Parking Lot Design Guidelines to Promote Salt Reduction

Lake Simcoe Region Conservation Authority

GHD | 651 Colby Drive Waterloo Ontario N2V 1C2

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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 sub base 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 addition 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

British Columbia – Ministry of Transportation. 2007. BC Supplement to TAC Geometric Design Guide.

City of Mississauga – Transportation and Works Department. 2009. Development Requirements Manual.

Credit Valley Conservation Authority and Toronto and Region Conservation Authority, 2010. Low Impact Development Stormwater Management Planning and Design Guide. Retrieved from

http://www.creditvalleyca.ca/wp-content/uploads/2014/04/LID-SWM-Guide-v1.0_2010_1_no-appendices.pdf

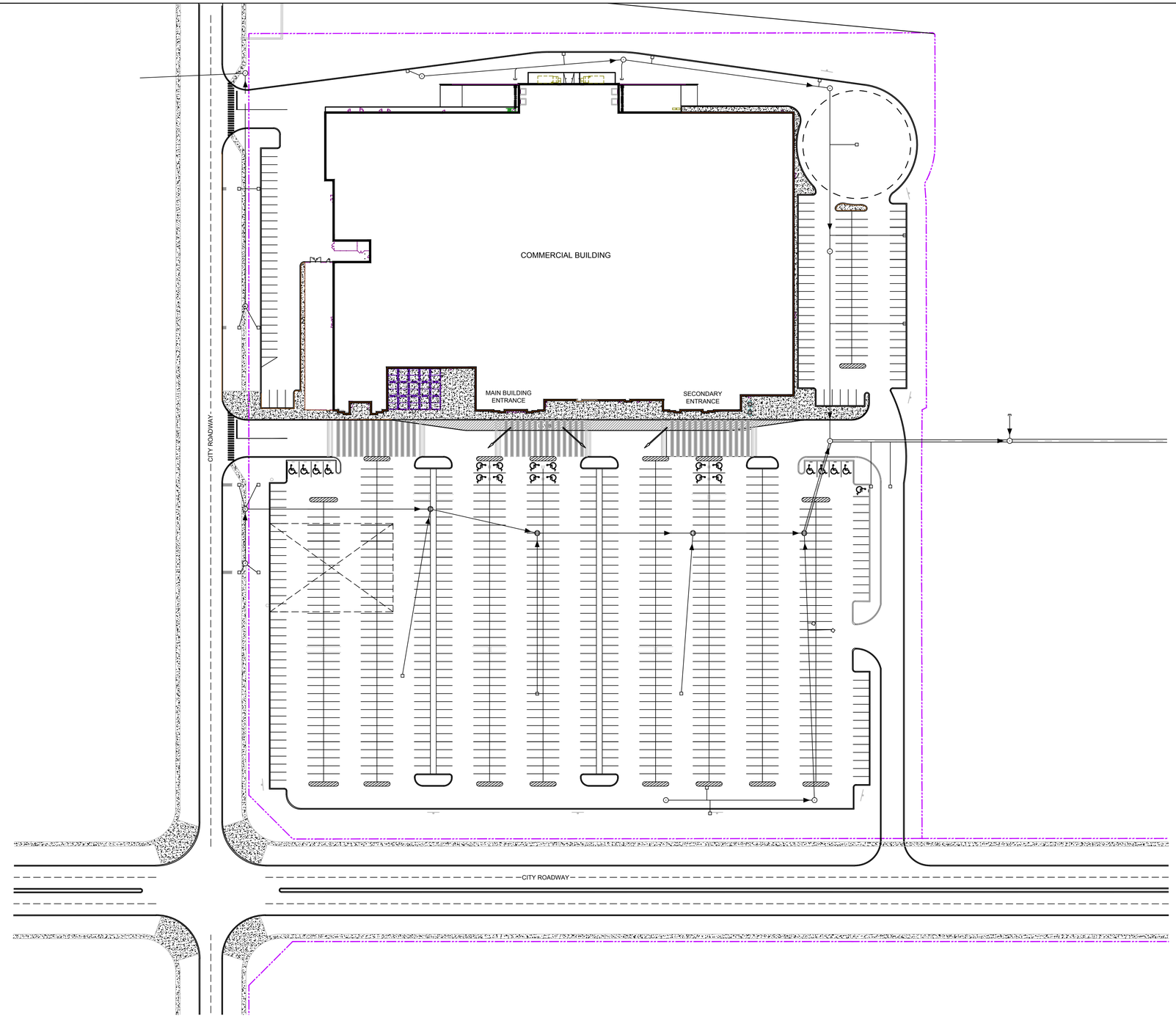
Drake, J., Bradford, A., Van Seters, T., and MacMillan, G., 2012. Evaluation of Permeable Pavements in Cold Climates – Kortright Centre, Vaughan. Toronto and Region Conservation Authority.

Environment Canada. 2004. Code of Practice for the Environmental Management of Road Salt.

Hossain, K. and Liping, F. 2015. Optimal Snow and Ice Control of Parking Lots and Sidewalks. iTSS Lab Department of Civil & Environmental Engineering University of Waterloo.

Transportation Association of Canada (TAC). 2003. Syntheses of Best Practices – Road Salt Management.

Drawings



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Project Manager		Date	FEBRUARY 2017
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Client LAKE SIMCOE REGION CONSERVATION AUTHORITY

Project

Title COMMERCIAL PROPERTY EXAMPLE #1 PARKING LOT DESIGN GUIDELINES

Project No. 11115623-01

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Sheet No.

Sheet 1 of 1

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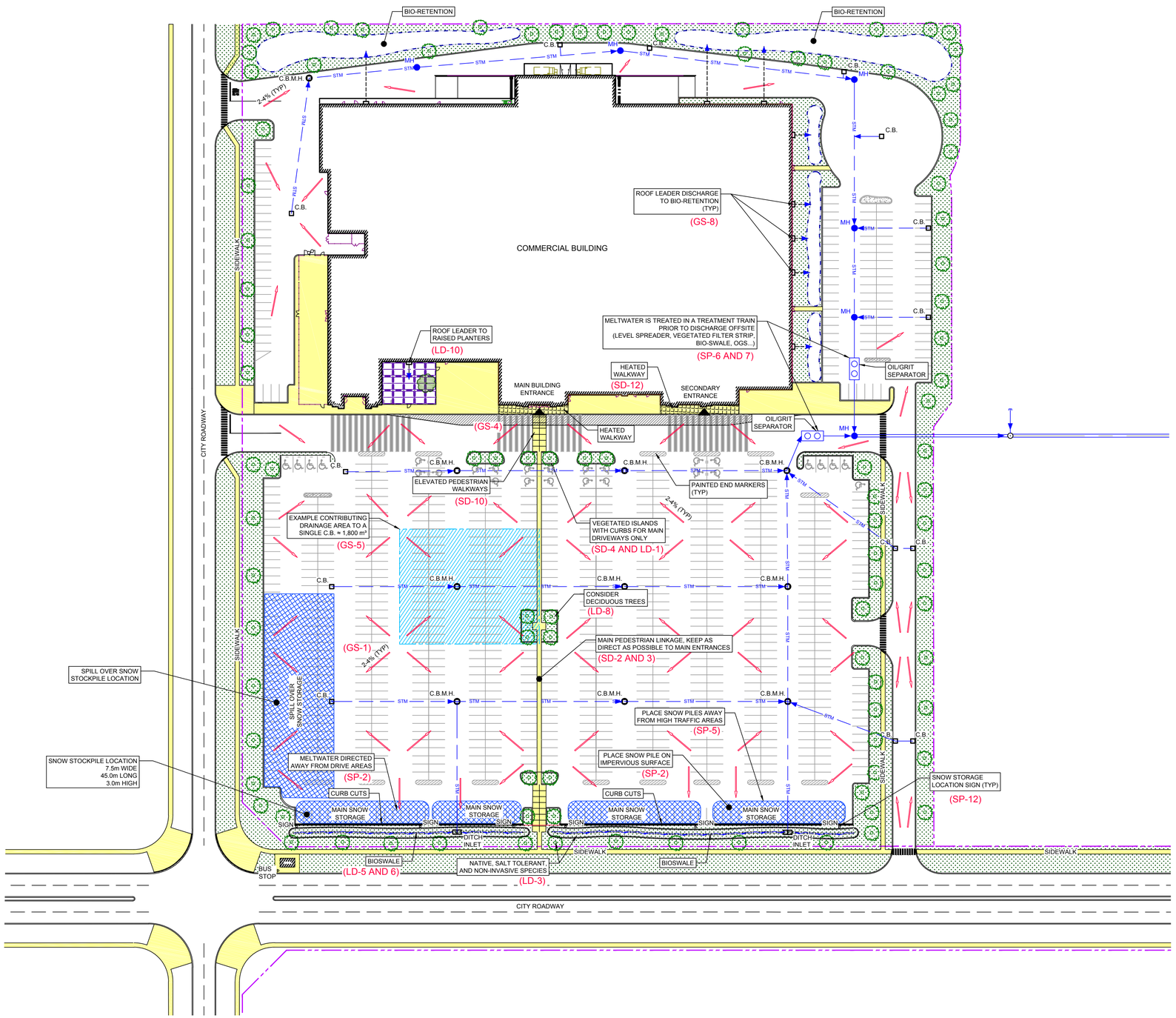

NOTES:

REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS.

(XX-X)REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

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Drafting Check		Design Check	
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Client LAKE SIMCOE REGION CONSERVATION AUTHORITY

Project

Title COMMERCIAL PROPERTY EXAMPLE #2 PARKING LOT DESIGN GUIDELINES

Project No. 11115623-01

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Sheet No.

Sheet 1 of 1

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Appendices

Appendix A
Site Design Factsheets and Primary Design Feature Drawings

Effective Grading and Stormwater Collection

1.1 General Description/Overview

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, bio-retention and 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.

1.2 Design Recommendations

Parking lots are used continuously year round, in all weather conditions. Effective grading and stormwater collection are design elements that impact parking lot drainage throughout all four seasons. This document specifically focuses on these two aspects with respect to the winter months and on how to reduce the use of salt.

The following sections present design recommendations to help reduce the amount of salt application on parking lots and identify design alternatives that should be avoided that may lead to the excessive application of salts.

1.2.1 Salt Reduction Recommendations

Listed below are multiple design recommendations that designers should take into consideration and incorporate where feasible and practical. It is acknowledged that the design is optimized by taking into consideration multiple constraints and not all suggestions can always be accommodated. Some of these recommendations are illustrated on Figure 1 and 2, noted with an asterisk below.

- GS-1* - Parking lots should (where possible) be designed with a grade of 2 to 4% in order to prevent ponding and refreezing of meltwater in pavement undulations that result from either imperfect grading/paving during construction, or soil and pavement heaving due to weather exposure over time.
- GS-2* - Proper geotechnical design should be completed to ensure that the parking lot design grades can be maintained over the long-term to prevent settling and uneven grades. This also includes the proper design of parking lots to drain the underlying gravel base appropriately to minimize the potential of frost heave of the pavement structure during winter months which can cause uneven pavements.
- GS-3* - Strong construction quality control practices are recommended to ensure that sub-grade, granular bases, and asphalt compaction and grading tolerances are achieved.
- GS-4* - Parking lots should be graded away from building entrances and in such a way that major drainage pathways do not cross heavily used areas of the parking lot. Also, parking lots should drain

to catch basins in the middle of the drive paths which would allow for traffic to help break up the snow and ice.

- GS-5* - Catch basins and other stormwater collection design features should be laid out such that the distance meltwater travels before being removed from the parking lot surface is minimized (drainage area of 1,000-2,000 m^2 per catch basin)[1] (the accompanying calculations are shown below). In addition, catch basins can be installed near or directly downgradient from the snow storage pile locations on parking lot areas which generate the most meltwater runoff.
- GS-6 - Stormwater collection systems and their contributing areas should be hydrologically isolated from surface water bodies, recharge zones and other environmentally sensitive areas.
- GS-7 - Stormwater pond design should fully consider the biological aspects of receiving watercourses, with the intent to protect the most vulnerable species present.
- GS-8* - Roof leaders should be directed to pervious, infiltration areas where possible. Where infiltration is not feasible or desired, roof drains can be connected to a stormwater collection system.
- GS-9 - Parking lots should be graded to drain away from surface water features and other environmentally sensitive areas.

1.2.2 Design Aspects to Avoid

1. Parking lot grades should not be less than 1%, as this may cause the requirement for additional salt application to fight refreeze of melt water.
2. Parking lot grades should not exceed 4%, as steeper grades may increase slip and fall hazards, may cause accessibility issues, lead to runaway carts and promote rapid runoff during rainfall events.
3. Roof leaders should not discharge onto public walkways, near entrances, or near high traffic areas.
4. Parking lots should grade away from the front entrance to avoid ponding/freezing in high pedestrian use areas.

1.3 Operation and Maintenance

1. Once properly graded, salt application can be concentrated in the upgradient areas of parking lots and rely on meltwater runoff to convey salt to downgradient areas.
2. The parking lot grade should be inspected during rain events (or shortly thereafter) for surface ponding, especially in high traffic areas, areas directly downstream from snow storage and removal piles and areas directly upstream from catch basins, or other site drainage features (swales etc.). If surface ponding is identified then regrading of these areas should be considered.
3. Undulations and other erosional features, which could promote ponding or channelized flow, should be repaired as early as possible following the spring melt, as should areas requiring regrading.
4. Catch basin filters should typically be inspected 3 to 4 times annually and cleaned or replaced every 1 to 2 years, when sediment buildup reduces permeability.

[1] City of Mississauga – Transportation and Works Department. 2009. Development Requirements Manual.

5. Oil grit separators should be vacuum-cleaned or dredged every 1 to 2 years when sediment accumulation occupies 25% of the sediment sump. Inspections should be performed once to twice annually and should not only look for sediment accumulation, but also for chloride buildups.

6. The release of chloride-laden water from stormwater ponds to receiving watercourses should be designed to protect the most vulnerable species present.

1.4 Costing

1. The cost of grading parking lots can vary widely depending on lot size, existing grades, native soil characteristics and whether sites have already been developed. Constructing catch basins to provide proper drainage for the new grade can also increase costs.

2. Grade surveying typically costs around $150 to 300/hour.

3. Fine grading of paved areas typically costs around $2.15/$m^2$.

4. Typical costs to install a catch basin range from $3,000 to $6,000, while costs for connecting it to municipal storm infrastructure typically range from $250/m to $500/m for small diameter storm sewer pipe + surface restoration.

5. Other costs may include demolishing existing asphalt, stripping and storing topsoil, excavating native soil, storing and transporting excavated soil, purchasing fill, backfilling excavations and providing control for dust and silt.

6. Fully installed oil grit separators can range in cost from $5,000 for small simple units, which are appropriate for low runoff volumes containing low contaminant loads, to over $150,000 for large complex units, which are required to treat large runoff volumes with abundant and complex contaminant loads.

7. Catch basin filters typically cost between $500 and $2,000 each.

Estimated Ponding Depth of Catchbasins with a 2,000m^2 Drainage Area During a 5-yr Storm Event

Date : 02/14/17
Project # : 11115623
Client: LSRCA Parking
Location: LSRCA Parking - Typical Parking Lot

Rainfall Intensity

Time of Concentration (Tc)

Catchment	*Slope (m/m)*	*Length (m)*	*T_c [a] (min)*
101	*0.04*	*25*	*5.00*

IDF Relationship for the Town of Brandford West Gwillimbury

(min)	*2*	*5*	*10*	*25*	*50*	*100*
A	789.07	980.848	1118.79	1284.892	1405.794	1443.947
B	6.205	6.013	6.018	6.008	6.012	5.273
C	0.823	0.806	0.8	0.793	0.788	0.776

Annual Maximum Rainfall Intensity (i) (mm/hr) [b]

Storm Duration (min)	*Storm Event*					
	2	*5*	*10*	*25*	*50*	*100*
5.00	108.00642	141.84883	164.08405	191.77494	212.29077	236.85042

Rational Method

$Q_p = CiA/360$

Catchment	*Area (ha)*	*C* [c]	*Peak Flow (m^3/s)*					
			2	*5*	*10*	*25*	*50*	*100*
101	0.2	0.95	0.057	0.075	0.087	0.101	0.112	0.125

Orifice Calculation

Q = CA*sqrt(2gH) p[d] = 0.5 $H = (Q_p/CA)^2/(2g)$

C	0.6		C	0.6
A[e] (m^2)	0.170328		A	0.170328
H (m)	0.025	m (assumption)	$Q_{5\text{-year}}$	0.075
Q (m^3/s)	**0.0715742**		**H (m)**	**0.0273514**

Therefore, assuming the area of the grate opening is equal to 50% of the overall grate area (conservative), the 5-year storm event will generate a ponding depth (head) of 27 mm over the catchbasin grate. This is considered to be a reasonable maximum amount of ponded depth.

Notes:
(a) Kirpich formula (1940) used to calculate time of concentration. Minimum of 5 minutes is utilized.
(b) IDF information obtained from Ministry of Transportation.
(c) C =0.95 was used to represent the asphalt surface
(d) 'p' represents the fraction of the overall catchbasin dimension that is open
(e) A is equal to the opening of the orifice that is the opening of the catchbasin grate
- Dimensions for the standard OPSD for a Cast Iron, Square Frame with Square Overflow Type Dished Grate for Catch Basins, Herring Bone Openings are 564 mm x 604 mm

NORTH

SCALE: N.T.S

CITY ROADWAY

SIDEWALK

ENTRY/ EXIT

(GS-1)

2-4%

(GS-5)TYP.

C.B.M.H.

MH

OIL/GRIT SEPARATOR

CURB CUTS

DITCH INLET

BUS STOP

BIO-RETENTION

MIN 4.0m

ROOF LEADER DISCHARGE TO PERVIOUS SURFACE

(GS-8)

B' FIG.2

B FIG.2

HIGH TRAFFIC ROUTE

SITE PARKING LOT AREA

EXAMPLE CONTRIBUTING DRAINAGE AREA TO A SINGLE C.B. ≈ 1,500 m³

(GS-5)

PRE-TREATMENT

GRADE AWAY FROM BUILDING

(GS-4)

A FIG.2

A' FIG.2

BUILDING

ROOF LEADER

C.B.

CATCHBASIN (TYP)

BIOSWALE

MAIN BUILDING ENTRANCE

STM

NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS.

