Parking Lot Design Guidelines to Promote Salt Reduction

Lake Simcoe Region Conservation Authority

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1. Introduction

GHD Limited (GHD) was retained by the Lake Simcoe Region Conservation Authority (LSRCA) to assist LSRCA and its partner organizations in the preparation of a design guideline document for the reduction of salt use on institutional and commercial parking lots. The primary goal of this report is to present design features and site examples to be used in the development of a site design guideline package for parking lots on commercial and institutional properties. The guideline package is intended to promote the construction of sites that do not require as much salt application for winter maintenance. These guidelines are intended to provide a practical, tangible, and cost effective approach to reducing the use of salt in the Lake Simcoe Watershed. It is noted that this report presents the design features and example drawings along with example site designs that are going to be used by LSRCA and its partner agencies to develop the design guideline document (i.e., this report is NOT the design guideline document).

While this report was prepared with the mandate of presenting design features that can reduce the use of salt on commercial and institutional parking lots within the Lake Simcoe Watershed, the recommendations can be applied to most paved parking/roadway areas where snow/ice maintenance is required such as in industrial lots, high density residential lots or jurisdictions outside the Lake Simcoe Watershed. Similarly, this report is intended for new development; however, it is recognized that several of the considerations within the design features can be applied in retrofit or re-development applications.

It is recognized that the design of parking lots and associated driveways, walkways, building entrances etc. are subject to several regulations, guidelines, policies, by-laws and other documents that are varied across the Lake Simcoe Watershed and across other jurisdictions. The information presented in this report must be used as applicable in each jurisdiction without compromising other objectives such as public safety, accessibility, stormwater management, source water protection and other similar considerations. In other words, this report provides recommended practices for reducing the use of salt across a broad range of potential conditions; the designers must evaluate the merit of each recommended practice carefully in conjunction with other considerations.

2. Background

Every year, Canada spends over $1 billion on winter maintenance on public and private roads, parking lots and sidewalks (Hossain, K and Fu, L., 2015). While the use of salts is essential to ensure public safety, there is a growing concern regarding the large quantities of salts, mainly chloride ions, released to the environment. These chloride ions from salts, as well as brines used in road deicing/anti icing and dust suppression, enter the environment through losses at salt storage and snow disposal sites, as well as through runoff and splash from roadway and parking lot application. To address these issues, Transportation Association of Canada (TAC) published the Synthesis of Best Management Practices in 2003, which documents best practices related to the effective management of road salt use in winter maintenance operations. In 2004,

Environment Canada developed the "Code of Practice for the Environmental Management of Road Salts" (Code of Practice), which requires organizations and municipalities using more than 500 tonnes of road salt annually or that have "vulnerable" areas with potential to be impacted by road salts, develop a Salt Management Plan (SMP).

The Code of Practice has been successful in promoting the uptake of salt management best practices with provincial, county, regional and municipal road maintenance authorities; however, it has not proven to do the same for the companies that apply salts on private roads, parking lots, and walkways. Many studies/training programs have been developed in Canada, the United States, and other parts of the world that aim to streamline the process of parking lot and sidewalk maintenance during the winter. These studies/training programs (e.g., "Smart About Salt") aim to educate private contractors on the science behind salts and how adopting best practices can improve the level of service provided, protect the environment, and reduce costs associated with salt application. However, there seems to be a slow uptake of these best practices by private road and parking lot maintenance operators.

LSRCA and its partner agencies identified a need for a guideline document that could be used by designers, regulatory agencies, owners, contractors, and others to consider design elements in the design and layout of parking lots and related infrastructure that can help reduce the requirement for salt application.

GHD has undertaken the following activities to research and prepare the design features discussed in the report:

- Review of existing design documentation;
- Preparation of a comprehensive list of design elements that could reduce the use of salt in parking lots;
- Selection of four primary design features to present in this report based on a multi-criteria evaluation matrix that considered cost, salt reduction potential, potential for acceptance/implementation, potential for long-term implementation and ability to accommodate overall stormwater management;
- Identification of stakeholders that have a vested interest in parking lot design, salt use, regulations, and environmental protection;
- Completion of interviews with several of the stakeholder groups, including winter parking lot maintenance contractors, parking lot designers, parking lot owners, regulators and academic researchers;
- Compilation of interview results and incorporation into design features;
- Preparation of design feature example drawings, design feature fact sheets, and an example site plan;
- Organization of a Design Charrette to present the design feature example drawings, design feature fact sheets, and example site plan to the stakeholders (parking lot maintenance contractors, designers, academic researchers, municipal agencies, regulators, owners, and planners); and

- Completion of the example design feature drawings, design feature fact sheets, site example drawings and vetting through LSRCA and landscape architects.
- The design guidance information that resulted from this process is presented in the following sections of this report.

