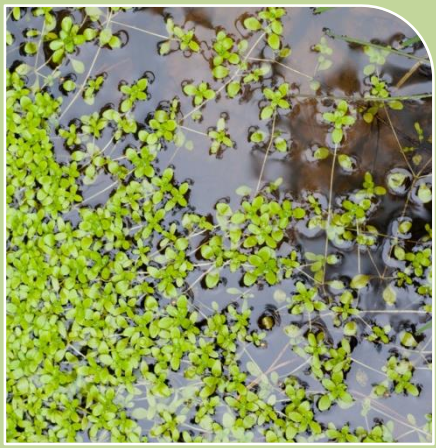
Landscape Design Guidelines for Stormwater Management Ponds



TORONTO

September 2015

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Landscape Design Guidelines for Stormwater Management Ponds

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Introduction

We have written *Landscape Design Guidelines for Stormwater Management Ponds* for City of Toronto staff and consulting engineers. The purpose of this guideline is to ensure there is consistency in our approval and construction practices. Clients—that's you—want to be instructed in the same way each time you come to us, regardless of which office you may visit. This guideline will help ensure that the information provided by staff is the same in all offices.

This guideline is written for City staff and consulting engineers working on preparing a landscaping plan for stormwater ponds for public or private developments.

This guideline takes you step by step through all the criteria you will need in preparing a landscape design for a stormwater management pond. If you are going to be preparing a landscaping plan for a stormwater pond in the city of Toronto, this guideline is for you.

This guideline is available in both print and online formats.

What This Guideline Contains

Chapter 1 – Preface – covers the purpose of vegetation for stormwater ponds and the objectives of this manual.

Chapter 2 – Landscape Design Guidelines – covers landscape concepts, design components, landscaping zones, inlet and outlet structures, cooling trenches, spillway, maintenance access road, algae control and public safety

Chapter 3 – Design Review and Pond Assumption Procedure – covers submission requirements, approval process, assumption process, inspection and maintenance activities, monitoring requirements and post assumption.

Appendix A – Acceptable Plant Species for Stormwater Management Ponds – contains acceptable plant species for tree, shrub, herbaceous, submergent, floating, robust emergent, broadleaved emergent and narrowleaved emerget plant types for stormwater ponds.

Appendix B – Wet Ponds: Summary of Design Guidance – contains a list of design elements necessary for the operational success of a wet pond.

Appendix C – Pond Warning Sign – contains a standard drawing on the placement of a pond warning sign on a steel post at a stormwater pond.

Appendix D – Bibliography – contains a listing of stormwater pond design guidelines and criteria published from current City departments, former cities of Toronto, and other neighbouring cities.

Glossary – an alphabetical list of technical terms relating to landscape design of stormwater ponds and their definitions.

Index – an alphabetical list of topics, keywords and synonyms used in this manual.

Acknowledgments

I must thank the working group for your active participation and contributions to this design guideline, which without your knowledge and experience, this document could not have been written:

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Thank you!

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Chapter 1 – Preface

Toronto City Council adopted the Wet Weather Flow Master Plan (WWFMP) and a 25-Year Implementation Plan in 2003. The goal of the WWFMP is to reduce and ultimately eliminate the adverse impacts of wet weather flow, which is runoff generated when it rains or snows, to protect our environment and improve the ecosystem health of the watersheds. The plan was developed with the recognition that wet weather flow will be managed on a watershed basis accompanied by a preferred hierarchy of solutions starting with "at source", followed by "conveyance," and concluding with "end-of-pipe."

End-of-pipe stormwater management facilities receive stormwater from a conveyance system and discharge the treated water to the receiving waters. Some examples of end-of-pipe stormwater management facilities include:

- wetponds
- wetlands
- dry ponds; infiltration basins

Stormwater management ponds are the most common end-of-pipe stormwater management facility, and are reliable in operation, over a range of different storm events. The City currently maintains about 85 retention and detention ponds for the purposes of stormwater management. Retention ponds, also commonly called wet ponds refer to facilities that maintain a permanent pool, while detention ponds, often called dry ponds contain stormwater only in the aftermath of significant rainfall events. A detention pond will hold the water for a short time and then slowly release it, normally within 24–48 hours. The design of these stormwater management ponds is subject to the approval of the Ministry of the Environment and Climate Change and must meet the requirements of the Ministry's *Stormwater Management Planning and Design Manual*.

Stormwater management ponds are usually constructed when a new subdivision is created. The City and Toronto Region Conservation Authority (TRCA) have site-specific requirements for new developments to control and reduce the peak rate of stormwater runoff from the subdivision so as not to cause flooding downstream and also improve the quality of the stormwater runoff by removing sediments. Stormwater ponds are one of the end-of-pipe solutions for meeting these requirements and therefore most of the existing ponds were built by developers and later assumed by the City. In recent years, the City

has also built several stormwater management ponds as retrofits to improve the quality of stormwater discharge from existing neighbourhoods.

Landscape Design in Stormwater Management Ponds

Vegetation is an integral part of many stormwater management facilities including ponds, wetlands, vegetated filter strips and bioretention filters. Vegetation takes up nutrients, and in wet facilities, it promotes settling by reducing flow velocities and preventing re-suspensionof sediments. Vegetation can also be utilized in the design of stormwater management facilities to achieve the following:

- Intercept rainfall and airborne pollutants.
- Filter out coarse sediments.
- Trap and accumulate floatables.
- Reinforce the structure of spreaders, weirs and retaining walls.
- Impede colonization by undesirable invasive species.
- Conceal fencing and structures.

