1. 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 **Figure 2**, noted with an asterisk in the following list:

- 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 to 2,000 m^2 (square metres) 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.

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

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 three to four times annually and cleaned or replaced every one to two years, when sediment buildup reduces permeability.
5. Oil grit separators should be vacuum-cleaned or dredged every one to two 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 (metres) 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 catch basins with a 2,000 m^2 drainage area during a 5-year storm event

Date: 02-14-17

Project #: 11115623/12597776

Client: LSRCA Parking

Location: LSRCA Parking - Typical Parking Lot

Rainfall Intensity

Time of Concentration (T_c)

Catchment	Slope (m/m)	Length (m)	T_c[2] (minutes)
101	0.04	25	5.00

Intensity-duration-frequency (IDF) Relationship for the Town of Bradford West Gwillimbury

Chicago Rainfall Distribution Input Parameters	2-Year Design Event	5-Year Design Event	10-Year Design Event	25-Year Design Event	50-Year Design Event	100-Year Design Event
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

[2] Kirpich formula (1940) used to calculate time of concentration. Minimum of 5 minutes is utilized.

Annual Maximum Rainfall Intensity (i) (millimetres per hour (mm/hr))[3]

Storm Duration (minutes)	Storm Event (mm/hr)					
	2	5	10	25	50	100
5.00	108.01	141.85	164.08	191.77	212.29	236.85

Rational Method

$Q_p = CiA/360$

Catchment ID	Area (ha)	C[4]	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[5] = 0.5 $H = (Qp/CA)^2/(2g)$

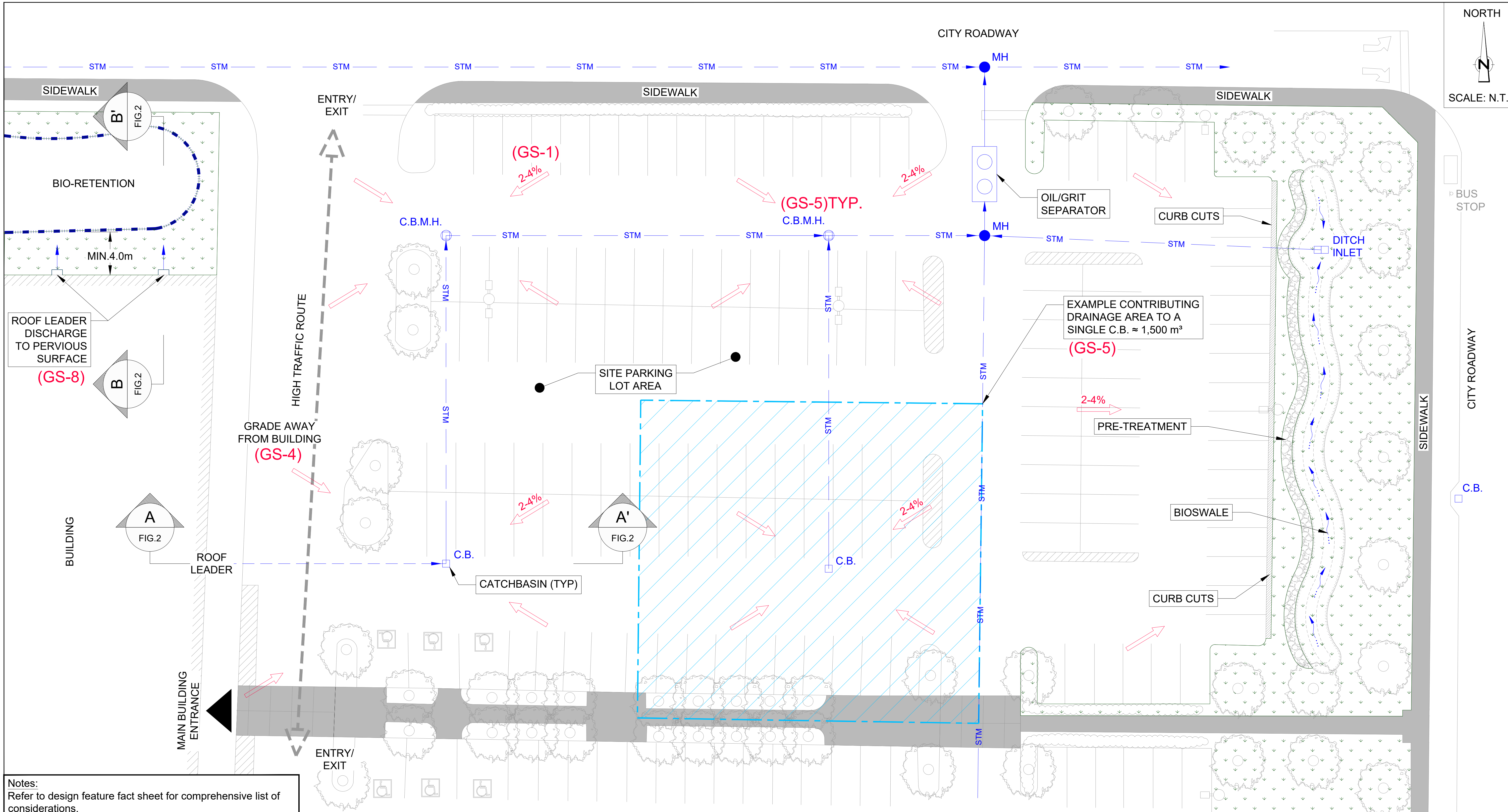
C	0.6	C	0.6
A[6] (m^2)	0.17	A	0.17
H (m)	0.025 m (assumption)	$Q_{5\text{-year}}$	0.075
Q (m^3/s)	**0.07**	**H (m)**	**0.03**