3. Primary Design Features

Several design features were evaluated, as described above, and four were selected as the primary design features to develop for use in the proposed guidelines. Information presented in this report is intended to be included in the design guideline document that is anticipated to be used by designers, planners, owners, and regulators throughout the development process.

- The four primary design features are as follows:
- Effective Grading and Stormwater Collection
- Snow Pile Storage Location
- Sidewalk Design and Pedestrian Flow
- Landscaping Features

A general overview of each design feature can be found below. A detailed design feature fact sheet for each feature is presented in Appendix A. The factsheets provide a description and overview, design recommendations, salt reduction recommendations, design aspects to avoid, operation and maintenance, and estimated costing information.

Example design drawings for each design feature are provided in Appendix A. These example design drawings demonstrate how each feature could be applied in an example situation. It is noted that each site has several factors that will determine which measures can be implemented and how they are implemented, and that these drawings are not intended to be prescriptive.

3.1 Effective Grading and Stormwater Collection

Effective parking lot grading can minimize the freezing of wet pavement surfaces as well as prevent melt water from ponding and refreezing, reducing the need for re-application of salts. Practitioners of parking lot design have noted that when parking surfaces are graded at slopes less than 2%, there is an increased risk of depressions forming that can result in the pooling of water and ice formation. Slopes of 2 to 4% are recommended to minimize the potential for depressions forming, as well as better compaction of granular base materials and construction quality control to ensure that consistent slopes are provided during construction. Effective grading can also direct melt water towards strategically placed stormwater collection infrastructure (such as catch basins, vegetated swales, bioretention, landscaped areas, etc.) thereby preventing salt application in heavy traffic areas that are also pathways for runoff. The key to effective stormwater collection during winter runoff is to ensure melt water from high traffic areas or snow piles does not have to travel great distances to a collection point.

3.2 Snow Pile Storage Location

Strategically locating snow storage piles in low traffic areas, along the outer edges of parking lots and downgradient from high traffic parking lot areas, can help minimize the risk of melt water draining across high traffic areas where it can refreeze. Situating snow storage piles in areas that receive abundant solar radiation (i.e. canopy free and/or south facing) can help to accelerate melting. Additionally, it is important to locate snow storage piles to prevent visual obstructions for drivers/pedestrians/cyclists and reduce snow drifts across parking lot surfaces. Therefore, it is important to understand the wind patterns of the parking lot and locate the snow pile in a location that is least likely to cause snow drifts. Designated snow storage areas can also be designed to promote sheet flow across shallow sloped vegetated surfaces, as an example, to promote water quality improvements. It is also important to place snow piles in locations that do not result in long plow routes that cause the snow to compact and enhance the bond between snow/ice and the pavement surface. Additionally, snow storage pile locations can be dual-functional and used as parking during the non-winter months. Snow storage areas should be clearly marked with signage to inform winter maintenance contractors where to pile snow which is important if there is contractor change over. The selected snow pile location is typically negotiated between property manager and contractor.

Snow piles can also be designed to promote melt water that drains away from high traffic areas towards specific catch basins through grading. Designing specific drainage collection features for snow piles can ensure that melt water is quickly collected within the vicinity of the pile so that melt water is not provided the opportunity to refreeze. Alternatively, snow piles can be placed on vegetated swales in areas where chlorides are not a source water concern, allowing the meltwater to infiltrate before it has the potential for discharge.

3.3 Sidewalk Design and Pedestrian Flow

Careful consideration of location and layout of sidewalks/pedestrian walkways can eliminate over-salting of unused walkways. The design process should consider that pedestrians typically follow the path of shortest distance and don't necessarily use the designed walkways. Occasionally, this leads to pedestrians walking along the vehicle routes and not the designed walkways, especially in large parking lots with walkways around the outer edge. By re-thinking the pedestrian walkways and designing them in a way that is more direct and user friendly, the reduction of walkway footprint on a typical parking lot can be achieved. This in turn leads to a reduction of salt application.

