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SECTION 4.0: STORM DRAINAGE AND STORMWATER MANAGEMENT

4.1 GENERAL

The principles and design criteria in this section are intended to augment the guidelines, policies, and standards established in the latest version of the Ministry of Transportation (MTO) Drainage Management Manual, the MTO Highway Drainage Design Standards, the Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Planning and Design Manual, the Nottawasaga Valley Conservation Authority (NVCA) Development Review Guidelines, the Lake Simcoe Region Conservation Authority (LSRCA) Watershed Development Policies, the Lake Simcoe Protection Act, the LSRCA Technical Guidelines for Stormwater Management Submissions, LSRCA and Ontario Regulation 219/09 and MECP's Lake Simcoe Phosphorus Reduction Strategy.

Where the Town's Engineering Design Standards and Specifications Manual does not provide specific details, all designs should stay in conformity with the most current version of the above listed documents, including all Ministry of Transportation standards.

In the planning and design of stormwater management facilities, the designer is to have full regard for the riparian rights of all surrounding, upstream and downstream landowners. Consideration of the surrounding topography, land uses, and environment and integration of the facility into such elements is paramount. Opportunities for linking these facilities with trail systems should be maximized.

Electronic copies of all native, editable, design models, such as Visual OTTHYMO (.voprj), PCSWMM/SWMM5 (.inp/.pcp), HEC-RAS (.prj), HY8 (.hy8), etc. used to produce the engineering drawings and reports shall be included in all Site Plan/Subdivision submissions to the Town. When submitting your models for review, package all of these native files and any associated modeling files, PDFs of reports or plot outputs alone will not suffice.

4.2 LOW IMPACT DEVELOPMENT

The Town encourages the implementation of low impact development (LID) measures as defined by the Lake Simcoe Protection Plan (LSPP) and the United States Environmental Protection Agency (U.S. EPA, 2007) to minimize post development runoff volumes and maintain existing hydrological conditions within new developments. As such, the Town requires the stormwater management design of new and infill developments, as well as reconstruction and retrofit projects, to promote at-source control of post development runoff, thereby reducing the dependence on end-of-pipe controls where site conditions permit. However, due to the absence of definite Provincial and Conservation Authorities standards for the design of structural LID's, the implementation of these measures can be considered as a developing science. Local Conservation Authorities and the MECP are working towards the development of provincial standards, which upon their completion, will be incorporated into the Town's Engineering Design Standards and Specifications Manual. As a result, the Town will require that each construction project be assessed on a case by case basis.

To assess the applicability of incorporating structural LID as part of the stormwater management design, a comprehensive report prepared by a qualified engineer will be required for each project, which must include the following information:

a) Describe existing site conditions, including significant environmental features as well as soil type, infiltration capacity, and depth to water table;
b) Depending on the extent of the proposed project, prepare maps identifying the environmental features, soil conditions, and water table depth to show all aspects under consideration in the environmental design of the stormwater management system for the development;

c) Complete single event and continuous (if required) simulation rainfall/runoff event models to establish the baseline quality and quantity of stormwater runoff originating from the development area under existing conditions as a framework for evaluating combinations of structural LID components with conventional end-of-pipe controls;
d) Prepare an assessment of the various combinations and sizing requirements of LID components and end-of pipe controls based on their suitability for achieving the stormwater management control targets under typical post development conditions accounting for snow accumulation and frozen ground conditions;
e) Select a preferred alternative for achieving stormwater management control targets for consideration by the Town and the governing Conservation Authority prior to proceeding to detailed design; and

The assessment and recommendations can be included in the project SWM Report or be submitted as a separate document.

The implementation of any design that employs the use of Low Impact Development practices will be subject to Town and Conservation Authority Approval.

4.3 NUTRIENT MANAGEMENT STRATEGY AND WATER BALANCE

The Town, as an environmental leader, supports the reduction of phosphorous contributions from Greenfield development into the streams and lakes of the watershed within the Town. To achieve this goal, the Town encourages that effective measures be taken to mitigate and reduce phosphorous contributions from new developments wherever possible.

The Town also recognizes that reduced groundwater recharge because of new development can impact stream baseflows needed to sustain aquatic life and result in increased stream erosion.

As such, the Town will require that stormwater management design for new developments incorporate the most recent advances in phosphorus reduction and water balance technologies or strategies within the development proposal as per the most recent guidelines and standards as set out by the MECP and relevant Conservation Authority.

4.4 RAINFALL DATA

Stormwater management facilities should be designed based on the IDF tables developed by Environment Canada for Barrie WPCC based on rain gauge data for the period 1979 - 2003 including a 15% increase in rainfall intensity data to account for climate change. The adjusted Chicago distribution parameters for different return periods are provided below.

Barrie WPCC IDF Curve Parameters –Adjusted for Climate Change

Parameter	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
A	678.085	853.608	975.865	1146.275	1236.152	1426.408
B	4.699	4.699	4.699	4.922	4.699	5.273
C	0.781	0.766	0.760	0.757	0.751	0.759

Rainfall Intensity, I (mm/hr) = $A/(t+B)^C$, where t is time duration in minutes
Parameters based on rain gauge data for the period 1979 – 2003 for the Barrie WPCC Station #6110557
Based on a review of the literature, the IDF intensity values for Barrie WPCC Station were increased by 15% before calculating a, b, c values to account for climate change.

Barrie WPCC 2003 Rainfall Intensity (mm/hr) + 15 % to Account for Climate Change

Duration (min)									
Return Period	5	10	15	30	60	120	360	720	1440
2 years	115.5	81.5	67.4	43.1	25.3	15.5	7	3.9	2.3
5 years	150	107.9	89.9	56.2	32.8	21.9	9.9	5.4	3.2
10 years	173	125.5	104.9	65.1	37.6	26.1	11.8	6.3	3.8
25 years	201.8	147.4	123.7	76	43.8	31.4	14.3	7.6	4.5
50 years	223.3	163.9	137.7	84.3	48.4	35.4	16	8.5	5.1
100 years	244.7	180.1	151.6	92.3	53	39.3	17.7	9.4	5.5

Barrie WPCC 2003 Rainfall Depth (mm) + 15 % to Account for Climate Change

Duration (min)									
Return Period	5	10	15	30	60	120	360	720	1440
2 years	9.7	13.6	16.8	21.5	25.3	31.1	42.3	46.7	55
5 years	12.5	17.9	22.4	28.2	32.8	43.8	59.5	64.3	76
10 years	14.4	20.9	26.2	32.5	37.6	52.2	70.8	76	89.9
25 years	16.8	24.6	30.9	38.1	43.8	62.9	85.2	90.7	107.5
50 years	18.6	27.3	34.4	42.1	48.4	70.7	95.9	101.7	120.6
100 years	20.4	30	37.8	46.2	53	78.5	106.5	112.5	133.6

4.5 STORMWATER MANAGEMENT SYSTEM - MINOR

Generally, storm drainage shall be accommodated by a system of curb and gutters as well as storm sewers, with the exception of rural roadways or estate residential subdivisions, where an open ditch system may be permitted if minimum design criteria can be realized.

Underground storm sewers within the public rights-of way are to be designed to convey a minimum of the 1:5-year storm without surcharge. However, when the major storm drainage system is inadequate, the Town may consider the approval of an underground storm sewer system designed to carry additional flows.

Underground storm sewers within site plans and private developments are to be designed to capture and convey a minimum of 1:100-year storm to the onsite storage facility.

4.5.1 Service Area

The system shall be designed to accommodate all on-site drainage areas as well as all external tributary areas to their maximum future development capacity in accordance with the Town's Official Plan.

4.5.2 Design Flows

The design flows used to size the storm sewer system or small developments (drainage area ≤ 50ha) are to be calculated using the Rational Method, as follows:

$$Q = \frac{(c)(i)(A)}{360}$$

where:
- Q = design flow (m^3/s)
- c = runoff coefficient (dimensionless)
- i = average rainfall intensity (mm/hr)
- A = drainage area (ha)

The average rainfall intensity is to be derived from the IDF curve from the Atmospheric Environment Service Branch of Environment Canada for the Barrie WPCC station 2003, adjusted for climate change, as follows:

$$I \text{ (mm/hr)} = A/(t+B)^{C}$$

where:
- i = average rainfall intensity (mm/hr)
- A = coefficient for the 5-year return period
- t = time (minutes)
- B = exponent for the 5-year return period
- C = exponent for the 5-year return period

The time of concentration is to be calculated as the sum of the initial inlet and the travel time in the pipe, where the initial inlet time is to be ten (10) minutes for the five (5) year storm.

This shall apply where the upstream drainage area does not include large open space areas. Where peak flows from external areas enter a subdivision sewer system, the more critical case based on either the time of concentration including the external area or the time of concentration excluding the external area shall be used. Actual velocities of computed peak flows shall be used to estimate time of concentration.

A design evaluation of inlet times must be submitted to justify inlet times different from those specified above.

Runoff coefficients are given by components of surface treatment and by land use. The land use values are intended as a guide only and the designer is expected to develop an appropriate coefficient using an arithmetic composite calculation as shown below:

$$C = \frac{(A_1C_1) + (A_2C_2) + \ldots}{A_t}$$

where:
- C = composite runoff coefficient (dimensionless)
- $A_{1,2...}$ = area corresponding to specific land use or soils type (ha)
- $C_{1,2...}$ = runoff coefficient corresponding to $A_{1,2...}$ (dimensionless)
- A_t = total drainage area (ha)

Source: adapted from the Ministry of Transportation Drainage Management Manual, 1997, Equation 8.10.

The higher of the arithmetic composite runoff coefficient or the minimum required runoff coefficient by land use, provided in the following table, shall be used to compute design flows.

TABLE 6 - Runoff Coefficients (Rational C) (5-yr to 10-yr) Based on Hydrologic Soil Group

Runoff Coefficient "C"

Land Use	A-AB	B-BC	C-D
Cultivated Land, 0 - 5% grade	0.22	0.35	0.55
Cultivated Land, 5 - 10% grade	0.30	0.45	0.60
Cultivated Land, 10 - 30% grade	0.4	0.65	0.70
Pasture Land, 0 - 5% grade	0.1	0.28	0.40
Pasture Land, 5 - 10% grade	.015	0.35	0.45
Pasture Land, 10 - 30% grade	0.22	0.40	0.55
Woodlot or Cutover, 0 – 5% grade	0.08	0.25	0.35
Woodlot or Cutover, 5 - 10% grade	0.12	0.30	0.42
Woodlot or Cutover, 10 - 30% grade	0.18	0.35	0.52
Lakes and Wetlands	0.05	0.05	0.05
Impervious Area (i.e., buildings, roads, parking lots, etc.)	0.95	0.95	0.95
Gravel	0.40	0.50	0.60
Unimproved Areas	0.10	0.20	0.30
Lawn, < 2% grade	0.05	0.11	0.17
Lawn, 2 - 7% grade	0.10	0.16	0.22
Lawn, > 7% grade	0.15	0.25	0.35
Land Use	**Recommended Minimum Coefficient**		
Parks	Calculated		
Single Family Residential	Calculated		
Semi-Detached Residential	Calculated		
Townhouses, Maisonettes, Row Houses, Apartments, etc.	Calculated		
Institutional	Calculated		
Industrial and Central Business District	Calculated		
Commercial	Calculated		

Run-off Coefficients shall be determined from the types of land uses within the drainage area.

The run-off coefficient values provided above are recommended minimum values; however, the Developer's Engineer should determine the appropriate coefficient of imperviousness based on the actual uses. The maximum size of proposed units shall be considered when calculating the total imperviousness of the development.

Adapted from Design Chart 1.07, Ontario Ministry of Transportation, "MTO Drainage Management Manual," MTO. (1997)

Note: Gravel parking or storage areas for new development should be considered as paved areas as they may be paved in the future

Runoff coefficients (Rational C) for development such as single family, semi-detached, Duplex, Town housing, Commercial, Industrial, Institutional, Schools, Churches, and Park etc.

shall be calculated using a weighted average of the runoff coefficients for the relative areas using the coefficients outlined in the table.

On a project specific basis, a detailed calculation of the run-off coefficient may be requested by the Town.

For estimating flows from storms larger than the 5-year event, the runoff coefficients should be increased to account for the increase in runoff due to saturation of the soil.

The runoff coefficient shall be adjusted for return period events greater than the 10-yr storm as follows:

Runoff Coefficient Adjustment for 25-yr to 100-yr Storms

Return Period	**Runoff Coefficient "C"**
25 years	C25 = 1.1*C5
50 years	C50 = 1.2*C5
100 years	C100 = 1.25*C5

Adapted from Design Chart 1.07, Ontario Ministry of Transportation,
"MTO Drainage Management Manual," MTO. (1997).
Note: When applying the runoff coefficient adjustment, the maximum c-value should not exceed 1.0.