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 catch basin grate. This is considered to be a reasonable maximum amount of ponded depth.

Note

Dimensions for the standard Ontario Provincial Standard Drawings (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.

[3] IDF information obtained from Ministry of Transportation.
[4] C = 0.95 was used to represent the asphalt surface
[5] 'p' represents the fraction of the overall catch basin dimension that is open
[6] A is equal to the opening of the orifice that is the opening of the catch basin grate



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

GHD

LAKE SIMCOE REGION CONSERVATION AUTHORITY
EFFECTIVE GRADING/STORM WATER
COLLECTION DESIGN EXAMPLE
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 1

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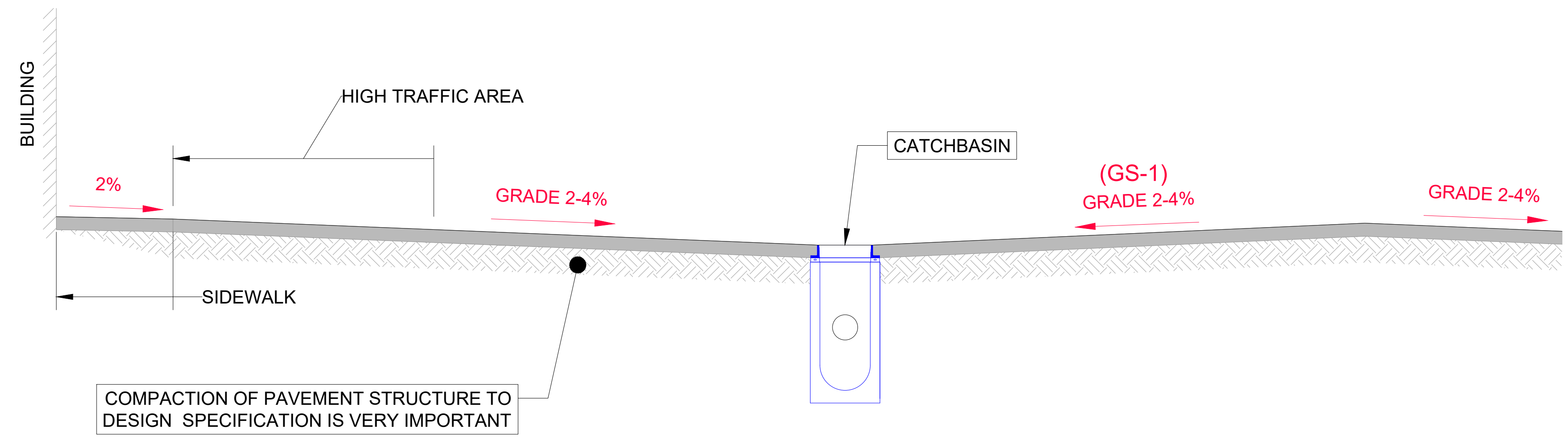
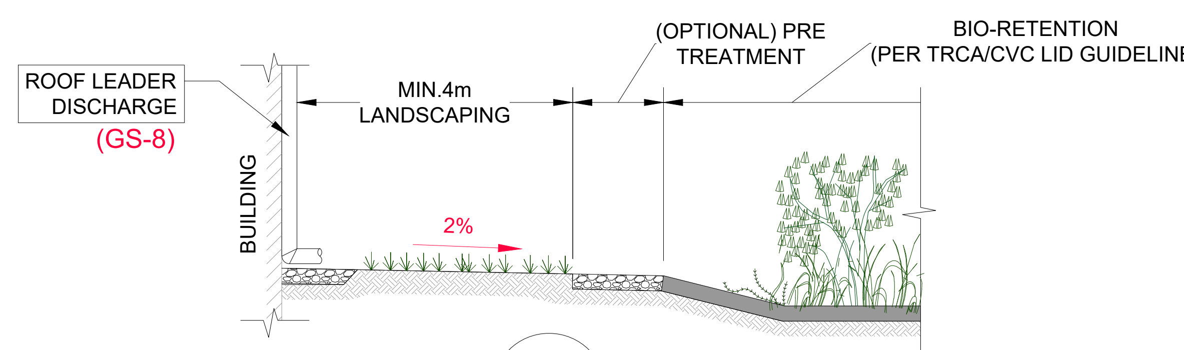