On sites where multiple pedestrian pathways are essential during warmer months, consideration should be given to temporary closure of the low traffic walkways during winter months to reduce the required winter maintenance. However, it is noted that priority should be given to the proper planning and placement of walkways during the initial planning process to avoid unnecessary walkways. It is recommended that pedestrian sidewalks are constructed with appropriate widths (minimum of 1.5m) that would allow contractors to plow, to minimize the potential of chemical snow removal methods being employed. In addition, the use of different

paving material that provided enhanced grip during the winter months could also lead to the reduction of salt application.

3.4 Landscaping Features

Landscaping features such as vegetated swales or landscaped islands can lead to a reduced requirement of salt application by reducing the amount of paved surface. Vegetated swales, bio-retention or landscaped islands with curb cut inlets can be used to collect and retain melt water runoff, reducing melt water ponding and refreezing. The vegetation used in swales and landscaped islands should be salt tolerant and suited to each site's soil, climate and moisture conditions. Additionally, using deciduous trees in the planting plan will provide shade during the hot summer months and allow the sun to directly hit the parking lot during winter months to help melt snow and ice. Where feasible, evergreen trees and/or shrubs can be used as treed windbreaks along the site perimeter, considering the predominant wind direction and adequate setback to avoid accumulation of snow drifts.

4. Other Design Feature Options

While LSRCA and GHD selected the above four primary design features to conduct detail analysis and development, it is recognized that there are several other features that can also be applied in the design of parking lots to minimize the use of salt. The other design feature options are presented below.

4.1 Permeable Pavers

Permeable pavers can reduce the need for salt application in parking lots by improving drainage and preventing melt water from ponding and refreezing (Drake, J et al., 2012). Permeable pavers consist of interlocking pavers with a permeable joint material in the voids between the pavers to promote infiltration. A storage bed of crushed stone and/or sand beneath the pavers collects runoff and allows for infiltration. An under drain system may also be installed if permeable pavers are constructed on poorly drained native soils or if infiltration is not desired.

Similar to permeable pavers, turf and grass block pavers (also known as concrete or plastic grid pavers) can provide a similar solution for pedestrian or low vehicular use areas. The open weave design (honeycomb design) allows for grass or moss to grow through, preserving the look of a lawn while providing additional infiltration and structural support.

The installation of permeable pavement has been demonstrated to reduce salt application requirements for paved surfaces by up to 75% (University of New Hampshire Stormwater Center, 2007). Additionally, the highly porous joint and subbase materials, which surround and underlie permeable pavers, absorb, and retain heat and further increases the efficiency of snow and ice melting from parking lot surfaces. Special consideration should also be given to the colour selection of the pavers/pavement. Dark coloured pavers will increase the absorption of solar radiation and lead to higher ice melting potential. For additional information on permeable pavers and turf and grass block pavers refer to CVC and TRCA, 2010.

4.2 Seasonally-Closed Parking Areas

Shoppers naturally tend to choose parking spaces closest to the building. As a result, other than the peak shopping period around Christmas, there tends to be low use of the remote parts of large parking lots, including during the coldest parts of the winter (mid-January to end of February). Therefore, during the low customer periods there is the potential for closing some of the less used parking lot areas and not performing any winter maintenance in these locations. This can lead to a reduction of overall salt application, as the area requiring winter maintenance has been reduced. Additional benefit can be achieved in these remote parts of the parking lots by using permeable features for stormwater improvements as mentioned in Section 4.1.

4.3 Shaded Canopies

Shaded roof canopies can be constructed over pedestrian walkways and building entrances to minimize snow and ice deposition, resulting in reduced salt application requirements. They can be constructed as extensions on buildings, or constructed as separate self-supporting structures. Roof canopies can consist of permanent or temporary structures. Special consideration should be taken for the runoff generated from the canopy stormwater or snowmelt, so it does not lead to ponding/refreezing on the walkway or designated drainage point. Typically, shaded canopies are considered for feature areas and for high traffic areas.

4.4 Conductive Pavement on Walkways and Entrances

Building entrances and pedestrian walkways typically receive high salt application rates. The use of conductive pavement can eliminate the need for salt application in these heavy traffic areas. Conductive pavements consist of electrically and thermally conductive materials mixed with the dielectric aggregates typically found in standard asphalt and concrete pavements. Once connected to a power or heat source, these pavements conduct electricity and emit heat to the pavement surface, melting ice and snow with constant and uniform heat. Electricity is the energy source that is most commonly used to heat conductive concrete pavements. Alternative options include, solar and geothermal energy used to heat water/glycol in pipes beneath conductive concrete pavements.