(XX-X) REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

TARGET SLOPES BETWEEN 2-4%

MAXIMUM CONTRIBUTING PAVED DRAINAGE AREA PER SINGLE CB ~ 1,000 m² TO 2,000 m²

MINIMIZE OVERLAND FLOW LENGTH TO DRAINAGE STRUCTURES

LAKE SIMCOE REGION CONSERVATION AUTHORITY

11115623-01

Feb 27, 2017

EFFECTIVE GRADING/STORMWATER COLLECTION DESIGN EXAMPLE PARKING LOT DESIGN GUIDELINES

FIGURE 1

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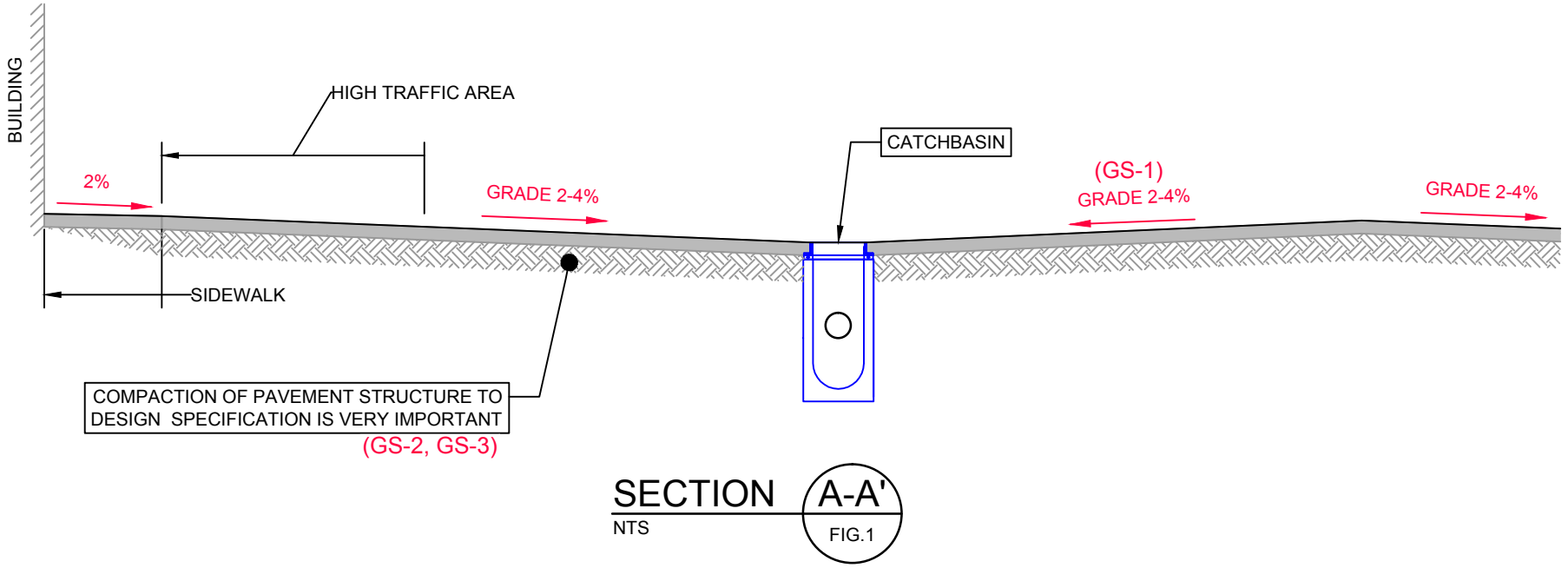
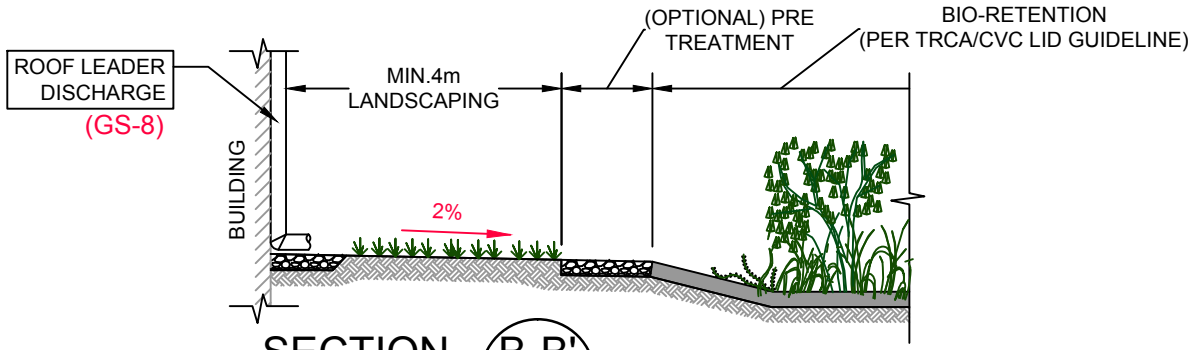


SECTION A-A'
NTS
FIG.1



SECTION B-B'
NTS
FIG.1

NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS.

(XX-X)REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

GRADE AWAY FROM BUILDING AND ENTRANCES AND DO NOT HAVE MAJOR DRAINAGE PATHWAYS CROSS HEAVY TRAFFIC OR PEDESTRIAN WALKWAYS

MINIMIZE OVERLAND FLOW LENGTH TO DRAINAGE STRUCTURES.

DRAIN AS MUCH OF THE CLEAN WATER AREAS TO LID MEASURES, SUCH AS ROOF DRAINAGE TO BIORETENTION.

LAKE SIMCOE REGION
CONSERVATION AUTHORITY

11115623-01
Feb 27, 2017

EFFECTIVE GRADING/STORMWATER COLLECTION (CROSS-SECTION) PARKING LOT DESIGN GUIDLINES

FIGURE 2

CAD File: P:\drawings\11115000s\11115623\11115623-REPORTS\11115623-01(002)\11115623-01(002)GN\11115623-01(002)GN-WA001.dwg

Snow Pile Storage Location and Design

1.1 General Description/Overview

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 to high traffic areas and refreezing. Situating snow storage piles in areas that receive abundant solar radiation (i.e. south facing and canopy free) 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 and ice. Additionally, snow storage pile locations can be dual-functional, used as parking during the non-winter months.

Snow piles should be designed to promote melt water to flow away from high traffic areas and 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 concern, allowing the meltwater to infiltrate before it has the potential for discharge.

1.2 Design Recommendations

Parking lots are used continuously year round, in all weather conditions. Snow pile storage locations may only be used during the winter months, however it is very important that during the design stage, consideration is made as to snow pile locations to ensure a smooth transition between seasons and to lessen the amount of salt used.

The following sections present design recommendations to help reduce the amount of salt application on parking lots and identify design alternatives that should be avoided as they may lead to the excessive application of salts.

1.2.1 Salt Reduction Recommendations

Listed below are multiple design recommendations that designers should take into consideration and incorporate where feasible and practical. It is acknowledged that the design is optimized by taking into consideration multiple constraints and not all suggestions can always be accommodated. Some of these recommendations are illustrated on Figure 3 and 4, noted with an asterisk below:

- SP-1* - Snow storage piles should be located along the downgradient edges of parking lots and positioned as far away from major pedestrian destinations as possible. If possible, the main snow pile should be placed at the lowest point of the parking lot.
- SP-2* - Parking lots should be graded such that meltwater runoff from snow storage piles is transported away from high traffic areas.
- SP-3* - It is suggested to plan for a snow pile storage volume range of 500 to 1,500m^3 per hectare of parking lot (accompanying calculations following text). The lower end of the range was calculated

using the average annual snow depth and a factor of three was used for the upper end of the range. Snow pile area and height will vary greatly depending on the size of the snow removal area and the snow removal equipment that is being used. For a maximum snow pile height of 3m[1] (trucks with plow attachments), approximately 3 to 8% of the paved area will be required for snow storage. If specialized snow removal equipment is available, the snow pile heights will increase (safety permitting) and the required snow storage area will decrease.

- SP-4* - It is preferred for the snow storage piles to be placed on impervious surfaces. However, if this is not possible, then the storage piles should drain directly to a catch basin.
- SP-5 - Catch basins should be located directly downgradient and in the immediate vicinity of snow storage piles to minimize the parking lot area which is subject to meltwater runoff (this may require the construction of additional catch basins).
- SP-6* - Oil grit separators, vegetated filter strips and grassed swales (planted using salt tolerant vegetation as outlined in Table 1) may be included downstream from snow disposal areas to attenuate runoff and reduce suspended solids, metals and petroleum hydrocarbon loads in parking lot runoff.
- SP-7* - Meltwater collected by catch basins downstream from snow storage piles should be routed through an oil grit separator to reduce meltwater contaminant loads, as snow storage piles typically contain high concentrations of oil, sediment and other contaminants.
- SP-8 - If groundwater recharge water quality is of major concern, then the snow storage locations can be designed using impervious surfaces to minimize infiltration (clay underlining of vegetated areas, asphalt pads, concrete pads etc.).
- SP-9 - If dedicated snow storage areas are not feasible, portions of the parking lot that may have lower winter month parking requirements can be designated as snow storage locations and drainage infrastructure in this area can be designed to maximize the capture of meltwater.
- SP-10 - Snow storage piles should be staged in areas which receive large amounts of solar radiation to promote more efficient melting.
- SP-11 - Snow storage piles should be located in areas which are easily accessible for plows and other mechanical snow and ice removal machinery. This may involve having multiple snow storage piles.
- SP-12* - 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. Example sign text: “These parking stalls are designated as snow pile storage areas during the winter months”. Also consider painting/marking the snow storage areas on the pavement.
- SP-13 - The installation of mountable curbs (push points) can allow the contractor to push snow over the curb into designated snow storage area without the concern of causing damage to the curb.

1.2.2 Design Aspects to Avoid

1. Snow storage and disposal piles should not be placed directly on top of catch basins or in prime parking areas (i.e. around the entrance) and should be kept away from pedestrian walkways.

[1] British Columbia – Ministry of Transportation. 2007. BC Supplement to TAC Geometric Design Guide.

2. Snow storage piles should not obstruct driver/pedestrian/cyclist line of sight.
3. Snow storage piles should not be placed in areas with significant shade.

1.3 Operation and Maintenance

1. Litter and debris that collects in snow storage piles should be collected and properly disposed of when snow piles melt.
2. Snow storage pads should be swept and/or properly washed following the spring melt to remove any contaminants left behind from the snow pile (salts, petroleum hydrocarbons, sediments etc.).
3. Snow piles should be broken up and spread apart in the spring to increase the surface area and allow for accelerated melting, because snow should be melted as early as possible in the spring, in order to maximize the dilution of salts in receiving water bodies
4. The pad or area where snow storage piles are located should be examined annually (after the spring melt) for signs of deterioration which could allow undesired direct infiltration of meltwater into subsurface soils
5. All catch basins and oil grit separators located downstream of snow storage piles should be inspected and, if necessary, cleaned shortly after the spring melt.
6. If snow piles grow large enough that they begin to obstruct drivers' sight lines, or begin to cause snow drifts across the parking lot surfaces, they should be separated into smaller alternative snow storage piles, or hauled to an offsite snow disposal facility.
7. Damage to curbs, grass, signs, gravel, speed bumps, and other features should be inspected and repaired.

1.4 Costing

1. If no alterations to the parking lot grade or drainage design are required, as is often the case, the only costs are those associated with installing signage for designated snow storage areas.
2. If additional catch basins must be constructed to properly drain snow storage and disposal areas, the costs are as follows:
    - Typical costs to install a catch basin range from $3,000 to $6,000
    - Costs for connecting a new catch basin to municipal storm sewer infrastructure typically range from $250/m to $500/m for small diameter pipe + surface restoration
3. If regrading of parking lots is required to properly drain snow storage and disposal areas, the costs are as follows:
    - Grade surveying typically costs around $150 to $300/hour
    - Fine grading of paved areas typically costs around $2.15/$m^2$
4. Hauling snow offsite typically costs $300/hour to $500/hour (including front end loader, dump truck and operators)
    - Melt pad construction (installation of an impervious base and liner) typically costs around $45/$m^2$.

Estimation of Snow Pile Volume per Hectare of Parking/Drive Areas

Date :	09/07/16
Project # :	11115623
Client:	LSRCA
Location:	LSRCA Parking - Typical Parking Lot

Average Annual Total Snow Fall Depth [1]	1.25	m
Assumed Total Melted Fraction	0.50	
Total Snow Depth Remaining on Parking Area	0.50	
New Snowfall Density - Canadian Convention	100	kg/m^3
Compacted Snowfall Density [2]	500	kg/m^3
Fresh/Compacted Snow Depth Ratio	0.20	
Snow Depth in Snow Pile	0.05	m
Snowfall Area	10,000	m^2
Snow Pile Volume for Average Annual Snow Fall	**500**	**m^3**
Snow Pile Volume for Max. Annual Snow Fall [3]	**1,500**	**m^3**

Notes:

1. Values taken from Bradford Muck Research Station Climate Normals (1980 - 2010)
2. BC Supplement to TAC Geometric Design Guide (2007)
3. A factor of 3 has been used to estimate the maximum snow pile volume to account for maximum snow fall value

Estimation of Required Snow Pile Area per Hectare of Parking/Drive Areas

Date :	09/07/16
Project # :	11115623
Client:	LSRCA
Location:	LSRCA Parking - Typical Parking Lot

Snow Pile Base Area	4.00	m^2
Snow Pile Volume per metre Length	7.50	m^3
Snow Pile Volume per square metre	1.88	m^3/m^2

Snow Pile Area Required for Average Annual Snow Fall	**267**	**m^2**
Snow Pile Area Required for Max. Annual Snow Fall	**800**	**m^2**

Percentage of Parking Area Required for Snow Piles During Average Annual	**3 %**
Percentage of Parking Area Required for Snow Piles During Max. Annual	**8 %**

Given the assumptions of a 3m high pile with a 1m top width and 2H:1V side slopes (the angle of repose), the cross-sectional area would be 7.5m^2 with a base of 4m. This snow pile would fit within a 6m parking space, with a 1m buffer for both the curb and the drive lane.

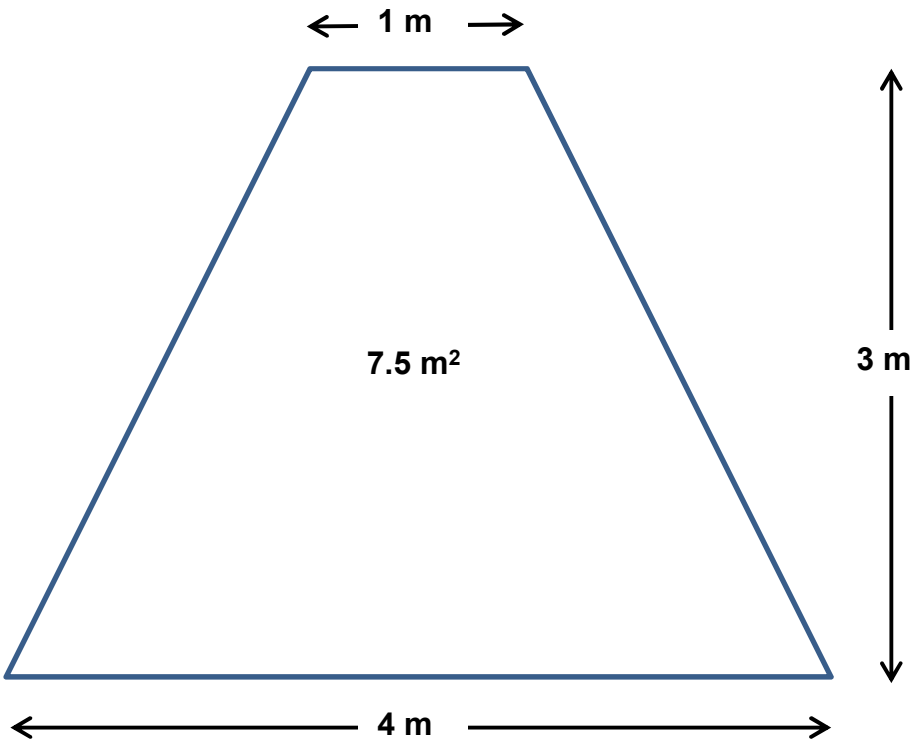


Table 1

Salt Tolerant Plant Species for Parking Lot Design

Botanical Name	Common Name	Native
Deciduous Trees		
Acer x freemanii	Freeman Maple	
Acer ginnala	Amur Maple	
Acer saccharinum	Silver Maple	*
Gleditsia triacanthos	Shademaster Honey Locust	
Ginkgo biloba	Ginkgo	
Pyrus calleryana	Ornamental Pear	
Quercus rubra	Red Oak	*
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	
Tilia americana	Basswood	*
Coniferous Trees		
Larix laricina	American Larch	*
Picea abies	Norway Spruce	
Picea pungens	Colorado Spruce	
Pinus nigra	Austrian Pine	
Decidious Shrubs		
Amelanchier	Serviceberry	*
Forsythia x intermedia	Forsythia	
Philadelphus species	Mockorange	
Spiraea x vanhouttei	Bridlewreath Spirea	
Symphoricarpos species	Snowberry	
Viburnum trilobum	Highbush Cranberry	*
Evergreen Shrubs		
Juniperus species	Juniper	
Perennials		
Sedum spectabile 'Autumn Joy'	Sedum Autumn Joy	
Hemerocallis	Daylily	
Heuchera	Coral Bells	
Hosta	Hosta	
Ornamental Grasses		
Calmagrostis acutifolia 'Karl Foerster'	Karl Foerster Reed Grass	
Festuca glauca 'Elijah Blue'	Elijah blue Festuca Grass	
Pennisetum alopecuroides	Fountain Grass	

NORTH

SCALE: N.T.S

CITY ROADWAY

MH

SIDEWALK

BIO-RETENTION

ROOF LEADER DISCHARGE

ENTRY/ EXIT

HIGH TRAFFIC ROUTE

MELTWATER IS TREATED IN A TREATMENT TRAIN PRIOR TO DISCHARGE OFFSITE (LEVEL SPREADER, VEGETATED FILTER STRIP, BIO-SWALE, OGS...)

(SP-6 AND 7)

2-4%

C.B.M.H.

STM

SITE PARKING LOT AREA

OIL/GRIT SEPARATOR

SPILL OVER SNOW STORAGE

PLACE SNOW PILE ALONG DOWNGRADIENT EDGE OF PARKING LOT

(SP-1)

CURB CUTS

SIGN

BUS STOP

DITCH INLET

MELTWATER IS TREATED PRIOR TO DISCHARGE

(SP-6)

MELTWATER DIRECTED AWAY FROM DRIVE AREAS

(SP-2)

A

FIG.4

A'

FIG.4

SNOW STORAGE LOCATION SIGN

(SP-12)

MAIN SNOW STORAGE

PLACE SNOW PILE ON IMPERVIOUS SURFACE

(SP-4)

BIOSWALE

C.B.

CATCHBASIN (TYP)

BUILDING

ROOF LEADER

MAIN BUILDING ENTRANCE

CURB CUTS

SPILL OVER SNOW STORAGE

PLACE SNOW PILES AWAY FROM HIGH TRAFFIC AREAS

(SP-2)

NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS.

(XX-X) REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

USE MULTIPLE LOCATIONS FOR SNOW PILES

SAFETY OF PEDESTRIANS AND VEHICULAR TRAFFIC IS PARAMOUNT.

LOCATION OF SNOW PILES MUST NOT OBSTRUCT SIGHT LINES

IF INFILTRATION OF SOME CHLORIDES ARE NOT A CONCERN FOR THE SITE, CAN PLACE SNOW PILES ON PERVIOUS AREAS.