SECTION A-A'
NTS
FIG.1



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
EFFECTIVE GRADING/STORM WATER COLLECTION DESIGN EXAMPLE
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 2

Filename: \\ghdnet\ghd\CA\Waterloo\Projects\662\12597776\CAD\12597776-01(002)GN-WA001.dwg
Plot Date: 12 December 2022 4:55 PM

Data Source

1. 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 **Figure 4**, noted with an asterisk in the following list:

- 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 m^3 (cubic metres) to 1,500 m^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 3 m (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.
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 off-site 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 #: 11115623/12597776

Client: LSRCA

Location: LSRCA Parking - Typical Parking Lot

Average Annual Total Snow Fall Depth[7]	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[8]	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[9]	1,500 m^3

[7] Values taken from Bradford Muck Research Station Climate Normals (1980 to 2010)
[8] BC Supplement to TAC Geometric Design Guide (2007)
[9] 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 3 m high pile with a 1 m top width and 2H:1V side slopes (the angle of repose), the cross-sectional area would be 7.5 m^2 with a base of 4 m. This snow pile would fit within a 6 m parking space, with a 1 m buffer for both the curb and the drive lane.

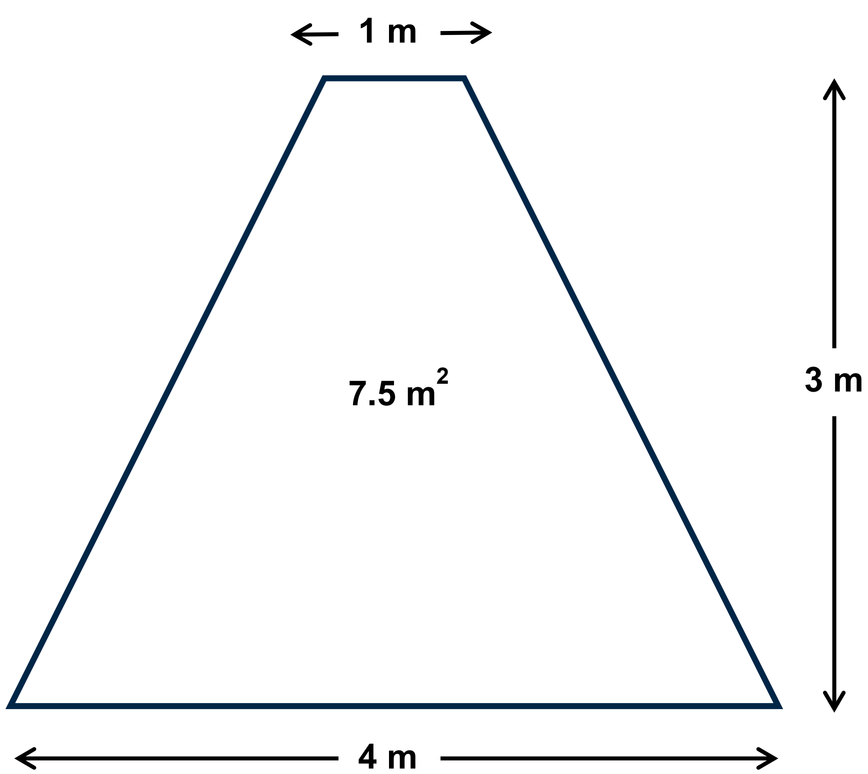
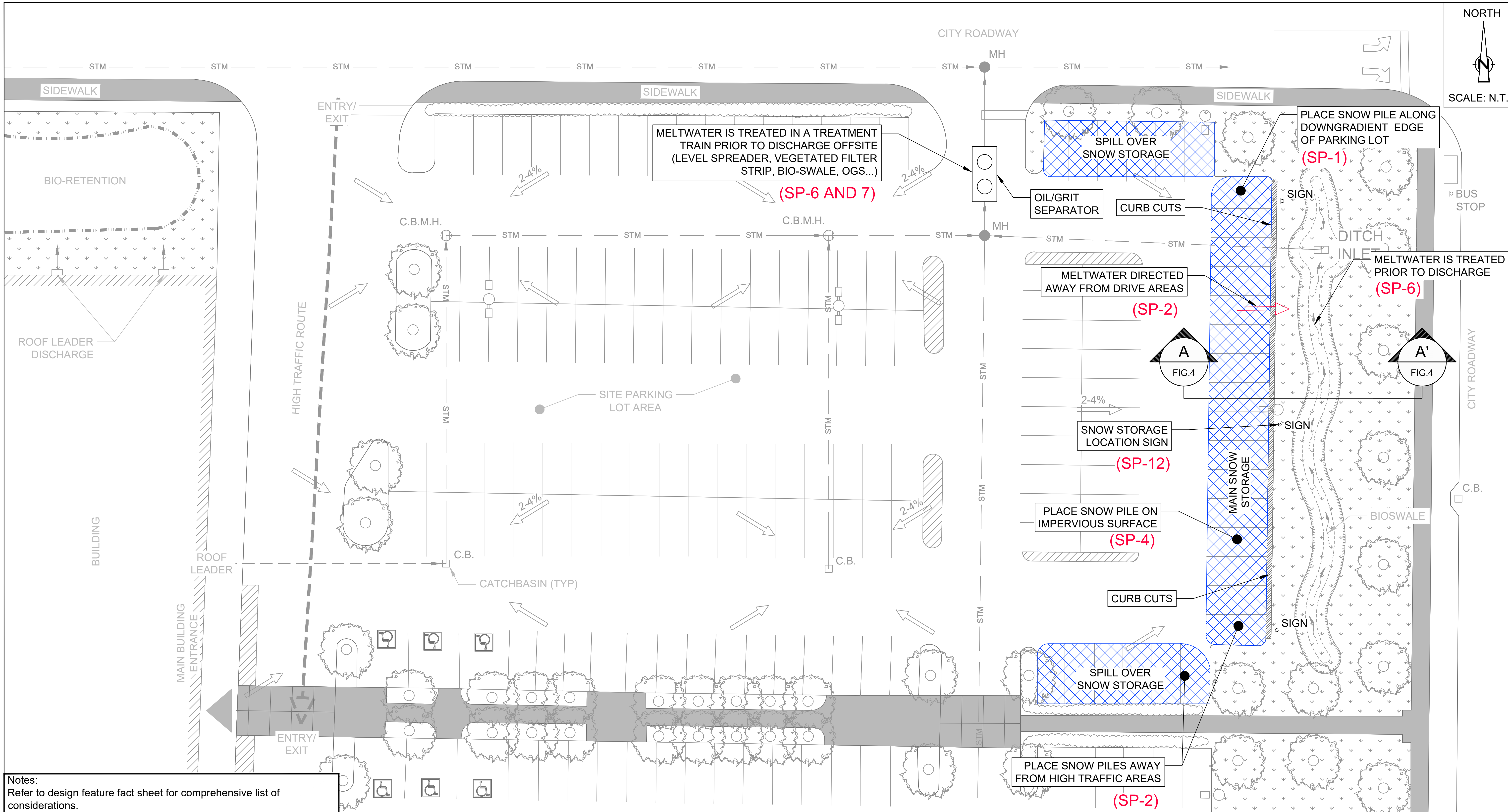