Barrie WPCC IDF curves as outlined above

$$I\ (mm/hr) = A/(t+B)^{C}$$

where:
- i = average rainfall intensity (mm/hr)
- a = coefficient from IDF tables
- t = time (minutes)
- B = exponent from the IDF tables
- C = exponent from the IDF tables

4.5.3 Pipe Capacity

Manning's Formula is to be used in calculating the full flow capacity of the storm sewer.

The roughness coefficients to be used in the calculation are as follows:

Concrete pipe, n = 0.013
PVC and Smooth walled PE pipe, n = 0.013
Corrugated pipe (for culvert use only), n = 0.024

Storm sewers are to be designed such that individual pipes only reach a maximum of 80% of their total capacity. On an individual as-needed basis, the Town will review designs where pipes reach a greater percentage of their total capacity.

Storm sewer design sheets are to be provided and included on the drainage area plans. The design sheets shall demonstrate that the proposed pipe capacity and velocities are in

accordance with the Town's standards. All design sheets submitted for approval shall be sealed, signed, and dated by a professional engineer licensed to practice in the province of Ontario.

4.5.4 Velocities

The minimum allowable actual velocity in a storm sewer shall be as follows:

a) The minimum flow velocity in the storm sewer shall be 0.75 m/s.
b) Velocities in storm sewers shall not exceed 6 m/s.
c) Additional protection against erosion, scouring, and pipe displacement must be provided by a Licensed Engineering Practitioner where flow velocities exceed 4.5 m/s.
d) In certain circumstances, such as rehabilitation/replacement of an existing Sewer where deepening of the individual Sewer section will not be possible, design flow velocities of less than 0.75 m/s may be considered, provided that appropriate measures are taken to facilitate frequent flushing and maintenance needs and the Town accepts the increased maintenance requirements.

4.5.5 Minimum and Maximum Pipe Slopes

The minimum pipe slope shall be that which is required to meet the minimum velocity, but shall not be less than 0.3%.

The maximum pipe slope shall be that which is required to meet the required capacity and maximum velocity.

4.5.6 Minimum Pipe Sizes

The minimum pipe size is 300 mm for mainline storm sewers. Pipe sizes 450mm and larger shall be drawn to the outside diameter on the engineering drawings to confirm there are no conflicts with adjacent infrastructure. The minimum clearances as stated in Appendix C shall be provided.

4.5.7 Pipe Material & Pipe Class

For storm sewer pipe diameters up to and including 450 mm, PVC may be used, while reinforced concrete pipe is required for diameters greater than 450 mm. The bedding design must be compatible with the selected pipe type. Refer to Appendix B for the approved list of materials for storm sewers.

The pipe class shall be selected based on the bedding type, final burial depth, and anticipated surface loads. Label the pipe class for the sewers on the engineering drawings.

4.5.8 Minimum Depth of Cover

The minimum depth of cover to be provided shall be the greater of:

a) 1.5 m below the centreline of road or finished ground surface elevation to the spring line of the sewer; or
b) 1.2 m to the obvert of the sewer, provided that there are no conflicts with utility crossings; or
c) That which is required to provide gravity foundation drain connections.

Where sufficient cover does not exist, the Town may consider shallower insulated sewers on an individual basis.

The maximum height of fill is not to exceed applicable OPSD (805.010 through 807.050) unless pipe strength design calculations are provided for approval by the Town.

4.5.9 Bedding and Backfill

All storm sewers are to be installed with bedding (well graded OPSS Granular 'A' or as recommended and approved by the Geotechnical Engineer and the Town) and backfill in accordance with OPSD 802.010 or 802.030 to 802.032 as applicable. Compaction is to be a minimum of 95% SPD or as indicated in the approved Geotechnical Report.

In soft or wet conditions, additional Geotechnical investigation may be necessary to determine the appropriate bedding and backfill measures.

4.5.10 Pipe Clearances

Minimum horizontal clearance between the outside wall of the adjacent sewer pipes (sanitary, or second storm) shall be 800mm. A minimum clearance of 500mm between the obvert of the sanitary sewer and invert of the storm sewer shall be provided if the sanitary connections are required to go under the storm sewer. Other minimum clearances shall be provided in accordance with MECP guidelines.

4.5.11 Sewer Layout

Storm sewers shall generally be located as per the typical road cross-sections.

Where storm sewers are located in easements, the easement width shall be a minimum of 9.0 m. However, the Town will review alternative easement widths on an individual basis in certain circumstances such as the utilization of a joint trench or installation of a sewer at a depth which is substantially greater than standard.

Where there is a rear yard catchbasin there is to be a 1.8 m easement on the lot with the rear catchbasin storm pipe and a 1.2 m easement on the adjacent, non-piped side of the property line.

4.5.12 Maintenance Holes

Maintenance holes shall be as per OPSD 701 and shall be placed at the beginning and end of each sewer line, at changes in pipe size and/or material, and at changes in grade and/or alignment. Curved (radius pipe) or properly deflected sewer lines may be permitted but written approval from the Town is required.

All maintenance holes shall be drawn to the outside diameter on the engineering drawings to confirm there are no conflicts with adjacent infrastructure. The minimum clearances as stated in Appendix C shall be provided.

During design phase, at the Town's discretion, maintenance hole waterproofing may be required.

All maintenance holes sized up to and including 1200 mm diameter are to be pre-benched to spring-line by the supplier. All maintenance holes larger than 1200 mm diameter are to be benched to spring-line on-site after installation.

The maximum spacing between maintenance holes shall generally be according to the following:

Diameter	Maximum Spacing between Maintenance Holes
300 to 750 mm	120 m
825 to 1200 mm	150 m
1350 to 1800 mm	200 m
> 1800 mm	250m

Note: The pipe sizes listed in the table refer to circular pipes and are applicable to elliptical or box sections equivalent circular pipe diameters.

The maximum change in direction for pipes 825 mm and smaller is 90°. The maximum change in direction for pipes 900 mm diameter and larger is 45°.

A sufficient drop shall be provided across each maintenance hole to offset any hydraulic losses. The minimum drops across a maintenance hole shall be as follows:

Change in Direction	Minimum Drop
Straight run (0°)	0.03 m
1 - 45°	0.05 m
> 45°	0.08 m

All maintenance holes within an asphalt roadway shall include a self-adjustable autostable frame. Structures outside roadways or existing frame and grates in base asphalt which require adjustment for top lift asphalt may use lift rings (when approved by the Town). Otherwise, when adjusting the top elevation of maintenance holes, a minimum of one to a maximum of three adjustment units (Moduloc) shall be installed on the top of the structure. The maximum vertical adjustment of maintenance holes via Moduloc shall not exceed 300 mm. Any adjustment exceeding this amount shall consist of precast concrete riser sections.

Drop structures shall be provided when the difference in the inlet and outlet inverts is equal to or greater than 0.6m that cannot be eliminated by changing sewer grades. Drop structures shall be in accordance with OPSD 1003.010, OPSD 1003.020, OPSD 1003.030, OPSD 1003.031, OPSD 1003.032, and OPSD 1003.033.

Safety platforms shall be installed in accordance with OPSD 404.020 for all maintenance hole depths of 5.0 m or greater.

Obverts of inlet pipes shall not be lower than obverts of outlet pipes. Springline connection principle for the inlet and outlet pipes requires a written approval from the Town.

Where maintenance holes are located in areas to be flooded by the major storm design and surcharged sewer design is not used, maintenance hole covers shall be of the sealed variety.

Where maintenance holes are located where the surcharged sewer design hydraulic grade line is higher than the rim elevation, maintenance hole covers shall be of the bolted variety. In all other areas, standard maintenance hole covers shall be used.

Except for special cases, the downstream pipe diameter shall always be greater than or equal to the upstream pipe diameter.

4.5.13 Catchbasins

Catchbasins shall be located upstream of pedestrian crossings and not within 1.0 m of any curb depressions. Preferably, catchbasins will be installed on projections of lot lines. Double catchbasins shall be located where flows are being received from more than one direction, such as at low points.

The maximum allowable spacing shall be in accordance with the following:

Pavement Width (m)	Maximum Spacing (m)	
	Slope ≤ 4.5%	Slope >4.5%
8.5	90	60
12.0	70	50
14.0	60	40

Catchbasin capacities shall be determined in conjunction with the overall stormwater management system. On roadways, catchbasins shall have a minimum capacity to pass the runoff from the 5-year return frequency storm. Where the pipe system is required to convey flows in excess of the 5-year return frequency storm, sufficient catchbasin capacity shall be provided to permit the design flows to enter the sewer system. Inlet control devices may be used where the hydraulic grade line needs to be strictly controlled to prevent surcharging of the sewer line and to allow storm sewer house connections.

Catchbasins located within site plans and private developments shall be designed to capture and convey the 1:100 year storms. Inlet capacity calculations for a 100-year return frequency storm are to be provided. Inlet capacity calculations for catch basins shall assume a 50% reduction due to potential blockage.

Where catchbasins are used as inlet controls, spacing shall be determined by design and must be approved by the Town.

When adjusting the top elevation of catchbasins, a minimum of one to a maximum of three (3) adjustment units shall be installed on the top of the structure. The maximum vertical adjustment shall not exceed 300 mm. Any adjustment exceeding this amount shall consist of precast concrete riser sections.

Leads shall be minimum 250 mm at 0.7% (1.0% is required to convey 60L/s that single CB can capture) grade for single catchbasins and 300 mm at 0.7% (1.5% is required for flows captured by double, or increase pipe to 375 mm) grade for double catchbasins.

Leads shall connect to maintenance holes and shall have a minimum depth of cover of 1.2 m to the obvert.

All catchbasins shown on the engineering drawings shall indicate the OPSD standard, top of grate elevation, and invert.

4.5.14 Groundwater & Foundation Drainage System

In order to minimize the flow rate from foundation drains, a minimum distance of 0.5 m shall be provided between the underside of the basement floor slab and the measured seasonal high groundwater table. Subdivision applications shall clearly include this difference of elevation at the time of the "Draft Plan Application" and shall be updated during the detailed design process. For subdivisions, fluctuating groundwater elevations shall be monitored for a period of not less than two (2) years prior to detailed design submission. Monitoring should continue through the design and construction phases. 12 months of continuous groundwater monitoring shall be conducted immediately prior to the date of the first detailed design submission.

For site plans, continuous monthly monitoring shall be conducted for a period of not less than one (1) year prior to detailed design submission.

The seasonal high groundwater elevations shall be indicated on the grading plan at the centroid of each building envelope/units along with the elevation of the bottom of the basement slab. The grading plan shall also provide the seasonally high groundwater contours for reference. The lots with basements shall be indicated on the plan.

Other methods of controlling foundation drain flow rate will be considered in consultation with Town staff.

A foundation drainage system is to be provided for each residential lot. The designer has three options to choose from:

1. A sump pump discharging to an underground storm sewer service connection as per TOISD 607
2. A gravity connection to the storm sewer, provided the 100-year hydraulic gradeline is minimum of 0.5 m below the finished basement floor elevation of the dwelling.
3. A sump pump or gravity connection to a third pipe (foundation drain) collection system that is separate from the storm sewer system, which discharges to a sufficient outlet, as per Section 4.5.3 or another approved location such as a valley or hillside.

4.5.15 Storm Service Connections

Single connections for residential lots shall be constructed in accordance with TOISD division 600 for each type of residential lot. Connections for commercial, institutional or multiple use will be considered on an individual basis.

The minimum depth of cover is 1.5 m and the minimum slope is 2.0%. Utility duct trench depths and other crossings must be considered in setting the depth of service connections.

Where a sump pump discharges to a storm service connection, a 25 mm air gap shall be provided at the building such that there is no direct connection between the building sump pump outlet and the storm service.

Where it can be shown to the satisfaction of the Town that groundwater conditions at footing level are unlikely to require more than two (2) sump basins and pumps for an entire townhouse block, storm service connections to the internal units in a townhouse block may be eliminated. However, storm service connections must be installed to the end units.

Single residential storm connections shall be 150 mm diameter with a 150 mm x 100 mm test fitting plugged and braced at the property line. Refer to TOISD 605.

Double "Y" residential storm connections shall have a 150 mm x 100mm x 100 mm boot jack fitting with a 100 mm diameter test fitting to each individual connection plugged and braced at the property line. Refer to TOISD 606.