In addition to water quality improvement, other benefits of utilizing vegetation as part of stormwater management facility design include:

- stabilization of banks, shoreline and slopes
- mitigation of effects on temperature and dissolved oxygen
- deterrence of geese
- provision of barriers to improve public safety
- enhancement of linkages
- provision of aesthetic benefits

Although constructed stormwater management ponds are not natural, they can be landscaped to look natural and are often used as habitat by migrant birds and animals. When they are located close to parks or vegetated areas, they should be integrated as naturally as possible into those areas. To provide for public safety, a variety of design features and safety measures should also be incorporated into the site-specific landscape design to mitigate risks.

The preferred approach is to consider the landscape as an component and recognize that elements of the landscape are effective functional design tools that can also be employed to achieve the stormwater management objectives. The application of this approach requires the efforts of a multi-disciplinary design team, working in collaboration to

explore solutions that integrate planning, engineering and landscape architecture.

Therefore, at the site-specific scale, the design of the landscape should be a key parameter that contributes to the successful integration of stormwater management facilities as amenities within the community's open space system. As a result, the site-specific landscape not only defines the visual character of the facility, but also contributes to functional performance in terms of operation and maintenance, public safety, contaminant removal, and other environmental benefits.

Purpose of the Document

The objective of this document is to identify acceptable standards on physical design, maintenance and monitoring of landscapes at a site-specific level, for stormwater management ponds in the City of Toronto. These facilities will ultimately achieve optimal functional performance while becoming valued community assets. For example, it will identify acceptable standards and requirements for side slopes, maintenance access, plant types, paths and fencing.

This document was prepared jointly by staff from Toronto Water, Engineering & Construction Services and Parks, Forestry & Recreation divisions. The design guidelines will be used in the review and approval of stormwater management ponds proposed by developers to meet City stormwater management requirements. The guidelines are intended to be used in conjunction with the *Stormwater Management Planning and Design Manual* prepared by the Ministry of the Environment, the City of Toronto's *Wet Weather Flow Management Policy and Guidelines*, and the *Guiding Principles for Infrastructure Review* prepared by Toronto Parks, Forestry & Recreation to guide practitioners in the process of developing stormwater management strategies and planning and designing stormwater management ponds.

Note that this guideline is not intended to deal with the hydraulic or hydrologic design of a storm water management pond. The *Stormwater Management Planning and Design Manual* and *Wet Weather Flow Management Guidelines* are the major reference documents for the stormwater management pond engineering design.

The guidelines present a general framework of the City's expectations of approval requirements on landscape design for stormwater management ponds and are not meant to restrict creative solutions. The City recognizes that flexibility is important to accomodate site-

specific conditions. As a result, the City may consider any innovative approach if it can be demonstrated that the approach can achieve the required performance objectives.

Chapter 2 – Landscape Design Guidelines

Landscape Design Concepts

Stormwater management ponds are the most common end-of-pipe stormwater management facility used in Toronto. Its main functions are stormwater quantity control and quality control to prevent a community from flooding and watercourses from becoming polluted. With appropriate design on landscaping, stormwater management ponds can also benefit the community. The landscape and grading design has to allow for maintenance and management of the pond over its lifetime. Issues to consider are collection of trash, maintenance of plants and dredging of sediment. The following sections describe the main concerns that should be addressed through landscape design.

The landscaping design for stormwater ponds shall consider the following factors:

- stabilization of shoreline
- mitigation of effects on temperature and dissolved oxygen
- deterrence of waterfowl such as geese
- barriers to public access and public safety
- enhancement of linkages
- community benefits

Example of landscaping of a stormwater management pond

Stabilization of Shoreline

Vegetation cover can play an effective role in preventing bank erosion at SWM ponds in two ways: (1) by increasing bank stability; (2) introducing shade.

In addition to buffers, the soils from the eroding forces of nature for instance, water and wind, the root systems of many species of trees, shrubs and herbaceous plants effectively bind soils to establish a layer that is resistant to surface erosion. Other features, such as outlet channel, spillway and maintenance access may also require paving or armouring with ripraps or armour stones to secure stability.

Typically, the pond shoreline, sideslopes, spillway and embankment, all may periodically suffer from slumping and erosion. Corrective measures such as regrading and revegetation may be necessary, where required. Similarly, the riprap protecting the channel near the outlet may also need to be repaired or replaced.

Mitigation of Effects on Temperature and Dissolved Oxygen

The planting of deciduous and coniferous trees along the edges of a pond can assist in mitigating undesireable increases in water temperature. In addition, vegetation can contribute to the maintenance of dissolved oxygen levels by inhibiting the growth of algae. Overbank vegetation also provides a canopy for protecting the pond from high summer temperatures. Trees or other appropriate vegetation should be located around the east, south, and west sides of a facility to maximize

shading and minimize solar exposure of open water areas. Reducing solar exposure will help to reduce heat gain in water before discharging to receiving water, which helps maintain a healthy and aesthetic pond conditions, reducing algae blooms and the potential for anaerobic conditions to develop.

Deterrence of Geese

Dense woody vegetation around a pond is the most effective method of discouraging undesirable species of waterfowl from contaminating facilities which have a permanent pool. Minimizing the amount of mown grass will also minimize the geese habitat.

Barriers to Public Access and Public Safety

Dense woody vegetation around the perimeter of a pond is useful to deter the public from accessing pond areas, steep slopes and other areas which are deemed potentially hazardous. Proper signage, fencing or railings can also be applied to warn and deter public access.

Enhancement of Linkages

The establishment of diverse communities of plants in conjunction with a stormwater management pond can contribute to the establishment of linkages between natural wooded areas, providing terrestrial habitat benefits at a larger scale.

Amenity Benefits

Vegetation can be utilized to enhance views and contribute to the establishment of a unique character for a development. Vegetation can also be effective in blending a pond into parks or specific surroundings and integrating with trail systems, overlook points, interpretive stations, and seating areas.

