City of Kingston
Report to Council
Report Number 26-116

To:	**Mayor and Members of Council**
From:	**Ian Semple, Commissioner, Transportation & Infrastructure Services**
Resource Staff:	**Karen Santucci, Director, Public Works & Solid Waste**
Date of Meeting:	**May 5, 2026**
Subject:	**Winter Road Maintenance Practices and Alternatives Review**

Council Strategic Plan Alignment:

Theme: Council requests

Goal: 3.4 Improve road condition, performance, and safety.

Executive Summary:

This report responds to Council's direction to provide an overview of the City's winter maintenance practices and assess the feasibility and impacts of beet-based and similar alternative de-icing products. It outlines current operations, existing chloride reduction measures, and a review of alternative materials from operational, financial, infrastructure, and environmental perspectives.

Kingston's winter maintenance program uses a coordinated approach that includes plowing, brine application, salt, and sand to maintain safe travel conditions while minimizing environmental impact. The City employs proactive anti-icing, pre-wetting, calibrated application, and temperature-based material selection to reduce overall salt use. These practices align with national best practices and are supported by operator training, protected storage, route tracking, and the identification of salt-vulnerable areas, resulting in a mature and well-managed program.

The report confirms that while road salt remains necessary for winter safety, its environmental impacts are actively managed through measures that reduce chloride loading and limit long-term effects on soil, vegetation, and aquatic systems. The City's current approach is intended to balance safety requirements with environmental stewardship and continuous improvement.

A review of beet-based and other organic additives indicates that these products do not provide meaningful advantages over existing practices. Municipal trials have identified limited performance benefits, increased costs, operational challenges such as equipment clogging and maintenance, and additional infrastructure requirements. Many municipalities and suppliers have discontinued their use. Emerging research further indicates that beet-based additives may pose greater risk to freshwater ecosystems than traditional salt due to their impact on dissolved oxygen levels.

The report also identifies that alternative organic additives beyond beet-based products have not demonstrated consistent operational reliability or environmental benefit and have not been adopted at scale. Initiating a pilot program in Kingston would require new infrastructure, additional operational resources, and higher material costs, without evidence of improved outcomes.

The City’s current winter maintenance practices are effective, evidence-based, and aligned with industry standards to minimize environmental impact. The City is well positioned to continue optimizing its program and will incorporate these findings into future reviews of its Winter Maintenance Program and Salt Management Plan in alignment with anticipated updates to Minimum Maintenance Standards in 2027.

Recommendation:

This report is for information only.

Authorizing Signatures:

ORIGINAL SIGNED BY COMMISSIONER

Ian Semple, Commissioner, Transportation & Infrastructure Services

ORIGINAL SIGNED BY CHIEF ADMINISTRATIVE OFFICER

Lanie Hurdle, Chief Administrative Officer

Consultation with the following Members of the Corporate Management Team:

Paige Agnew, Commissioner, Growth & Development Services	Not required
Jennifer Campbell, Commissioner, Community Services	Not required
Neil Carbone, Commissioner, Corporate & Emergency Services	Not required
David Fell, President & CEO, Utilities Kingston	Not required
Desirée Kennedy, Chief Financial Officer & City Treasurer	Not required
Jenna Morley, City Solicitor	Not required

Options/Discussion:

On March 24, 2026, Council passed the following motion:

> **Whereas** Council has received inquiries regarding the potential use of beet-based or other organic additives for winter road maintenance; and
>
> **Whereas** staff have identified operational, financial, infrastructure, and environmental considerations associated with these products, and noted that several municipalities have discontinued their use following trials;
>
> **Therefore Be It Resolved** That Council direct staff to prepare an information report to be provided to Council by Q4 2026 that summarizes Kingston's current winter road maintenance practices, including existing chloride reduction measures, and provides an assessment of beet-based and similar alternative de-icing products, including operational performance, infrastructure requirements, cost implications, and environmental considerations.

The report provides a comprehensive overview of the City's current winter maintenance practices, existing chloride reduction measures, and a review of beet-based and similar alternative de-icing products, including their operational, financial, infrastructure, and environmental considerations.

Background

The City uses a coordinated suite of winter control techniques including plowing, brine, salt, and sand to on the City's transportation network to maintain safe travel options during the winter season. The scale and type of operation completed is based on weather and temperature forecasts and is intended to maximize the effectiveness of the winter control program while minimizing any environment impact created by the salt application.