For new developments, the service shall be extended 3.0 m beyond property line, with an additional test fitting, plug, brace, and marker.

Roof leaders shall not be connected to the storm sewer system. Roof leaders are to be discharged to the ground surface onto splash blocks or extended by a minimum of 450mm outwards, and flows shall be directed away from the building in such a way as to prevent ponding or seepage into the foundation weeping tile.

Where flat roofs are used, as in commercial or industrial sites, detention roof hoppers requiring smaller or fewer roof leaders may be used as part of the stormwater management design. No connections are to be installed directly to storm sewers.

4.5.16 Testing

The following testing requirements apply to all new storm sewers. Any sections of sewer or service connections which fail to meet the requirements shall be repaired or replaced at the direction of the Town.

An Inspection and Testing Plan shall be prepared and submitted to the Town at least two (2) weeks prior to the inspection or testing. The plan shall follow the requirements outlined in the most recent revision of the MECP Design Criteria for Sanitary Sewers, Storm Sewers and Forcemains for Alterations Authorized under an Environmental Compliance Approval.

4.5.15.1 Deflection Testing

All newly installed PVC and Polyethylene storm sewers shall be subjected to deflection testing in accordance with OPSS 410.

Deflection testing is not required for concrete storm sewers.

4.5.15.2 Infiltration/Exfiltration Testing

Infiltration/exfiltration testing of the storm sewer is not required.

4.5.15.3 CCTV Inspection

All newly installed storm sewers shall be subjected to a CCTV Inspection. Refer to Appendix D for the Town's CCTV Inspection Requirements.

4.5.15.4 Visual Inspection

All maintenance holes shall be visually inspected by the Town for deficiencies. When requested by the Town, maintenance hole scans shall be provided by a qualified third-party sewer inspection firm. Scans must be completed using 100% digital panoramic scanning equipment. The digital files provided must include a distortion-free virtual pan and tilt to view the MH from any angle and at any depth. The Town must be able to view all pan, tilt, and unfolded views. If specific software is required it must be provided to the Town with the digital files.

4.5.17 Materials

Refer to Appendix B for a list of materials and specifications.

4.6 STORMWATER MANAGEMENT SYSTEM – MAJOR

Runoff rates in excess of the design capacity of the minor system shall be conveyed via roadways, swales, walkways, drainage easements, and in special circumstances the storm sewer system, to a sufficient outlet, reference 4.6.3. The combination of the overland flow system and the minor system shall be designed to prevent flooding of private property with maximum level of road flooding and surface detention as defined in the table below. These flows shall be conveyed within the public rights-of-way.

In the event of a blockage of the SWM system, A minimum of 0.15m shall be provided between the major flow spill elevations and the proposed units/building.

It shall also be demonstrated that overland flow conditions resulting from the 100-year/Hazel storm will not cause unacceptable flooding damage to private property with a maximum level of road flooding and surface detention as outlined in the table below.

TABLE 7 – Ponding: Maximum Allowable Flow Depths

LOCATION	STORM RETURN FREQUENCY (YEARS)		
	5	25	100/Hazel
Walkways	minor surface	as required	as required
Open Spaces	flow up to 25 mm on walkways	for overland flow outlets	for overland flow outlets
Local Roads (2 Lane)	No ponding	0.05m above crown	0.15m above crown
Collector (4 lane+), Local and Industrial Roads (extra wide lanes)	1.0 m wide in gutter or 0.10m deep at low point catchbasins	up to crown “contradictions” - discuss	0.10m above crown maximum depth of flooding of 0.3 m

LOCATION	STORM RETURN FREQUENCY (YEARS)		
	5	25	100/Hazel
Arterial Roads (4 lane+)	1.0m wide in gutter or 0.1 m deep at low point catchbasins	1 lane clear	up to crown maximum depth of flooding of 0.30m Typically, 1 lane clear is required for 100yr
Private Property (House, Townhouse, etc.)	minor ponding in swales	no structural damage, ponding in yard areas below building openings - no basement flooding	up to 0.15m unless otherwise directed by the Town no structural damage from overland flow
Public Property	minor ponding in swales or ditches	no structural damage, ponding in flat areas, no erosion	no structural damage, ponding in flat areas, some erosion
Site Plan			up to 0.30m, maximum ponding depth of 0.20m preferred. (See Section 4.10.4)

In new subdivisions the limit of overland flow route floodlines for the 100 year/Hazel storm event shall not extend onto private property unless protected by a drainage easement. Development of the site must not increase flood levels upstream or downstream of the development.

For all classes of road, the product of depth of flow at the gutter (m) times the flow velocity (m/sec) shall not exceed 0.65 m^2/sec.

Street grading must provide a continuous gradient to direct street flows to a safe outlet at low points. Outlets can be walkways or open sections of roadways leading to parks, open spaces or river valleys.

Pre-development peak flows shall be computed by an approved hydrologic model. Watershed definition and pre-development flows must be approved by the Town.

Preliminary estimates of post-development flow rates may be computed using the Rational Method.

For all systems and for the design of surcharged sewers and detention facilities, the latest version of the computer model OTTHYMO is recommended. Other hydrograph methods may be considered if it is demonstrated that the results are comparable to those from OTTHYMO. Post-development design flows may be determined using the Rational Method only where the design area is less than 40.0 ha and runoff control facilities are not considered.

4.6.1 Open Ditches

In rural areas, industrial areas, or estate residential subdivisions, open ditches may be permitted by the Town. Ditches shall be constructed a maximum of 0.5 m and a minimum of

0.15 m below the sub-grade of the roadway. Where this cannot be achieved, a sub-drain may be provided under the invert of the ditch and day-lighted once the minimum depth can be attained.

The minimum ditch grade shall be 0.5% and the maximum 5%. In exceptional cases and where ditches are on easements off the Road Allowance, ditches with grades greater than 5% may be allowed by the Town, but these shall be suitably protected against erosion to the satisfaction of the Town. Where ditch grades exceed 5%, the Town may require that an urban cross-section be applied for that road segment.

The minimum ditch protection on all ditches shall be 300 mm of topsoil and staked sod on the side slopes and bottom of the ditch regardless of the ditch gradient.

4.6.2 Open Channels

Open channels are to be utilized in the following circumstances:

a) For the Regional Storm where the upstream watershed area exceeds 1 square kilometre (100 ha);
b) For a minimum 25-year return frequency storm with protection from erosion damage for larger storms if required by the Town;
c) To maintain the natural storage characteristics of the watercourse;
d) To maintain a natural appearance as far as possible; and
e) To meet specific requirements of the Conservation Authority in each case.

4.6.3 Sufficient Outlet

All developments must demonstrate that the stormwater generated onsite is directed to a sufficient outlet.

A sufficient outlet typically constitutes a lake or permanently flowing watercourse. Sufficient outlet may also include public right-of-ways provided that written permission is obtained from the Town. In the case where the discharge is directed over private land, the developer must obtain a legal right of discharge registered on title for both properties. Copies of all written documentation such as a legal right of discharge registered on title and/or written permissions from the Town must accompany the design submission.

The designer shall provide calculations for the conveyance capacity of the downstream conveyance routes to demonstrate that upstream, downstream and adjacent landowners do not incur adverse impacts, including increased runoff volumes, and that the flow is conveyed in a safe manner.

4.7 STORMWATER MANAGEMENT FACILITIES

All stormwater management facilities are to be designed to ensure that post-development peak flows do not exceed pre-development levels for storm events up to and including the 1:100 year event applying the 4 hour Chicago storm and the 12 hour and 24 hour SCS Type 2 Storm. Where downstream flow constraints or flooding risks exist, additional quantity controls may be required at the discretion of the Town. Further, in accordance with the Lake Simcoe Protection Plan and Ontario Regulation 219/09, all new stormwater management facilities are required to provide an Enhanced level of water quality protection.

The Town does not support the use of the Modified Curve Number method CN*. Curve numbers should be derived as outlined in the US Soil Conservation Service (1972) SCS curve number method. The Initial abstraction should be set as follows.

Initial abstraction/depression storage

Cover	Depth (mm)
Woods	10
Pasture/Meadow	8
Cultivated	7
Lawns	5
Wetland	12/16
Impervious areas	2

Ref: UNESCO, Manual on Drainage in Urbanized Areas, 1987.

Notes: The representative area method should be used to calculate the IA value for catchment areas.

The Town supports the design of stormwater management facilities using hydrologic computer programs including VISUAL OTTHYMO and SWMHYMO. Due to various industry standard software programs prior to submission the Town is to be contacted to confirm the current software packages which will be accepted in modeling submissions. If the submission does not use software that the Town has, the proponent could be directed to resubmit their analysis using the software in use at the Town.

All stormwater management facilities are to be designed in accordance with the preferred criteria listed in the most current MECP “Stormwater Management Planning and Design Manual” and the relevant requirements of the Nottawasaga Valley Conservation Authority (NVCA) and the Lake Simcoe Region Conservation Authority (LSRCA). The information provided below is intended to supplement the aforementioned manuals and requirements.

4.7.1 Stormwater Design Guidelines for Proposed Upstream Developments From Existing SWM Facilities

Where proposed development discharges into existing development and there is a downstream SWM facility designed to treat the existing and proposed development, the proposed development shall meet current engineering guidelines at the time of first detailed design submission for each phase and the following targets:

a. All storms up to the 5-year storm event (4-hour Chicago, 12 & 24-hour SCS Type II) must be controlled to the outlet storm sewer capacity as previously designed and approved by the Town.

b. All storms up to the 100-year storm event (4-hour Chicago and 12, 24-hour SCS Type II) must be controlled to the capacity of the major flow system as specified in the current engineering guidelines at the time of first detailed design submission of the current phase, using current IDF curves for the entire watershed.

4.7.2 Stormwater Quantity and Quality Controls

Current stormwater management practice advocates the consideration of Stormwater Management Practices (SWMP's) on a hierarchical basis, whereby more pro-active techniques are considered first. The SWMP's are grouped under the following headings in order of preferred application:

1. Lot Level Techniques and Source Controls
2. Transport or Conveyance Controls
3. End-of-Pipe Controls

The philosophy behind this hierarchy is that stormwater management techniques are usually more effective when applied at the source. Development can result in negative impacts to the hydrologic cycle elements of evaporation, infiltration, soil storage, and runoff as well as runoff water quality and erosion of local water courses and water bodies. Low Impact Development (LID) measures and Storm Water Management (SWM) measures can help reduce the impacts of development by increasing infiltration, evaporation, soil storage, water reuse, and reducing runoff, detrimental water quality impacts, and downstream erosion.

In Ontario, the Low Impact Development Stormwater Management Planning and Design Guide (Version 1, CVC/TRCA, 2010) is a comprehensive guideline that provides guidance on planning, site selection, design, construction, and operations and maintenance of LIDs.
This guidance document, commonly referred to as the "LID Guide", must be used to select, design, and maintain LID practices

The Town of Innisfil supports the progressive implementation of a wide range of stormwater management techniques. This range is expected to increase and change over time, as long-term monitoring results indicating the level of success of various techniques become available. The Town also supports the integration of stormwater management facilities with passive recreational opportunities, where the intended function of either is not impaired.

LID functions may vary in time due to sedimental loading and shall not be used for quantity control or end-of-pipe quality control. LIDs may be used as part of a treatment train approach in addition to a quality control facilities

LID measures implemented within private lots will be the homeowner's responsibility to maintain. The Town will not assume ownership or maintenance of these proposed measures. The Town will assess the feasibility of LID measures on private lots on a case-by-case basis.

LID measures may be implemented within the ROW adjacent to private lots. The Town does not endorse LIDs being placed directly in front of private lots and in between driveways, as this presents operational and maintenance challenges.

The following table provides the current perspective of the Town of Innisfil regarding available stormwater management practices, as well as special supporting documentation which is required for implementation of each technique.