Landscape Design Factors

Landform, Grading and Orientation

Grading should be designed to reflect the landform character of the surrounding natural landscape. Orient wet ponds with their longest axis aligned northwest to southeast, or west to east to maximize opportunities to mitigate temperature increases through shading. Orientation should be carefully considered in situations where the stormwater management pond is a tributary to an existing or proposed coldwater aquatic community. For more information on recommended grading and proper slope design, see Figure 2-1. The planar grading design, as shown in Figure 2-2, is not recommended for its angular transitions and long stretches with standard slope gradients.

For detailed side slopes design, see Appendix B, *Wet Ponds: Summary of Design Guidance.*

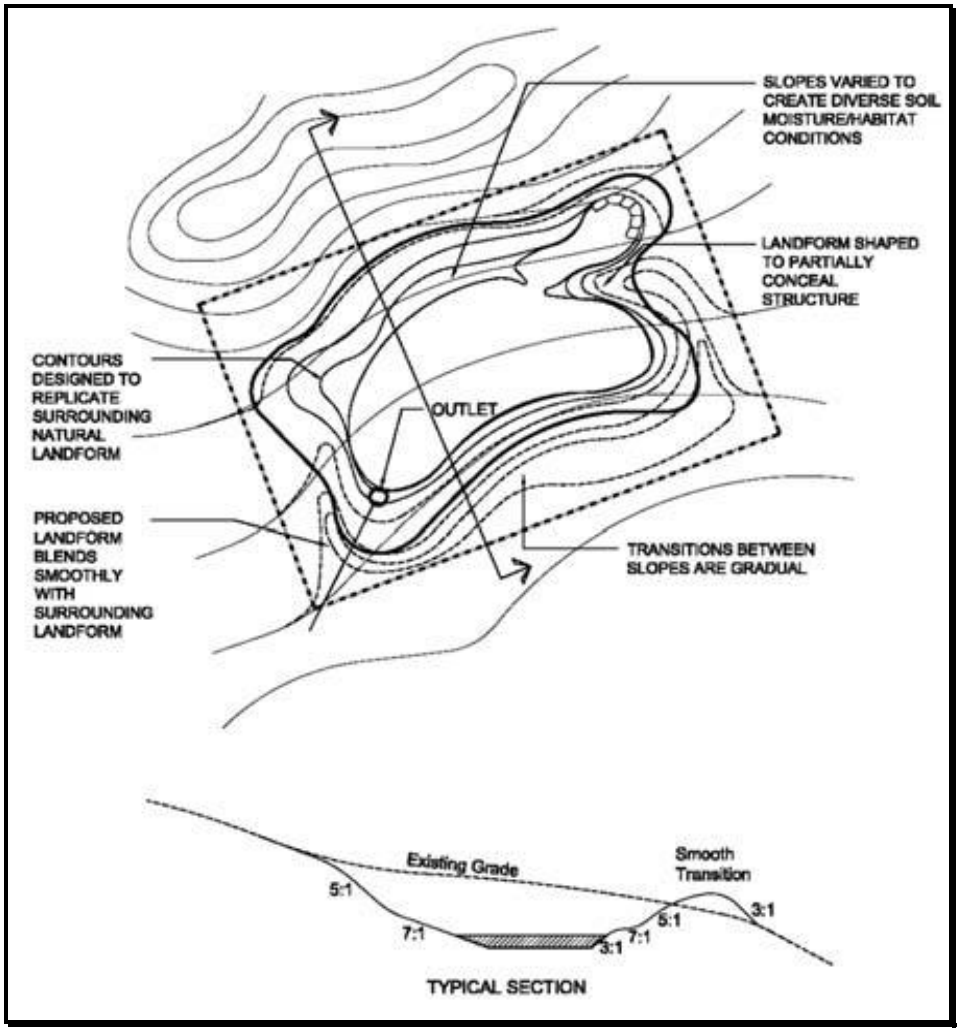

Figure 2-1: Landform Grading – Recommended Design [1]