Table 1

Salt Tolerant Plant Species for Parking Lot Design

Botanical Name	Common Name	Native
Deciduous Trees		
Acer x freemanii	Freeman Maple	No
Acer ginnala	Amur Maple	No
Acer saccharinum	Silver Maple	Yes
Gleditsia triacanthos	Shademaster Honey Locust	No
Ginkgo biloba	Ginkgo	No
Pyrus calleryana	Ornamental Pear	No
Quercus rubra	Red Oak	Yes
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	No
Tilia americana	Basswood	Yes
Coniferous Trees		
Larix laricina	American Larch	Yes
Picea abies	Norway Spruce	No
Picea pungens	Colorado Spruce	No
Pinus nigra	Austrian Pine	No
Decidious Shrubs		
Amelanchier	Serviceberry	Yes
Forsythia x intermedia	Forsythia	No
Philadelphus species	Mockorange	No
Spiraea x vanhouttei	Bridlewreath Spirea	No
Symphoricarpos species	Snowberry	No
Viburnum trilobum	Highbush Cranberry	Yes
Evergreen Shrubs		
Juniperus species	Juniper	No
Perennials		
Sedum spectabile 'Autumn Joy'	Sedum Autumn Joy	No
Hemerocallis	Daylily	No
Heuchera	Coral Bells	No
Hosta	Hosta	No
Ornamental Grasses		
Calmagrostis acutifolia 'Karl Foerster'	Karl Foerster Reed Grass	No
Festuca glauca 'Elijah Blue'	Elijah Blue Festuca Grass	No
Pennisetum alopecuroides	Fountain Grass	No



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.

