trees that shade road corridors and create "cold spots" can be complicated when the trees are located on State land that is protected by Article XIV of the NYS Constitution, which prohibits the removal or destruction of the timber thereon.[19]

The Task Force recommends a vegetation management pilot for managing "cold spots" created on road surfaces that typically require more frequent application of road salt compared to pavement surfaces exposed to radiant heating from the sun. One function of the pilot should include determining what the process(es) and potential legal constraints will be for accomplishing this in areas within the Adirondack Park that are Forest Preserve and are, therefore, protected by Article XIV of the New York State Constitution.

Furthermore, it is recommended road surface-temperature models be developed and overlaid with a map of the Forest Preserve to identify cold spot area candidates.

Goal

Develop a documented 'Proof of Concept' model for managing roadway "cold spots" by implementing a vegetation management pilot as an additional alternative to the need for frequent and excess road salt application in certain locations.

Objectives

1. Identify pilot areas to perform vegetation management based on road surface temperature-salt application rate models under various vegetation management scenarios.

2. Develop a process and documentation format to sufficiently articulate the desired site conditions of the pilot area, the expected impacts to the Forest Preserve necessary to achieve those conditions, and a methodology for evaluating the effectiveness of any actions taken.

3. Given the sensitivity of the Forest Preserve, emphasize transparency and solicit public and stakeholder feedback throughout the pilot project.

4. Measure salt output(s) and LOS consistently with recommended technology and methods.

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18 NYS Travel Corridor Unit Management Plan for the Adirondack Travel Corridors, May 2019, p. 4-32

19 NYS Constitution, Article XIV, Section 1.

Recommended Pilot Project Areas and Plan

The Task Force recommends that DOT, DEC, and the APA identify a limited number of specific "cold spots" from known problem areas adjacent to vulnerable water resources or private water supplies that are known to have elevated sodium and chloride levels. For these locations, DOT should complete site-specific temperature modeling of road surfaces under various vegetation management scenarios with modeled outputs of resulting reductions in road salt application rates. Specific pilot locations should be selected from areas where modeled scenarios suggest significant reductions in road salt applications under the most limited vegetation management scenarios.

Additional Considerations

- Management and Monitoring Plans – Once the limited "cold spot" areas are identified, the agencies should prepare a detailed vegetation management work plan that delineates the cutting limits, identifies which trees would be removed, and tabulates the total number of trees of each species and size class to be cut and removed. Each plan should also describe how the area would be managed following the cutting to discourage regrowth of coniferous trees. Plans should also identify target road salt reductions, based on modeling, and a monitoring protocol for evaluating the effectiveness of the tree cutting on achieving target(s).

- Public Notice and Input – These management plans should be publicly noticed for a period of at least 60 days to receive public comments on suggested plans. Notification of the public comment period should be announced through various state and local services, including print and digital media, and DEC's Environmental Notice Bulletin (ENB), if applicable. A public information meeting should be conducted during the comment period. A response to public comment on the suggested plans should be published, describing how comments were addressed in the revised plans.

- Finally, as outlined in the Vegetation Management and Monitoring Plans, the agencies should carefully monitor and record the results of the limited number of pilot projects undertaken to determine if the cutting was beneficial, if less road salt was necessary to maintain reasonably safe driving conditions, and what lessons were learned that could be applied to future "cold spot" management projects.

Pilot Category 4: Chloride Free Zone(s)

Designate chloride-free areas and or routes to test the effectiveness and efficacy of chloride-free alternative deicing products (i.e., Potassium Formate).

Goal

Develop a proof case model that achieving safety and level of service performance expectations can be met or exceeded when implementing chloride-free deicing alternatives.

Objectives

1. Identify low travel areas to test alternatives. Higher traffic areas may be considered too risky to initially test, and higher traffic conditions are easier to manage snow and ice conditions than low traffic conditions.

2. Measure salt output(s) and LOS consistently with recommended technology and methods.

3. Set 'fail safe' methods, including having the traditional methods and materials on hand.

4. Analyze level of service achieved with chloride-free alternatives and methods compared with the cost of traditional materials and methods.

Location Candidates

1. Mirror Lake – test and analyze segregated areas within the Village of Lake Placid.

2. Lake Clear – test and analyze segregated area(s) of pilot category 2.

Pilot Category 5: Seasonal Speed Warnings

Establish "low salt" or "no salt" use areas for posting seasonal speed warning signage if the implementation of such areas is deemed safe for the traveling public. Signage is to include inclement weather warning statements of hazardous driving conditions and recommending travelers significantly reduce their speed of travel.

Goal

Develop a proof case that weather warning signage statements provide opportunities to reduce road salt rates and frequency of application.

Objectives

1. Identify areas/routes to install signage
2. Decide on statement(s) to include on signage
3. Decide on signage type (e.g., digital)
4. Establish salt application measuring and level of service monitoring to benchmark application rates and levels of service achieved during each storm event

Pilot Category 6: Private Properties

Evaluate the use of road salt throughout the Park within private parking lots, sidewalks, and other surfaces where road salt is used to manage slippery conditions on privately owned commercial properties that are publicly accessible. Retail, commercial office, and hospitality properties are recommended to be the primary focus for this pilot.

Goal

Encourage private property owners to develop a baseline analysis of salt applied as a benchmark for future salt reduction.

Objectives

1. Provide salt measuring and monitoring technology to private property candidates.
2. Establish a comparative analysis framework for properties to be measured and compared when applying road salt—Season 1 “business as usual” compared with a Season 2 introduction of salt reduction methods and technology.

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