1. City of Hamilton, Landscape Design Guidelines for Stormwater Facilities – May 2009.

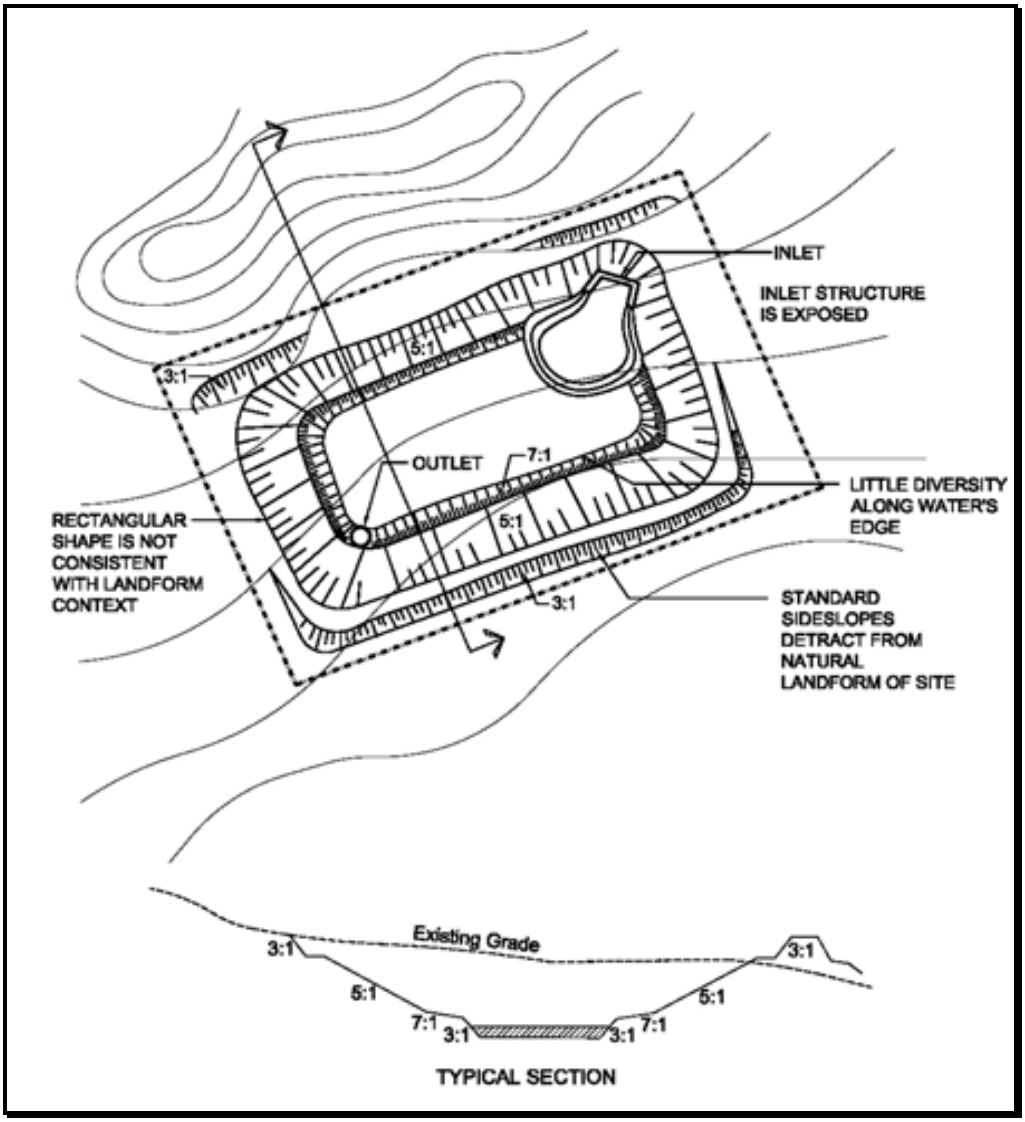

Figure 2-2: Planar Grading Design – Not Recommended [1]

1. City of Hamilton, Landscape Design Guidelines for Stormwater Facilities – May 2009.

Tree Protection Plan

All trees and natural plant communities located within 15 m of the site of a proposed stormwater management pond are to be identified and assessed. A tree protection plan is to be prepared, which identifies trees and features to be preserved and sets out recommendations to facilitate their protection. The plan should illustrate the location of tree protection fencing, according to the *Tree Protection Policy and Specifications for Construction Near Trees*, to the satisfaction and approval of Urban Forestry, as well as remedial measures required to

minimize impacts on trees during the construction period, including pruning, root pruning or fertilization.

As part of this process, plant material suitable for transplantation or reuse in the landscaping of stormwater management ponds should be recommended for its relocation, or transplantation. For more information, call Parks, Forestry & Recreation Division, at 416-338-TREE(8733) or go to www.toronto.ca/trees/bylaws_policies.htm.

Planting Strategy

Careful selection of plant material is the critical factor to ensure that stormwater pond functional objectives are achieved and minimize maintenance requirements.

The following principles should be applied to guide the selection of plant material and the generation of planting strategies for stormwater management ponds.

Plan for Succession

Vegetation communities are dynamic and can change over time to adapt to the developing environment. Planting design must recognise this process to ensure that planting objectives are achieved over the long term.

Maximum Benefits to Site Environment

An understanding of the ecological, physical and social context of a site will help to direct the selection of appropriate plant species and the assembly and configuration of plant communities which are appropriate to the site in order to provide the maximum benefit.

Avoid Non-Native and Invasive Species

Since stormwater management ponds are linked to a network of habitats which are connected by the watercourse downstream of the facility, it is important that plant material within the stormwater management pond site be native and indigenous to the bioregion. The introduction of non-native, invasive species can threaten plant communities throughout the watershed and must be avoided.

Maximum Diversity

The use of a wide range of native, indigenous trees, shrubs, wildflowers, grasses, sedges and aquatic plants will enhance biodiversity on a watershed-wide scale and also contribute to the system's resiliency and ability to maintain itself. Plants such as cattail and common reed are aggressive and may thwart diversity goals.

Recognize Human Factors

Planting design should be developed with recognition of the requirements of the adjacent residents, users of the site and the community-at-large related to interpretive opportunities, aesthetics, public safety issues and other associated factors.

The planting plans shall be prepared by a landscape architect and approved by the City, and all plantings to be in accordance with the Canadian Standards for Nursery Stock as prepared by the Canadian Nursery Landscape Association.

Landscape Design Components

There are four main design components for stormwater management ponds (see Figure 2-3) including

- forebay
- permanent pool
- inlet
- outlet.