GHD

LAKE SIMCOE REGION CONSERVATION AUTHORITY
SNOW PILE STORAGE LOCATION
DESIGN EXAMPLE
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 3

Filename: \\ghdnet\ghd\CA\Waterloo\Projects\662\12597776\CAD\12597776-01(002)GN-WA002.dwg
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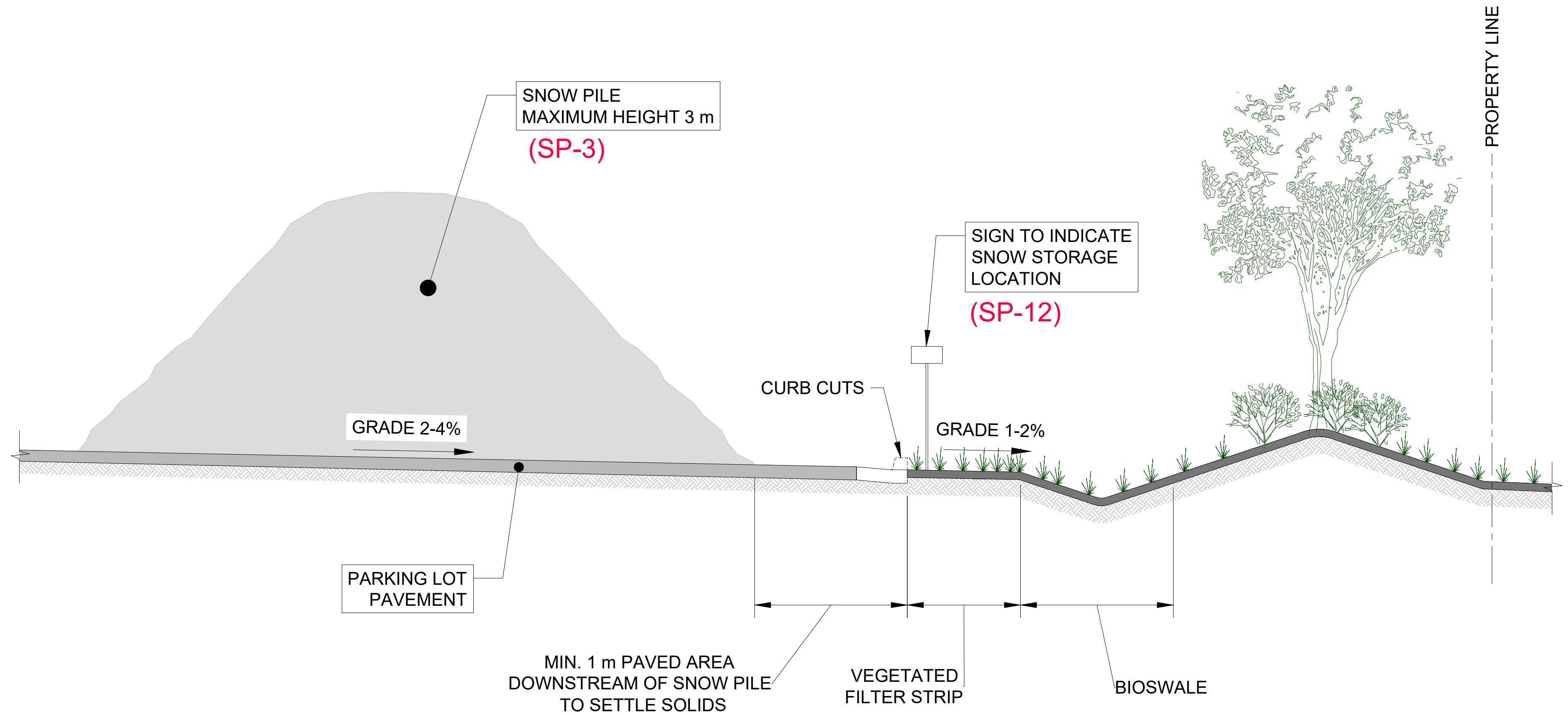
Data Source



SECTION A-A'
NTS
FIG.3

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.

SCALE : N.T.S.

LAKE SIMCOE REGION CONSERVATION AUTHORITY
SNOW PILE STORAGE LOCATION
(TYPICAL SECTION)
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 4

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Plot Date: 12 December 2022 4:56 PM

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1. 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 1.5 m) 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 **Figure 5B**, noted with an asterisk in the following list:

- 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 (1.5 m 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 roadway, 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