Proponents must contact the Town prior to submitting formal applications to discuss specific LID and SWM objectives for each project. In the absence of specific design criteria, proponents must utilize the following criteria for development projects:

Stormwater Management Technique	Town of Innisfil Perspective	Supporting Documentation
Lot Level Techniques and Source Controls		
Green roofs	On a case-by-case basis	Requires Town acceptance
Bioretention	Encouraged for clean source areas	Requires Town acceptance on municipal lands
Roof leader discharge to surface	Encouraged	Uses an elbow which either directs towards a splash pad or utilizes a 450mm extension outwards from the structure
Soakaway, infiltration trench	Encouraged	On site 5 m from buildings, clean or pre-treated runoff
Rear lawn ponding	Discouraged in residential land use due to maintenance and impacts on use of rear yards, including West Nile Virus	But occurring in Dry Ponds and Wetlands and to some extend in Wet Ponds – same problem will occur with West Nile Virus.
Roof top storage	On a case-by-case basis	Requires Town acceptance
Parking lot storage	On a case-by-case basis	Requires Town acceptance
Permeable pavement	Encouraged	On private property
Rainwater harvesting	Encouraged	On private property
Vegetated filter strips	Encouraged	On private property
Enhanced grass swales	Encouraged	On private property or Requires Town acceptance
Dry swales	Encouraged	On private property or Requires Town acceptance
Conveyance Controls		
Perforated pipe systems under asphalt	Not currently endorsed on public lands	
Perforated pipe systems under boulevard	Encouraged	Requires Town acceptance
Pervious catchbasins	Not currently endorsed	
Grassed swales	Encouraged	On private property or Requires Town acceptance
Oversized pipes	Encouraged	On private property or Requires Town acceptance
End of Pipe Controls		
Wet ponds	Encouraged	SWM Report
Wetland ponds	Encouraged	SWM Report
Hybrid ponds	Encouraged	SWM Report
Dry ponds	Hybrid ponds	Drainage areas <5 ha or infiltration > 25mm
Oil/grit separators	Encouraged	Drainage areas <5 ha
Infiltration basin	On a case-by-case basis	Requires Town acceptance

Note: Several criteria are inter-related, for example retaining the first 5 mm of precipitation on-site not only produces water balance benefits, it also provides runoff water quantity reduction, water quality improvements, and downstream erosion benefits.

Application of in-ground LID measures has to be evaluated taking into consideration the groundwater levels observed in the project area.

4.7.3 Emergency Spillway

All stormwater management facilities shall be designed with an emergency spillway to allow drainage to safely exit the facility should the outfall structure fail to function, or should the storm event have a frequency lower than the 100-year storm. The emergency spillway shall be designed to convey the Regional Storm event post development routed peak flow with the invert of the spillway set, as a minimum, at the 100-year controlled water level (or Regional controlled water level for ponds where Regional control may be required). A freeboard of 0.30 meters shall be provided above the maximum routed Regional Storm water level to the top of the pond berm.

The emergency spillway shall incorporate erosion protection measures that are adequately designed to withstand the erosive velocity associated with the uncontrolled governing flow. The erosion protection shall be integrated with a natural vegetated surface treatment that is aesthetically pleasing.

Spillway side slopes shall not be steeper than 3:1 and shall be no steeper than 10% when incorporated into the access road. The spillway shall not be located directly above the outlet control structure and a minimum horizontal clearance of 3.0 m shall be provided.

4.7.4 Grading (Side Slopes)

Grading within stormwater management facilities shall be designed with the minimum slope requirements for the various components of the facility are as follows:

- Stormwater management facilities shall be designed with 4:1 above and below the safety shelf
- A safety shelf shall be provided with a slope of 7:1 extending 3m horizontally above and below the normal water level
- There must be a 3.0m flat buffer (2% to 5%) between the top bank of the facility and any existing or proposed private property where there is no maintenance road.
- 4:1 where the slope backs on to the rear yard lot line or an adjacent valley system
- 4:1 where the pond is adjacent to a municipal boundary
- 5:1 where the slope backs on to an adjacent road system
- 5:1 where the pond is being used as part of a trail system or passive recreation area

Retaining walls will not be permitted in the design of stormwater management facilities

4.7.5 Major System Overland Flow Routes

The major system overland flow route to the SWM facilities shall be designed to safely convey the Regulatory (i.e. the larger of the 100-yr storm and Hurricane Hazel or Timmins Storm) overland flow. Should the overland flow route to the SWM facility consist of the access road and path, then the flow depth shall not exceed 300 mm or a velocity of 0.65 m/s. Where feasible, the overland flow should not be directed into the forebay to avoid the re-suspension of settled sediments.

For subdivision walkways, the maximum drainage area shall be 2.0 ha.

4.7.6 Anti-seepage Collars

Anti-seepage collars shall be installed on all outlet pipes or as directed by a geotechnical engineer.

4.7.7 Existing Groundwater Elevation

Within the stormwater block, at least one borehole shall be located near the center of the block as part of the geotechnical investigation, to assess the nature of existing soils and the groundwater elevation. The groundwater elevation shall be compared to the proposed permanent pool water elevation within the facility. Where soil conditions are very permeable and the groundwater elevation is below the permanent pool water level, lining of the permanent pool area with an impermeable material may be required to ensure permanent pool levels are maintained. A liner may also be required when groundwater contamination may be a result of the permeable soils and the water quality within the stormwater management facility. The type and thickness of lining material shall be based on Geotechnical recommendations; however, a clay liner is preferred over synthetic materials for stormwater management facilities.

Where the groundwater elevation is above the permanent pool water elevation, an investigation shall be undertaken to assess the impacts of a localized reduction in groundwater levels, potential impacts to groundwater aquifer systems and flow regimes, watercourse baseflow quantity and temperature, and to assess potential slope stability and groundwater seepage concerns within the facility. The scope of this investigation will be determined based on site specific conditions. The consultant shall consider all feasible design alternatives to limit or negate any impact to local groundwater levels to the satisfaction of the Town.

The forebay should always be lined where the majority of the contaminants are contained.
If an impermeable liner is required, the liner is to be constructed of impermeable clay or silt as per the geotechnical engineer's recommendation. The use of a manufactured bentonite geosynthetic liner is not supported. The installation of the liner must be supervised and certified by the geotechnical engineer.

4.7.8 Fire Use

In certain locations of the Town (e.g., remote development locations where access to fire hydrants is not available), and subject to review by the Town, it may be desirable to utilize the SWM pond as a source of water for fire use by incorporating a dry hydrant design. The design must meet the requirements of the Ontario Building Code for dry hydrants which is currently in accordance with FPA 1142, Water Supplies for Suburban and Rural Fire Fighting.

4.7.9 Sediment Forebay Bottom

A berm shall be constructed with a forebay spillway invert at the NWL with appropriate erosion protection to enable, as a minimum, the flow of the water quality event (25 mm event) without overtopping any other part of the forebay into the main cell of the facility. The minimum top width of the berm shall be 1.0 m and side slopes 3:1.

A dewatering sump shall be installed in the forebay to enable the drawdown of the permanent pool for maintenance and sediment removal. Where feasible, the forebay sump shall be connected to the pond outlet structure with a control valve to drain by gravity. Where draining by gravity is not feasible, a dewatering sump shall be included and drained by pump.

The sediment forebay bottom is to be lined with 500 mm of 25 mm crushed stone or approved alternative to assist in the maintenance operations of the facility. A Geotechnical Engineer must certify that the forebay bottom design has sufficient bearing capacity to support maintenance equipment assuming the forebay has been drained.

4.7.10 Sediment Drying Areas

Sediment drying areas are to be incorporated into the design of wet end of pipe stormwater management facilities such that water from the sediment drains back into the sediment forebay with a slope of 2% to 4%. The sediment drying area shall be designed to:

- accommodate 30% of the forebay volume
- have a maximum sediment stockpile depth of 1m
- have a maximum sediment side slopes of 10:1
- located in areas that avoid high publicity
- is accessible from the maintenance access road
- is located above the five (5) year water level
- setback a minimum of 6 m from property line

4.7.11 Inlet Structures

Inlet structures shall be installed with the invert set to the NWL or higher. Suitable erosion control and energy dissipation treatment shall be provided at all inlets to the pond. The sizing of rip rap or river stone shall be based on appropriate erosive velocity calculations. Maintenance access roads shall be provided to all inlet structures.

Headwalls, barricades and safety grating shall be installed at all inlets as per OPSD 804.040, OPSD 804.030, OPSD 980.101 and OPSD 804.050. SWM pond inlet elevations are to be designed such that the one (1) in five (5) year storm design sewer capacity as per the storm sewer design sheet is maintained and not reduced due to tail water conditions.

4.7.12 Outlet Control Structures

Outlet control structures shall be designed with flow regulating devices to control the flow and pond drawdown time. The standards for end of pipe stormwater management pond outlets are as follows:

a) The Town is requesting one control maintenance hole with a central wall designed with an orifice and/or notches to provide flow control and located at the top of the berm outside of the emergency spillway. It can be located on the maintenance road if the road is paved and the maintenance hole fitted with autostables

b) If feasible, the intake pipe will be sized for the 100-year flow have sufficient cover to prevent freezing. For larger catchments to reduce the intake pipe size, a grated inlet can be used preferably above the 25-year water level

c) Where the permanent pool elevation is greater than 1 m above the obvert of the intake pipe, a reverse slope pipe shall be used. The intake pipe must be anchored and stabilized and be fitted with a grate of sufficient size that a swimmer would not be pinned against it at high flow

d) Where the permanent pool elevation is less than 1 m above the obvert of the intake pipe, the outlet should be designed with a heavy duty galvanized CSP riser with pre-punched perforations with 1.5 times the 100 year flow capacity, a lockable non-hinged lid and large riprap placed against the riser to provide protection and filtering of stormwater. No hickenbottom or flow controls shall be in the riser.

e) The low flow orifice on the center wall should be designed with an adjustable knife gate valve to control the flow and pond drawdown time and be accessible for adjustment through a standard maintenance hole cover without entering the maintenance hole. This would provide the Town with the ability to:

   i. Adjust the low flow discharge to set the draw down rate (details provided in the Operations and Maintenance Manual)
   ii. Open the valve fully to clear any clogging in the inlet pipe
   iii. Shut the valve to control any spills from moving downstream

The outlet should also include a maintenance pipe with shut off valve for draining the SWMF if possible

The minimum design orifice size is 75 mm with filtered stormwater, or 100 mm. Outlet structures are to be designed in a safe and aesthetically pleasing manner with the majority of the structure contained within the berm. The use of orifice plates are not accepted by the Town for site plan developments.

Suitable erosion control and energy dissipation treatment shall be provided at the pond outfall where it discharges to the receiving body. The sizing of rip-rap or river stone at the outfall shall be based on appropriate erosive velocity calculations. Maintenance access roads shall be provided to all outlet structures.

When stormwater is discharged into an existing or proposed ditch, rip-rap must be installed from the outlet to halfway up the opposite side of the ditch to prevent erosion. In cases where the pond emergency spillway discharges into the ditch, the Town may require the applicant to install rip-rap to the top of the ditch, depending on the flow rate.

The outlet structure should be designed to operate under free-flowing conditions where feasible. The return period water surface elevations of the receiving body must be determined and verified to ensure the proper operation of the outlet structure. Where it is not feasible to operate the outlet structure under free-flowing conditions, appropriate submergence calculations must be completed to ensure that the outlet structure is sized correctly.

4.7.13 Fencing and Gates

Fencing shall be installed where the stormwater management facilities abut private lots, municipal boundaries, elementary schools and active recreation areas frequented by young children unless maximum slopes of 6:1 are provided. Town may request to install fencing in other conditions on project by project basis. Where required, fencing shall be installed as per Town of Innisfil Engineering Design Standards and Specifications Manual.

All stormwater management facilities are to be designed such that perimeter fencing is not required where it is adjacent to municipal right of ways. Gates with a locking system shall be provided on all maintenance road access points

4.7.14 Signage

Town Standard Sign, TOISD 818, shall be clearly visible and erected at the stormwater management facility's maintenance access road entrances, as approved by the Town. Town Standard signs shall be supplied and installed by the developer and designed in accordance with Town standards.

Warning signs shall be clearly visible and erected at all access points (maintenance access roads or pedestrian trail access points) to the stormwater management facility. Warning signs shall be supplied and installed by the developer and designed in accordance with Town of Innisfil Standard TOISD 818.

4.7.15 Geotechnical Review

As part of final design, the geotechnical engineer should review the detailed design of the stormwater management facilities as well as the procedures outlined in the operation and maintenance manual and provide written certification confirming that they meet current geotechnical standards and are suitable from a geotechnical perspective. Drawing for the SWM facilities should include any geotechnical design parameters required such as soil and compaction specifications for berm construction, sub-base for maintenance roads and erosion protection materials. The same requirements are required for temporary erosion and sediment control facilities.