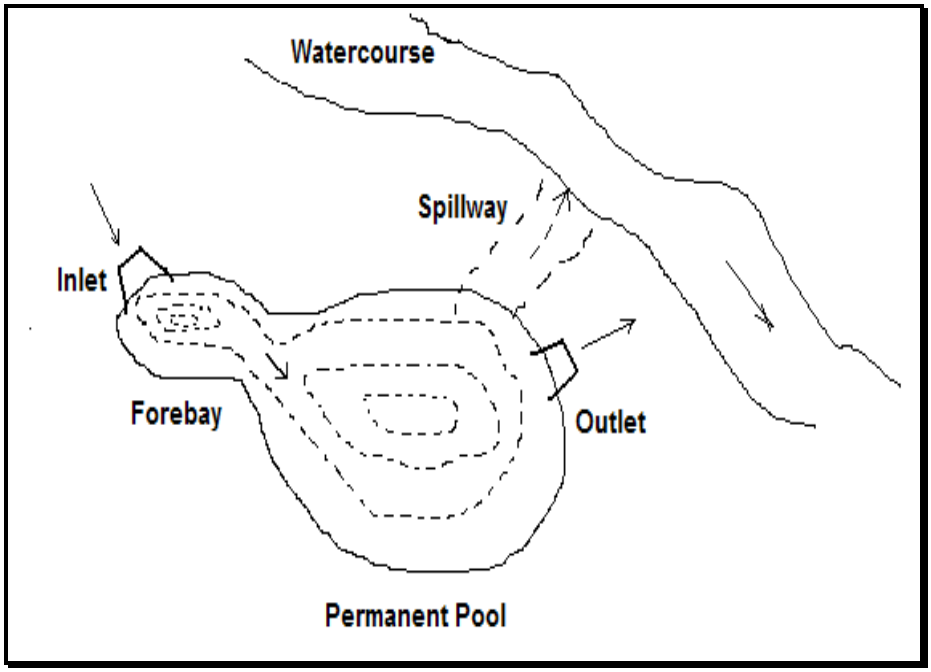

Figure 2-3: A typical stormwater management pond

The landscaping design shall focus on specific situation of the components. The detail landscaping design guideline will be described below.

Permanent Pool and Forebay

The main function for a forebay is to improve pollutant removal by trapping larger particles near the inlet of the pond. The forebay should be one of the deeper areas of the pond to minimize the potential for re-suspension material to the permanent pool of the pond.

The permanent pool is the main component of a SWM pond and is used to store and treat the stormwater conveying from the forebay to the outlet/spillway and eventually to receiving watercourses. The average permanent pool depth in a pond should be 1 to 2 m. The maximum depth in a pond should be restricted to 3 m—preferably 2 m. Although ponds deeper than 3 m may have some benefits in terms of water temperature, deep ponds will often become stratified and the reduced oxygen content may create anoxic conditions releasing metals and organics from the pond sediments. Too much water level fluctuation can have a negative impact on the tolerance of plants. Therefore the maximum active storage depth should be 1 m preferred limited to 1.5 m. A minimum 0.3 m freeboard should be provided above the maximum design water level. The detail water level design

can be referenced in Appendix B, *Wet Ponds: Summary of Design Guidance*.

In forebay and permanent pool, the planting design criteria may cover up to five zones based on frequency of inundation, adopted the five distinct moisture zones recommended by *Stormwater Management Planning and Design Manual*, see Figure 2-4:

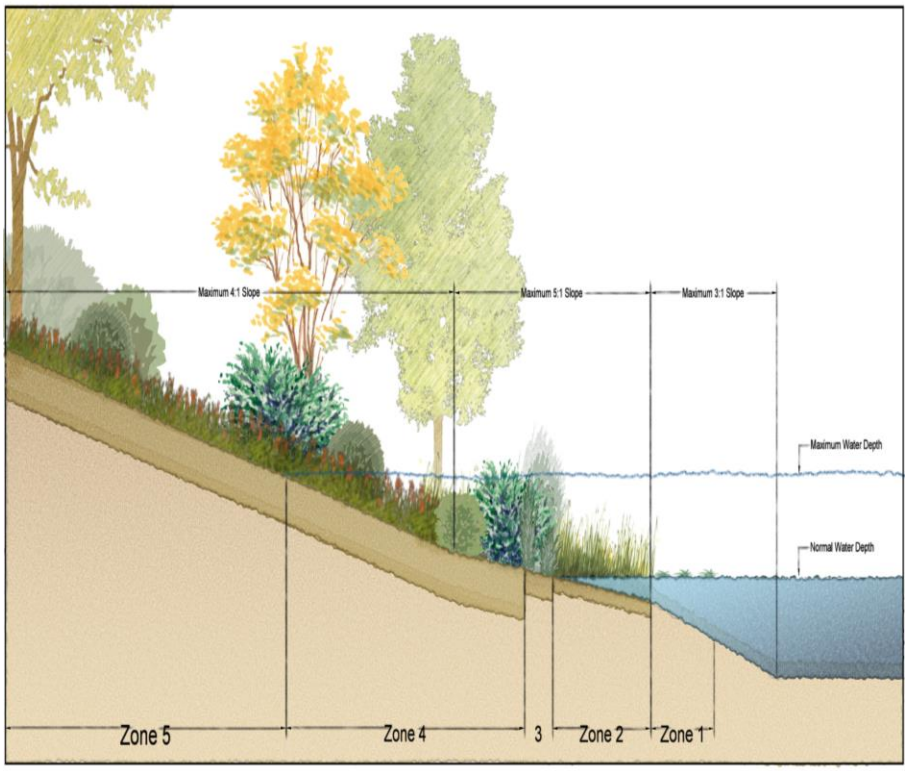

Figure 2-4: Five landscaping zones for typical stormwater management pond (wet pond)

Zone 1 – Deep Water Areas

Aquatic species, including submergents and floating-leaved, are appropriate for deep water areas where depths are greater than 0.5 m.

Plantings

Include a minimum of two species each of submergent and floating aquatic species between water depths of 0.5–2 m. Acceptable native plant species for this zone can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Topsoil

Provide a layer of 0.3 m of topsoil for the first one metre below the permanent water level. The design engineer or site supervisor or both should review the suitability of subsoil material and compaction with the landscape architect. Side slopes should be 3H:1V or flatter, to maximize the area available for plantings.

Spacing

Provide a minimum of 40 per cent vegetative coverage to minimize shallow water warming and help to prevent algae growth. Recommended number of plants is three plants per linear metre of water's edge.

Planting Time

Plant bare root tubers or rhizomes in:

- Spring: from frost free ground, generally early-April to mid-May, must be before bud break.
- Fall: from approximately 2 to 3 weeks after leaf drop to mid-October.