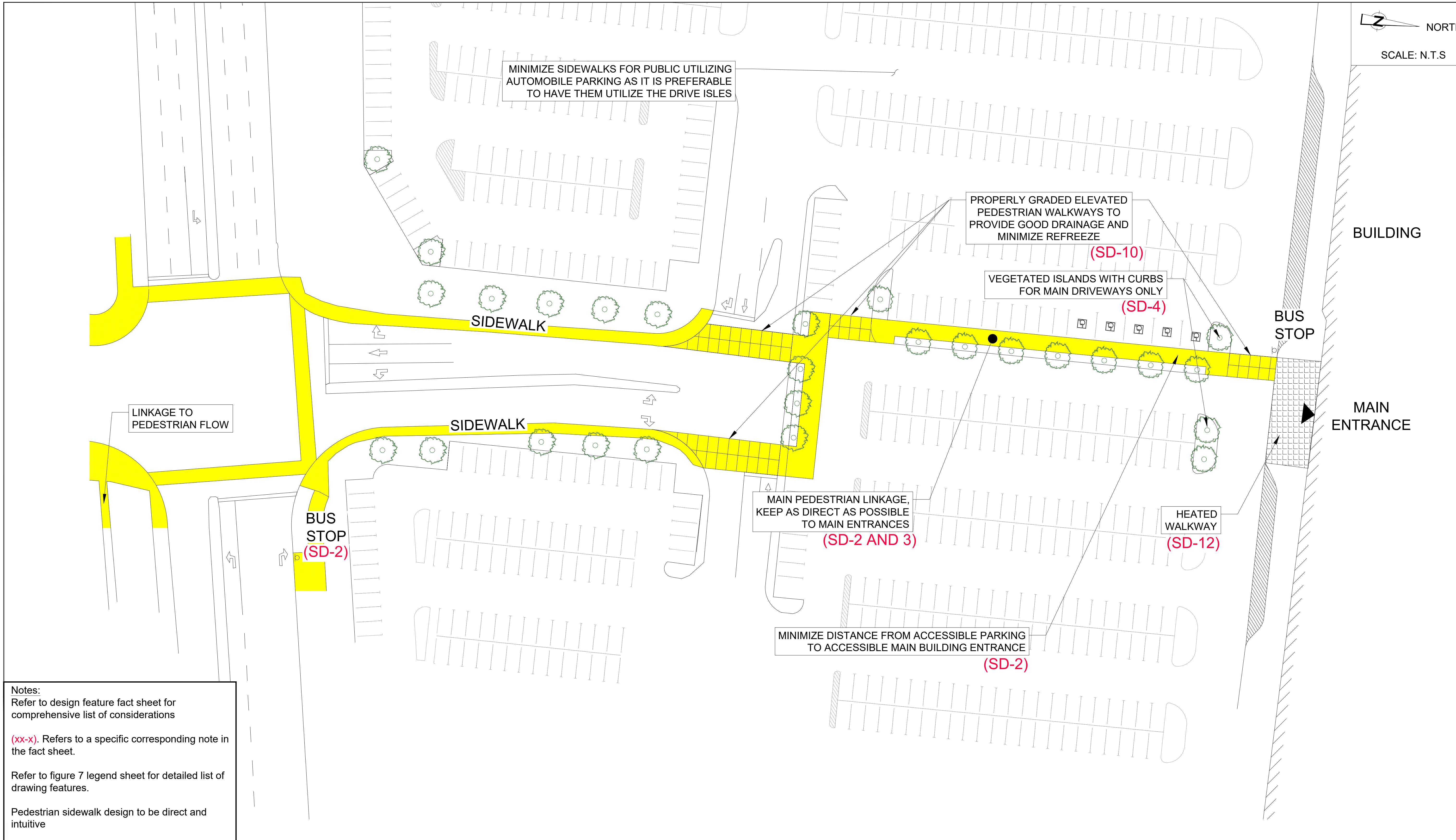
1. The creation of pedestrian walkways that are unnecessary or unused should be avoided, as they will increase the application of salts.
2. The design of winding sidewalks should be avoided to assist snow plow operators in efficient sidewalk management.
3. Where possible avoid draining upstream areas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

GHD

LAKE SIMCOE REGION CONSERVATION AUTHORITY
SIDEWALK DESIGN AND
PEDESTRIAN FLOW
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 5A