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Feb 27, 2017

SNOW PILE STORAGE LOCATION DESIGN EXAMPLE PARKING LOT DESIGN GUIDELINES

FIGURE 3

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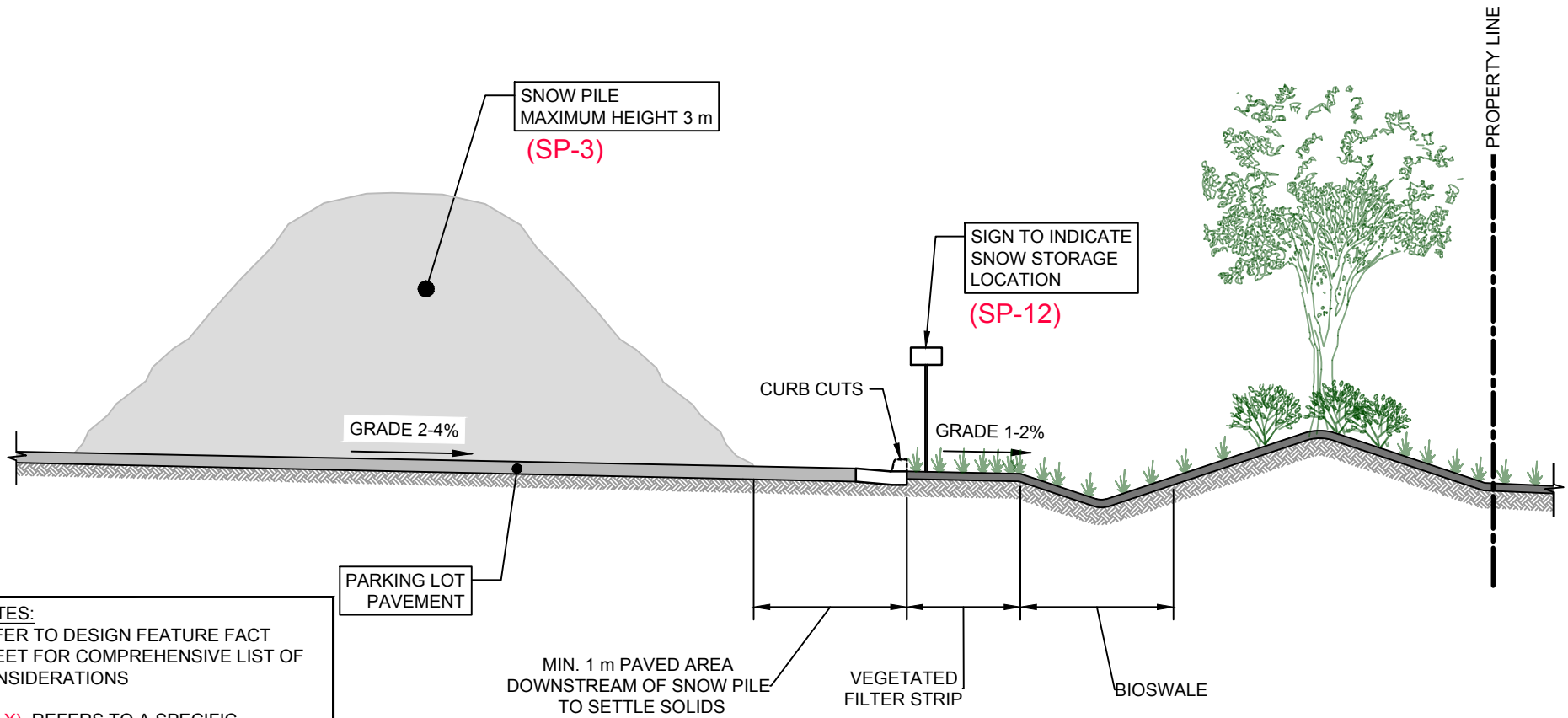

SECTION A-A'

NTS

FIG.3

SCALE : N.T.S.

NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS

(XX-X). REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

USE MULTIPLE LOCATIONS FOR SNOW PILES

SAFETY OF PEDESTRIANS AND VEHICULAR TRAFFIC IS PARAMOUNT.

LOCATION OF SNOW PILES MUST NOT OBSTRUCT SIGHT LINES

IF INFILTRATION OF SOME CHLORIDES ARE NOT A CONCERN FOR THE SITE, CAN PLACE SNOW PILES ON PERVIOUS AREAS.

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SNOW PILE STORAGE LOCATION (TYPICAL SECTION)
PARKING LOT DESIGN GUIDLINES

FIGURE 4

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Sidewalk Design and Pedestrian Flow

1.1 General Description/Overview

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 do not 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. If pedestrian sidewalks were constructed with appropriate widths (minimum of 1.5m) that would allow contractors to plow instead of having to shovel, additional reductions in salt application could be achieved.

1.2 Design Recommendations

Parking lots are used continuously year round, in all weather conditions as are the sidewalks that surround them. Sidewalk design and pedestrian flow guidelines are important for the winter months as they can help minimize the amount of salt required to make sidewalks safe for pedestrian traffic.

The following sections present design recommendations to help reduce the amount of salt application on sidewalks and identify design alternatives that should be avoided as they may lead to the excessive application of salts.

1.2.1 Salt Reduction Recommendations

Listed below are multiple design recommendations that designers should take into consideration and incorporate where feasible and practical. It is acknowledged that the design is optimized by taking into consideration multiple constraints and not all suggestions can always be accommodated. Some of these recommendations are illustrated on Figure 5A and 5B, noted with an asterisk below.

- SD-1 - Planners should verify that the number of sidewalks for the specific building/location is suitable for pedestrian traffic.
- SD-2* - Sidewalk layout should take into consideration pedestrian traffic flow to and from buildings, transportation corridors (such as bus stops), and connectivity to main pedestrian thoroughfares in addition to considerations for vehicular traffic. Pedestrian walkways should also be focused on family oriented locations: i.e. designated parking for families and elderly near the sidewalks.
- SD-3* - Pedestrian sidewalk design should be direct and intuitive.
- SD-4* - Vegetated islands can be used to help protect pedestrians from vehicular traffic. However, vegetated islands should be limited and strategically located so they do not create unnecessary obstacles for plows.
- SD-5 - Owners should look into the utilization of sidewalks and determine whether a sidewalk is primary or secondary. Consideration should only be given to the design of primary sidewalks.

- SD-6* – Partially covered walkways (i.e. overhang) can be eliminated and centralized covered walkways and main building entrances can be used where practical. Consider covering the walkway or blocking direct runoff to the building frontage and entrance. Where possible, for major pedestrian thoroughfares, design the width to promote snow removal by conventional equipment and minimize manually shoveled areas (1.5m minimum width). Ensure that runoff from covered walkways is directed to appropriate stormwater management facilities, and not allowed to drain onto paved surfaces.
- SD-7 - Snow storage locations for walkway clearing should be located to prevent melt water draining back over the walkway.
- SD-8 - Prevailing wind direction should be considered when selecting sidewalk location. When sidewalks are constructed on only one side of a roadway, consideration should be given to placing the sidewalk on either the north or west side.
- SD-9 - For mobility concerns, sidewalk plowing near transit stops should be a priority.
- SD-10* - Properly graded pedestrian walkways can be implemented between the parking lot and building entrance to promote good drainage and minimize refreeze. The use of “rough” material that reduces slip risks without promoting heaving could prove beneficial. The use of darker materials can promote solar heating of walkways.
- SD-11 - By placing the building entrance near the road way, the length of sidewalk needed for primary pedestrian traffic walkways would decrease.
- SD-12* - Consider the use of heated walkways in front of the building. Heated entrances could limit the amount of salt applied.
- SD-13 - Where possible, pedestrian walkway design should consider plow routes.

1.2.2 Design Aspects to Avoid

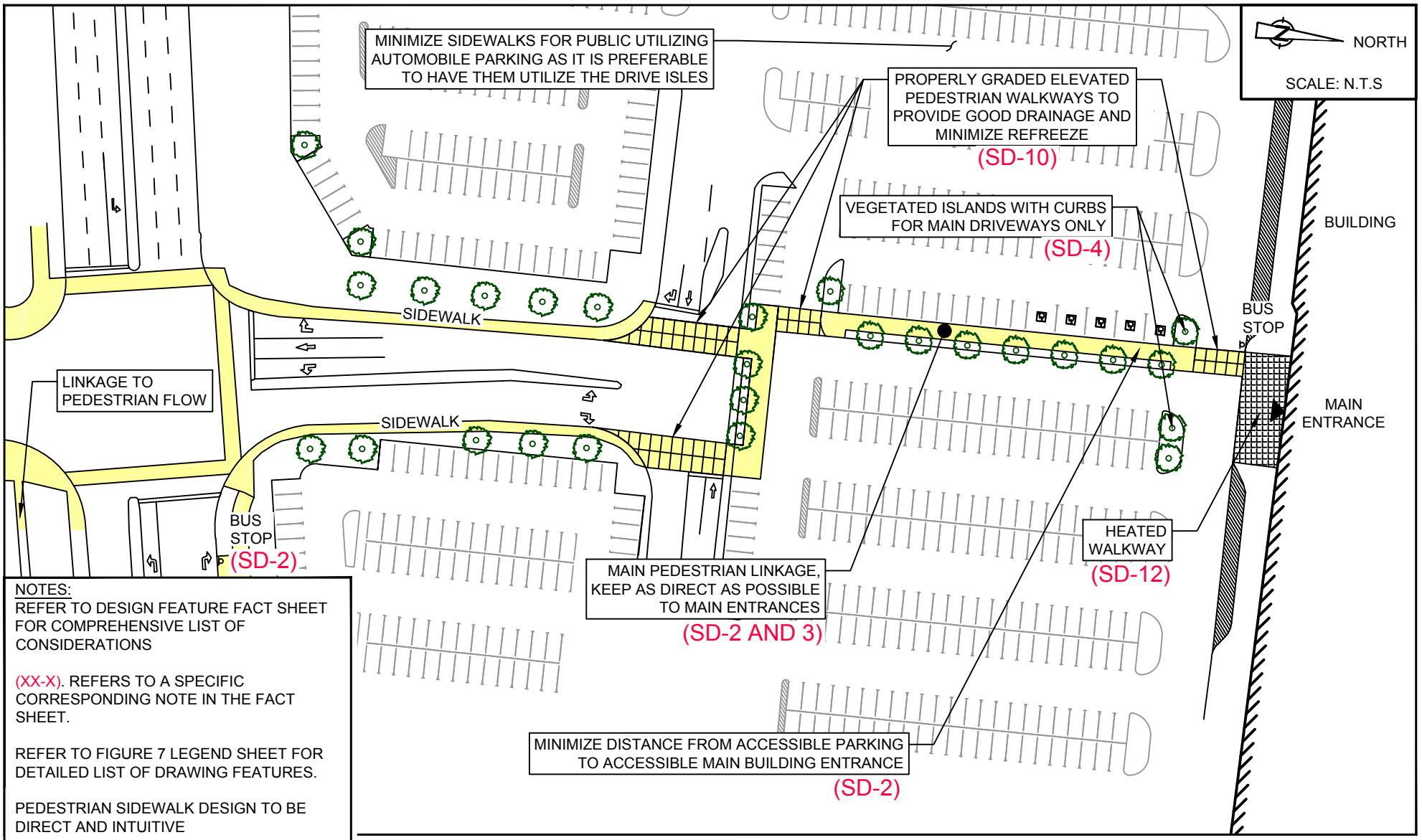
1. The creation of pedestrian walkways that are unnecessary or unused should be avoided, as they will increase the application of salts.
2. The design of winding sidewalks should be avoided to assist snow plow operators in efficient sidewalk management.
3. Where possible avoid draining upstream areas across sidewalks and walkways. In addition, avoid grading sidewalks and walkways that promote the ponding of water.

1.3 Operation and Maintenance

1. Periodic maintenance is recommended to ensure that signage for closed sidewalks (during winter months) are visible/ clear of snow, bollards are upright and chains are still intact.
2. Depressions that may form on sidewalks/walkways should be repaired to minimize the retention of water and potential safety hazards.
3. Drop spreaders rather than broadcast spreaders should be used on walkways to increase the amount of material retained on the walkway. This also helps limit salt damage to vegetated areas and buildings.

1.4 Costing

1. The only costs involved are installing the signage, chains and bollards surrounding the pedestrian walkway to be closed in addition to installing signage for snow storage areas.



NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS

(XX-X). REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

PEDESTRIAN SIDEWALK DESIGN TO BE DIRECT AND INTUITIVE

VEGETATED ISLANDS CAN BE USED TO PROTECT PEDESTRIANS; HOWEVER, ONLY FOR MAIN TRAFFIC AREA

CONSIDER WALKWAYS FOR MAIN PEDESTRIAN ROUTES ONLY

CONSIDER HEATED WALKWAY IN FRONT OF STORE

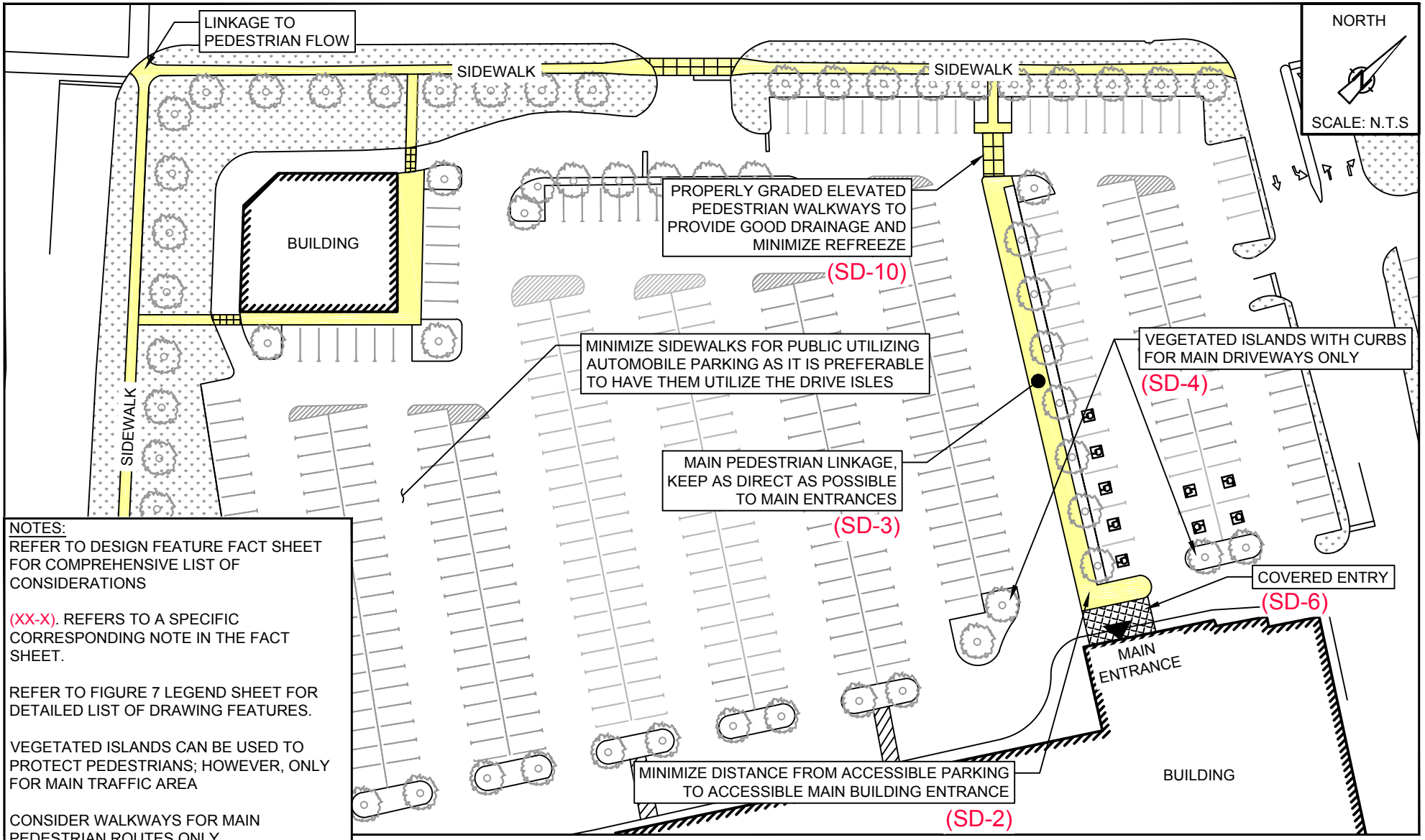
LAKE SIMCOE REGION
CONSERVATION AUTHORITY

11115623-01
Feb 27, 2017

SIDEWALK DESIGN AND PEDESTRIAN FLOW PARKING LOT DESIGN GUIDELINES

FIGURE 5A

CAD File: P:\drawings\11115000s\11115623\11115623-REPORTS\11115623-01(002)\11115623-01(002)GN\11115623-01(002)GN-WA003.dwg



NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS

(XX-X). REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

VEGETATED ISLANDS CAN BE USED TO PROTECT PEDESTRIANS; HOWEVER, ONLY FOR MAIN TRAFFIC AREA

CONSIDER WALKWAYS FOR MAIN PEDESTRIAN ROUTES ONLY

PEDESTRIAN SIDEWALK DESIGN TO BE DIRECT AND INTUITIVE

CONSIDER HEATED WALKWAY IN FRONT OF STORE

CONSIDER CANOPY AT FRONT ENTRANCE WITH EAVESTROUGHS

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CONSERVATION AUTHORITY

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SIDEWALK DESIGN AND PEDESTRIAN FLOW PARKING LOT DESIGN GUIDELINES

FIGURE 5B

CAD File: P:\drawings\11115000s\11115623\11115623-REPORTS\11115623-01(002)\11115623-01(002)GN\11115623-01(002)GN-WA005.dwg

Landscaping Features

1.1 General Description/Overview

Landscaping features such as vegetated swales or landscaped islands can lead to a reduced requirement for 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 vegetated 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.

1.2 Design Recommendations

Parking lots are used continuously year round, in all weather conditions. Landscaping features add an aesthetic aspect to an otherwise bleak area, as well as contributing to urban stormwater management. By designing landscaped parking lots with the winter months in mind, snow plowing and removal will become more efficient, reducing the amount of salt required. This document specifically focuses on these two aspects with respect to the winter months and on how to take advantage of landscaping to reduce the use of salt. Additional guidelines exist that may prove useful for designers and landscape architects, such as, "Landscape Ontario's Survival Guidelines for Professional" (http://gerrytreenursery.com/Salt-Tolerant-Trees.pdf).

The following sections present recommendations for design approaches to follow/avoid to help reduce the amount of salt application on parking lots and identify design considerations that should be avoided that may lead to the excessive application of salts.

1.2.1 Salt Reduction Recommendations

Listed below are multiple design recommendations that designers should take into consideration and incorporate where feasible and practical. It is acknowledged that the design is optimized by taking into consideration multiple constraints and not all suggestions can always be accommodated. Some of these recommendations are illustrated on Figure 6, noted with an asterisk below.

- LD-1* - Parking lot layouts should be conducive to mechanical snow removal by snow plows. This may involve minimizing the number of tight turns and obstacles that snow plows encounter by allowing them to plow in straight lines as much as possible. Landscaped islands can be kept to the outside/ends of parking aisles.
- LD-2* - Curb cuts can be installed around the perimeter of the parking lot to promote drainage into landscaped areas.
- LD-3* - All vegetation used in landscaping features should be non-invasive and tolerant to local climate and soil conditions. Preference should also be given to native plants where possible. Table 1 (following text) provides a list of some recommended salt tolerant plant species that can be used in parking lot design.
- LD-4* - All vegetated landscaping features should be composed of salt tolerant vegetation, (refer to Table 1) for vegetated islands, filter strips and swales. Due to the mobility of salt in soils, in source water protection areas vegetated filter strips and grassed swales should be constructed with an

impermeable base material (i.e. clay). Bioretention features should be combined with other upstream salt reduction design features.

- LD-5* - Bioswales should be installed in well-drained soils, or should include underdrain systems when installed in poorly drained soils (CVC and TRCA, 2010[1]).
- LD-6* - The inlet for a bioswale should be designed to promote sheet flow, in order to limit erosion and maximize contaminant removal efficiency. This can be achieved by using wide curb cuts or installing energy dissipaters with flow spreaders on the ends of inlet pipes. Pre-treatment is recommended prior to discharge into the bioswales, per CVC and TRCA, 2010[1].
- LD-7 - Bioswale vegetation should be tolerant of periodic flooding and drought. Plants with deep roots should be planted when constructing bioswales.
- LD-8* If trees are included in the landscaping areas, consideration should be given to deciduous trees with high canopies to maximize solar energy to melt snow/ice during winter months, and promote cooling of parking lots in summer months and maintaining visibility.
- LD-9 - During winter months, burlap can be used to protect trees and vegetation from damage.
- LD-10* - Bioretention features can be implemented to collect stormwater runoff from roofs and canopies.
- LD-11 - Planting along the property boundary and the inclusion of various bio-retention features is encouraged, provided they don't promote snow drift accumulation directly adjacent to paved surfaces.
- LD-12 - Using raised planters can also protect vegetation from being exposed to increases in salt.
- LD-13 – 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.