Ahead of most winter events, unless rain is forecast, the City applies a liquid brine as a direct liquid anti-icer (DLA) on arterial and collector roads. This prevents snow and ice from bonding to the pavement, making plowing more effective, reducing the amount of solid material required, and lowering overall road salt use. The liquid brine made from a controlled blend of calcium chloride, magnesium chloride, and sodium chloride to support its winter maintenance program. This brine has a lower environmental impact than applying straight rock salt because it allows operators to use significantly less total chloride while still maintaining safe road conditions.

When applied as an anti-icer or pre-wetting agent, the brine adheres to the pavement, reduces scatter loss, and prevents snow and ice from bonding to the road surface, which in turn reduces the amount of granular salt required later in the storm. Although the brine still contains chlorides and is not environmentally neutral, its targeted application and reduced overall usage help limit chloride loading in local waterways and make it a more environmentally responsible option than traditional rock salt.

Operationally, Public Works begins plowing early in the storm rather than waiting for accumulation, which reduces the amount of salt over the course of the winter event. During and after storms, crews apply a combination of salt and sand depending on pavement temperature and conditions: a stronger salt based mix is used when temperatures are warm enough for it to function effectively as a chemical de-icer, while a predominantly sand-based mix is used to provide traction when temperatures are too cold for salt to melt ice efficiently. To balance traction needs with environmental stewardship, a small amount of salt is added into the sand stockpile during placement into storage to prevent clumping and improve performance while still significantly reducing chloride use.

The City regularly calibrates its sanding and salting equipment to ensure that the correct amount of material is being applied during winter operations. Calibration aligns the spreader's output with operator settings, preventing under-application, which can compromise road safety, and over-application, which wastes material and increases environmental impact. Proper calibration ensures that sand, salt, and mixed materials are delivered at consistent rates based on truck speed and equipment settings.

Calibration is considered one of the most effective tools municipalities have to proactively reduce chloride loading in waterways and minimize the amount of sand entering stormwater systems. By applying only what is needed for traction and de-icing, Kingston reduces unnecessary salt use, limits sediment accumulation in ditches and catch basins, and supports healthier soils, vegetation, and aquatic ecosystems.

Complementing these approaches, the City also uses nationally recognized best practices for reducing road salt use including:

- Covered salt storage on impermeable pads, preventing runoff and minimizing product loss, consistent with Environment and Climate Change Canada's Code of Practice.
- Operators receive regular, structured training on application rates, environmental impacts, and equipment operation, ensuring consistent and defensible practices across all routes.
- Salt-vulnerable areas such as bridges over waterways have been identified and sand or alternative materials are used in these locations to protect sensitive environments.
- Location tracking technology is used to track salt usage by vehicle and route, supporting continuous improvement, accountability, and data-driven decision-making.

Environmental Considerations of Road Salt Use

While road salt is an essential tool for winter safety, it carries well-documented environmental impacts that municipalities must actively manage. Chloride from road salt does not break down in the environment; it accumulates in soil, groundwater, streams, and lakes over time. Elevated chloride levels can harm aquatic life, stress vegetation along roadways, and degrade soil structure, making it harder for plants to absorb water and nutrients. Salt can also accelerate corrosion of vehicles, bridges, and municipal infrastructure. Based on these cumulative effects, municipalities focus on reducing overall salt use through strategies such as pre-wetting, anti-icing with brine, temperature-based material selection, and blending small amounts of salt

into sand to prevent clumping without over-applying chlorides. These practices help maintain road safety while minimizing long-term environmental harm and align winter operations with the City's broader sustainability and watershed-protection goals.

Testing Alternatives to Road Salt

Recognizing the desire to reduce the environmental impact of winter maintenance operations, municipalities and industry began exploring alternatives in the late 2000s. Municipalities initially explored beet-juice-based additives as a way to enhance the performance of traditional salt and reduce overall chloride use. The appeal of beet-juice additives was rooted in the idea that an organic, agricultural by-product could improve efficiency, reduce salt consumption, and potentially lessen environmental impacts.

Beet-juice products were expected to lower the freezing point of brine, improve melting effectiveness at colder temperatures, and help salt adhere better to the pavement, reducing scatter loss and the amount of granular salt required. Initial trials were of pure beet juice and over time this changed to beet juice being an additive to a salt brine.

A number of municipalities in Ontario and Canada tested beet-based products to determine if these additives would support safer winter operations during extreme cold, extend the effective temperature range of their existing brine programs, and offer a more environmentally friendly alternative to conventional de-icers.