4.7.16 Aesthetics and Landscaping

The stormwater management facilities shall be constructed with acceptable building materials (e.g. no gabions) to ensure that the pond is an aesthetically pleasing component of the community. Stormwater management facilities shall be integrated with parks and trails where feasible. Access to the SWM ponds by unauthorized vehicles should be restricted by the placement of armour stone and large trees around the perimeter where there is no fencing

4.7.17 West Nile Virus

Reasonable measures should be incorporated in the design of wet ponds and wetlands to minimize the proliferation of mosquitoes and the potential spread of the West Nile virus and to reduce the need to apply larvicide. Such measures, which focus on creating habitat less suitable for mosquito breeding and survival, include the following (adapted from TRCA Innovative Stormwater Management Workshop, Culex Environmental, May 2008):

- Encourage a plant-dominated state as opposed to an algae-dominated state – A plant dominated state (i.e., lots of submerged and floating-leaved aquatic plants) provides habitat for predators whereas algae dominated state is less favourable for predators and more favourable for mosquitoes with increased availability of nutrients and turbidity as a food source and warmer water. In addition, mosquito larvae tend to avoid submerged and floating-leaved plants
- Introduce predators – Along with a plant-dominated state introduce predators that feed on mosquito eggs and larvae, such as: grazing invertebrates (e.g., snails, Mayfly larvae, Chironomids), neustonic insects (e.g., water striders, water

boatmen, whirligig beetles), benthic invertebrates (e.g., flatworms, leeches, Asellus, shrimps), three-spined sticklebacks, fathead minnows, dragonfly nymphs, water beetles, Alderfly larvae, and frogs and toads. In addition, bird and bat houses should be erected to encourage the nesting of bats and birds such as swallows and purple martins which rely on flying insects including mosquitoes as their primary food source

- Minimum water depths – Where possible, the minimum depth of water within the permanent pool should be 1.0 m or greater

4.7.18 Thermal Impacts

When discharging stormwater to a watercourse identified as a Cold Water Fishery, mitigation measures such as shoreline planting, shading with trees, bottom draw outlet pipes from deeper pools, or cooling trenches shall be implemented in SWM facilities to minimize thermal loading to the receiving watercourse. Bottom draw quality control pipes should have an inlet invert 500 mm above the bottom of the SWM facility to prevent sediment from entering the pipe. Cooling trenches should have a minimum length of 30 m.

4.7.19 Trails

Pedestrian circulation trails shall be incorporated into SWM facilities where public safety has been fully addressed in terms of access, side slopes and fencing requirements. The feasibility of connections to adjacent neighborhood parks, recreation areas and existing trail networks is to be explored as part of the initial SWM facility submission plans to the satisfaction of the Town. Wherever possible trails shall be co-located with maintenance access roads.

4.7.20 Operations and Maintenance Manual

A stand-alone operations and maintenance manual will be required as part of the design for the SWM facilities and stormwater infrastructure. The manual shall include inspection checklists, maintenance descriptions and projected frequency, as well as recommendations for facility and infrastructure cleanup. Refer to Chapter 6 in the MECP Stormwater Management Planning and Design Manual for further details and requirements.

4.8 FACILITIES PLANTING GUIDELINES

The following section outlines the specific design criteria and planting requirements which are to be followed within stormwater management (SWM) facilities and/or wetlands within the Town of Innisfil. These criteria are in addition to the minimum standards outlined within the MOE's Stormwater Management, Planning and Design Manual and planting standards for both the LSRCA and the NVCA.

Landscaped areas shall consist of native species only as per the *Native Plant Species in Ontario* (Riley, 1989) provided in the *NVCA Pond Planting Guidelines* (NVCA, April 2006) with the exception of those unacceptable/invasive species identified by the LSRCA and included in **Appendix J**. If a development is located within an area where an overall SWM planning study *(i.e. Environmental Impact Study, Ministry of the Environment Special Provisions)* is available, the design criteria and recommendations as specified in the appropriate study must also be followed where specific direction is given.

4.8.1 Landscaping

In cases where there are residential lot(s) adjacent to a stormwater management facility, a minimum 6 m wide landscaping buffer with a maximum slope of 4:1 will be required between the maintenance access route and the residential lot(s) to provide separation between the stormwater management facility and private property. This buffer can be included within the stormwater management block.

4.8.2 Planting Zones

SUBMERGENT (*Deep Water*) – Water depth 0.5 m to 2.0 m

- Planting is to consist of a combination of both floating and submergent species.
- Planting must include at least (3) three species each of robust, broadleaf and narrow leaf plant varieties

AQUATIC FRINGE (*Shallow Water*) – Water depth 0.0 m to 0.5 m

- Planting is to consist of a combination of both floating and submergent species.
- Planting must include at least (4) four species each of robust, broadleaf and narrow leaf plant varieties

SHORELINE FRINGE (*Extended Detention*) – 1.0 m (horizontal) from the permanent pool elevation

- Plantings zone appropriate wetland species must include perennial sedges, rushes and wild flowers in combination with shrubs and wetland seed mix
- The shoreline fringe is subject to fluctuations in water levels which will result in regular flooding and therefore plant selections must be flood tolerant

FLOOD FRINGE – 2.0 m (horizontal) from the limit of the shoreline fringe limit to the 100 year flood level

- Plantings must include a diverse variety of no less than five (5) flood tolerant species each of shrubs, deciduous trees and coniferous trees
- Trees and shrubs within the flood fringe will provide canopy structure to mitigate thermal effects on water temperature
- Herbaceous plant material may be provided by the use of an approved wet meadow seed mix which will be applied in combination with an annual rye nurse crop or suitable equivalent nurse crop
- UPLAND – includes all areas outside the flood fringe
- Plantings will include a minimum of seven (7) species each of drought tolerant shrubs, deciduous trees and coniferous trees
- Upland planting is intended to provide visual screening, aesthetic appeal, wind blockage and shading to mitigate thermal effects on water temperature
- Tree plantings to have no more than five (5) trees of the same species in a grouping

- Provide a minimum 1.5 m buffer between plantings and any structures such as maintenance roads and drying areas and fencing which abuts residentially zoned property
- Trees planted along fenced areas, bordering residential properties should be structurally sound, strong branched so to prevent falling branches into adjoining residential properties

4.8.3 Planting Guidelines

AQUATICS (Submergent and Aquatic Fringe)

- Spacing requirements for aquatics in plug form is five (5) units per m2
- Spacing requirements for aquatics in 100 cm potted form is four (4) units per m2
- Spacing requirements for aquatics in 150 cm potted form is three (3) units per m2
- Cattails (Typha spp.) will be planted as interim perimeter vegetation in sediment forebays to increase sediment trapping. The use of this material will not limit maintenance access and it is acceptable that this material will be removed during dredging operations
- Other aquatic species will not to be placed within the forebays as they would be less likely to re-colonize after dredging operations
- Plant material must be comprised of 100% native stock
- Protection from geese and other waterfowl may be required during initial aquatic plant installations
- Aquatic fringe plant installations should be installed one (1) full growing season after that of both the shoreline and flood fringe or at such time as a complete vegetative buffer is established around the pond perimeter as deterrence to geese

TERRESTRIAL (Shoreline Fringe, Flood Fringe and Upland)

- Do not utilize plant material which has been removed or harvested from natural wetlands or roadsides as they may contain invasive or non-native species
- Plant material must be comprised of 100% native stock from a reputable grower/supplier
- Plant shrubs in groupings of no less than 15 units [and no more than thirty (30) units] to promote both colonization and spreading
- Shrubs are to be no less than 60 cm height (container grown stock only)
- Deciduous trees within the flood fringe are to be no less than 50 mm caliper stock. Canopy to be structural sound with strong central leader, no co-dominant leaders will be accepted. Canopy to be healthy and balanced around main central trunk of tree with no rubbing branches nor damages/inclusions on bark. Bio-degradable support materials shall be as per Town standards or approved by project leader. Metal “T” bar and wire support will not be accepted

- Deciduous trees within the upland may utilize a combination of caliper material and whip stock where caliper trees are planted based on a rate of one unit per 25 m2. Whip stock is to be installed at a rate of 6.25 units per 25 m2
- Whips and any bare root stock to be planted prior to the third Friday of May in any given year
- Coniferous material will be no less than 2000 mm in height where height is measured from the top of the root ball to the first whorl (does not include the leader)
- Where applicable, shrubs, deciduous trees and coniferous trees are to be installed in accordance to current Town Standards
- Rodent protection will be installed around the base of all deciduous trees. It will be the installer's responsibility to remove rodent protection (2) two years prior to accepted/assumed. Biodegradable options will also be considered
- Weed abatement measures will be used around trunks of trees using mulch, coco fiber mats or Town approved substitute
- Bio-engineering (e.g. live staking) should be implemented on steep slopes in conjunction with other stabilization methods. Live staking will not be considered for use against density calculations for plant material

4.8.4 Calculation Table for Planting Density

Table 4.8 - Calculation Table for Planting Density

	A	B	C	D	E	F
ZONE	ZONE AREA	WATER'S EDGE	[1] QUANTITY OF AQUATIC SPECIES 35% Coverage	QUANTITY OF PLANT COVERAGE 50% Coverage	[2] NUMBER OF TREES REQUIRED	NUMBER OF SHRUBS REQUIRED
SUBMERGENT	n/a	B (lin. m)	C = B*0.35	n/a	n/a	n/a
AQUATIC FRINGE	n/a	B (lin. m)	C = B*0.35	n/a	n/a	n/a
SHORELINE FRINGE	A (m^2)	n/a	n/a	D = A*0.5	n/a	F = D
FLOOD FRINGE	A (m^2)	n/a	n/a	D = A*0.5	E = (A/1000)*25	F = D-(E*15)
UPLAND	A (m^2)	n/a	n/a	D = A*0.5	E = (A/1000)*25	F = D-(E*15)

Note:
1. Quantities are based on plugs (5 units per sq/m)
2. Quantities are based on caliper stock (1 unit per 25 m^2)

4.8.5 Topsoil

- Topsoil must meet the current Ontario Provincial Standard Specification No.570 (OPSS-570)
- Topsoil will be laboratory tested and the subsequent findings forwarded to Parks Planning and Development for approval prior to placement of topsoil
- Testing must demonstrate that topsoil has sufficient organic and nutrient content and is suitable for sustaining plant material which is to be placed into the pond and/or wetland
- Soil amendments required as a result of laboratory testing must be completed prior to or during the placement of topsoil in accordance with laboratory findings and amendment requirements
- For terrestrial habitats in the flood fringe, provide 0.35 m of topsoil
- For terrestrial habitats in the upland area, provide 0.20 m of topsoil
- For aquatic habitats, provide 0.45 m of topsoil for the first 1 m from the permanent pool elevation
- Stabilize topsoil after placement prior to the installation of woody plant material. In the event that erosion control blankets are utilized in combination to approved seed mixes for stabilization purposes, the netting and blanket material will be 100% bio-degradable. Photo-degradable plastic or plastic netting is not permitted for ground stabilization
- If topsoil stabilizations cannot be completed within one (1) construction year's growing season, the topsoil should not be placed until the following spring. In this event, sediment controls must be in place to prevent erosion of stockpiled materials

4.8.6 Seeding

- All seed mixes are to be placed in combination with an annual rye nurse crop or suitable equivalent nurse crop and will be applied at a rate of 12 kg per hectare
- All upland areas are to be seeded using a 'Simcoe County Native Seed Mix' or seed mixture indigenous to the area and applied at a rate of 20 kg per hectare
- Shoreline Fringe and Flood Fringe areas are to be seeded using an approved 'Wet Meadow' or seasonally flooded annual/perennial seed mix which are to be applied at a rate of 20 kg per hectare
- Seed application is to follow directly after topsoil placement in order to establish vegetative cover quickly for stabilization of topsoil. Seed application should be done at a time of year to ensure the best possible germination and mitigate seed loss
- Erosion control blankets are to be placed over top of seeded areas immediately after application where required
- Contractor will insure 100% coverage and establishment within the stormwater facility throughout the warranty period

4.8.7 Guarantee Period

- All aquatics, perennials, trees and shrubs are to be guaranteed for a period of not less than one year from the beginning of the maintenance period
- If aquatics, perennials, trees and/or shrubs are found dead, diseased, missing or are deemed to be unhealthy within the guarantee period the defective plants are to be replaced and re-guaranteed for an additional two (2) years

4.8.8 Monitoring and Maintenance

- Vegetation monitoring plans and schedules are required with all landscape plan submissions which will include monitoring of the performance and effectiveness of interim measures (e.g. nurse crops) and monitoring of plant health during droughts
- Monitoring reports for will be provided to the Town from the time of the initial plant installations until the end of the guarantee period. Inspections are to take place during September of each year and are to be provided to the Town no later than October 7th of each year
- Mulch saucers should be placed and maintained around the base of trees to retain water
- Watering activities should continue for the first two years after planting

4.8.9 Alternative Landscape Treatment for Low Impact Development

The Town of Innisfil supports a Low Impact Development approach to stormwater management. Given that this is an emerging and evolving technology, the Town will review landscape design requirements on a case-by-case basis.