1.2.2 Design Aspects to Avoid

1. The water treatment design velocity for a bioswale should promote infiltration unless it is located in an environmentally sensitive area where infiltration should be avoided.
2. Vegetated islands should be limited and strategically located so they do not create unnecessary obstacles for plows

1.3 Operation and Maintenance

1. Vegetation used in landscaping features should be pruned appropriately to promote long term health and growth, and to maintain safe visibility.
2. Bioswale vegetation should be trimmed once every year or two to prevent succession by woody species.
3. Bioswales should be inspected for bank erosion and slumping on an annual basis.

[1] Credit Valley Conservation Authority and Toronto and Region Conservation Authority, 2010. Low Impact Development Stormwater Management Planning and Design Guide. Retrieved from http://www.creditvalleyca.ca/wp-content/uploads/2014/04/LID-SWM-Guide-v1.0_2010_1_no-appendices.pdf

4. Sediment accumulation should be removed from a bioswale when it exceeds 25% of the swale's design volume.
5. Landscaping vegetation requires regular watering and weed control for the first 3 to 5 years following planting.
6. Newly planted landscaping vegetation may require protection from wildlife for the first 5 to 7 years.

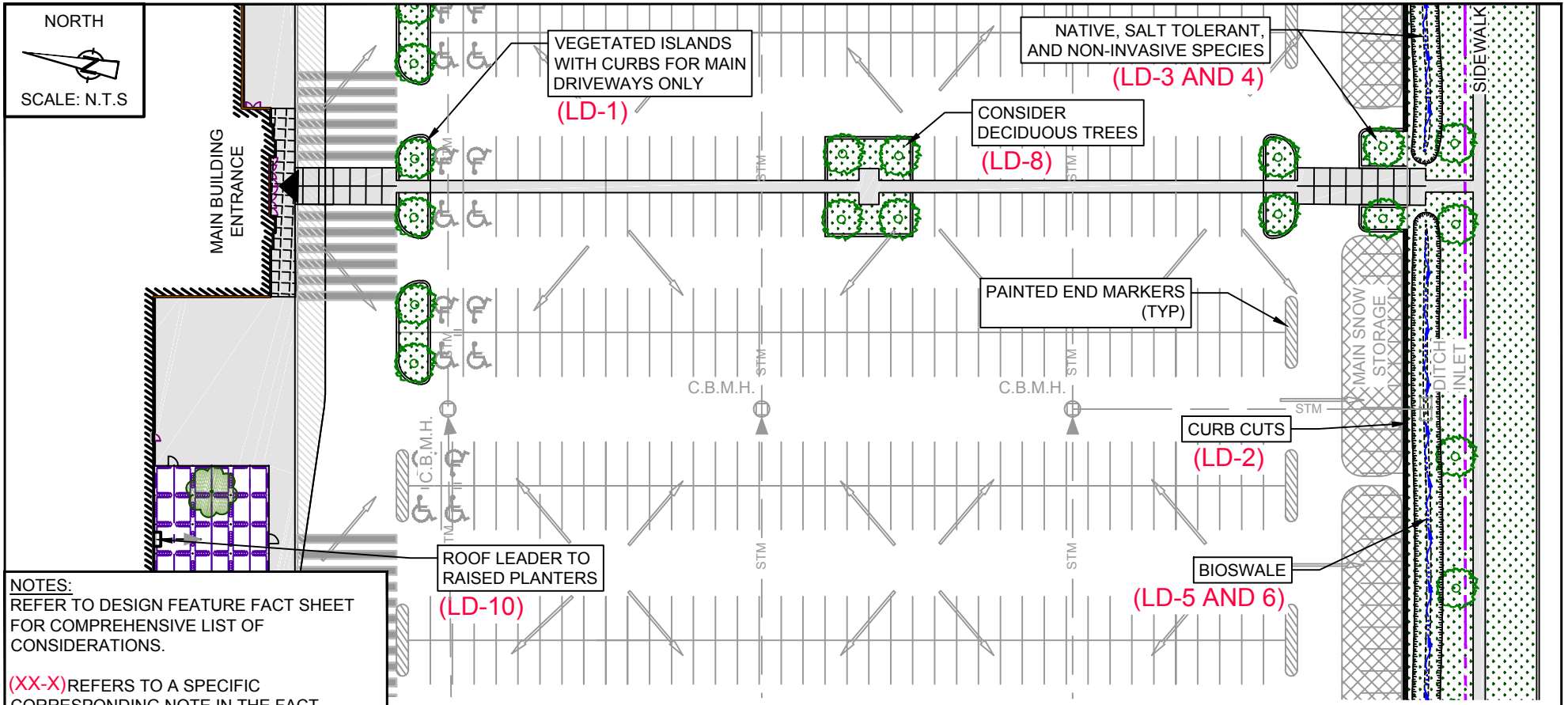
1.4 Costing

1. Costs for single trees used in landscaping features (such as landscaped islands) can range from a few dollars for saplings, to between $200 and $500 for large mature trees. Although less expensive, saplings can take years to develop and many will not survive to maturity. Thus, mature trees provide a more rapid and reliable solution. Shrubs typically range from $30 to $40 each.
2. Bioswale costs can range from $\$5.50/m^2$ to $\$55.00/m^2$.
3. Vegetated filter strips typically cost between $\$3.50/m^2$ and $\$35.50/m^2$.
4. Fully installed oil grit separators can range in cost from $5,000 for small simple units, which are appropriate for low runoff volumes containing low contaminant loads, to over $150,000 for large complex units, which are required to treat large runoff volumes with abundant and complex contaminant loads).

Table 1

Salt Tolerant Plant Species for Parking Lot Design

Botanical Name	Common Name	Native
Deciduous Trees		
Acer x freemanii	Freeman Maple	
Acer ginnala	Amur Maple	
Acer saccharinum	Silver Maple	*
Gleditsia triacanthos	Shademaster Honey Locust	
Ginkgo biloba	Ginkgo	
Pyrus calleryana	Ornamental Pear	
Quercus rubra	Red Oak	*
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	
Tilia americana	Basswood	*
Coniferous Trees		
Larix laricina	American Larch	*
Picea abies	Norway Spruce	
Picea pungens	Colorado Spruce	
Pinus nigra	Austrian Pine	
Decidious Shrubs		
Amelanchier	Serviceberry	*
Forsythia x intermedia	Forsythia	
Philadelphus species	Mockorange	
Spiraea x vanhouttei	Bridlewreath Spirea	
Symphoricarpos species	Snowberry	
Viburnum trilobum	Highbush Cranberry	*
Evergreen Shrubs		
Juniperus species	Juniper	
Perennials		
Sedum spectabile 'Autumn Joy'	Sedum Autumn Joy	
Hemerocallis	Daylily	
Heuchera	Coral Bells	
Hosta	Hosta	
Ornamental Grasses		
Calmagrostis acutifolia 'Karl Foerster'	Karl Foerster Reed Grass	
Festuca glauca 'Elijah Blue'	Elijah blue Festuca Grass	
Pennisetum alopecuroides	Fountain Grass	



NOTES:
REFER TO DESIGN FEATURE FACT SHEET FOR COMPREHENSIVE LIST OF CONSIDERATIONS.

(XX-X) REFERS TO A SPECIFIC CORRESPONDING NOTE IN THE FACT SHEET.

REFER TO FIGURE 7 LEGEND SHEET FOR DETAILED LIST OF DRAWING FEATURES.

LANDSCAPING SHOULD NOT REDUCE THE ABILITY FOR SNOW REMOVAL CONTRACTORS TO EFFICIENTLY PLOW PAVED AREAS

PLANT SPECIES SELECTED MUST BE SALT TOLERANT

AVOID TOO MANY ISLANDS

LARGER LANDSCAPE AREAS BUT FEWER OF THEM

ENCOURAGE PLANTING AROUND PERIMETER

LAKE SIMCOE REGION CONSERVATION AUTHORITY

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Feb 27, 2017

LANDSCAPING PARKING LOT DESIGN GUIDELINES

FIGURE 6

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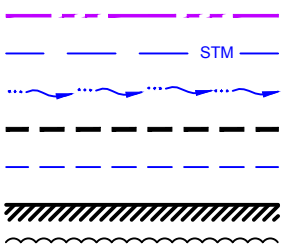
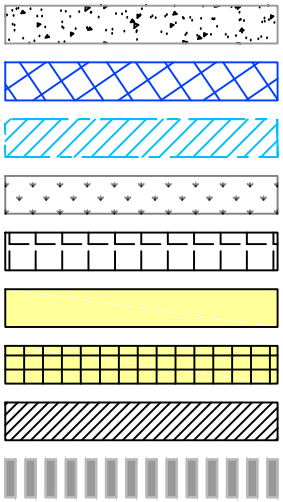
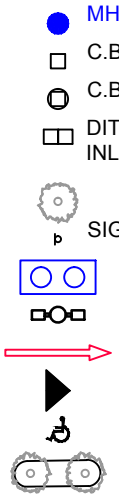


PROPERTY LINE
STORM SEWER
VEGETATED SWALE
TRAFFIC ROUTE
ROOF LEADER
BUILDING OUTLINE
VEGETATION



CONCRETE WALKWAY
SNOW PILE LOCATIONS
CONTRIBUTING DRAINAGE AREA
VEGETATED AREAS
HEATED WALKWAY
SIDEWALK/ PEDESTRIAN WALKWAY
ELEVATED PEDESTRIAN WALKWAY
PAINTED END MARKERS
PASSENGER LOADING AREA



MAINTENANCE HOLE
CATCHBASIN
CATCHBASIN MAINTENANCE HOLE
DITCH INLET
TREE
SNOW PILE SIGNAGE
OIL/GRIT SEPARATOR
LIGHT POLE
OVERLAND FLOW DIRECTION
BUILDING ENTRANCE
ACCESSIBLE PARKING
RAISED END MARKERS

LAKE SIMCOE REGION
CONSERVATION AUTHORITY

LEGEND
SHEET

11115623-01

FIGURE 7

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Appendix B
Design Feature Brief for Interviewees

Final Interviewee List
Site Design Guidelines to Promote Salt Reduction
Lake Simcoe Region Conservation Authority

Selected Interviewee List

Category	Name	Job Title	Organization	Telephone No.	Email
Contractors	Cameron Smith	Regional Manager	TCG	905-260-0155	c.smith@tcgnational.ca
Contractors	Nichole Ashton	Operations Manager	Clintar Landscape Management	519-897-0160	ashtonicho02@gmail.com
Designers	Conrad Stang	Water Resource Engineer	NovaTech	613-254-5867	c.stang@novatech-eng.com
Designers	Mike Petepiece	SWM Team Leader	NovaTech	613-254-5867	
Regulators	John McIntosh	Source Protection Coordinator	Halton Region	905-825-6000 x 7512	john.mcintosh@halton.ca
Regulators	Adam Gilmore	Supervisor, Municipal Water Resources Planning	Halton Region	905.825.6000 x 7134	adam.gilmore@halton.ca
Regulators	Katie Thompson	Risk Management Official	City of Barrie	705-739-4220 ext. 4796	Katie.Thompson@Barrie.ca
Academics	Liping Fu	Professor	Department of Civil & Environmental Engineering - University of Waterloo	519-888-4567 x33984	lfu@waterloo.ca
Academics	Jennifer Drake	Professor	Department of Civil Engineering - University of Toronto	416-978-8248	jenn.drake@utoronto.ca

July 19, 2016 Reference No. 11115623

Kaitlyn Read M.Sc., B.Sc.
Subwatershed Planning Assistant
120 Bayview Parkway
Newmarket, Ontario L3Y 3W3

Dear Madam Read:

Re: Design Feature Brief for Interviewee's – Identification of Design Features that Promote the Reduction of Road Salt Application on Commercial and Institutional Parking Lots

GHD Limited is pleased to submit the following Design Feature Brief to the Lake Simcoe Region Conservation Authority (LSRCA) for review and comment. This Brief (Attachments A) will be provided to each of the selected industry representatives prior to the interview. Attachment A is intended to introduce the GHD selected design features to the LSRCA and provide LSRCA with the opportunity to provide comments and include additional design features, if desired.

Also included in this Design Brief Package is the list of selected industry representatives (Attachment B), previously reviewed by LSRCA, and the preliminary list of questions for each category of industry representatives (Attachment C). The preliminary list of questions is intended to initiate the conversation with the industry representatives with additional questions to be included based on the direction of the interview.

Please let us know if you have any questions.

Sincerely,

GHD

Dilan Singaraja, P.Eng

Andrew Betts, M.A.Sc., P.Eng.,

DS/aj/1

Encl.

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Attachment A
Design Feature Brief

Memorandum

Draft for Review

To:	(Insert Industry Representative Name)	Ref. No.:	11115623
From:	Dilan Singaraja (GHD), Andrew Betts (GHD)/aj/1	Date:	July 19, 2016
CC:	Kaitlyn Read (LSRCA)		

Re: Design Feature Brief - Identification of Design Features that Promote the Reduction of Road Salt Application on Commercial and Institutional Parking Lots

1. Introduction

Lake Simcoe Region and Conservation Authority (LSRCA) recently initiated a project to develop guidelines for the design of commercial/institutional parking lots for salt reduction. This project was conceived to advance LSRCA and other Regulatory Agencies initiatives to improve the Lake Simcoe Watershed and the health of our natural environment, specifically from the negative environmental impacts associated with road salts. GHD Limited (GHD) was awarded the contract to execute this project with LSRCA and other partner agencies.

On behalf of the LSRCA, GHD has developed the following Design Feature Brief to identify design features that promote the reduction of road salt application on commercial and institutional parking lots. This brief is intended to provide a high level overview of the identified design features.

A group of stakeholders, who are involved in snow and ice control during winter maintenance operations, have been selected for interview. They will provide input on the feasibility of the implementation of the identified design features and their ability to promote the reduction of road salt application. The results from the interviews will be used to inform the selection of a minimum of three key design features that promote the greatest reduction of road salt application and are most likely to be implemented in the design of future parking lots or the retrofit of existing parking lots.

2. Background

Increasing chloride concentrations due to the use of road salts pose a threat to aquatic organisms within the Lake Simcoe Watershed. LSRCA models estimate that continued urban development in the Lake Simcoe Watershed could cause average annual chloride concentrations in some of Lake Simcoe's major tributaries to increase from near-zero to greater than 24,000 mg/L. Such chloride concentrations have the potential to cause considerable damage to aquatic ecosystems, as they far exceed the exposure guideline of 640 mg/L for aquatic organisms (acute chloride concentration), which was established by the Canadian Council of Ministers of the Environment (CCME) in 2011. Monitoring data collected from privately owned commercial

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parking lots within the LSRCA jurisdiction have also supported this conclusion with stormwater runoff chloride concentrations reaching over 80,000 mg/L.

A major cause of increasing chloride concentrations within the Lake Simcoe Watershed is the application of road salts to commercial and institutional parking lots. It is believed that improvements in the design of parking lots can lead to an overall reduction in the need for road salt application to control snow and ice conditions. The following design brief provides a summary of several examples of parking lot design options that potentially promote the reduction of road salt application.

3. Design Features

The proposed design features include the following:

- Permeable pavers
- Grading of parking lots
- Snow pile storage location
- Landscaping features
- Shaded canopies
- Conductive pavement on walkways and entrances
- Brine holding tank for anti-icing or pre-wetting

3.1 Permeable Pavers

Permeable pavers reduce the need for road salt application in parking lots by improving drainage and preventing melt water from ponding and refreezing. 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.

The installation of permeable pavers has been demonstrated to reduce road salt application requirements for paved surfaces by up to 75% (University of New Hampshire Stormwater Center, 2007). Additionally, the highly porous joint and sub-base 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.

3.2 Grading of Parking Lots

Effective parking lot grading can prevent melt water from ponding and refreezing on parking lot surfaces, reducing the need for re-application of road 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/ice formation. Slopes of 2 to 5 percent 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 low traffic areas or vegetated swales/landscaped areas, thereby preventing salt application in heavy traffic areas that are also pathways for runoff.

3.3 Snow Pile Storage Location

Strategically locating snow storage and disposal 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 on to high traffic areas and refreezing. Situating snow storage piles in areas that receive abundant solar radiation can help to accelerate melting. Additionally, it is important to locate snow storage piles to prevent visual obstructions for drivers and reduce snow drifts across parking lot surfaces. Designates snow storage areas can also be designed to promote sheet flow across shallow sloped vegetated surfaces, as an example, to promote water quality improvements.

3.4 Landscaping Features

Landscaping features such as living snow fences, vegetated swales or landscaped islands can lead to a reduced requirement of road salt application by limiting the amount of snow drift and provide locations to direct snowmelt runoff. Snow fences can consist of shrubs and/or coniferous trees surrounding the perimeter of the parking lot. They work by limiting snow drift from adjacent properties. Vegetated swales 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 living snow fences, vegetated swales and landscaped islands should be salt tolerant and should be suited to each site's soil, climate and moisture conditions.

3.5 Shaded Canopies

Shaded roof canopies can be constructed over parking spots and pedestrian walkways to minimize snow and ice deposition, resulting in reduced road 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. Similar sheltering from snow and ice deposition can also be achieved by planting shaded tree canopies.

3.6 Conductive Pavement on Walkways or Entrances

Building entrances and pedestrian walkways typically receive high road 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 or heat to the pavement surface to melt ice and snow with constant and uniform heating. Electricity is the energy source which is most commonly used to heat conductive concrete pavements, but solar and geothermal energy used to heat water in pipes beneath conductive concrete pavements may also provide thermal energy to melt ice and snow.

3.7 Brine Holding Tank for Anti-Icing or Pre-wetting

Collection of first flush (high chloride concentration) melt water runoff from a road salt induced snowmelt has the potential to be beneficial if captured and reused as 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 in a catch basin to divert and collect the high chloride concentration runoff into a brine holding tank.

Attachment B
Interviewee List

Draft Initial Interviewee List
Site Design Guidelines to Promote Salt Reduction
Lake Simcoe Region Conservation Authority

Selected Interviewee List					
Category	**Name**	**Job Title**	**Organization**	**Telephone No.**	**Email**
Contractors	Cameron Smith	Regional Manager	TCG	905-260-0155	
Contractors	Nichole Ashton	Operations Manager	Clintar Landscape Management		ashtonicho02@gmail.com
Owners	Rick Mutuchky	Central Operations Supervisor	Simcoe County District School Board	(705) 734 – 6363 ext.11393	RMutuchky@scdsb.on.ca
Owners	Tom Bazinety	Senior Director/Property Manager	Calloway (Smart Center)	(905) 326-6400 x7625	tbazinet@callowayreit.com
Designers	Clark Gunter	Director at Road Salt Management Council of Canada	WSP	519-743-8777	gunterc@mmm.ca
Designers	Conrad Stang	Water Resource Engineer	NovaTech	613-254-5867	c.stang@novatech-eng.com
Academics	Bahram Gharabaghi	Professor	School of Engineering - University of Guelph	519-824-4120 x58451	bgharaba@uoguelph.ca
Regulators	Lise Trudel	Senior Regulation and Evaluation Specialist	Environment Canada	819-938-4547	lise.trudel@canada.ca
Regulators	Adam Gilmore	Supervisor, Municipal Water Resources Planning	Halton Region	905.825.6000 x 7134	adam.gilmore@halton.ca
Additional Interviewee's (if required)					
Contractors	Tony DiGiovanni	Executive Director	Landscape Ontario Horticultural Trades Association	416-848-7575 x.2304	tonydigiovanni@landscapeontario.com
Contractors	Unknown	Winter maintenance contractor	K.J. Beamish	705-726-8061	
Contractors	Terry Nicholson	Vice President	Clintar Landscape Management	905-943-9530	info@clintar.com
Academics	Liping Fu	Professor	Department of Civil & Environmental Engineering - University of Waterloo	519-888-4567 x33984	lfu@waterloo.ca
Regulators	Eric Hodgins	Manager, Hydrogeology & Surface Water	Region of Waterloo/President Smart About Salt	519-575-4434	ehodgins@regionofwaterloo.ca
Regulators	Robert Burlie	Chair and President	Ontario Good Roads Association	416-392-0285	
Regulators	Katie Thompson	Risk Management Official	City of Barrie	705-739-4220 ext. 4796	Katie.Thompson@Barrie.ca

Attachment C
Interview Questions

Questionnaire

The following list of example questions will be provided to the stakeholders prior to conducting the interview. Only the questions that relate to their particular stakeholder category will be provided to each individual. The questions outlined below are intended to facilitate the conversation and additional questions may result from the individual responses to these questions.