Zone 2 – Shallow Water Areas

Submergent and emergent vegetation should be used in the shallow water area zone, where the water is less than 0.5 m deep.

Plantings

Provide a minimum of two species each of robust, broadleaved and narrow leaved emergent plants for water depths less than 0.5 m. The planting rows should be perpendicular to the direction of the water flow to minimize the potential for channelization. Acceptable native plant species for this zone can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Topsoil

Provide a layer of 0.3 m of topsoil below the permanent water level. The design engineer or site supervisor or both should review the suitability of subsoil material and compaction with the landscape architect. For safety reasons, side slopes should be 5H:1V or less.

Spacing

Provide 100 per cent vegetative coverage to discourage loafing geese and to act as a barrier to casual entry. Recommended number of plants is three plants per linear metre of water's edge.

Planting Time

If bare root stock including root tubers and rhizomes is used:

Spring: from frost free ground, generally early-April to mid-May, must be before bud break.

- Fall: from approximately 2 to 3 weeks after leaf drop to mid-October.
- If container grown stock is used, plant from mid-April to mid-October.

Seeding

Emergents can be introduced using an approved seedbank material or an appropriate stormwater management pond native seed mix. Native grass and herb seed mixtures should be sown in the early spring before mid-April or late in the fall; mid-October to mid-November.

Zone 3 – Extended Detention or Shoreline Fringe Areas

The extended detention or shoreline fringe is defined as the area below the 2-year floodline or normal water depth, and is generally within one metre horizontally from the permanent water level. This zone will be subject to higher soil moisture conditions as a result of frequent water level fluctuations, and the influence of the permanent pool itself.

Plantings

Include a minimum of two species each of flood tolerant shrubs, grasses and herbs. There should be at least two planting rows of shrubs, perpendicular to the direction of the water flow, to minimize the potential for channelization. Acceptable native plant species for this zone can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Topsoil

Provide a minimum layer of 0.3 metre of topsoil for seeding areas, 0.6 metre of topsoil for the shrub planting areas, and one metre of topsoil for the tree planting areas.

The design engineer or site supervisor or both should review the suitability of subsoil material and compaction with the landscape architect. For safety reasons, side slopes should be 5H:1V or flatter, for at least 3 m beyond the permanent pool.

Spacing

Provide 100 per cent vegetated coverage to discourage loafing geese and to act as a barrier to casual entry. Small shrubs should be planted at one metre on centre and large shrubs at 1.5 to 2 m on centre.

Planting Time

If bare root stock is used:

- Spring: from frost free ground, generally early-April to mid-May, must be before bud break.
- Fall: from approximately 2 to 3 weeks after leaf drop to mid-October.

If container grown stock is used, plant from mid-April to mid-October.

Seeding

Flood tolerant grasses and herbs can be introduced using an approved seedbank material or an appropriate stormwater management pond native seed mix.

Native grass and herb seed mixtures should be sown in the early spring before mid-April or late in the fall; mid-October to mid-November.

Zone 4 – Flood Fringe Areas

The flood fringe is defined as the area between the 2 and 100 year floodlines. As this area is only infrequently flooded, the plants must be able to withstand periods of inundation and periods of drought.

Plantings

Include a minimum of two flood tolerant species each of grasses and herbs, and four flood tolerant species each of shrubs and trees. A suitable mix of deciduous and coniferous trees should be used. Acceptable native plant species for this zone can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Topsoil

Provide a minimum layer of 0.3 m of topsoil for seeding areas, 0.6 m of topsoil for the shrub planting areas, and one metre of top soil for the tree planting areas. The design engineer or site supervisor or both should review the suitability of subsoil material and compaction with the landscape architect. For maintenance reasons, side slopes should be 4H:1V or flatter.

Spacing

Provide a minimum of 50 per cent of an overall planting coverage Example: number of trees and shrubs = ½ x dry area of the pond block above the permanent pool water level ÷ spacings of trees/shrubs.

- small shrubs should be planted at one metre on centre
- large shrubs at 1.5–2 m on centre
- tree whips at 3 m on centre
- caliper trees at 5 m on centre

Within a horizontal distance of 3 m from the permanent water level edge, suitable overhanging trees should also be planted to provide shade to the pond.

Planting Time

If bare root stock is used:

- Spring: from frost free ground,generally early-April to mid-May, must be before bud break.
- Fall: from approximately 2 to 3 weeks after leaf drop to mid-October.

If transplanted stock including balled and burlapped (B&B) stock is used:

- Deciduous trees: Fall after leaf drop, or in spring and prior to leaf out.
- Coniferous trees: Spring planting only.

If container grown stock is used, plant from mid-April to mid-October.

Seeding

A commercially available native grass and herb seed mixture suitable for slope stabilization is recommended. Native grass and herb seed mixtures should be sown in the early spring; before mid-April or late in the fall; mid-October to mid-November.

Zone 5 – Shoreline Areas

The upland planting area should provide a minimum of a 3 m buffer strip from the maximum design water level mark. Since soil moisture is not directly influenced by the presence of the pond, the plants selected for this area must be tolerant of drought conditions.

Plantings

Provide a minimum of two upland species each of grasses and herbs, and four upland species each of shrubs a suitable mix of deciduous and coniferous trees should be used. Acceptable native plant species for this zone can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Topsoil

Provide a minimum layer of 0.3 m of topsoil for seeding areas, 0.6 m of topsoil for the shrub planting areas, and 1 m of topsoil for the tree planting areas. The design engineer or site supervisor or both should review the suitability of subsoil material and compaction with the landscape architect. For maintenance reasons, side slopes should be 4H:1V or flatter .

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Provide a minimum of 50 per cent of an overall planting coverage Example: number of trees and shrubs = ½ x dry area of the pond block above the permanent pool water level ÷ spacings of trees/shrubs.