4.9 FACILITIES MAINTENANCE AND INSPECTION PROTOCOL

4.9.1 Operations and Maintenance Manual

Prior to final Site Plan or Plan of Subdivision approvals at the detailed design stage, a stand-alone Operation and Maintenance Manual shall be prepared for all proposed SWM facilities that identifies on-going operation protocol including inspection and maintenance issues, inspection checklists, maintenance descriptions and projected frequency, as well as recommendations for facility cleanup. The Toronto and Region Conservation Authority (TRCA) document entitled “Inspection and Maintenance Guide for Stormwater Management Ponds and Constructed Wetlands”, dated April 2018, can be used as a guide for development of the Operations and Maintenance Manual. The specific requirements that must be included in SWM facility Operation and Maintenance Manuals submitted to the Town shall include, as a minimum, the items outlined below:

4.9.1.1 Background Information

Introductory material describing the property location, including both municipal and legal descriptions, and the drainage area tributary to the facility.

4.9.1.2 Design Elements and General Description of Operation

- A general description describing the operation of the SWM facility and applicable water quality, erosion and quantity control criteria

- Indicate and describe the various design elements of the SWM facility (e.g. sediment forebay, permanent pool, extended detention and flood storage, drawdown time and how the facility operates under various storm events, inlet and outlet control structures including maintenance by-pass valve, drawdown valve and spill containment valve, if applicable)

4.9.1.3 Responsibility for Maintenance Activities

Provide details as to who is responsible for SWM facility maintenance before and following assumption by the Town.

4.9.1.4 Inspection and Maintenance Procedures

Prepare a list of key inspection items including but not limited to the following:

- Check inlet and outlet structures for accumulation of miscellaneous construction debris and other trash that may affect performance
- Check for unusually long extended detention drawdown time that could indicate a blockage in the outlet structure
- Check for sediment accumulation in the forebay and downstream of the facility
- Note evidence of seepage along the berms
- Check for vandalism including illegal access (e.g., gates) or encroachment around the perimeter of the facility
- Confirm that safety and security measures are in good working order
- Check for the presence of any unusual erosion around berms and inlet or outlet structures
- Complete visual inspection to confirm that vegetation is healthy
- Complete visual inspection to confirm no oil sheen present on water surface or the presence of other visible contaminants or odours
- Check drawdown valve and spill containment valve (if applicable) for proper operation

Provide recommended maintenance procedures for items including but not limited to the following: grass cutting around walking trails; weed control; upland and fringe plantings; shoreline fringe plantings; aquatic vegetation replanting; outlet adjustments; bathymetric survey to assess the need for sediment removal; trash removal; and winter maintenance.

4.9.1.5 Monitoring Program and Performance Evaluation

- Prepare a recommended plan for water quality monitoring that will accurately characterize the average water quality treatment provided by the SWM facility per the Lake Simcoe Protection Plan and demonstrate that it is in accordance with the MECP Certificate of Approval
- Include recommended procedure to verify the rating curve of the outlet control structure

- Provide a recommended plan to complete a SWM facility bathymetric survey to determine the quantity of sediment to be removed (if any)
- Include a list of key structures to confirm as-constructed elevations and dimensions (e.g., inlet, outlet control structure components including weirs and orifices) and proper installation (e.g., safety and security measures, vegetation, erosion protection)

4.9.1.6 Removal and Disposal of SWM Facility Sediments.

- Indicate the procedure required to dewater the permanent pool prior to sediment removal and how to divert storm flows away from the facility during maintenance operations
- Provide a sediment handling, removal and disposal plan including but not limited to the following: written notification to residents within 120 m of the SWM facility identifying maintenance works and duration; erosion and sediment control plan to prevent the release of TSS to the downstream receiver; treatment, sediment dewatering and drying techniques to be used; and the required chemical analyses to be completed in accordance with Ontario Regulation 558/00 prior to disposal

4.9.1.7 Estimated Annualized Operation and Maintenance Costs

Provide calculations of the estimated annualized operation and maintenance costs for the SWM facility. Costs should include but not be limited to the following: debris and litter removal; grass cutting and weed control (if applicable); maintenance of aquatic/shoreline fringe and upland/flood fringe vegetation; sediment testing; sediment removal and disposal; inlet/outlet structure repairs; side slope and access road repairs; and retaining wall repairs.

4.9.1.8 Primary Tables and Supporting Calculations

- SWM facility inspection checklist.
- Estimated annualized operation and maintenance costs and supporting calculations
- Sediment accumulation cleanout frequency calculations

4.9.1.9 Primary Figures and Drawings

- SWM facility location plan.
- Post-development drainage area plan tributary to the SWM facility.
- SWM facility stage-storage-discharge relationship and curve.
- General plan for the SWM facility and detailed drawings of key elements (e.g., inlet, outlet control structure, maintenance valve, spill containment valve).

4.10 POST-CONSTRUCTION REQUIREMENTS

4.10.1 Post-Construction Monitoring

At 95% build-out and after the facility has been cleaned-out, the Developer must request in writing, approval to begin the post-construction monitoring program for the Stormwater Management Pond that will eventually be assumed by the Town.

4.10.1.1 Monitoring Criteria

The purpose of the post-construction monitoring program is to ensure that the stormwater management facility, including end-of-pipe infiltration facilities, continues to satisfy the design criteria specified in the subwatershed study, SWM report, and MECP CLI ECA. It is also in place to identify any specific additional maintenance requirements and remedial works that may be necessary.

The Developer shall inspect, maintain, and monitor the stormwater management facilities as per the requirements of the SWM Report and the Town's CLI Environmental Compliance Approval (ECA). Monitoring of the stormwater management pond and reporting of the results shall be conducted in accordance with Sections 4.0 and 5.0 of Schedule E of the Town's CLI ECA.

Annual monitoring reports are to be submitted to the Town prior to January 31st of each calendar year for reporting to the MECP. At a minimum, the monitoring reports must include the requirements detailed in the Town's CLI ECA.

The post-construction monitoring program must be in place for a minimum of 5 years prior to Final Acceptance of the SWM facility.

Should the monitoring results show that the SWM facility is not functioning as outlined per the SWM Report and MECP ECA certificate, the Developer is responsible for remediating the SWM facility in order to meet the outlined objectives at the Developer's own expense.

4.10.2 Stormwater Management Pond Post – Cleanout (Final Acceptance)

Following removal of accumulated sediment, the developer's engineer shall provide a survey of the cleaned out SWM facility and provide As-Recorded SWM facility report and drawings which includes the following;

- A summary table with the design, pre, and post cleanout permanent pool volumes;
- A summary table with the design and as-recorded elevations of inlet headwall(s), outlet(s), weir(s), forebay berm inverts, emergency spillway inverts, and any other structures which are required for the facility to function as designed.
- As-recorded storage volume and discharge calculations of the entire SWM pond are to be quantified and certified by a Professional Engineer to verify conformance with the approved drawings and SWM report.
- Plan and sections of the pond which illustrate the maintenance access, hydraulic structures, and representative pond side slopes.

- The 100-year storm flow must be contained within the as-recorded pond.

Refer to Appendix G for additional as-recorded requirements for the SWM Facilities.

A geodetic monument shall be installed on the inlet headwall with the exact location and elevation included on the As-Recorded SWM Pond drawings set. The monument shall have horizontal and vertical controls in accordance with the Town's standards.

All required warning signage shall be installed with proof of installation provided to the Town via timestamped photographs.

The developer's engineer shall provide the Town with an Engineering Certification letter which confirms that all of the components of the SWM facility are in good condition and do not require repair, and have been installed in general conformance with the approved SWM Facility design and final approved drawings. The additional information should be included in a package to the Town:

- The approved SWM Facility Report;
- All approvals associated with the SWM facility and associated infrastructure (e.g. outfall headwalls to the natural environment) shall be provided to the Town. Approvals should include the Ministry of Environment, Conservation and Parks (MECP), Environmental Compliance Approval (ECA), formerly called Certificate of Approval (COA), LSRCA Ontario Regulation 179/06 (works within a regulated area); possibly Ministry of Natural Resources and Forestry; and/or Fisheries and Oceans Canada (DFO).

The developer shall provide the Town with a Landscape Certification letter which confirms that all of the plantings associated with the SWM facility are in good condition and do not require replacement, and are in general conformance with the approved landscape plans. The additional information should be included in a package to the Town:

- The final approved Landscape plans associated with the SWM facility;
- All approvals associated with the landscape plans.

The Town reserves the right to request modifications to the SWM pond if it is determined that the pond is not functioning as per the accepted design.

4.11 WATER QUALITY TREATMENT UNITS

4.11.1 Oil/Grit Separators (OGS)

Oil/grit separators are most appropriate for commercial/industrial land use and shall not be used as a standalone Stormwater Management Plan, but rather part of a "treatment train" approach to achieve the required water quality treatment. Oil/grit separators typically serve drainage areas under 2 ha and are predominantly encouraged by the Town to be used for spill control. Oil/grit separators are also appropriate for providing water quality control for redevelopment, or infill areas which typically have space limitations and where a stormwater management pond is not practical. Oil/grit separators should not be used as a substitute for an end of pipe SWM facility forebay. Standards as outlined by the LSCRA for OGS units will be applied.

Supporting calculations and anticipated maintenance requirements shall be provided to the Town along with certification of the design by a Professional Engineer. Additional documentation may be required on a case-by-case basis.

Design for an OGS shall use the OGS Review Sheet available at the Sustainable Technologies Wiki site using the analysis interval closed to the time of concentration and Barrie RG3 rainfall data. The target quality is 60% TSS removal.

4.11.2 Roof Top and Parking Lot Storage

The use of rooftop and parking lot storage for stormwater management has some challenges. The two issues would be the potential for flood damage to private property and the continual functioning of such devices if on-site controls are altered after construction (e.g. rooftop flow control inadvertently removed).

The use of roof top or parking area to provide peak flow control is generally not preferred, and shall be considered on a site specific basis by the Town through pre-consultation. On-site controls should generally be avoided on school sites and other sensitive institutional uses. Water quality and quantity controls in new development areas should be provided in Township-owned municipal blocks or easements.

4.11.3 Roof Top Storage

When used, flat roofs may be used to store runoff to reduce peak flow rates to storm sewer systems to mitigate the need for downstream storm sewer size increases. Per the SWMPD Manual (MOE, 2003), rooftop storage can typically store 50 mm to 80 mm of runoff subject to the roof loading design. Detention time is typically between twelve (12) to twenty-four (24) hours.
Supporting calculations and design drawings must be provided to indicate the following:

- The total number and location of proposed roof drains and emergency overflow weirs
- The type of control device proposed (i.e. product name and manufacturer). Tamper proof devices are preferred where feasible (provision of shop drawings required)
- Unless otherwise deemed appropriate by the Town and/or CA, a maximum flow rate of 42 L/s/ha of roof area
- Product specifications (i.e. design release rates for identified control devices)
- Emergency overflow weirs shall be provided at the maximum design water level elevation
- The maximum ponding depth, storage volume, and drawdown time for roof top storage during the 2-yr through 100-yr design storms
- Roof top control devices may require registration on title as part of the Site Plan Agreement and/or Subdivision Agreement)
- Certification from the structural and mechanical engineers that the roof structure and vertical drain pipes are designed to account for the roof top storage.

4.11.4 Parking Lot Storage

Since vehicles may be flooded, with water entering the passenger compartment at depths of less than 0.3 m, the use of parking lot storage represents a significant liability risk. Where other options for stormwater management practices exist, it is the preference of the Town that alternatives to parking lot storage be used. Should parking lot storage be supported, the following conditions must be met:

- Parking lot storage may require registration on title as part of the Site Plan Agreement and/or Subdivision Agreement) to ensure they are properly maintained and cannot be removed or altered during future site alterations without the provision of adequate alternative storage
- The site owner is responsible for all liability related to the proposed parking lot storage system, including all damages resulting from the designed operating conditions and any downstream damages resulting from removal, modification or lack of maintenance to on-site controls;
- Parking lot storage must be controlled by pipe size reductions within the storm sewer network and not through the use of orifice plate restrictors to a minimum size of 100 mm
- Surface ponding is only allowable during storm events greater than the 1:5-year design storm
- The maximum allowable ponding depth within the parking lot is to be limited to 0.3 m; however, maximum ponding depths of 0.2 m are preferred
- The 100-year ponding elevation and storage volume provided at each ponding location must be shown on the design drawings
- An emergency overflow system and overland flow route must be provided to allow all runoff exceeding the 100-year storage to be safely routed from the site to a suitable outlet (i.e. municipal R.O.W.) This flow route must be shown on an engineering plan

4.12 END-OF-PIPE CONTROLS

End-of-pipe control facilities shall provide the required quantity and quality control in accordance with the governing guidelines which are currently documented in the Ministry of the Environment's Stormwater Management Planning and Design Manual (MOE, 2003), unless otherwise specified below by the Town.