Landscaping and Snow Removal Contractors

Background Knowledge

1. Does your business currently track road salt application quantities or rates, if so how is it tracked?
2. What is the current level of training that your employees have with reducing salt application?
3. In your experience, what is the current level of awareness among your industry peers and your clients when it comes to salt reduction measures and their importance in protecting the environment?
4. What barriers, if any, prevent landscaping and snow removal contractors from implementing road salt reduction measures?
5. Have you discussed salt application record keeping and/or reduction of road salt use with your insurance company? If so, what is their stance on the issue?

Design Features

1. Do you have any landscaping or snow removal experience on sites with permeable pavements, conductive pavements or pavements with mechanical grooving or texturing? If so, does the presence of any one these pavement types change your landscaping or snow removal approach, or create any significant challenges for your operations?
2. After initial plowing and salting of the parking lot, what measures are in place to prevent melt water from refreezing? Are you familiar with particular areas of the parking lots you work on with areas that commonly pond and meltwater refreezes?
3. If design grades were in the range of 2-5%, do you think this would help limit the amount of meltwater refreeze and reduce the need for additional salt application?
4. With regards to the location of snow storage piles, does the property owner direct you where to place snow piles, or do you independently decide where to place snow piles?
5. Does your company strategically locate snow storage piles to promote melting or minimize meltwater runoff across high traffic parking lot areas?
6. If designated walkways were replaced with bioswales, what additional measures, if any, would you recommend implementing to maintain pedestrian safety in parking lots?
7. Are there any other site layout recommendations that you can make for improving mechanical snow removal efficiency?
8. How can covered walkways or shaded canopies be incorporated into parking lot designs such that they minimize obstacles to landscaping and snow removal activities (ie plowing)?
9. What is your current salt application policy on pedestrian walkways and entrances?
10. Do you perform any proactive measures to fighting snow and ice conditions (e.g. anti-icing)?

11. Do you pre-wet your salt before application?
12. If brine holding tanks we located on-site for use as anti-icing or pre-wetting would you use such infrastructure? Why or why not?
13. Do you have any concerns about how any of the proposed design features might impact your organization ability to perform your winter maintenance work?
14. What possible benefits can you foresee the proposed design features have for winter maintenance operations?
15. Do you have any suggestions for improving any of the proposed design features to better meet the needs of winter maintenance operations?
16. Are there any additional design features, or considerations for the proposed design features or new ideas, which you believe may have been overlooked?
17. Would you be willing to participate in a design charrette (essentially a group discussion) and provide input on the design of the selected design features?

Owners

Background Knowledge

1. What type of contracts do you use with your winter maintenance contractors (event based or lump sum or other)?
2. What is the current level of training and/or knowledge within your organization with regards to reducing salt application?
3. Do you require your contractors to track their road salt use? Why, or why not?
4. What barriers, if any, prevent property owners from implementing road salt reduction measures in their parking lots?
5. How much capital would you be willing to invest in design features and management practices for reducing road salts in your parking lots?
6. Do you get any pressure from your tenants/site staff on snow removal/salting?

Design Features

1. How familiar are you with the use of permeable pavers? Would you consider installing permeable pavers in your parking lots? Why or why not?
2. Did you consider minimizing meltwater runoff across high traffic areas and into environmentally sensitive areas when building your parking lots?
3. Do you inform your contracts where to locate the snow piles? If so, do you consider the runoff direction of the meltwater?
4. If there are designated walkways in your parking lots, are they heavily used by pedestrians? If not, would you consider replacing them with bioswales and living snow fences? Why, or why not?
5. Would you consider building covered walkways/shaded canopies in your parking lot? What are some of the reasons parking lots may, or may not incorporate covered walkways/shaded canopies?
6. Have you or would you consider installing conductive/heated walkways and entrances? What if electricity costs were less than salt costs?

7. Would you consider installing brine collection systems and storage tanks in your parking lots? Why, or why not?
8. What actions could be taken to encourage property owners to incorporate road salt reduction design features and management practices into their parking lots?
9. How can the design features proposed in this project be improved to better meet the needs of your business?
10. Do you see these parking lot design features affecting the safety of your customers and employees?
11. Which of the proposed design features would you be most/least likely to implement and why?
12. Do you have any concerns about how the proposed design features might impact your business?
13. Are there any additional design features, or considerations for the proposed design features, which you believe may have been overlooked by this project?
14. Would you be willing to participate in a design charrette (essentially a group discussion) and provide input on the design of the selected design features?

Designers

Background Knowledge

1. In your professional opinion, what are the most important considerations when designing parking lots with low-impact infrastructure?
2. Do you consider road salt application when designing parking lots?
3. What barriers, if any, prevent designers from incorporating road salt reduction features in parking lot designs?
4. What can be done to encourage designers to incorporate road salt reduction measures into infrastructure projects?

Design Features

1. Have you designed pavement surfaces with permeable pavers before? If so, is the application of road salt considered in the design?
2. What grades do you typically use when designing parking infrastructure?
3. Do you consider meltwater refreezing potential in part of your design of grades?
4. Do you consider snow storage piles when designing parking lots? If so, do you consider the potential refreezing of the meltwater in selecting the location?
5. How do you design for pedestrian traffic?
6. How often do you incorporate landscape features as a component of your stormwater management design?
7. If designated walkways were removed in favour of bioswales with curb cuts, how might you alter your parking lot designs to be more pedestrian friendly?
8. Have you considered incorporating conductive/heated concrete into your design of pedestrian walkways or entrances? Why or why not?
9. Have you ever incorporated covered walkways or shaded canopies in your design of pedestrian walkways? If not, would you?

10. Would you consider incorporating brine collection and storage systems into parking lot designs? Why or why not?
11. Which of the proposed design features would you be most likely to include in your own parking lot designs and why?
12. Do you have any suggestions for improving the effectiveness of the proposed design features?
13. From a design perspective, which of the proposed design features do you believe would be the simplest to implement and which do you think would be the most complex?
14. Based on your experience and professional judgment, how effective do you think the proposed parking lot design features will be able at reducing road salt application?
15. Are there any additional design features, or considerations for the proposed design features, which you believe may have been overlooked by this project?
16. Would you be willing to participate in a design charrette and provide input on the design of the selected design features?

Academics

Background Knowledge

1. Have you encountered any research which examines the effectiveness of parking lot design to reduce or limit the amount of winter maintenance required?
2. To your knowledge, is there any current/ongoing research which you feel should be consulted for the design of road salt reduction features in parking lots?
3. How can owners/designers/contractors be enticed to incorporate road salt reduction measures into their winter maintenance operations and parking lot designs?

Design Features

1. Have you performed any research or monitoring with permeable pavers before? If yes, did you investigate the potential for permeable pavers to reduce the overall salt application requirements?
2. Have you conducted any or aware of any research that is related to the effect of different grades/slopes on parking lots and the impact to stormwater collection or winter maintenance operations?
3. Based on your previous research, has strategic selection of snow storage piles on a parking lot been a consideration of owners/designers/contractors?
4. If you were to design a snow pile location on a parking lot, what criteria would you consider?
5. What is your opinion on the effectives of grading parking lots towards vegetated swales or landscaped islands to prevent meltwater refreeze?
6. Do you think planting a living snow fences around the perimeter of a parking lot would minimize the accumulation of snow and ice on a parking lot?
7. Are you aware of any research that has been completed on the use of covered walkways or shaded canopies to reduce the accumulation of snow cover on pedestrian walkways?
8. Are you aware of any research that has investigated the design of conductive/heated pavement and its effect on snow and ice accumulation?

9. Based on your knowledge of road salt concentrations in urban runoff and the required brine concentrations and volumes for anti-icing applications, do you think that collection of first-flush meltwater for re-use as anti-icing purposes is feasible? What about re-use for pre-wetting purposes?
10. In your professional opinion, which of the proposed design features will perform best at reducing the concentrations of road salt in runoff from parking lots and how effective will these design features be?
11. Do you have any suggestions for improving the effectiveness of the proposed design features?
12. Are there any additional design features, or considerations for the proposed design features, which you believe may have been overlooked by this project?
13. Would you be willing to participate in a design charrette and provide input on the design of the selected design features?

Regulators

1. What are the most important things that your organization looks for in projects which aim to reduce environmental impacts from site runoff?
2. In your professional opinion, how effective will the proposed design features be at reducing chloride concentrations in runoff?
3. Which design features do you think will be the most and least effective?
4. How can organizations protect themselves from liability for injuries resulting from reduced road salt application in the winter months?
5. How does your organization encourage public and private entities to incorporate road salt reduction into their parking lot designs and winter maintenance plans?
6. What is the current level of awareness about road salt reduction measures among your organizations?
7. What steps should be taken to monitor, measure and report the effectiveness of the proposed design features that would lead to your organization adopting these guidelines for all future parking lot designs?
8. Are there any forms of credit or recognition that organizations can receive for implementing road salt reduction design measures in their parking lots?
9. Are there any specific guidelines or regulations that parking lot owners need to consider for maintaining pedestrian safety if they remove designated walkways from their parking lots in favour of bioswales with curb cuts?
10. Are there any additional design features, or considerations for the proposed design features, which you believe may have been overlooked by this project?
11. Would you be willing to participate in a design charrette and provide input on the design of the selected design features?

Appendix C
Design Feature Evaluation

Memorandum

September 27, 2016

To:	Kaitlyn Read	Ref. No.:	11115623
From:	Dilan Singaraja (GHD), Andrew Betts (GHD)/aj/2	Tel:	519-884-0510
CC:	Bill Thompson		

Subject: **Design Feature Evaluation - Identification of Design Features that Promote the Reduction of Road Salt Application on Commercial and Institutional Parking Lots**

1. Introduction

GHD Limited (GHD) is pleased to submit the following Design Feature Evaluation memorandum (memo) to the Lake Simcoe Region Conservation Authority (LSRCA). This memo provides a summary of the selected design features, the results from the stakeholder interviews and the selection process of the preferred design features.

In conjunction with the Lake Simcoe Region Conservation Authority (LSRCA), a list of design features for commercial and institutional parking lots were selected with the potential for promoting the reduction of road salt used during winter maintenance operations. The list consisted of a total of 9 design features. Section 2 of this memo provides a summary of each design feature.

A group of stakeholders, who are involved in snow and ice control during winter maintenance operations, were selected for interview. The selected stakeholders included individuals from the following groups: contractors; owners; designers; regulators; and academics. Unfortunately, no owners agreed to take part in the interview process and therefore no input has been included from this key stakeholder group. The stakeholder groups that did participate provided input on the feasibility of the implementation of the identified design features and their ability to promote the reduction of road salt application. The results from the interviews were used to inform the selection of the preferred design features that promote the greatest reduction of road salt application and are most likely to be implemented in the design of future parking lots or the retrofit of existing parking lots. A summary of the results from the interviews are provided for each design feature from all stakeholder groups in Section 2 of this memo. Each stakeholder group was also asked if there were additional design features or input they could provide that we may have missed or overlooked. A summary of the additional comments are provided in Section 3 of this memo.

The selection process of the design features utilized a selection evaluation matrix to score each design feature and determine the preferred design features. A summary of the process, the selection evaluation matrix and the results of the selection process is included in Section 4.

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2. Design Features and Interview Results

The proposed design features include the following:

- Permeable pavement
- Effective grading and stormwater collection
- Snow pile storage location and design
- Landscaping features
- Shaded canopies
- Conductive pavement on walkways and entrances
- Brine holding tank for anti-icing or pre-wetting
- Sidewalk design and pedestrian flow
- Seasonally-closed parking areas

Each of these design features are described below, along with the interview results from each stakeholder group.

2.1 Permeable Pavement

Permeable pavement reduces the need for road salt application in parking lots by improving drainage and preventing melt water from ponding and refreezing. Permeable pavement consists 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.

The installation of permeable pavement has been demonstrated to reduce road salt application requirements for paved surfaces by up to 75% (University of New Hampshire Stormwater Center, 2007). Additionally, the highly porous joint and sub-base 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.

2.1.1 Interview Results - Contractors

- Major concern from contactors was about frost heave over time on the stones and the potential for the plows to dislodge or damage the stones, which would result in the contractor having to pay for the repair work
- Additional concern regarding the immediate infiltration of the salt laden melt water as it won't stay on the surface and produce additional melt of surrounding snow and ice
- In general, there is a lack of experience and knowledge surrounding the impact of permeable pavement on winter maintenance operations
- Biggest limitation to the uptake of permeable pavement is the cost of installation and maintenance

- If the pavers had a bigger radius bevel on the edge it would help prevent catching of the blade

2.1.2 Interview Results - Designers

- Major concern from the designers was about trapping the pollutants before they get into the ground (i.e. oils and sediments)
- They have experienced push back from municipalities and conservation authorities because they don't believe they get the water quality treatment. They prefer oil grit separators or bio-swales.
- A lined system under the pavement could work, but this alternative could make the paver system not cost-effective
- This option might make sense in the snow disposal area, but it might get plugged with sediment and grit

2.1.3 Interview Results - Regulators

- From an operational point of view, they take a stringent installation technique and have a higher than normal maintenance frequency
- When the pavers are in an interlocking pattern they tend to sink and fail
- There is a concern with the plow blades damaging the pavers
- If the issue is water quantity then it is a good solution, but if the issue is water quality then it is not a good option (water quality is often prioritized over water quantity)
- The infiltration of the melt water may not be desirable from a source water protection point of view

2.1.4 Interview Results - Academics

- Frost heave does not have an impact on permeable pavement because the void space is so large that a saturated condition does not occur
- With the concrete pavers, if installed correctly the plows will not disturb them
- You can get rust marks or plow marks on the concrete from the plows but can be fixed by installing rubber on the plows, however the rubber does leave streak marks on the pavers
- The evidence that permeable pavement requires less road salt is strictly anecdotal
- There isn't strong academic research to prove that they actually reduce the requirement for road salt, however there is one study out of New Hampshire that presented results that they require less salt, but they used porous asphalt which is not commonly used in Ontario
- There has been some practical experience that has noted the overall trend of needing less salt on permeable pavers during winter maintenance operations
- If infiltration of melt water is undesirable due to high chloride levels, then the use of an impermeable liner (bentonite liner or geomembrane) that is tied into the surface water drainage system is a good option

- Even if you are not reducing the rate of salt application, the use of permeable pavement significantly reduces the release rate of the chloride impacted melt water (reduces the peak by a significant order of magnitude e.g. from 30,000 mg/L down to 30 mg/L), especially for an underdrain system.
  - This can be seen in the Kortright results and a site in St. Catharine's (a report will be coming out in 2017)
  - The first flush ends up being diluted by the melt event due to the slower release rate in the system. It dampens the peaks but prolongs the release of the salty water.

2.2 Effective Grading and Stormwater Collection

Effective parking lot grading can prevent melt water from ponding and refreezing on parking lot surfaces, reducing the need for re-application of road 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/ice formation. Slopes of 2 to 5 percent 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 catch basins or vegetated swales/landscaped areas, 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.

2.2.1 Interview Results - Contractors

- It is very common (just about every parking lot we see) for parking lots to have ponding water on the surface due to settlement and freeze thaw, and this does lead to additional application of road salt in these areas
- If the site layout allows for the higher slopes then this would reduce the amount of road salts needed during winter maintenance operations. However, how likely is it that the existing grades will allow for the design of higher slopes?
- Grading the parking spots to drain to grates in the middle of the drive pathway is the best
  - The traffic will help break up the snow and ice
  - As long as the melt water drains away from the entrance and the high traffic areas
  - Should drain to the back of the parking lot
- If you are going to design a parking lot then engineered winged curbs at the back should be incorporated, so when you are driving your plow at the back you're not going to damage the curb and this will allow you to push the snow over the curb
- Parking lots are not typically designed with designated push points
  - They are not design to allow you to push snow they are designed for parking

- Typically the drive lanes are perpendicular to the entrance way and you can't just drive it straight to the back because there are islands in the way with parking spaces behind it
- If the snow has any moisture content to it the more you move and push the snow the more it compacts and you are going to promote the bond with the surface and ice, therefore having multiple snow storage locations in a parking lot will help

- Overall, parking lots need less decorative islands. Don't just throw up a random island in the middle of the parking lot just to have it. You should be able to push the snow in big paths instead of detailed work around the islands or posts. It is very difficult to maneuver around these obstacles.
- Melt water runoff needs to be collected as close to where it melts as possible as we typically have to re-salt (approx. 40%) due to refreeze

2.2.2 Interview Results - Designers

- Parking lot grading is not typically designed for melt water runoff
- Drainage is typically done to meet infiltration requirements.
- Grading is typically around 2%, where applicable and higher up to 5% if grades allow.
- Placement of storm inlets works for both summer and winter runoff because you don't want backup/ponding to occur in high traffic areas the same as for refreeze areas.
- In smaller parking lots the higher grades are easier, but big parking lots are harder. It is common that in municipal regulations there is a minimum slope of 0.5% with a preferred slope of 2-5% for parking lots.
- It is standard practice to keep slopes as high as possible, but it comes to down to cost if the site doesn't preclude it
- This is a good option that can be implemented to reduce salt application

2.2.3 Interview Results - Regulators

- There is typically a grading policy within the municipality
- Grading is a great way to mitigate ponding and reduce road salt application
- Strategically locating the collection points on a parking lot is a good idea
- Grading is less important than where the source of the melt water and collecting as close to that point as possible
- It does make sense to get the melt water off the parking lot as quick as possible so it doesn't refreeze
- The site conditions need to allow for this, so it might not be possible everywhere

2.2.4 Interview Results - Academics

- Effective grading is good for minimizing the potential for refreeze, as demonstrated in a recent study

2.3 Snow Pile Storage Location and Design

Strategically locating snow storage and disposal 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 to high traffic areas and refreezing. Situating snow storage piles in areas that receive abundant solar radiation can help to accelerate melting. Additionally, it is important to locate snow storage piles to prevent visual obstructions for drivers 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 locate snow piles in locations that do not result in long plow routes that cause the snow to compact and enhance the bond between snow and ice.

Snow piles can also be designed to promote melt water from flowing away from high traffic areas towards specific catch basins through grading. Designing specific drainage collection features for snow piles will ensure that melt water is quickly collected within the vicinity of the pile and melt water is not provided the chance to refreeze. Alternatively, snow piles can be placed on permeable paver pads or vegetated swales, allowing it to infiltrate before it has the potential for discharge.