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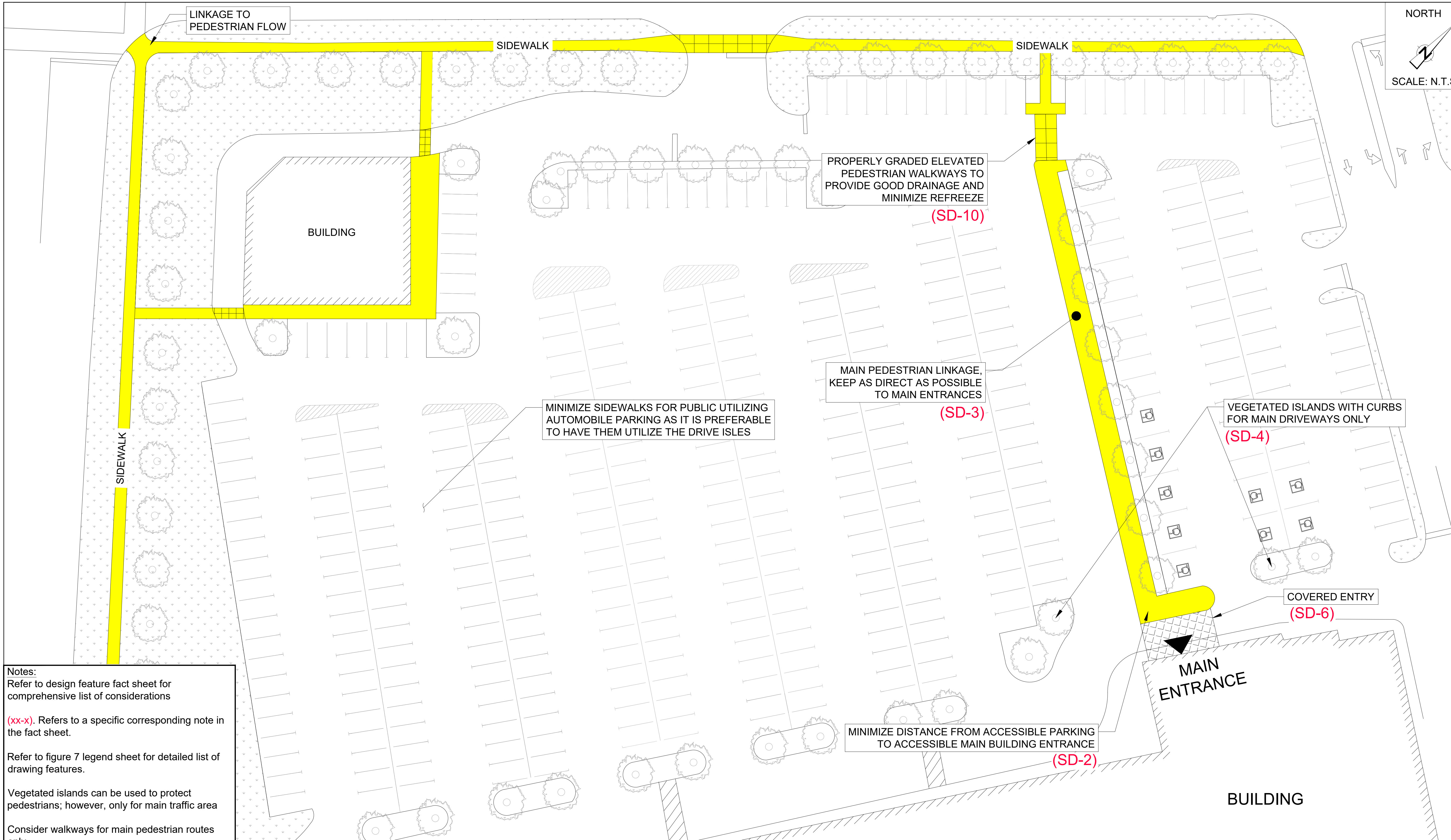

Notes:

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.

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

GHD

LAKE SIMCOE REGION CONSERVATION AUTHORITY
SIDEWALK DESIGN AND
PEDESTRIAN FLOW
PARKING LOT DESIGN GUIDELINES

Project No. 12597776
Date Dec 16, 2022

FIGURE 5B

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Data Source

1. 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 **Credit Valley Conservation's "Woodland Plants for Landscaping"**.

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 in the following list.

- 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** 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).
- 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, (CVC and TRCA, 2010).
- 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.
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 three to five years following planting.
6. Newly planted landscaping vegetation may require protection from wildlife for the first five to seven years.