The planning and design of each pond shall also focus on opportunities to integrate the pond with the surrounding topography and land uses. Ponds are to be created as public amenity features and are to be safe, significantly visible and accessible to the general public. Opportunities for linkages through the use of trails to larger open space, floodplain areas or other SWM facilities are to be maximized.

4.12.1 Wet Pond with Extended Detention

Wet ponds are typically the preferred end-of-pipe control facility for drainage areas greater than 5 ha. Wet ponds shall be designed in accordance with the governing guidelines unless otherwise specified in the Town's guidelines.

4.12.2 Wetland with Extended Detention

A constructed wetland is an acceptable stand-alone end-of-pipe control facility. Constructed wetlands shall be designed in accordance with the governing guidelines unless otherwise specified in the Town's guidelines.

4.12.3 Hybrid Wet Pond / Wetland with Extended Detention

A wet pond / constructed wetland hybrid is an acceptable stand-alone end-of-pipe control facility. Hybrid wet ponds / constructed wetlands shall be designed in accordance with the governing guidelines unless otherwise specified in the Town's guidelines.

4.12.4 Dry Pond with Extended Detention

Dry ponds servicing development larger than 5 ha will not be permitted unless Low Impact Development has been designed to infiltrate the runoff from the 25mm storm event. Dry ponds for smaller development may be used as a part of a treatment train approach provided that an enhanced level of water quality treatment is achieved.

4.12.5 Infiltration Basin

In general, infiltration basins shall not be accepted as a stand-alone end-of-pipe facility, unless as part of a treatment train approach or as an additional feature. Infiltration basins shall not be permitted for drainage areas > 5 ha.

4.12.6 End of Pipe Water Depths

Maximum water depths for various end-of-pipe SWM facilities shall follow the recommendations in the latest version of the MECP Stormwater Management Planning and Design Manual, Preferred Criteria.

4.12.7 Maintenance Access

Maintenance access roads are required to all inlet and outlet structures, sediment forebays, sediment drying areas (if applicable), and emergency spillways associated with the stormwater management facility. Co-location of access roads with trails shall be implemented wherever possible. Where feasible, two access points shall be provided from the municipal road allowance such that the access road is looped to key hydraulic features. In situations where this is not practical, dead end access roads shall be designed with a hammerhead turning area consisting of a minimum hammerhead width of 17.0 m and a 12.0 m centerline turning radius, however this option is not ideal.

Where the access road enters the forebay below the NWL, the forebay ramp shall be constructed consistent with the lining of the bottom of the forebay or as recommended by a geotechnical engineer. Minimum width of 4.0 m and a maximum grade of 10% should be used. Ramp access should favour "green" solutions.

The access roads shall provide for all-weather ingress and egress with a minimum width of 4.0 m and a maximum grade of 3%. The maintenance access road shall consist of 50 mm HL4 with a minimum base of 300 mm of compacted Granular "A"(19mm CRLS) which extends 0.5 m on either side of the paved surface. The access road must have a 3m buffer to the adjacent private property. Curves on all access roads shall have a minimum centerline radius of 12.0 m. Maintenance access roads shall be set a minimum of 300 mm above the Regulatory pond water level. For industrial developments, the Town may consider an alternative pavement structure for the SWM Pond maintenance access route.

At locations where overland inlet flow routes or the emergency spillway cross the maintenance access, reinforcing measures shall be incorporated to strengthen the access route to carry truck loading and permit bike/stroller crossing.

4.12.8 Berming

Berms around wetlands and wet ponds shall be designed with a minimum top width of 3.0 m (where trails and access roads are not located) with a 3:1 maximum side slope on the outside. The core of the berms shall be constructed with engineered fill on the basis of the recommendations of a licensed geotechnical engineer. Topsoil is not permitted for berm construction except as a dressing to support vegetation on the top of the core.

For pond berms exceeding 2.0 m in height from the top of the berm to the toe of slope, the berm must be designed by a qualified professional engineer in accordance with the latest edition of the Ontario Dam Safety Guidelines (MNR).

4.13 EROSION AND SEDIMENT CONTROL

Sediment control measures have been required on construction sites for several decades, however, even on sites where recommended practices are applied, sediment continues to be discharged at concentrations above those required to protect aquatic life. It is important to consider that effective erosion and sediment control must move beyond the installation of devices such as silt fence and move towards an ongoing “process” within a project framework - from conception to construction.

A complete ESC plan includes the following:

1. Erosion and Sediment Control (ESC) Plans (report and drawings)
2. Spill Control and Response Plans
3. Inspection and Maintenance of ESC
4. Performance Monitoring and Reporting

This section presents the minimum criteria for the design of some commonly used erosion and sediment controls. For additional information and/or information on control options that have not been included in this section, please also refer to the latest revision of the Ministry of the Environment (MOE) *Stormwater Management Planning and Design Manual*, the Nottawasaga Valley Conservation Authority *Development Review Guidelines*, the Lake Simcoe Region Conservation Authority *Watershed Development Policies*, and the Greater Golden Horseshoe Area Conservation Authorities *Erosion and Sediment Control Guidelines for Urban Construction*.

Every control measure and all control plans must meet or exceed the specifications set out in these documents and must be designed to achieve adequate performance at all times. At final design submission, a stand-alone ESC report is required as outlined in the Greater Golden Horseshoe guidelines so that copies can be provided to all staff responsible to ESC on the construction site. The ESC report will include the following:

a) Project Description
b) Conditions of Existing Site
c) Condition of Existing Receiving Water
d) Adjacent Areas and Features
e) Soils
f) Critical Areas

g) Permanent Stabilization
h) Design Details of ESC Measures
i) Record Keeping Procedures
j) Stockpile Details
k) Emergency Contacts
l) Stamped and Signed Report

A complete application submission requires ESC drawings that work with the ESC report to form a complete ESC Plan. The ESC Drawings should include the following:

a) General Items
b) Existing Contours
c) Existing Vegetation
d) Water Resources Locations (lakes, rivers etc.)
e) Regional Storm Floodplain and CA Regulated Areas
f) Critical Area
g) Proposed Contours/Elevations
h) Site Boundary Limits
i) Existing and Proposed Drainage Systems
j) Limits of Clearing and Grading
k) Stockpiles and Berm Data
l) ESC Measures Locations and Details
m) Stormwater Management Systems
n) Stormwater Discharge Locations
o) Access Road
p) Internal Haul Road
q) Construction Phasing and Scheduling
r) Inspection and Maintenance
s) Signed and Stamped Drawings

The ESC controls should be designed using a phased approach whenever feasible to minimize the exposed area of the site at any given time. The ESC report should lay out the various phases of construction and any changes or additions to the ESC systems for each phase. Erosion prevention is the preferred mitigation measure for eliminating and/or reducing the potential for sedimentation. Topsoil stripping should be conducted in a logical sequence in order to minimize the areas where soil is exposed. Any areas that are scheduled to remain exposed for longer than thirty (30) days should be protected with vegetative cover. The method used to establish vegetative cover will vary depending on the soil type, site grading and time of year.

This section presents the minimum criteria for the design of some commonly used erosion and sediment controls. For additional information and/or information on control options that have not been included in this section, please also refer to the latest revision of the Ministry of the Environment and Climate Change (MOECC) *Stormwater Management Planning and Design Manual*, the Nottawasaga Valley Conservation Authority *Development Review Guidelines*, the Lake Simcoe Region Conservation Authority *Watershed Development Policies*, and the Greater Golden Horseshoe Area Conservation Authorities *Erosion and Sediment Control Guidelines for Urban Construction*.

Every control measure and all control plans must meet or exceed the specifications set out in this document and must be designed to achieve adequate performance at all times.

The controls should be designed using a phased approach whenever feasible to minimize the exposed area of the site at any given time. There must also be a contingency plan for repair, replacement and upgrading of control measures as required to achieve adequate performance at all times.

4.13.1 Runoff Control

The development of the control plan shall examine concentrated runoff from adjacent areas that will pass through the site and shall provide for the diversion of the runoff around disturbed areas. If this is not possible, the runoff shall be directed into armoured channels flanked by silt fencing with appropriate low point protection and shall outlet into a treatment facility prior to discharge.

For sites where sediment control ponds are not being proposed, sediment control fences and cut off swales/channels or equivalent control measures shall be placed along all down gradient boundaries of the site.

For sites adjacent to existing residential areas, a cut-off swale/channel shall be placed around the entire perimeter of the site to prevent drainage onto private lands. A 3.0 m wide buffer strip and/or sediment control fence shall be provided along the perimeter of the down gradient boundaries of the site.

4.13.2 Temporary Sediment Control Ponds

Temporary sediment control ponds are required for any project that has a construction area greater than 5.0 ha.

The location of the pond(s) shall intercept runoff from the entire disturbed area unless other controls are implemented, in conjunction with the pond, to ensure that adequate performance is achieved for the entire area.

In general, the pond shall consist of a:

a) Permanent pool to contain accumulated sediment and post-storm waters;
b) Water quality treatment volume that allows for settlement of suspended sediment from storms; and
c) Forebay to quiet incoming flow if the construction project is anticipated to take place over more than one year.

The required active storage volume shall be designed with a minimum of 125 m^3/hectare of contributing area.

The required permanent pool volume shall be designed with a minimum of 125 m^3/hectare of contributing area.

The draw down time shall be a minimum of twenty-four (24) hours, or as required by the governing Conservation Authority.

The outlet works shall consist of a perforated riser system, with a minimum orifice diameter of 75 mm.

The forebay shall be designed with a minimum depth of 1 m, a maximum volume of 20% of the permanent pool, have a stable bottom to allow mechanical clean out, and incorporate sediment depth indicators.

The overall pond shall be designed with a minimum depth of 1.0 m, a maximum depth of 2.5 m, maximum side slopes of 4:1, and an emergency spillway sized to safely convey the 1:100 year storm event from the contributing area.

4.13.3 Silt Fences

Silt fence is to be installed on the perimeter and on the up-gradient side of sensitive areas, streams and rivers, and at the base of slopes. It should not be used in areas of high flows.

When silt fence is proposed, it shall be:

a) Aligned with site contours;
b) A minimum above grade height of 900 mm with a minimum of 300 mm of the fabric toed into the ground.
c) Constructed of suitable woven UV stabilized fabric (with a weave density of 270R or greater) fastened with wire fasteners to 150 mm page wire fencing or acceptable equivalent.
d) Supported by steel T bar fence posts with a separation distance of no more than 2.5 m.
e) Accompanied by a vegetative buffer strip on the down gradient side.

4.13.4 Vegetative Buffer Strips

Vegetative Buffer Strips shall be provided between the site alteration area and every down gradient protected area. They shall be protected from up gradient erosion by silt fences and shall consist of established vegetation that is growing, whenever possible, on undisturbed soil. They are to be a minimum of 3.0 m wide between the perimeter of the property and a disturbed area and a minimum of 15.0 m wide between surface water and a disturbed area. Additional width may be required if the adjacent surface water is classified as a cold water source.

4.13.5 Non-Vegetative Buffer Strips

Non-Vegetative Buffer Strips shall be installed where there is not a minimum undisturbed area of established vegetation down gradient of the site alteration area. They shall be a minimum of 2.0 m wide between the perimeter of the property and a disturbed area and a minimum of 15.0 m wide between surface water and a disturbed area.

A second silt fence must be installed no closer than 1.0 m to the primary silt fence and there must be space provided for access to clean out trapped sediment and complete any repairs to the fence.

4.13.6 Channel Low Point Protection (Stone Silt Traps)

Channel Low Point Protection Devices shall be constructed in channels and ditches that will contain concentrated flows to reduce the velocity; thereby reducing erosion of the sides and invert. They shall be designed as follows:

a) So that the crest of the downstream device is at the same elevation as the downstream base of the device further upstream;
b) With 100 mm to 150 mm diameter rip rap, wrapped in geotextile fabric, from the invert of the channel or ditch to a maximum of 250 mm below the top of the channel or ditch;
c) With a downstream slope not to exceed 4H:1Vand an upstream slope not to exceed 1.5H:1V;
d) With a 2.5 m long excavated sediment trap approximately 600 mm in depth at the upstream face.