2.3.1 Interview Results - Contractors

- It is important to have the conversation with the client to discuss the location of the snow pile
- It is important to have a site map and walk around with the owner to determine where they don't want snow and try to educate them the best place to place the snow from a contractor side of things
- It should be decided based on everyone's need
- You don't want the snow pile location to be too far from where you are plowing snow
- The best time to complete a site walk to pick the snow pile location is when it is raining or right after a rainfall to see where any of the ponding spots are and your potential ice spots
  - You will also see the locations where the eavestrough is leaking or spilling
  - Some parking lots have the eavestrough spills right into the parking lot near the entrance, which always leads to the use of more road salts
- It is very important to strategically locate the snow piles so they don't drain across the parking lot
- This is a good feature for reducing the amount of road salt used on a parking lot
- When designing the site the wind must be considered and the snow piles must be located where the wind will not put it right back on the site
- Pile should be placed far away from the building and melt water should be directed away from the high traffic areas so we don't have to add additional salt
- Should have multiple snow pile locations with extra catch basins for collection

- Owners want the pile as far away from the building as possible, but we want it either on a catch basin or as close to one as possible
- This is a feature that needs the owner to be educated on in order for it to work

2.3.2 Interview Results - Designers

- It is very common to account for snow storage area in our design drawings for planning and approvals
- There are guidelines for where you are putting it so they know where it drains
- It is usually in a corner of the parking lot, which is typically only used when the parking lot is at max capacity
- It is not typical to design something specific for collection and routing of the snow pile melt water, it tends to be an afterthought
- It is common to include a location for snow piles in the design, but there is no consideration for melt water runoff and refreeze, but we will now
- Not much thought has been put on the location of the pile based on where the melt water goes
- This is a good design feature to improve upon

2.3.3 Interview Results - Regulators

- This is a great option because it is typically an afterthought in the design process
- The owner needs to have strong input on where the contractors put the snow piles
- Owners need to think beyond out-of-site out-of-mind, meaning the owner needs to understand the implications of the selected locations of the snow pile (i.e. runoff pattern, drift potential etc.)
- Could use signage to indicate where snow piles should be located so that everyone knows where the pile will be
  - The sign can be there all year long so people think about it and if new people plow they will know where to place the snow pile
- Effect drainage is key and infiltration must be out of Well Head Protection Area (WHPA) A or B

2.3.4 Interview Results - Academics

- Need to find a way to minimize drifting and potential refreeze
- Locate the pile near trees and year round vegetation to prevent the drifting
- Our research didn't really focus on this component of winter maintenance

2.4 Landscaping Features

Landscaping features such as living snow fences, vegetated swales or landscaped islands can lead to a reduced requirement of road salt application by limiting the amount of snow drift and provide locations to

direct snowmelt runoff. Snow fences can consist of shrubs and/or coniferous trees surrounding the perimeter of the parking lot. They work by limiting snow drift from adjacent properties.

Vegetated swales 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 living snow fences, vegetated swales and landscaped islands should be salt tolerant and should be suited to each site's soil, climate and moisture conditions. Additionally, using deciduous trees in the planting plan will provide additional 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.

2.4.1 Interview Results - Contractors

- Snow fences need to be located 150 feet away from where you don't want snow, so if you place them to close they will cause the drifting
- Not a good option for parking lots
- Vegetated islands are hazards that a plow has to maneuver around and make winter maintenance operations more difficult
- Most vegetation will not survive the salt concentrations that you get off these parking lots
- Vegetated swales along the perimeter of the parking lot with push points could work well if there was somewhere for the snow to go
- The vegetated areas need to have a collection point so the water doesn't re-enter the parking lot
- This could lead to the reduction of road salt application
- There needs to be thought on a way to design so blades do not cause damage to the structure
- These features may cause drift points

2.4.2 Interview Results - Designers

- Landscaping is not typically done specifically for winter maintenance, but they are starting to look into these features
- Salt tolerant plants are very commonly thought of in the design
- Some clients want to show a green parking lot, but most want as many parking spaces as possible
- There is a big push for infiltration on parking lots so the majority of BMPs are in place for this
- Most clients will only go this route if the regulations require it
- The clients need the incentive to include BMP in the design through regulation requirements otherwise they won't do it
- Some clients will strive for LEED credit, but most try to maximize building footprint and number of parking spaces

- We typically include landscaped features around the perimeter, parking islands, landscape strips to divide drive aisles, and entrance features for parking area/buildings
- If melt water is allowed to drain into the features through curb cuts to prevent refreeze, then it is possible this will reduce the need for road salt application

2.4.3 Interview Results - Regulators

- Snow fences will not work well in an urban area
- Municipal planting policies must be considered when thinking about urban planning as what needs to go into the design must follow these policies and planting plans
- We find we are replacing trees on a regular occurrence as a result of salt impacts
- It would be good to use the vegetated swales or islands as a location to place the clean fresh (unsalted) snow
- Using deciduous trees to provide shade during summer and direct sun in the winter is a good idea

2.4.4 Interview Results - Academics

- Not within their realm of experience

2.5 Shaded Canopies

Shaded roof canopies can be constructed over pedestrian walkways and building entrances to minimize snow and ice deposition, resulting in reduced road 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. Similar sheltering from snow and ice deposition can also be achieved by planting shaded tree canopies.

2.5.1 Interview Results - Contractors

- This could work for small areas like entrances or walkways along the building edge
- If you have a heavy snowfall you have to look at the structure and you would have to remove the snow, however, if they are built correctly they could work
- Green roofs are great
- Just make sure the canopy is on the right side of the building and make sure it isn't a drift point
- It would limit the amount of snow that falls on the walkway and reduce the need for salt on the walkway
- You will still need some salt for the snow that makes it on the walkways via people's boots and drift, but it will definitely reduce the salt needed
- Canvas canopies can be a problem as they hold the snow and after you plow and salt they melt and wash your salt away
- These do help reduce the accumulation of snow

- As long as the runoff doesn't accumulate and can drain this would work

2.5.2 Interview Results - Designers

- This will not eliminate snow from getting on the walkways, pedestrian traffic could bring it on as well as wind
- Hard to design it in a way to eliminate salt application, but could minimize it
- It is more a feature of the building not a component of the design of a parking lot

2.5.3 Interview Results - Regulators

- This is a good measure to promote, but would be difficult to get owners to implement
- As long as runoff isn't directed towards these walkways then this is a good idea

2.5.4 Interview Results - Academics

- Good for reducing the accumulation of snow and ice on walkways, but sounds expensive
- Good on the most used walkways/entrances
- Suggest looking at platform winter maintenance at train stations

2.6 Conductive Pavement on Walkways or Entrances

Building entrances and pedestrian walkways typically receive high road 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 or heat to the pavement surface to melt ice and snow with constant and uniform heating. Electricity is the energy source which is most commonly used to heat conductive concrete pavements, but solar and geothermal energy used to heat water in pipes beneath conductive concrete pavements may also provide thermal energy to melt ice and snow.

2.6.1 Interview Results - Contractors

- This has been done before, but typically only on private residence or loading ramps
- It does eliminate the need for salt application as you only have to shovel occasionally
- However where it ends you do need to put salt unless the transition is done in an area with no pedestrian or vehicle traffic
- It is great if the owners will invest the money in it

2.6.2 Interview Results - Designers

- We have seen it on occasion, but it is not common (more often on high end residential)
- This would be something that building engineers would design not stormwater engineers

- Very expensive for entire parking lot, but good for entrance way and therefore it will only reduce salt application on a small area of the overall salted area.

2.6.3 Interview Results - Regulators

- Haven't seen this very often and cost will be a limiting factor
- This sounds like it would work if the owners were willing to invest the money

2.6.4 Interview Results - Academics

- Also used on platforms in train stations, but seems expensive for parking lot design

2.7 Brine Holding Tank for Anti-Icing or Pre-wetting

Collection of first flush (high chloride concentration) melt water runoff from a road salt induced snowmelt has the potential to be beneficial if captured and reused as 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 in a catch basin 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 the salts. It would be important to include a filter at the intake for the holding tank to remove any grit from the melt water. Special attention will have to be paid to the concentration of chlorides in the holding tank and if necessary either additional chlorides area added or addition water is used to dilute the brine solution.

2.7.1 Interview Results - Contractors

- The high cost and the need to filter the water to make sure it is the right concentration makes it tough to see it work
- It is a fun idea and if it could be done properly it would work great
- Who is going to monitor it and who is going to track it and take responsibility for it?
- Brine is great and should be used

2.7.2 Interview Results - Designers

- Good on a concept level, but hard to picture it in application
- Hard to construct and implement
- This would only work for an owners who are trying to get LEED credits
- Salt is so cheap it would be hard to convince owners to pay for this system
- Good way to use the high chloride runoff water
- Important to know what the concentration of the brine solution so it must be easy for owners/contractors to determine this
- Concerned with cost/maintenance

2.7.3 Interview Results - Regulators

- Interesting idea and would be worth finding out more about it
- Sounds expensive and tough to implement
- On a concept level it is a great option for reusing the high chloride concentration melt water
- Need to have some sort of off the shelf product

2.7.4 Interview Results - Academics

- There needs to be a clear way to determine what the chloride concentration is and ensure it is as close to 23% as possible
- Sounds like a good Masters research project
- Would be expensive to implement

2.8 Sidewalk Design and Pedestrian Flow

If pedestrian sidewalks were constructed with appropriate widths that would allow contractors to plow instead of having to shovel, additional reductions in salt application could be achieved. Additionally, re-thinking the typical pedestrian routes on a parking lot may also lead to the ability to remove some areas from requiring the high salt applications typically found on pedestrian walkways. The design process would consider that pedestrians typically follow the path of shortest distance and not necessarily the designed walkways. Sometimes 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 of the parking lot. By re-thinking the pedestrian walkways and designing them in a way that is more user friendly, the reduction of walkway footprint on a typical parking lot can be achieved, in turn leading to a reduction of salt application.

2.8.1 Interview Results - Contractors

- This is where the highest salt application rates are placed
- Biggest limitation to reduction of salt application in these areas is the concern with liability and potential litigation
- If a contractor is lazy they will find a way to plow the sidewalks no matter how wide they are
- Many of the walkways that aren't typically used in the winter still have to be maintained
- There needs to be a place to put the snow from the entrance way and walkways
- The walkways that don't get used should be blocked off from foot traffic and even the restriction of parking areas that don't get used should be done because then winter maintenance doesn't need to be done and the client can save some money.
- We have placed additional snow on sidewalks at times to hide them from the public so they don't see them and try to use
- If done properly this will reduce salt application

2.8.2 Interview Results - Designers

- Walkways are not typically designed with winter maintenance in mind; they are designed for full parking lot conditions
- It is typical that access to walkways is sporadic and pedestrians commonly walk along the drive access not the designated walkways
- A question best posed to planners not stormwater engineers. They are the ones who place the walkways.
- If the unused walkways could be removed then this would reduce the amount of road salt used on parking lots

2.8.3 Interview Results - Regulators

- This is also a good feature
- Need to design walkways to where people walk
- The only way to realize the benefit is to reduce the mass of salt applied so this would be good
- Would be good to block off stairs

2.8.4 Interview Results - Academics

- Could use signage to indicate which areas are closed
- This is a good idea

2.9 Seasonally-Closed Parking Areas

Many parking lots during the winter months only use the parking spaces closest to the building. Other than the peak shopping period around Christmas, there tends to be a low period for commercial parking lots in 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 sections. This will lead to the reduction of salt application simply because the area requiring winter maintenance becomes smaller.

2.9.1 Interview Results - Contractors

- This has been done before and does reduce salt application because of the smaller area
- Have to be careful that it won't affect business
- Would make our job easier
- Need to include barriers or signage to inform the public that they can't use the area for parking
- This is a good option

2.9.2 Interview Results - Designers

- Typically owners try and maximize parking areas so this may be tricky to get them to buy in

- In theory this would work on larger parking lots, but might be difficult on smaller parking lots
- This would be something the owners would have to determine over time as to what percentage of the parking lots they don't use during a typical winter period
- This would not be part of the parking lot design

2.9.3 Interview Results - Regulators

- This would be great if you can get the owners to buy in
- It makes sense to not maintain areas that don't get used

2.9.4 Interview Results - Academics

- This was not part of our research area and haven't seen any specific research in this area
- It would make sense that this would work; good idea

3. Additional Comments

Throughout the interviews, the stakeholders presented comments not directly related to any of the identified design features. These comments were collated and are presented below.

3.1.1 Interview Results - Contractors

- There needs to be federal or provincial guidelines or policy on salt application rates to remove some liability on us or we will never be able to really reduce our salt rates
- Winter maintenance operators are typically landscapers (first passion) that are forced into winter maintenance to keep their guys busy or because their clients expect them to have a full year service. It's not something they like to do or want to do, they just do it because they have to and so they don't take the time to learn about it and to improve it and to do it properly. It's a means to an end and not a professional business.
- Education is key!
- Winter Maintenance Contracts:
  - The intelligent/business thing to do with snow removal contracts is a variety. Never have just one type so a combination of salt plus, per visit and lump sum for the year is desired. If you only bill per visit and you get a winter with not much snow then you might not cover your equipment costs.
  - Many owners decide what contracts to use
  - With salt plus contracts, many contactors don't have the right equipment to bill accurately so they end up billing more because they don't really know how much they apply. They have to bill not only for the salt, but the equipment, the storage, the administration cost etc.
- Record Keeping for insurance company:

- Contact has been made with insurance companies about recording data to reduce rates. However, you have to speak to the people at the top and not the brokers (who can't make these decisions). There are some insurance companies that do offer lower rates for SMART ABOUT SALT contractors. Marsh Canada is an insurance company that came out of the snow industry that provides incentives to implementing BMPs.

- Question: What barriers are there for snow removal contactors from implementing road salt reduction measures?
  - Cost is the biggest barrier to implementing salt reduction measures
  - Clients – huge disconnect between a contractor and a client. The contactor doesn't know enough about BMPs to educate their client and to defend themselves, the client doesn't know enough, so if the contractor can't educate the client then they can't defend themselves when clients ask the contractors why they should implement such measures. It all comes down to education.
  - Financial burden on the contractor to purchase BMP equipment, alternative salts, machines to tract the salt at the beginning of the year. They might not be able to afford salt training.
- Add signs on buildings for education purposes
- Make all store entrances face the south (as much as possible)
- Make runoff drain the opposite way from the store front
- Remove the islands from the parking lot
- Having the high point in the parking lots at the place where the bumpers meet in the parking space
- Wind can be a major factor in how often a parking lot gets plowed and salted
  - Typically blows from the northwest in the winter

3.1.2 Interview Results - Designers

- Location of roof downspout should be discharged directly to green spaces or underground storm sewers
- Travel distance from where rainfall lands to where it enters the drainage network needs to be minimized
  - Question: What barriers are there for snow removal contactors from implementing road salt reduction measures?
    - Lack of knowledge in industry, cost of BMPs, maximizing parking spaces/building footprint are commonly the biggest barriers preventing designers from incorporating road salt reduction features in parking lot designs.
    - More guidelines/regulations, industry education/experience and LEED credits are needed to overcome these barriers.
- Parking lots are typically designed for your extreme events and not for all season runoff events
- Biggest issue is contractor education

3.1.3 Interview Results - Regulators

- There needs to be federal or provincial guidelines or standard on the limits of salt application for us to stand behind
- Need to develop a common Level of Service for parking lots to standardize the application rates
- Use of signage is important
- Promote salt reduction measures by posting in local papers, websites and social media how to reduce the use of salt
- Educating contractors and public is essential for anything to work
  - We can design it however we like, but how can we get the owners and contractors to implement these design features
- It is tough to offer tax incentives for implementing green technology
- Orientation of the parking lot so it gets the most sunlight to promote melting
- Reducing the amount of stoppage for the salt truck is important since more salt often comes out when they stop since they don't always have the speed actuated spreaders

3.1.4 Interview Results - Academics

- There is not much research out there about parking lot design
- There is research on the type of cover in parking lots and how they affect the amount of salt required. It was only a small component of our research.
- The large difference between the cost of salt (cheap) and some of these design features is so large it will be hard to promote the uptake of some of these design features
- The industry needs to come together and define a Level of Service. This needs to be done to limit the liability on the contractors in order to help them with potential litigation.
- Use of signage on parts of the parking lot or pedestrian walkways that will not be maintained during the winter
- Alternative salt types will also lead to reduced chloride concentrations
- Educating the contractors is the best way to reduce salt application

4. Design Feature Selection

A selection evaluation matrix was developed to help determine which design features should be selected as the preferred features. The selection evaluation matrix considered the following criterion:

- Cost

- Salt reduction potential – effectiveness to reduce the quantity of road salts applied during winter maintenance operations.
- Potential for acceptance/implementation – likelihood of acceptance and implementation by as many stakeholders as possible.
- Potential for long-term implementation – effectiveness over the long-term and the cost/effort of required long-term maintenance requirements
- Ability to accommodate overall stormwater management – the impact to quantity and quality control of stormwater management

Each criterion was assigned a weighting factor based on the level of importance to the design features success. The results from the stakeholder interview, inputs from the LSRCA and GHD's experience and expertise combined to determine the criterion score for each design feature. Table 1 provides a summary of GHD's scoring of each design feature. Tables 2-10 in Attachment A provide the detailed individual scoring for each design feature.

Table 1 Summary of Design Feature Scoring

Design Feature	Evaluation Score	Ranking
Effective Grading and Stormwater Collection	8.4	1
Snow Pile Storage Location and Design	7.5	2
Sidewalk Design and Pedestrian Flow	7.4	3
Landscaping	7.2	4
Permeable Pavers	7.0	5
Seasonally-Closed Parking Areas	6.9	6
Shaded Canopies	6.3	7
Conductive Pavement on Walkways and Entrances	6.2	8
Brine Holding Tanks for Anti-icing or Pre-wetting	5.7	9

Based on the selection evaluation matrix and the inputs received from the LSRCA the preferred design features selected for the detailed design phase are:

- Effective grading and stormwater collection of parking lots
- Snow pile storage location and design
- Sidewalk design and pedestrian flow
- Landscaping features

Several other design features showed strong potential for promoting the reduction of salt application and the potential for acceptance/implementation, and may warrant further investigation. These include permeable pavement, shaded canopies and seasonally-closed parking areas.