Municipal Experience in Using Beet-Based Additives

Through these trials, municipalities identified operational and logistical challenges associated with beet-juice-based de-icers.

1. Limited Performance Advantage

While beet additives can extend the effective temperature range of salt brine, municipal trials found minimal performance improvement compared to other treated-salt products already available. In several cases, beet-based additives increased pretreatment costs by approximately 35% without providing measurable operational benefits.

2. Operational Reliability Concerns

Municipalities that tested beet-based additives reported recurring operational issues, particularly in cold weather. The viscosity of the product led to clogging of spreader equipment, pumps, and spray nozzles, resulting in increased downtime during winter events. Brine systems required more frequent cleaning, flushing, and maintenance, increasing labour demands and reducing the reliability of winter operations. These challenges raised concerns about the ability to consistently meet Minimum Maintenance Standards during storms.

3. Storage and Infrastructure Requirements

Beet-juice additives require heated or insulated storage tanks to prevent thickening, crystallization, and equipment clogging. The tanks also require enhanced cleaning procedures to prevent residue buildup. The City of Kingston does not have heated storage infrastructure, and retrofitting existing facilities would require capital investment without demonstrated operational benefit.

4. Staining and Aesthetic Impacts

Beet-based additives leave a reddish-brown residue on road surfaces, sidewalks, building entrances, and interior floors of businesses and public facilities. Municipalities with high-traffic commercial districts reported significant complaints from business owners regarding tracking, staining, and cleanliness. This aesthetic impact was a key factor in several municipalities discontinuing use.

5. Supplier Availability and Discontinued Additive Programs

Over the past five years, most major suppliers have discontinued beet-based additive programs due to widespread municipal reports of clogging, staining, odour, tracking into buildings, and the need for heated and agitated storage. As a result, reliable supply chains for beet-juice additives in Ontario are now limited to a single provider that can provide this material in the formats required by a municipality.

Kingston’s contracted de-icing liquid supplier has confirmed that they no longer carry beet-based products, noting that these additives have been phased out of municipal use due to the same operational and maintenance concerns identified in trials.

Emerging Environmental Considerations of Beet-Based Additives

Emerging research indicates that beet-based additives may pose significant environmental risks. A recent study by researchers at Queen’s University (https://doi.org/10.3390/w16030426) found that beet-juice-based de-icers can be more harmful to freshwater ecosystems than traditional road salt.

The study showed that beet-based additives caused a 68-fold decrease in dissolved oxygen levels due to the high sugar content, which accelerates microbial activity and leads to oxygen depletion and shifts in aquatic microbial communities. These conditions can push freshwater systems into a degraded, low-oxygen state from which recovery is unlikely. The researchers concluded that beet-juice de-icers pose significant ecological risks and may have greater negative impacts on freshwater habitats than the road salt they are intended to replace.

Status of Existing Beet-Based Programs

The municipalities of Toronto, Barrie, London, Chatham and Belleville all previously incorporated beet-juice-based additives into its winter maintenance program but have since

discontinued their use. Following a survey of municipalities in Ontario, we were unable to find any municipalities that are still using beet-juice or beet-juice based additives. Speaking with the City's contracted de-icing supplier, the last sale of beet-juice-based additive de-icing material that their firm completed in the province of Ontario was to the City of London in 2021. London has since moved to the multi-chloride brine product currently in-use by the City of Kingston.

In discussion with representatives from the municipalities of Chatham and Belleville, it was indicated that both municipalities moved away from beet-juice-based additives in the early 2020s based on the ongoing operational challenges, staining, equipment maintenance issues, and environmental concerns. These concerns could not be resolved after various attempts at looking at the percentage of beet juice and mixtures of other components. Representatives from the City of Chatham specifically referenced the additional cleaning procedures required after each application to ensure that settlement would not occur in the application tank and efforts required to prevent clogging on distribution lines and nozzles. The City of Belleville also referenced diminishing supply availability within the province as another factor in moving away from beet-juice-based additives.

In a recent study by McGill University on the use of beet juice, after reviewing its use with many municipalities, they found that cleanliness was a major issue. "Depending on the form of the product used, the sticky mixture can cling not just to roads, but to boots, tires and vehicles. It also can leave dark reddish-brown stains behind, an aesthetic choice many people find unappealing."