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- Deciduous trees: Fall after leaf drop, or in spring and prior to leaf out.
- Coniferous trees: Spring planting only.

If container grown stock is used, plant from mid-April to mid-October.

Seeding

A commercially available native grass and herb seed mixture suitable for slope stabilization is recommended. Native grass and herb seed mixtures should be sown in the early spring; before mid-April or late in the fall; mid-October to mid-November.

Inlet Structure

The inlet structure of a stormwater management pond refers to the location where stormwater conveyance system discharges into the pond. There are two types of inlet: non-submerged pond inlet and submerged inlet. Both types of inlet require flow dissipation processes to prevent erosion at the entrance to the ponds.

Inlet structure should employ a forebay as means to dissipate energy and controlling the velocity of stormwater entering the facility rather than chute blocks, gabion mats and rip rap or poured concrete spillways.

The minimum depth of standing water in forebay is to be one metre.

Figure 2-5: Example of an inlet structure that is concealed from view – L'Amoreaux Park pond

Concealing Inlet Structures

In order to prevent public access and maintain public safety, inlet structures should be designed to be concealed from view as shown in Figure 2-5. The following recommendations to achieve this objective are provided.

- Locate inlet structures back from the edge of the pond, with the connection to the pond following a narrow embayment or connecting channel.

- Where an inlet structure must be located at the pond edge, topography should be sculpted to conceal the structure behind an overlapping land form with extensive planting.

- Utilize planted fieldstone to construct wing walls, conceal concrete headwalls and mitigate erosion.

Safety barriers, such as railings or fence, may be necessary in critical areas such as above headwalls or where there are significant changes in grade, for example, 600 mm in height. Typically, a railing will be required when the permanent water depth exceeds 0.6 m with interior sideslopes steeper than 3H:1V.

Generally, a pond that is gently sloping less than 3H:1V and has other safety features like warning signage, vegetative and barrier plantings, and safety ledges along the pond perimeter does not require a fence. See "Public Safety" on page 38. Where the installation of a fence is required to provide fall protection, a 1.2 m black vinyl coated chainlink fence according to OPSD 972.131 should be used. For example of a black vinyl coated chainlink fence, see Figure 2-6.

Figure 2-6: Inlet structure of stormwater wet pond (at southwest corner of Staines Road and Seasons Drive)

Recommended Plantings

Extensive planting should be installed to conceal fences and barriers. See Zones 3, 4 and 5 descriptions above for detailed requirements. Acceptable plant species for these zones can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Outlet Structures

In order to achieve water quality and quantity control objectives as well as ecological targets in the receiving watercourse and downstream watershed, outlet structure designs should be developed in consideration of a range of factors beyond those related to the regulation of flows discharged from the stormwater management facility, including the following:

- Aquatic habitat and fish community targets for the receiving watercourse and subwatershed, for instance, water temperature.
- Watercourse stability and fluvial geomorphological characteristics. Outlet structures should be designed, located and oriented based on an understanding of fluvial characteristics of the receiving watercourse to ensure that the installation of the outlet and flows generated do not result in erosion, increased instability or alteration to channel morphology.
- Groundwater interflow and discharge patterns should be considered in the design process to ensure that groundwater movement to existing discharge areas is not interrupted, as well as to identify opportunities to enhance groundwater discharge where it is appropriate.
- Ecological influences on adjacent vegetation communities and ecosystems should be understood to ensure that the implementation of outlet structures does not impact adjacent habitats.

There are at least three basic parts to an outlet structure

- outlet structure in the pond
- flow control structure/device, which may be in a chamber below ground or in a small building
- outlet discharge to the environment, like a diversion structure.

The site-specific requirements for any outlet structure design will be determined on a case by case basis. For example, the requirement and design of any diversion structure in a natural creek will need to be discussed with the staff of TRCA and Toronto Water. In general, the outlet channel immediately below the pond should be modified to conform to natural dimensions, and lined with properly-sized riprap placed over filter cloth. For outfall protection, emergency spillways, stilling basins/plunge-pools, rock deflectors, check dams and other

devices could be used and designed to reduce flow velocities to non-erosive levels.

If outlet structures are to be placed within environmentally sensitive sites, then the placement and design of such structures should be determined by experts from the consultant, City and approval agencies such as, Toronto and Region Conservation Authority, Ministry of Natural Resources and Department of Fisheries and Oceans prior to submission of the engineering drawings.

Pond outlets should be designed with the objective of mitigating downstream impacts. Some innovative design of the outlet system can reduce the potential thermal impact. The following alternative outlet designs should be considered to achieve this target.

Bottom-Draw Outlets

There are temperature benefits from a bottom-draw facility, although this is dependent on the size of the permanent pool and the release depth. Lower temperatures – in the order of several degrees Celsius occur several metres below the permanent pool surface. Ponds with permanent pool depths greater than 3 m, however, are likely to become thermally stratified during the summer months. The water at depths can become anoxic, and there is a potential for metals and nutrients to be remobilized. Although oxygen deprivation can be solved by re-aeration at the outlet, for example discharge over rocks, the discharge of polluted water would be undesirable. Accordingly, ponds with a very deep release—greater than 3 m—should consider re-aeration in the pond itself to prevent thermal stratification from occurring. The design must also take into consideration the possible reductions in sedimentation and resuspension of sediment collected at the pond bottom.

Cooling Trenches

Cooling trenches are designed to cool down discharging of the pond water to the downstream watercourse. The required dimensions of the trench are determined by: pond size, effluent rates, temperature of discharge from the pond, existing downstream temperature, and distance from the receiving waterbody.