Attachment A

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 1 Permeable Pavement	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	6	- Low to moderate increase in the cost of paving
Salt reduction potential	- Effectiveness	0.3	9	- Moderate to high as the potential for ice formation can be reduced significantly
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	6	- Low to moderate, the higher implementation and potential increased long-term maintenance may make some owners and maintenance contractors reluctant
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	6	- Moderate as there may be some concerns regarding maintaining the pavement, potential for snow plow blades catching etc.
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	7	- Moderate as there will be benefits during summer runoff periods, but may lead to chloride contamination of winter runoff
Total Score		1.00	**7**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 2 Effective Grading and Stormwater Collection	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	9	- Low cost, the cost of grading may increase slightly, but the cost of paving will remain largely unchanged
Salt reduction potential	- Effectiveness	0.3	7	- Low to moderate, will lead to less salt application to fight refreeze
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	9	- High potential for acceptance by all due to it's simplicity, ease of implementation, and minimal drawbacks
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	9	- High as there would be minimal changes to operating procedures, costs and does not have increased effort
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	9	- High as effective grading and stormwater collection is a critical component of year round stormwater management
Total Score		1.00	**8.4**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 3 Snow Pile Storage Location and Design	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	8	- Low to moderate cost, potential for slightly increase land requirements
Salt reduction potential	- Effectiveness	0.3	6	- Low to moderate, can reduce re-freezing of melt water for limited areas
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	8	- Moderate to high, owners may be reluctant to lose potential land
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	9	- High as once established the maintenance is relatively simple with low cost
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	8	- moderate to high as the effective collection of snow pile melt water will benefit stormwater management during winter months and there will be no negative impacts during the other seasons stormwater management
Total Score		1.00	**7.5**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 4 Landscaping	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	7	- Low to moderate cost, may require slightly larger land area
Salt reduction potential	- Effectiveness	0.3	6	- Low to moderate as landscaping can only screen small portion of lots typically
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	8	- Moderate as land requirements may be higher resulting in owner reluctance
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	9	- Moderate to high as once the measures are setup, the effort to maintain is minimal, if designed and constructed well
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	8	- moderate to high as the effective landscaping can benefit water quality and quantity control for stormwater management
Total Score		1.00	**7.2**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 5 Shaded Canopies	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	6	- High cost
Salt reduction potential	- Effectiveness	0.3	6	- Low to moderate - can be effective, but typically only for limited areas
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	6	Low as it has a low range of applicability and owners are likely reluctant due to the high costs
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	9	- Moderate to high as after initial implementation this would be easy to operate and maintain
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	6	- low as there will be no benefit to stormwater management
Total Score		1.00	**6.3**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 6 Conductive Pavement on Walkways and Entrances	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	5	- High cost
Salt reduction potential	- Effectiveness	0.3	7	- Moderate to high, however likely can only be used for the most critical areas due to capital and ongoing costs
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	6	- Low to moderate due to the likely reluctance of owners due to costs and ongoing energy costs
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	8	- Moderate as once constructed, this can easily be operated. If energy costs increase significantly, can potentially not be used as much
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	6	- low as there will be no benefit to stormwater management
Total Score		1.00	**6.2**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 7 Brine Holding Tanks for Anti-icing or Pre-wetting	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	5	- Moderate cost
Salt reduction potential	- Effectiveness	0.3	6	- Low to moderate, as this is not a concept that is typically used; therefore will require some study
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	5	- Low to moderate as this would be an operator intensive system with high costs that has not been tested
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	6	- Low to moderate as it would likely require a moderate level of effort to monitor and maintain
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	8	- moderate to high as this will remove the high chloride concentration stormwater runoff from leaving the site
Total Score		1.00	**5.7**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 8 Sidewalk Design and Pedestrian Flow	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	8	- Moderate cost
Salt reduction potential	- Effectiveness	0.3	6	- Low to moderate, as walkways are only a small component of parking lots
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	8	- Moderate to high as it would target heavy use areas
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	9	- Moderate to high as long-term operation would not be significantly different than the do nothing option
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	7	- low to moderate as this may lead to a slight reduction in total impervious surface
Total Score		1.00	**7.4**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Multi-Criteria Evaluation Matrix
Road Salt Reduction Design Features - Lake Simcoe Region Conservation Authority

Evaluation Criteria			Feature 9 Seasonally-Closed Parking Areas	
Criterion	**Factors Considered**	**Criterion Weight**	**Score[1]**	**Rationale for Score**
Cost of implementation	- Capital cost	0.3	9	- Low cost
Salt reduction potential	- Effectiveness	0.3	6	- Moderate, this will reduce the quantity of salt application based on reduced area, however the size of the area may not be vary
Potential for acceptance/implementation	- Acceptance by as many stakeholders as possible - Likely to be implemented - Minimal drawbacks	0.2	6	- Low to moderate as this may not be favourable to the owner
Potential for long-term implementation	- Effectiveness over the long-term - Likelihood for long-term maintenance - Cost of ongoing maintenance - Effort to maintain	0.1	6	- Low to moderate as may not be favourable to the owner
Ability to accommodate overall stormwater management	- Impact to quantity control of stormwater management - Impact to quality control of stormwater management	0.1	6	- low as there will be no benefit to stormwater management
Total Score		1.00	**6.9**	

Note:

1. Scoring system for rating each alternative in this decision matrix is based on a scoring range of 1-10 (1 least favourable - 10 most favourable)

Appendix D
Summary of Design Charrette

Memorandum

December 12, 2016

To:	Kaitlyn Read (LSRCA)	Ref. No.:	11115623
From:	Dilan Singaraja (GHD), Andrew Betts (GHD)/aj/3	Date:	December 12, 2016
cc:	Bill Thompson (LSRCA)		

Subject: Summary of Design Charrette

1. Introduction

GHD Limited (GHD) is pleased to submit the following Summary of Design Charrette memorandum (memo) to the Lake Simcoe Region Conservation Authority (LSRCA). This memo provides a summary of stakeholder feedback for the preferred Design Features and Site Plan.

In conjunction with the Lake Simcoe Region Conservation Authority (LSRCA), four preferred Design Features for commercial and institutional parking lots were selected with the potential for promoting the reduction of road salt used during winter maintenance operations.

A Design Charrette was used in a participatory setup with key stakeholders to solicit input on the 60% designs prior to finalizing the draft designs. This Design Charrette will help ensure that proposed site designs will achieve greater ownership by stakeholders if they are provided the opportunity to participate in the design process through the review of Design Feature Drawings and Sample Site Plans. Participants were divided into four tables with a mixture of stakeholders. The Design Charrette began with an overview of each of the four Design Features; their drawings and factsheets. Later, a Sample Site Plan was circulated and participants were encouraged to add Design Features to the existing plan. Each table summarized key take away points for each of the four Design Feature and the Site Plan.

Section 2 of this memo provides a summary of the comments/notes received for each Design Feature.

Section 3 of this memo provides a summary of the comments/notes received for the example Site Plan.

Notes complied by GHD during the Design Charrette can be found in Attachment A. Sample Site Plans from each table can be found in Attachment B.

2. Summary of Charrette - Design Features

2.1 Effective Grading and Stormwater Collection

- Grading has to be site specific

GHD
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- It is typically a 2% max grading in a parking lot so we should use curbs to control grade to reduce ponding in the middle of the parking lot. Anything more than 2% might be problematic from a public opinion
- Grades should be more than 2% but less than 5%. What to do with very flat sites – 5% would be extreme. Higher grade (>2%) = less ponding
- Too steep a slope might be problematic for customers (cart runaways drive slope guidelines).
- Steep slopes may move your salt off faster. Too steep, how does that work with residual salt and having it not wash away too quickly
- Direct drainage away from the building and away from the entrances
- Direct runoff towards outer edge of property, with an inverted bowl shape. This design option could lead to quantity control issues. Direct sheet flow to the four corners of the parking lot
- Directing runoff towards curbs is a good way to control grades, use of curbs to control grade
- Minimize the flow distance to catch basins, also have lots of catch basins around the perimeter of the site
- The number of catch basins doesn't affect the ability to plow snow
- Minimize drainage catch basins to keep costs down
- Catch basins are better placed in drive aisles over parking stalls to avoid potential ponding where cars park, allow for more sunlight to hit the pavement (not covered by cars), and to allow traffic to break up any ice formation
- Move LID to minimize ponding
- Current catch basin outlets are designed to encourage ponding
- Minimize ponding during winter months
- Use adjustable catch basin outlet valves (manual control or gates)
- Drainage catch basins based on summer storm (100 year) – this overrides more winter focused drainage
- Four season SWM policies/design
- Use LID as flood volume treatment train
- Direct to the 4 corners so during summer months it will pond
- Underground SWM system beneath paved lot (avoid ponding during winter months)
- Underground storage more costly
- Make sure to account for roof runoff/canopy runoff in design, and direct it to infiltration or storm system. Focused collection on roof drains so it doesn't drain across entrance.
- Direct roof runoff to underground infiltration
- Concern with spills contaminating groundwater
- Have pedestrian walkways flush with driveways with different material so the contractors can plow the sidewalks rather than chemically remove snow with salt
- Should have raised sidewalks to assist with pedestrian safety

- Can have rolled curbs for sidewalks and make them wide enough so contractors can plow
- If decent soil conditions roof drains should be directed to infiltration galleries
- The less islands the better and maybe have a few bigger islands
- May be a requirement of customer – client will have their own design guidelines
- Catch basin placement
- Roof runoff
- Drainage away from building
- Direct flow to the 4 corners – also ponds
- SWM design in non-winter
- Flus (rolled curbs) pedestrian walkways
- Underground infiltration
- Less, or larger islands
- Curbs to control grades
- 2% max
  - Customer satisfaction
  - Safety
  - Salt moves more

2.2 Snow Pile Storage Location

- Parking requirements will determine where snow piles go
- Some municipalities (Innisfil and Waterloo) have requirements to place snow piles on paved surfaces, but also have required number of parking stalls; it's hard to balance the two in urban areas with limited space
- In urban areas, bylaws require 20% of the space be dedicated to snow piles, which can be hard to accommodate in small urban lots
- Include signage to locate snow storage area. Signage is key to maintain designated snow pile if contractor change over
- Keep snow piles away from pedestrian walkways
- 3m height is appropriate
- Need to determine a max height of pile. There needs to be some thought on maximum height for safety concerns and visibility: needs to be a good calculation for what size height you need
- Ensure that catch basins are placed immediately down gradient of snow piles. Snow storage needs to be at the lowest grade point

- Catch basins should be spread out to collect melt water. Catch basin placement needs to consider the other pollutants that may drain into it…may need to include a OGS and/or underground storage
- The contractor liked our design, with the snow piles spread along the back of the property. It's easier to have flexibility for where to place the snow rather than one large pile in the corner. Like the idea of having snow along the back of the parking lot with additional pile location around the edge. Snow piles pushed to the outside may cause problems with proper drainage
- No parking stalls in front of snow storage areas to allow access for plows – loss of parking spaces. Not have parking spots parallel to snow pile locations to discourage people parking near these piles
- Large snow/ice chunks in snow piles are a concern since they can fall off into parking areas – need to break up pile
- Could also pile snow in excess parking areas after busy periods; it's important to be flexible with snow storage options. Should be a discussion between the contractor and owner to allow for the ability to reduce the amount of available parking area based on seasonal demands (i.e. Christmas all open after some areas closed)
- As long as the snow pile doesn't lead to re freeze potential then it shouldn't cause additional salt application
- Small snow storage areas are an issue but large areas result in less buildable area for development
- Dedicate overflow parking areas to snow storage
- Dedicate parking spaces for snow storage areas is a good idea, over catch basins
- Snow piles need additional non credited parking spots – balance bylaw requirements for parking
- Make snow piles more difficult to access for parking
- Treat snow piles in a compartmentalized fashion like the drainage design is done
- It's easier for the contractor to make one big pile or lots of small piles. There needs to be multiple pile locations so there is flexibility on location based on seasons. Multiple piles are easier for contractors
- Everyone agreed that it's better to have snow piles on impermeable surfaces rather than vegetation:
  - For contractors, it's easier to plow onto a paved surface, they don't have to worry about replacing damaged vegetation, and it's easier to remove off-site if the pile gets too full
  - For municipalities, they are very concerned about chloride reaching groundwater drinking sources and recommends that we just focus on snow pile placement to avoid ponding/drainage issues
  - Bedding material below snow pile has to be site specific: notes should be on drawing to deal with water quality issues for multiple sites
  - Paved surface vs vegetation: paved surface is easier for contractors and better for drinking water protection

  - Some municipalities require snow piles to be on paved surface
  - Notes are included on the drawings to specify subsurface materials required to deal with water quality concerns
  - Low permeability (tight soils) if a vegetated area is chosen as a snow storage location. A liner may be an option
  - Several municipalities have concerns/issues with chloride in drinking water wells (Innisfil, Barrie, Halton)
  - There's no real use to the gravel transition area
  - General preference is that all designs have pile locations on the parking lot itself and not on vegetation
- Dedicated salt storage areas on parking areas would reduce costs to contractors and can better track salt usage with security
- Semi-circle around the entrance is prime parking – don't put piles there
- Snow piles could result in die-off in landscaping areas due to salt
- Fringes can have more complications with drainage
- Site plan agreements require the maintenance of a snow pile area
- Can locate the snow piles in the trouble spots to remove them from winter maintenance needs
- The contractor needs to be able to discuss seasonal maintenance requirements with the property owner or manager
- Changes in the development industry are required to move this design issue ahead
- "push the design envelope" in these design guidelines
- Champion more progressive developers to help profile best practices for salt management (i.e. set a greener standard
- More focus needs to be put on the building itself (green roofs, rainwater collection)
- More focus needs to be put on water
- Back of parking lot
- Bedding material very site specific
- Catch basins near snow storage
- Lowest point
- Signage
- No parking parallel to storage
- SWM for all seasons
  - Ensure its captured
  - Catch basins as oil/grit separators
- On parking lot, not vegetated areas

- Flexibility, more than one location
- Maximum height – safety
  - Configuration, slope
- Outside of semi-circle prime parking
- Drainage off of piles
- Dictated by drainage
- Paved, not vegetated
- Multiple piles are easier
- Pervious vs. impervious not relevant
- Be flexible on amount of parking throughout the year

2.3 Sidewalk Design and Pedestrian Flow

- Urban design in municipality dictates where pedestrian flow goes
- Aesthetics also drives pedestrian flow. Aesthetics can dictate where the walkways go so that they can break up the appearance of long parking lots
- Design should be intuitive, logical, easy and a direct path to the store
- Limit the amount of walkways
- Islands protect pedestrians
- Who is actually using sidewalks?
- University of Victoria has completed a study on sidewalk placement
- What percentage of the parking area is sidewalk?
- Put sidewalks in areas where they will actually be used. Place walkways along main routes
- If you place the buildings near the corner (near road ways) could limit the amount of walkways needed
- Design a parking lot to make walkways the easier route – clearly mark them and build them for actual pedestrians (people taking the bus or walking to the building), not drivers walking from their care to the building. Having the pedestrian walkways focused on family oriented locations: designated parking for families and elderly near the sidewalks as they are the people who will be using the sidewalks
- Group similar businesses in the same areas to reduce walking across parking areas
- People want to walk the shortest distance from A to B, which is usually across parking areas rather than walkways
- Risk management templates already consider and require some of the proposed design features (e.g. closed walkways in the winter, accounting for prevailing winds in design)
- Some stakeholders have found that blocking off low-use walkways over the winter works well. Close off sidewalks that are not in use. Blocking off low use walkways in winter
- Important to minimize ice on raised walkways since stepping up onto a surface is when people are most prone to slips and falls

- Raised sidewalks are a challenge from an operational standpoint
- Get rid of raised sidewalks. Make them flush with the parking lot and brightly coloured to stand out. Have the sidewalks flush with the drive aisles and painted or use of different material
- Minimize raised sidewalks and instead have level ground with a "rough" material that reduces slip risk and can still be plowed
- Seriously consider the materials used for walkways:
  - Some areas have used wooden 'boardwalks' which are extremely slippery and hard to keep ice free
  - Use materials that can easily absorb sunlight
  - Interlock pavers should not be used since they will inevitably heave and sink, creating ponding and tripping hazards
  - Concrete works well
  - Concrete material with added friction (e.g. patterns) is actually more slippery in the winter since it's harder to remove ice
  - Use rough interlocking material. Interlock pavers not a good idea, concrete is better with a longer lifespan
- Snow drift can be an issue in urban areas with no space. Need to account for snow blowing off roofs
- Contractors can use sidewalk plows to clear raised walkways, but need to ensure there is a minimum of 5 feet of clearance (taking into account garbage cans, planters, light posts, signs, overhanging cars, etc.) Make them nice and wide for plowing
- Make sure there is somewhere to put the snow plowed from walkways
- Have a buffer along the sides of walkways, or use raised planters to avoid vehicle overhang blocking walkway. Trucks backing in causes problems so use of large planters could prevent trucks overhanging the walkways
- Cars (trucks) parking beside walkways can hang over and block some of the walkway – need to have a buffer to avoid this
- Eliminate partially covered walkways (i.e. overhang), but use centralized covered walkways. Cover the walkway or think about blocking direct runoff to the building frontage and entrance
- Canopies and awnings may cause more issues than they solve – more roof runoff, more refreeze since they're not heated, clearance for plows
- Covered walkways or snow fences to protect walkways from wind
- Curb stops along parking stalls are a big hazard and should be avoided – really hard to remove snow/ice from between the curb stop and the curb and they cause slipping and tripping hazards
- Use heated walkways in front of store. Heated entrances could limit the amount of salt
- End islands in parking areas are salted or planted with a large plant – better to have them paved (permeable pavers?) and flush with the grade (i.e. not raised)
- Less small islands, and fewer larger islands is better
- Could use plantings to focus public on the walkways

- Consider barrier-free access
- Infrastructure – look at 1+1 studies to see if there is pipe failure
- Over salting impedes cart traffic. If you have a walkway that a shopping cart can't walk down (i.e. too much salt) it won't get used
- Unnecessary salting of unused islands
- Walkways should be direct
- Decrease the number of sidewalks and make them more central
- NO semi-covered walkways
- Heated walkways in front of stores
- Need to be accessible for shopping carts AND barrier free
- Blocking low use walkways
- No interlock pavers
- 5' minimum to ensure wide enough to plough
- Buildings closer to corners
- Focus on barrier free areas and families
- Flush sidewalks but different material or colouring
- Planters along walk ways

2.4 Landscaping Features

- The primary contractor doesn't think about maintenance and will just install what is cheapest/easiest
- Plants in parking lots die from salt spray, salty runoff and from plows
- Trees in tree islands always die – not enough soil, salt issues
- Could use river rock or armourstone instead of trees in islands, as long as it still meets planting requirements elsewhere on the site. Can use rock for decorative features rather than veg
- Can use navistone (greener parking areas) in the less used areas
- Important to use deciduous trees to avoid shading the pavement
- Could also wrap vegetated islands in burlap over the winter – cheap and easy way to protect vegetation. Can use burlap to protect trees and veg from damage
- Using raised planters can protect vegetation from these issues
- It's really hard to find and plant native/salt tolerant plants. Hard to find salt tolerant species
- Salt tolerant plants can do well
- Use salt tolerant plants
- Reduce the number of islands for contractors to weave around. Rather than small veg areas (chicken pot areas) maybe larger units but less, so redistribution of the landscaping on the parking lots
- Avoid too many tree islands so snow plows have long runs for snow removal

- Better to have several marked islands
- Vegetated swales might not work if snow gets plowed into them and blocks drainage – ensure there are curbs with curb cuts
- Bioswales are great for snow storage if built right
- Encourage planting along property boundary and include various bio-retention features
- How can you maximize parking and maximum LID and SWM management
- Preserve simple paths for contractors
- Balance with aesthetics
- Bioswales?
- Burlap islands
- Armourstone or river rock instead of plants
- Encourage planting along outside border
- Concentrated landscaped areas

3. Summary of Charrette - Site Plan

3.1 Group 1

- New buildings are more commonly requiring that the building be placed along the main roadways/sidewalks to minimize pedestrians having to walk across parking lots
- Should the snow piles be that close to the roads?
- Need more catch basins in the drive aisles
- It's easier to plow a commercial or institutional lot over a retail lot since they aren't open as late (i.e. have more time to clear lot within 24-hour window)
- Could implement these guidelines for site plan amendments
- Consider snow drift control around perimeter
- Placement of cart corrals?
- Move snow storage pile from top right corner to top left
- Add snow storage area in back area of parking lot
- Add more catch basins around all parking/driving areas

3.2 Group 2

- See site plan drawings in Attachment B

3.3 Group 3

- Don't store snow anywhere near trees

- Better to have the snow storage on the parking lot near catch basins, but watch for entrance visibility – move storage area to top left corner of parking lot
- Site catch basins near snow storage areas
- Central walkway in middle of parking lot
- Drainage design must consider location of snow pile and runoff
- Flexibility of snow pile locations depending on month
- Localized heated walkway in front of store

3.4 Group 4

- Big box stores are saturated – any that are coming are already pre-approved
- How much of the coming development will be commercial?
- Need to apply these to a much smaller parking lot (e.g. Tim Hortons or a bank)

Attachment A
GHD Notes

Grading

- catchbasin placement
- Roof runoff
- Drainage away from building
- Direct flow to 4 corners → also ponds
- SWM design in non winter
- flush pvd walkways → rolled curbs ~~pulses~~ safety
- underground infiltration
- less n island
  larger
- curbs to control grades
- 2% max - customer satisfaction
  - safety
  - salt moves more

Snow Pile

- back of parking lot
- bedding material very site specific
- catchbasins near snow storage
- lowest point
- signage
- no parking parallel to storage
- SWM management for all seasons
  - ensured its captured
  - catchbasins as oil/grit separators
- on Parking lot, not vegetated areas
- flexibility, more than 1 location
- max height - safety
- is a configuration, slope
- outside of semi-circle prime parking
- drainage off of piles
- dictated by drainge

- paved, not vegetated
- multiple piles are easier
- pervious vs. impervious ~~doesn't~~ not relevant
- be flexible on amount of parking throughout year

Sidewalks

- Unnessesary salting of unused islands
- walkways should be direct
- ↓# more central

- NO semi-covered walkways
- heated walkways in front of stores
- Need to be accessible for shopping carts and barrier free

- blocking low use walkways
- No interlock pavers
- 5' min to ensure wide enough to plough
- buildings closer to corners
- focus on barrier free areas & families
- flush but diff. material or colours
- planters along walkways

Landscaping

- Preserve simple paths for contractors
  ↳ balance w/ aesthetics

- Bio-swales?