4.5 Brine Holding Tanks for Anti-icing or Pre-wetting

Collection of first flush (high chloride concentration) melt water runoff from a salt induced snowmelt (as opposed to rain and temperature induced snowmelt) has the potential to be beneficial if captured and reused as an anti-icing or pre wetting solution. In order to collect the first flush runoff, an electronically actuated valve controlled by an electrical conductivity sensor would be installed at the desired conveyance point to divert and collect the high chloride concentration runoff into a brine holding tank. The brine holding tank would be placed below ground and a pump could be connected to pump the brine solution into an anti-icing tank or directly used to pre-wet rock salt. Additional stormwater treatment steps may need to be incorporated to treat the stormwater for other pollutants such as metals, petroleum hydrocarbons etc., unless the areas downstream of the application area already have designed stormwater treatment elements to capture and treat the anticipated pollutants. Special

attention will have to be paid to the concentration of chlorides in the holding tank and if necessary either additional chlorides are added or additional water is used to dilute the brine solution.

5. Site Examples

The intent of the site example is to show how several design features for the reduction of salt use can be applied to various sites. Four example sites have been selected that represent different potential site developments. These include:

- Large commercial site – greater than 10 ha
- Medium size commercial development – 5-6 ha
- Small size commercial development – less than 3 ha
- Institutional development – Public School

The base plan for each development type was taken from an existing development and slightly altered to become a standalone site. The existing site layouts were revised to demonstrate how the four design features can be implemented. At the time of the submission of this publication only the medium size commercial development site example (existing and proposed) were completed and are provided following the text on Drawing 1 and 2. The additional three site examples will be provided at a later time as Drawings 3 to 8. Effective grading and stormwater collection systems are applied to the parking area, making sure to minimize the flow paths to the catch basins by strategically locating the catch basins in the drive aisles. By having fewer, but larger vegetated islands and replacing the rest with painted hatch marks, in addition to having designated and signed areas for snow piles, snow plowing becomes more efficient. By designing sidewalks that are wide enough for mechanical clearing and anticipating pedestrian flow, the number of walkways and salt required on them is minimized. Vegetated swales can be used to retain melt water runoff in addition to reducing the potential for melt water refreezing, which would require additional salt applications.

In areas where source water protection considerations are not paramount, the snow piles may be located on pervious areas; however, for these design examples it is assumed that minimizing infiltration of snow pile meltwater is desired due to source water protection concerns.

6. Conclusions/Discussion

Rising chloride concentrations associated with salting of paved areas is increasing impacts to the environment, including contamination of surface water and ground water resources. Increasing chloride concentrations in groundwater can negatively affect drinking water sources and have been known to impact surface water through groundwater discharge in local creeks and wetlands. Elevated chloride concentrations in surface water have been directly linked to several negative impacts, including creating toxic environments for flora and fauna, changing the ecological balance in natural systems, impacting drinking water supplies as well as adding to the impairment of storm water treatment systems such as wet ponds and wetlands.

Parking lots at commercial and institutional facilities tend to apply a considerable amount of salt as a winter maintenance technique to minimize slippery conditions and manage site use. This leads to potential degradation of downstream receiving waterways as well as advanced degradation of constructed infrastructure.

This report presented four primary design features that, if incorporated into site design, have the potential to reduce salt use. The four primary design features considered are: effective grading and stormwater collection, snow pile storage location, sidewalk design and pedestrian flow, and landscaping features.

Several other elements can be incorporated into site design to provide additional reduction in salt use, such as permeable pavers, seasonally closing parking areas, shaded canopies, conductive pavements of heated walkways, and brine holding tanks for anti-icing or pre-wetting.

This report presents only design elements that can be incorporated in site design to reduce the use of salt. There are several other initiatives that should be considered, that can also play a significant role in the reduction of salt use, such as:

- Public education campaigns (in classrooms, through media, through public sector information sessions etc.);
- Using signage to promote public education at places where salt reduction strategies are implemented;
- Working with regulators and the insurance and legal community to re-think the framework to better protect winter maintenance operators from litigation due to slips, trips and falls, and minor vehicular incidents if proper best practices are implemented;
- Conducting workshops for landscaping/snow removal contractors to educate them on the proper use of salt;
- Re-thinking how compensation is accounted for in winter maintenance contracts between owners and contractors (i.e. removing salt-plus contracts);

- Ensuring owners and their maintenance staff/contractors prepare snow/ice management plans to be used and updated prior to the winter salting seasons (these plans should be living documents and can include information on where to store snow, which areas of the parking lots are not used for off-season winter parking, which sidewalks can be closed for the winter, what the stormwater collection system is like for the site, etc.)

7. References

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