4.13.7 Construction Access Mats

Construction Access Mats shall be installed at all exits from the site and shall be designed and maintained to remove most of the sediment accumulated on vehicle tires. They shall be designed as follows:

a) 300 mm of 50 mm – 100 mm clear limestone placed on a geotextile fabric suitable for allowing ex-filtration of water and preventing the quarry stone from becoming contaminated with the substrate soil (Terrafix 270R or approved equal).
b) To be a minimum of 6.0 m in width and extend a minimum of 30 m onto the site.
c) To be flanked by silt fences and vegetative buffers from the property line to the
d) t of any on-site roadways (refer to TOISD 505 for the detailed drawing).

4.13.8 Topsoil and Spoil Pile Management

Topsoil and spoil piles shall be designed such that they are not in low areas of a site where water may accumulate and they must be surrounded by one or more silt fences.

Any piles containing more than 100 m^3 of material shall be a minimum of 15 m from a roadway or channel.

If topsoil or spoil piles are to be left in place for more than sixty (60) days, they shall be stabilized by mulching, vegetative cover, tarps or other equivalent means.

4.13.9 Drain Inlet and Catchbasin Protection

Protection of all potentially affected storm drain inlets and catchbasins shall be accounted for in the design.

Filter cloth protection may be used over the catchbasin inlet where ponding of water will not occur and where traffic will not affect the filter cloth. In all other cases, catchbasin inserts shall be used constructed of filter cloth with or without a metal support structure.

4.13.10 Site Dewatering/Discharge

Effluent from site dewatering operations must not discharge directly into receiving bodies of water or streams.

Water pumped from the site shall be treated by control devices such as a sediment control pond, grit chambers, sand filters, upflow chambers, swirl concentrators or other appropriate controls, and must not contain particles more than 40 microns in size, or more than 100 mg/L of suspended solids.

In instances where construction water is to be discharged into the natural environment or conveyed to a municipal storm or sanitary sewer system, a groundwater sample shall be obtained from the dewatering system prior to the initial discharge. This sample must be collected following the implementation of any pre-treatment processes.

The sample shall undergo laboratory analysis to determine the presence and concentration of metals, petroleum hydrocarbons (PHCs), volatile organic compounds (VOCs), and inorganic constituents.

Analytical results must demonstrate compliance with the applicable regulatory standards, including the Provincial Water Quality Objectives (PWQO) or the Town of Innisfil Sewer Use By-law 062-21, as appropriate

4.13.11 Other Erosion & Sediment Control Features

The Town will consider Erosion and Sediment Control measures not listed in the Town's Standard on a case-by-case basis.

4.14 SALT MANAGEMENT

Road salt application is necessary to provide safe conditions during the winter on roads, parking lots and sidewalks, however it is a major source of sodium and chloride ions in the environment. Many studies have shown that road salts have a negative impact on the receiving environment and urban infrastructure. Reducing the need for salt use through design of parking lots and road along with better application practices will help to minimize the impacts. Development must submit a salt management plan at the detailed design.

4.14.1 Salt Management Plan

The main objective of a SMP is to ensure environmental protection while maintaining safe roadway and parking lot to the public. A SMP is intended to set out a policy and procedural framework for ensuring that site owners continuously improve the management of road salt used in winter maintenance operations. A SMP for a development should consist of the following components:

- Establish effective operating procedures (e.g. snow storage/disposal, plow routes, minimum required equipment etc.)
- Identify ice control products
- Recommend/establish effective salt application rates
- Establish a benchmark to assist the site owners to assess/mitigate their onsite use of road salt and the impact to the natural environment

- Training program
- Record keeping protocol

The SMP for private sites should consist of a letter, report or technical memorandum that address the required content and a Site Plan drawing of appropriate scale. The site plan drawing must include:

- North arrow and scale
- Building footprint including all entrances and exits and locations of all downspouts
- All parking areas
- Sidewalks and all wheelchair access areas
- Vegetated areas
- Site entrances and exists
- Stormwater management collection system
- Snow pile storage areas
- Any winter maintenance material storage areas
- Any sensitive areas to salt
- Municipal maintained areas

4.14.2 Parking Lot Design

4.14.2.1 Snow Pile Storage Location

Snow piles on parking lot that are not designed with winter maintenance and salt management in mind can lead to significant application of additional road salt as well as cause further adverse impacts to the local environment. Melt water from snow piles must be collected as close to the piles as possible to limit the travel distance and potential for refreeze. Snow piles can be a significant source of road salts and other typical road runoff pollution source. Therefore, special attention must be given to the water quality treatment solution for snow pile runoff.

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.

- 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.
- Parking lots should be graded such that meltwater runoff from snow storage piles is transported away from high traffic areas.
- It is suggested to plan for a snow pile storage volume range of 500 to 1,500m3 per hectare of parking lot (LSRCA, 2017). 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 (trucks with plow attachments), provide a snow storage area equivalent to 10% of the total area to be cleared on site. If specialized snow removal equipment is available, the snow pile heights will increase (safety permitting) and the required snow storage area will decrease.

- 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.).
- 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).
- Oil grit separators, vegetated filter strips and grassed swales (planted using salt tolerant vegetation) may be included downstream from snow disposal areas to attenuate runoff and reduce suspended solids, metals and petroleum hydrocarbon loads in parking lot runoff.
- 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.
- 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.
- Snow storage piles should be staged in areas which receive large amounts of solar radiation to promote more efficient melting.
- 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.
- 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.
- 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.
- Snow storage shall not be located in any SWM facility, swale, or low impact development (“LID”) feature.

4.14.2.2 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.

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.

- Planners should verify that the number of sidewalks for the specific building/location is suitable for pedestrian traffic. 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.
- 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.
- 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. And where secondary sidewalks are required, consideration to temporary closing these during the winter months can lead to the reduction of salt application requirements.
- Partially covered walkways (i.e. overhang) can be eliminated and centralized fully covered walkways and main building entrances can be used where practical. Ensure that runoff from covered walkways is directed to appropriate stormwater management facilities, and not allowed to drain onto paved surfaces.
- 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).
- Snow storage locations for walkway clearing should be located to prevent melt water draining back over the walkway.

- 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.
- For mobility concerns, sidewalk plowing near transit stops should be a priority.
- 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.
- By placing the building entrance near the road way, the length of sidewalk needed for primary pedestrian traffic walkways would decrease.
- Consider the use of heated walkways in front of the building. Heated entrances could limit the amount of salt applied.
- Where possible, pedestrian walkway design should consider plow routes.

4.14.2.3 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

Although vegetation varies in its reaction to salt-affected soils, salt generally reduces the ability of the roots of the plant to take up water and nutrients by impeding uptake of moisture from soil with salt-laden water. This phenomenon essentially mimics drought conditions for the plant. If salt is sprayed onto plants from automobile traffic it can reduce cold hardiness in buds and new twigs, which may then become more susceptible to freezing, mortality or deformation. Road salt can also be directly toxic to plants; the dissolved sodium and chloride ions separate, and the chloride ions can reach toxic levels as they are absorbed into roots and then build up in the leaves.

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.

- 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.

- Curb cuts can be installed around the perimeter of the parking lot to promote drainage into landscaped areas.
- 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.
- All vegetated landscaping features should be composed of salt tolerant vegetation, 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.
- Bioswales should be installed in well-drained soils, or should include underdrain systems when installed in poorly drained soils (CVC and TRCA, 2010).
- 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.
- During winter months, burlap can be used to protect trees and vegetation from damage.
- 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.
- Using raised planters can also protect vegetation from being exposed to increases in salt.

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. A list of salt tolerant plant species for parking lot design can be provided upon request.

4.14.2.4 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 underdrain 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.

4.14.2.5 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.

4.15 DE-ICING CHEMICALS

Several de-icing products are available in either liquid or solid form. The most commonly employed de-icing chemicals are chloride-based salts, but acetate-based deicers have also been used on winter roads. Airport de-icing operations typically use acetates and glycols for their pavements and aircrafts due to the corrosive nature of chloride-based salts. A brief summary of the most common liquid and solid de-icing chemicals are provided below.

4.15.1 Sodium Chloride

Sodium chloride is a naturally occurring mineral and is the most commonly used de-icing chemical. Sodium chloride has a practical working temperature as low as -9.4°C and a eutectic temperature of -21°C at a mixture of 23.3% by weight in solution with water; however, it is generally considered ineffective below -17°C. Typical application rate of 113 to 142 kg per 2-lane km is used and costs approximately $27-91 per tonne. Sodium chloride is generally readily available, easy to store, handle and distribute.

Sodium chloride is highly mobile and can have adverse effects on vegetation, soil, aquatic species, wildlife, and water quality. Sodium chloride is also known to cause corrosion and other damages to vehicles and infrastructure

4.15.2 Calcium Chloride (CaCl2)

Calcium chloride in its natural state is a synthetic liquid brine solution but can be found as solid flakes. Calcium chloride is more effective as a de-icing chemical than sodium chloride and works at lower temperatures (practical working temperature -31.6°C and eutectic temperature of -51.1°C at a mixture of 29.8% by weight in solution with water). Recommended application rates are 28 to 55 kg per 2- lane kilometer and cost approximately $110-270 per tonne.

Calcium chloride is known to have similar negative environmental impacts as sodium chloride, however, it is more corrosive to metal.

4.15.3 Potassium Chloride (KCl)

Potassium chloride is a common fertilizer and is less effective than sodium chloride ad calcium chloride. It has a practical working temperature of -3.8°C and a eutectic temperature of -11.1°C at a mixture of 19.8% by weight in solution with water. Potassium chloride costs are similar to sodium chloride per tonne. Potassium chloride is slightly less toxic to vegetation and aquatic species but is slightly more corrosive to infrastructure than sodium chloride.

4.15.4 Magnesium Chloride (MgCl2)

Magnesium chloride in its natural state is a synthetic liquid brine solution but can be found as solid flakes. It is only approximately 48% active. It has a practical working temperature of -15°C and a eutectic temperature of -33.6°C at a mixture of 21.6% by weight in solution with water. Magnesium chloride costs approximately $90 per tonne and has similar effect on the environment and corrosion.

4.15.5 Calcium Magnesium Acetate (CMA)

Calcium Magnesium Acetate (CMA) is a synthetic powder but can also be found in liquid form. It has a practical working temperature of -6°C and a eutectic temperature of -27°C at a mixture of 32.5% by weight in solution with water. CMA does not work by melting snow and ice, rather it turns it into a slush. Therefore, CMA must be combined with plowing activities and applied to prior to or near the onset of a winter storm event to function well in winter maintenance. CMA is a biodegradable substance and there is no evidence that it has an adverse impact on the environment. However, some studies have identified the potential for CMA to decrease dissolved oxygen as it decomposes. CMA is less corrosive to infrastructure than sodium chloride.

CMA is typically used in powder form and as such difficult to handle and store (as it is less dense than sodium chloride and requires approximately 60% more space). CMA has also been known to cause skin irritation. CMA is typically applied at approximately 70 to 113 kg per 2-lane kilometer and costs $550-1,800 per tonne.

4.15.6 Potassium Acetate

Potassium acetate is typically found in liquid form but can be found in solid form. It is generally considered to perform better than CMA. It has a practical working temperature of -26°C and a freezing point of -60°C.

It is biodegradable and non-corrosive, but as it decomposes to potassium and acetate which exerts a slight Biological Oxygen Demand (BOD). Potassium Acetate must be kept in a clean sealed container or it can prematurely biodegrade. Potassium acetate costs approximately $550-1,100 per tonne.

4.15.7 Urea Co (NH2)

Urea is a common synthetic fertilizer comprised of ammonia and carbon dioxide, which is typically found in pellet or liquid form. Urea is less active than sodium chloride and calcium chloride. It has a practical working temperature of -3.8°C and a eutectic temperature of -11.6°C.

Urea can lead to eutrophic condition in water and as it degrades it converts to ammonia, which is toxic to aquatic life. Urea is less corrosive than chlorides.

Urea is typically applied at 113 to 142 kg per 2-lane km and costs approximately $180 per tonne.

4.15.8 Sodium Formate (HCOONa)

Sodium formate is a waste by-product and found in solid form. It has a similar performance as sodium chloride, with respect to de-icing speed, temperature range and longevity, but it has a eutectic point of -18°C. Sodium formate has similar environmental impacts with regards to sodium ions (i.e. can damage soil structure and contributes to roadway vegetation burn). However, it is a non-corrosive material and costs approximately $180-320 per tonne.