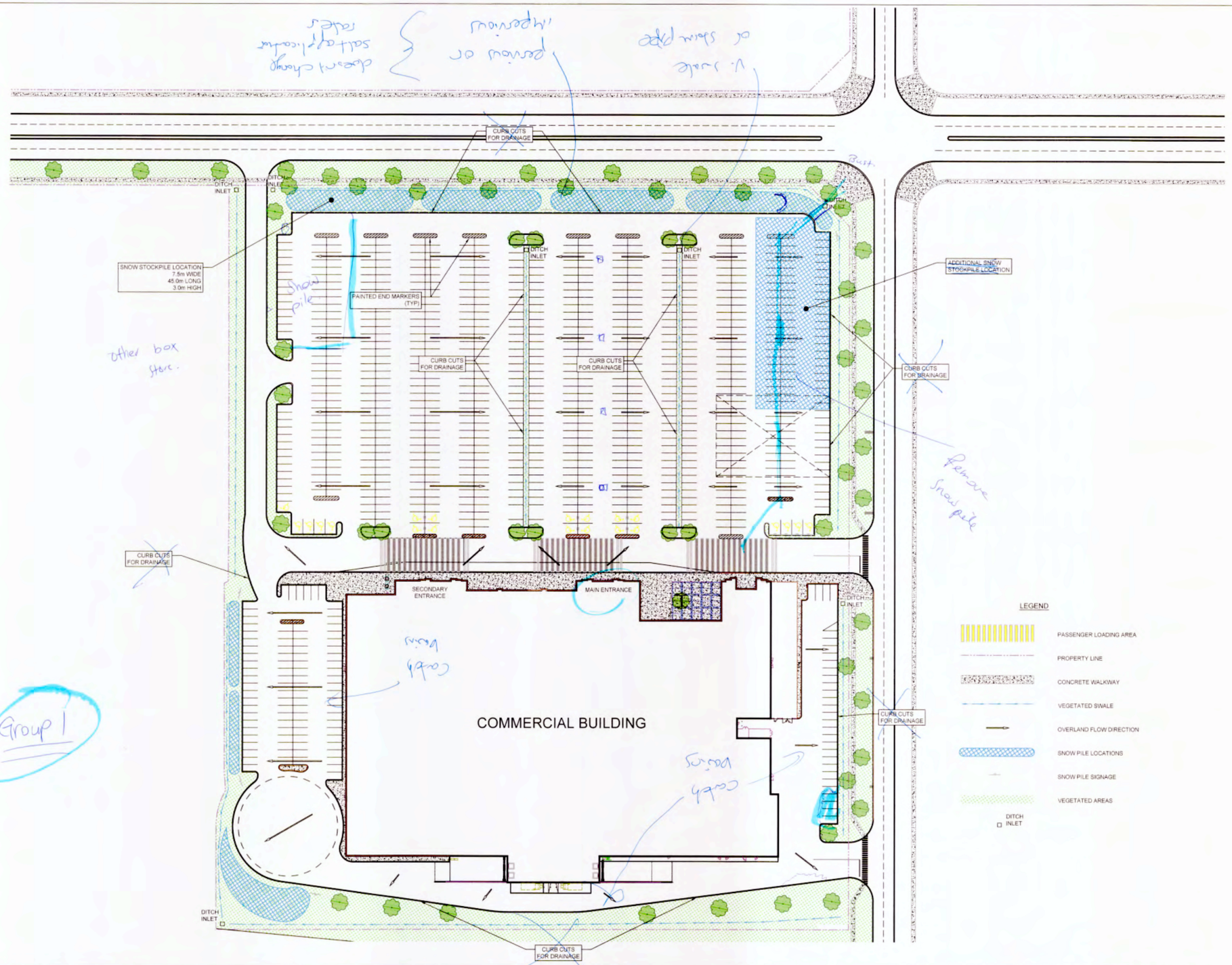
- Burlap Islands

- Armour stone or river rock instead of plants

- encourage planting along outside border

- Concentrated landscaped areas

Attachment B
Site Plan Notes



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Project No. 11115623-01
Original Size ANSI D
Sheet No.
Sheet 1 of 1

Plot Date: 8 November 2016 - 1:34 PM Plotted By: Branko Susenski
CAD File: P:\drawings\11115000s\11115623\11115623-PRES\11115623-01(PRES002)\11115623-01(PRES002)CI-WA001.dwg

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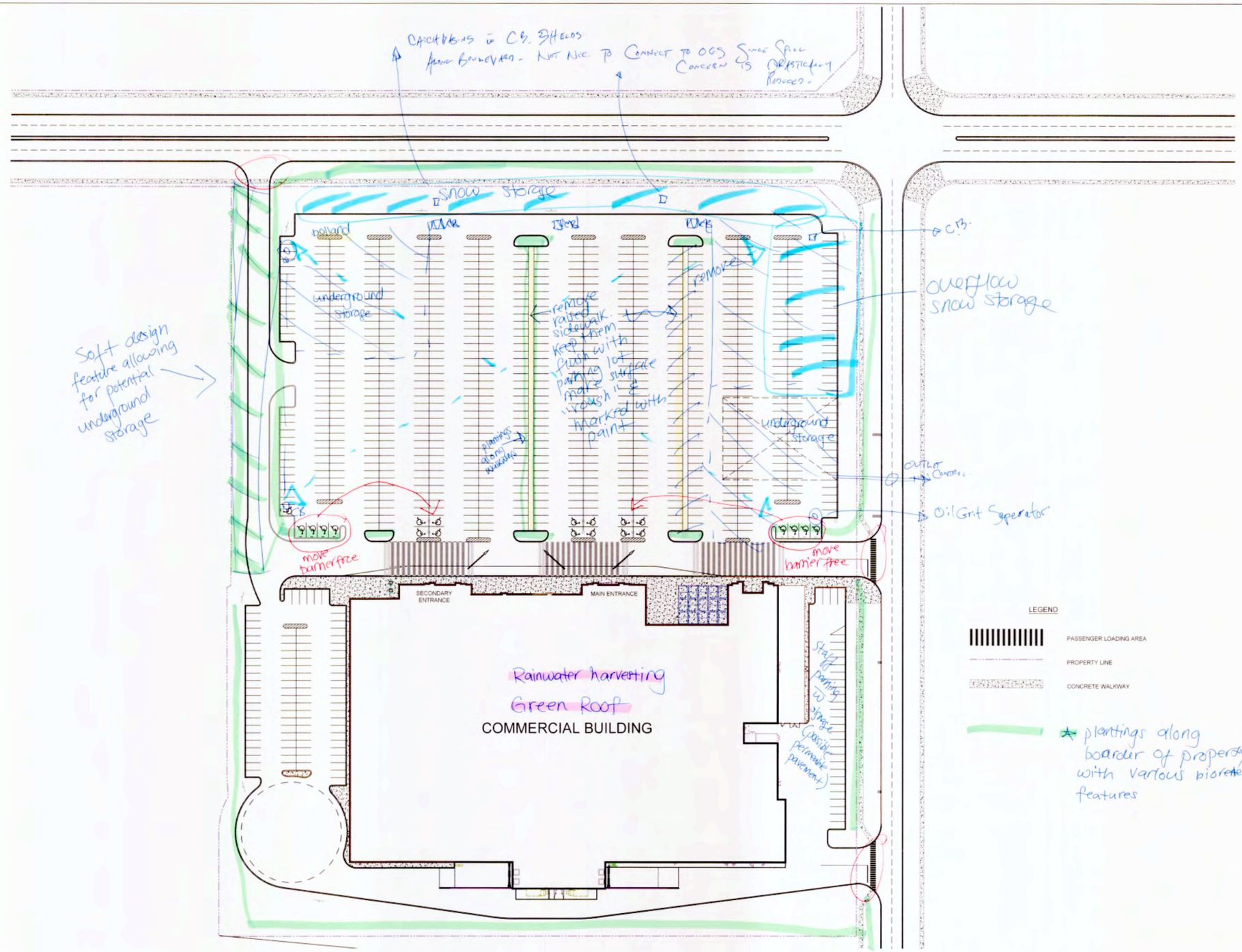

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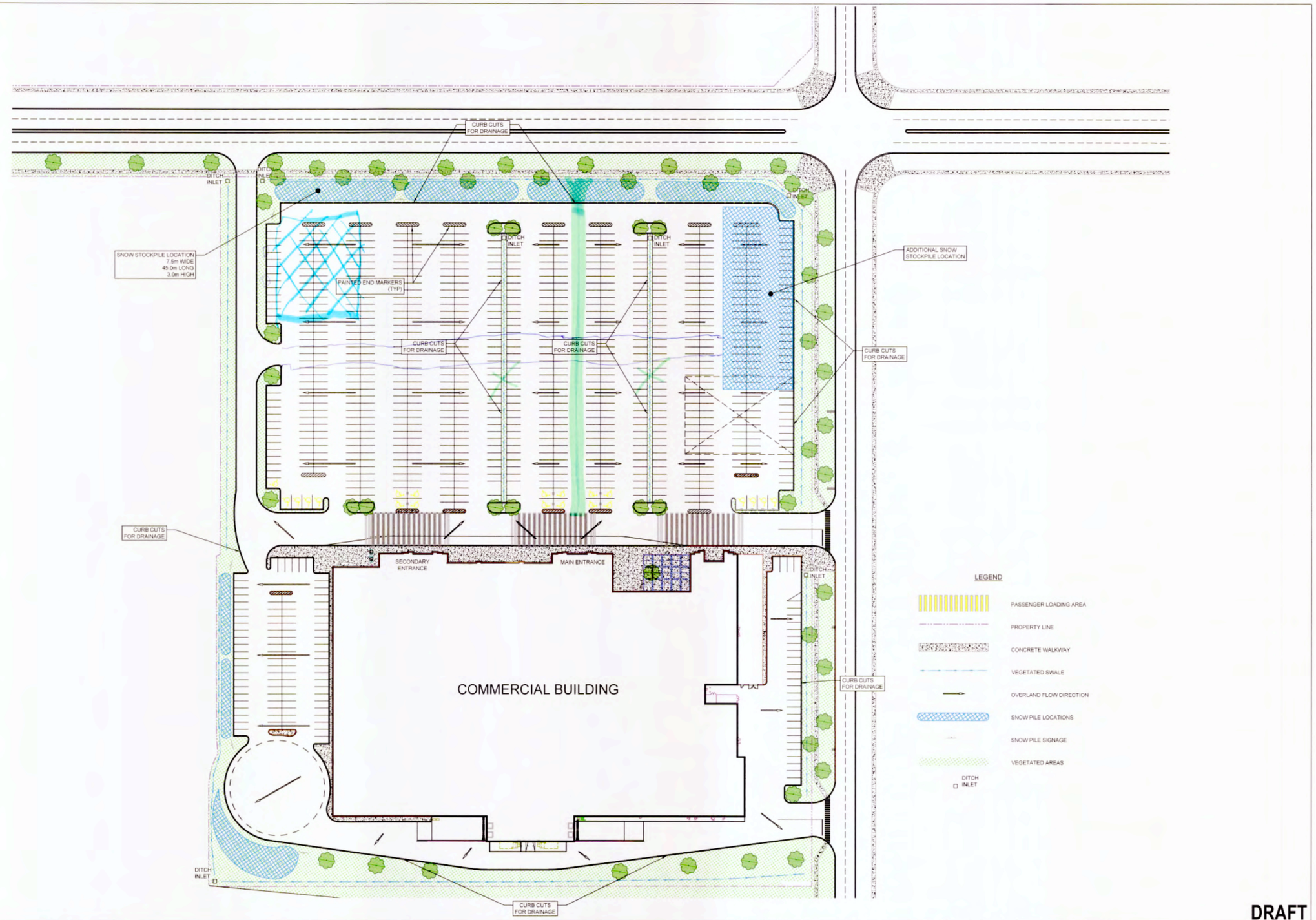

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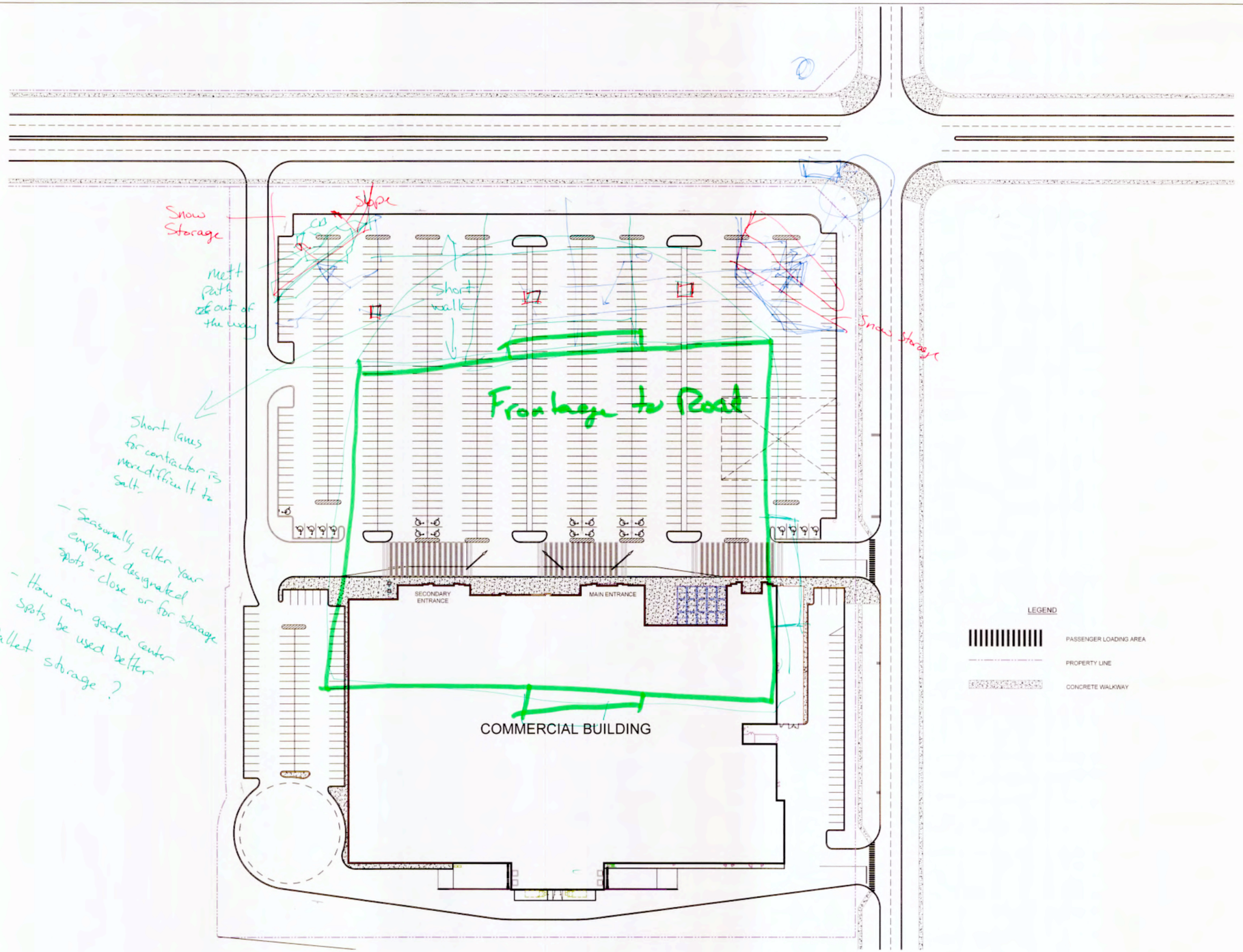

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Parking Lot Design Guidelines to Reduce Winter Salt Application
Design Charrette
November 9, 2016

Attendee Sign-in Sheet

	Name	Company	Stakeholder Group	Present?	Group
1	Amy Domaratzki	Region of Waterloo	Municipality		1
2	Carolina Cautillo	Innisfil	Municipality		2
3	Clark Gunter	WSP	Designers		1
4	Cory Gastis	York Catholic District School Board	Owners		1
5	Dan Hurley	CC Tatham & Associates Ltd.	Designers		2
6	Darryl Neate	Oxford Properties	Owners		2
7	Glen McArthur	Aurora	Municipality		3
8	Jakub Wrobel	CVC	Regulator		4
9	James Daniel	East Gwillimbury	Municipality		4
10	Jennifer Best	York Region	Municipality		1
11	John McIntosh	Halton Region	Municipality		2
12	Kathy Brislin	City of Barrie	Municipality		3
13	Katie Thompson	City of Barrie	Municipality		4
14	Ken Jorgenson	Total Property Care	Contractors		1
15	Mario Tosic	Walmart	Owners		3
16	Natalie Salkauskis	MOECC	Regulator		1
17	Patrick Turner	Counterpoint Engineering	Designer		4
18	Rachel Prudhomme	Newmarket	Municipality		3
19	Rick Mutuchky	Simcoe County District School Board	Owners		4
20	Shawn Sowten	Industrial Property Service	Contractors		3
21	Shehani Serasinghe	MOECC	Regulator		2
22	Steve Auger	LSRCA	Regulator		2
23	Steve VanHaren	MMM Group Ltd.	Designers		4
24	Tim Krsul	MOECC	Regulator		3
25	Toktam Nikfarjam	MOECC	Regulator		4
26	Tom Hogenbirk	LSRCA	Regulator		3
27	Trish Kernan	Town of Innisfil	Municipality		1
28	Wayne Trang	Desjardins Group	Owners		2
29	Wesley Cyr	Orillia	Municipality		4
40	Taimur Usman	University of Waterloo	Academic		4
41	James Li	Ryerson University	Academic		2
42	Steve Bishop	North American Development	Designer		3

	Name	Company	Stakeholder Group	Present?	Group
43	John Priamo	SCS Consulting	Designer		1
30	David Lembcke	LSRCA	Regulators		4
31	Bill Thompson	LSRCA	Regulators		3
32	Hailey Ashworth	LSRCA	Regulators		2
33	Kaitlyn Read	LSRCA	Regulators		1
34	Andrew Betts	GHD	Designers		-
35	Dilan Singaraja	GHD	Designers		-
36	Katrina McCullough	GHD	Designers		-
37	Asta Sernas	MBTW Group	Designers		-
38	Ben Longstaff	LSRCA	Regulators		3
39	Andee Pelan	LSRCA	Regulators		2
	37 Attendees Total				

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