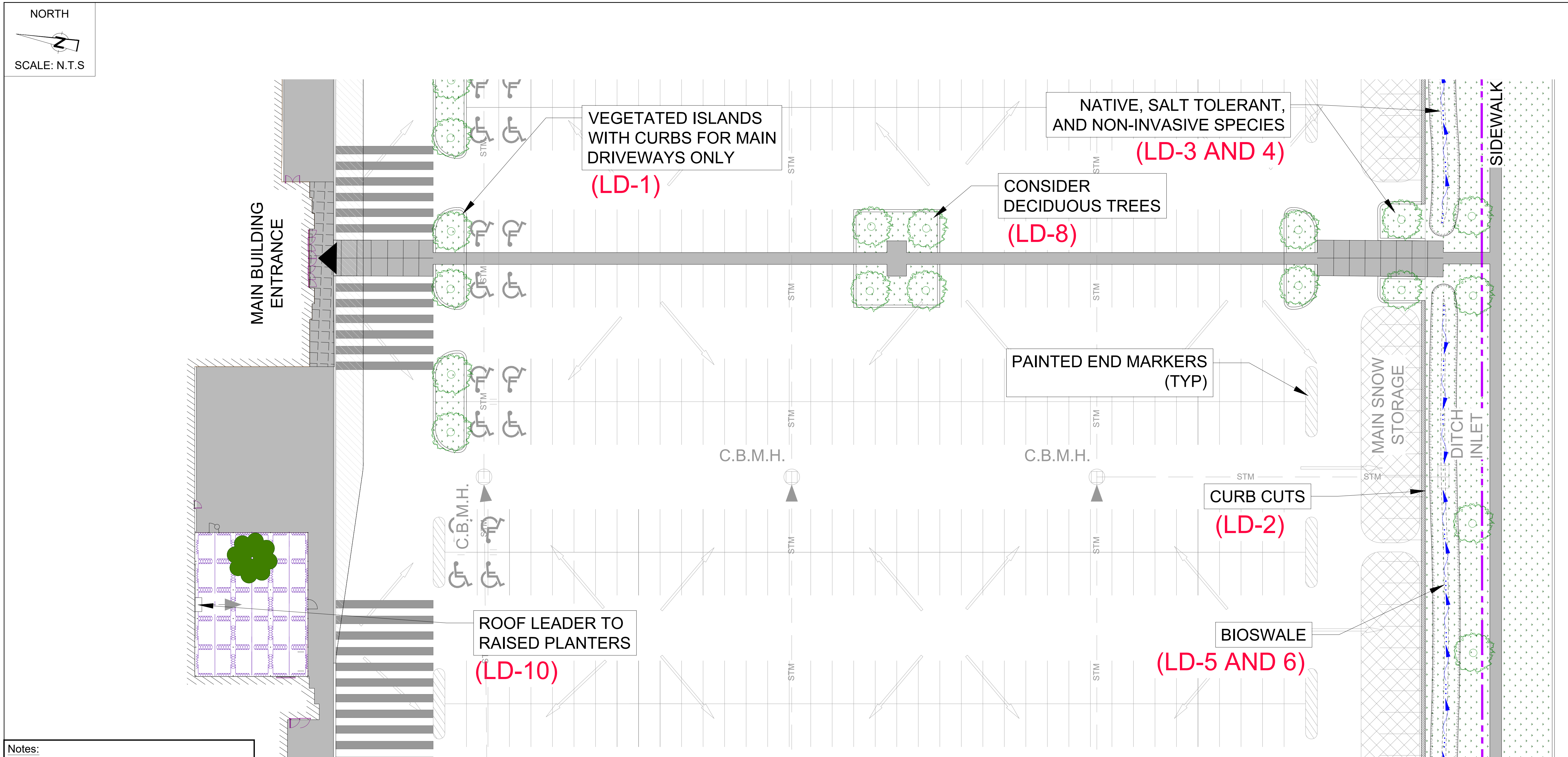
1.4 Costing

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	No
Acer ginnala	Amur Maple	No
Acer saccharinum	Silver Maple	Yes
Gleditsia triacanthos	Shademaster Honey Locust	No
Ginkgo biloba	Ginkgo	No
Pyrus calleryana	Ornamental Pear	No
Quercus rubra	Red Oak	Yes
Syringa reticulata 'Ivory Silk'	Ivory Silk Tree Lilac	No
Tilia americana	Basswood	Yes
Coniferous Trees		
Larix laricina	American Larch	Yes
Picea abies	Norway Spruce	No
Picea pungens	Colorado Spruce	No
Pinus nigra	Austrian Pine	No
Decidious Shrubs		
Amelanchier	Serviceberry	Yes
Forsythia x intermedia	Forsythia	No
Philadelphus species	Mockorange	No
Spiraea x vanhouttei	Bridlewreath Spirea	No
Symphoricarpos species	Snowberry	No
Viburnum trilobum	Highbush Cranberry	Yes
Evergreen Shrubs		
Juniperus species	Juniper	No
Perennials		
Sedum spectabile 'Autumn Joy'	Sedum Autumn Joy	No
Hemerocallis	Daylily	No
Heuchera	Coral Bells	No
Hosta	Hosta	No
Ornamental Grasses		
Calmagrostis acutifolia 'Karl Foerster'	Karl Foerster Reed Grass	No
Festuca glauca 'Elijah Blue'	Elijah Blue Festuca Grass	No
Pennisetum alopecuroides	Fountain Grass	No



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

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LAKE SIMCOE REGION CONSERVATION AUTHORITY
LANDSCAPING PARKING LOT
DESIGN GUIDELINES

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FIGURE 6

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Data Source

	Property Line
STM	Storm Sewer
	Vegetated swale
	Traffic route
	Roof leader
	Building outline
	Vegetation
MH	Maintenance hole
C.B.	Catchbasin
C.B.M.H.	Catchbasin maintenance hole
DITCH INLET	Ditch inlet
	Tree
SIGN	Snow pile signage
	Oil/Grit seperator
	Light pole
	Overland flow direction
	Building entrance
	Accessible parking
	Raised end markers

	Concrete walkway
	Snow pile locations
	Contributing drainage area
	Vegetated areas
	Heated walkway
	Sidewalk/ Pedestrian walkway
	Elevated pedestrian walkway
	Painted end markers
	Passenger loading area

LAKE SIMCOE REGION CONSERVATION AUTHORITY
LEGEND SHEET

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FIGURE 7