In reviewing information regarding salt alternatives, it is often reported that Sweden uses beet-based or edible de-icing products as part of their winter maintenance programs however this is not true. Sweden's Transport Administration has confirmed that the country does not use beet-based de-icers and continues to rely on conventional road salt. Limited sugar-based additive trials conducted between 2003 and 2006 did not lead to national adoption.

Alternatives to Beet-Based Additives

Municipalities have explored several natural or agricultural-based de-icing additives beyond beet juice, including molasses-based products, cheese-processing brines, distillery by-products, and lignin-derived materials; however, none have demonstrated consistent operational reliability or clear environmental advantages.

While these additives can offer minor improvements in adhesion or freeze-point depression, they commonly introduce significant drawbacks such as equipment clogging, staining, odour, inconsistent chemical composition, and high oxygen demand in waterways which are issues similar to or greater than those associated with beet-juice additives. As a result, these products have not been adopted at scale in Ontario or across Canada, and suppliers appear to have largely withdrawn them from the market.

Pilot Opportunities and Estimated Costs

Initiating a pilot project to test beet-based additives and application would require a new heated and agitated storage infrastructure, at an estimated capital cost of approximately $75,000. To operate the pilot, the City would also need to secure an additional vehicle for the winter control season, with rental costs of roughly $75,000. The additive itself is priced 6–10% higher than the City's current DLA mixture, representing an additional $10,000 in material costs for a season-long pilot covering 50% of DLA routes.

In total, the estimated cost of the pilot is $160,000, not including the increased likelihood of equipment repairs associated with clogged valves and related maintenance issues documented in other municipalities.

The ongoing availability of the additive may also be a risk in starting or maintaining any pilot program of this nature as all but one supplier in Ontario has discontinued the sale of products containing beet juice.

Review and Next Steps

The City uses established, evidence-based practices for winter maintenance that prioritize public safety while actively minimizing environmental impacts. Current operations align with best practices for chloride reduction, including the use of direct liquid anti-icing, pre-wetting, calibrated application rates, targeted material selection based on temperature, and the identification of salt-vulnerable areas. These measures are continuously monitored and refined using available data, operator training, and evolving industry guidance to ensure that salt use is limited to what is necessary to meet service levels and regulatory requirements.

Based on the findings summarized in this report, beet-based additives and similar organic alternatives do not demonstrate a clear operational or environmental benefit over the City's existing practices. Kingston's current program reflects a high level of operational and environmental maturity, with no identified service gaps that would be addressed through the introduction of these products. Municipal experience indicates limited performance improvement, higher costs, and increased operational complexity, including equipment maintenance, reliability concerns, and additional infrastructure requirements. Industry trends further show that most suppliers and peer municipalities have moved away from these additives due to these challenges. Emerging research also indicates that these products may pose greater risks to freshwater ecosystems than conventional road salt due to their impact on dissolved oxygen levels.

As updates to the Minimum Maintenance Standards are anticipated in late 2026 or 2027, the City will incorporate the findings of this report into a comprehensive review of its Winter Maintenance Program and Salt Management Plan. This work will build on the City's existing, evidence-based practices and continue to focus on optimizing performance, reducing chloride use, and aligning with evolving regulatory requirements and industry best practices.

Climate Risk Considerations

The City's winter maintenance program is primarily an adaptation initiative, as it ensures safe mobility during increasingly variable winter conditions driven by climate change, including more frequent freeze–thaw cycles and heavier, wetter snowfalls. The program is also indirectly influenced by climate trends, as warmer winter temperatures can expand the effective range of brine and reduce reliance on granular salt.

While the initiative does not significantly reduce greenhouse gas emissions, it does support mitigation goals by minimizing overall salt use, reducing material production and transport needs, and lowering the environmental impacts associated with chloride loading. Continued monitoring of emerging technologies and anticipated updates to the Minimum Maintenance Standards will help ensure the program remains resilient to changing winter patterns while aligning with the City's broader climate and environmental objectives.

Financial Considerations

This report is for information purposes and the existing winter maintenance practices outlined are reflected in approved department operating budgets.

Initiating a pilot project to test beet-based additives and application would require an estimated capital investment of $75,000 and an ongoing annual investment of $85,000 to service approximately 50% of existing city routes. This estimate does not include equipment maintenance and repairs that have been observed by other municipalities.

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Other City of Kingston Staff Consulted:

Adam McDonald, Operations Manager, Public Works & Solid Waste

Exhibits Attached:

None