Cooling trenches are placed at the pond outlet and are typically built by a stone-filled trench buried below ground. By contact with the stone media results in a transfer of heat from the water to the stones, effectively reducing the temperature of water discharged at the outlet

of the trench. It is preferred that the cooling trenches have multiple outlets in order to simulate the natural pattern of discharge to the downstream watercourse as seen in Figure 2-7 and 2-8.

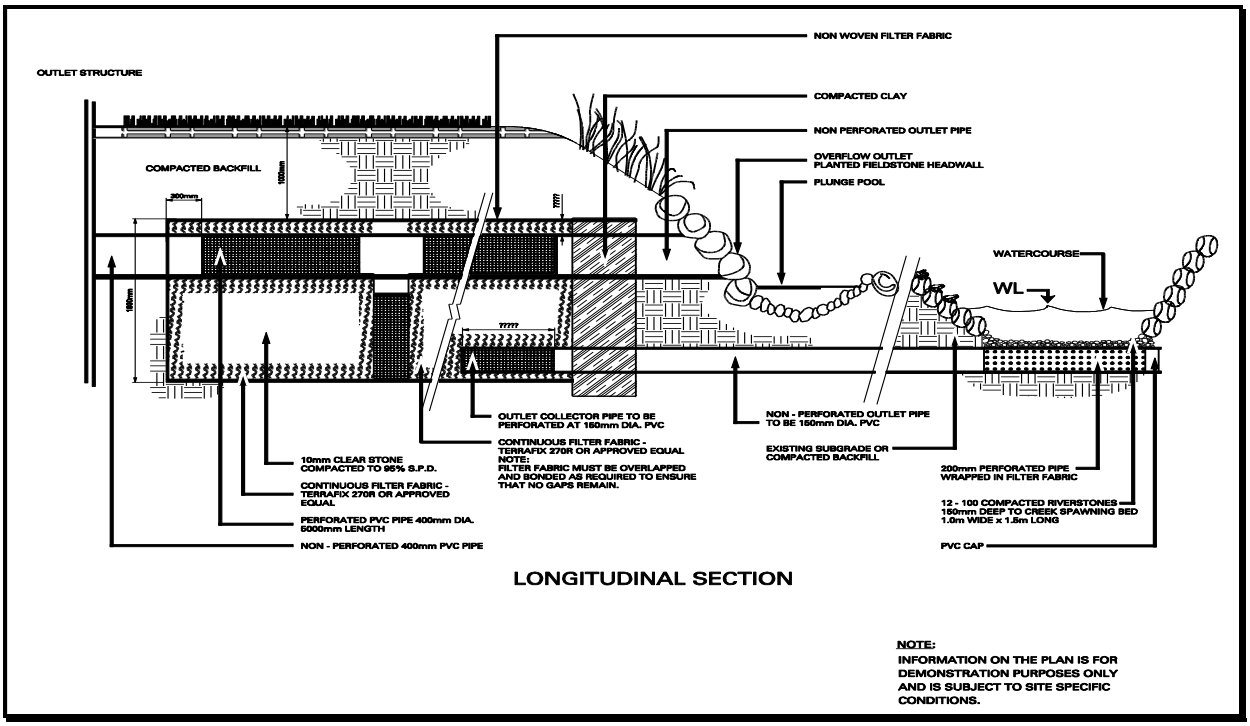

Figure 2-7: Cooling trench – longitudinal section

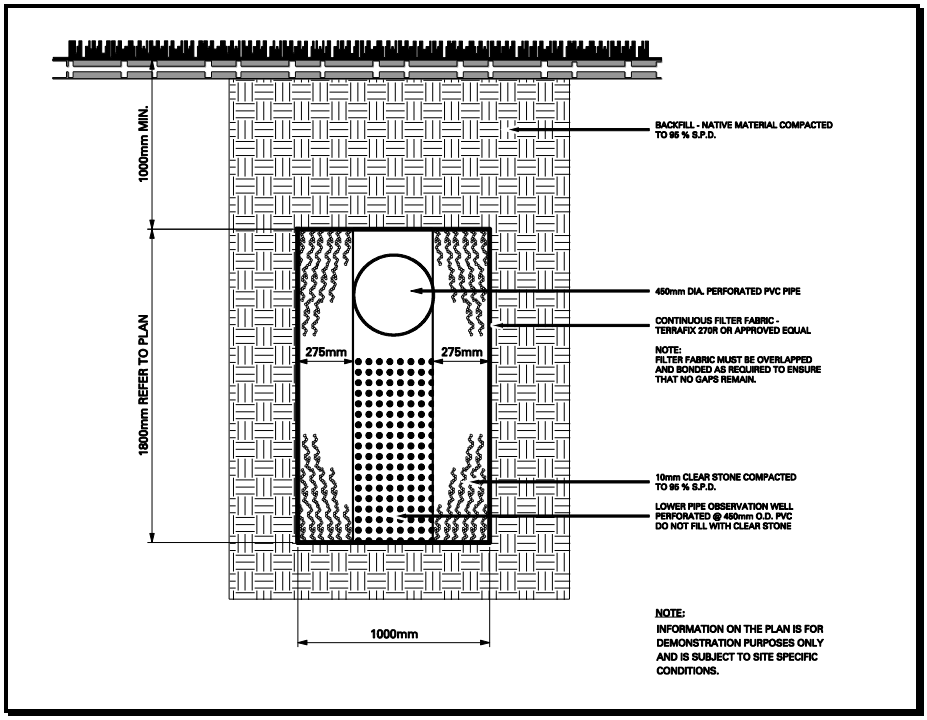

Figure 2-8: Cooling trench – profile section

Seepage Outlets

Seepage outlets are designed to achieve temperature reduction objectives through three processes

- heat transfer with filter medium, similar to the cooling trench
- gradual discharge to densely shaded, well vegetated buffer strips
- provision of groundwater recharge and discharge to the watercourse through subsurface interflow.

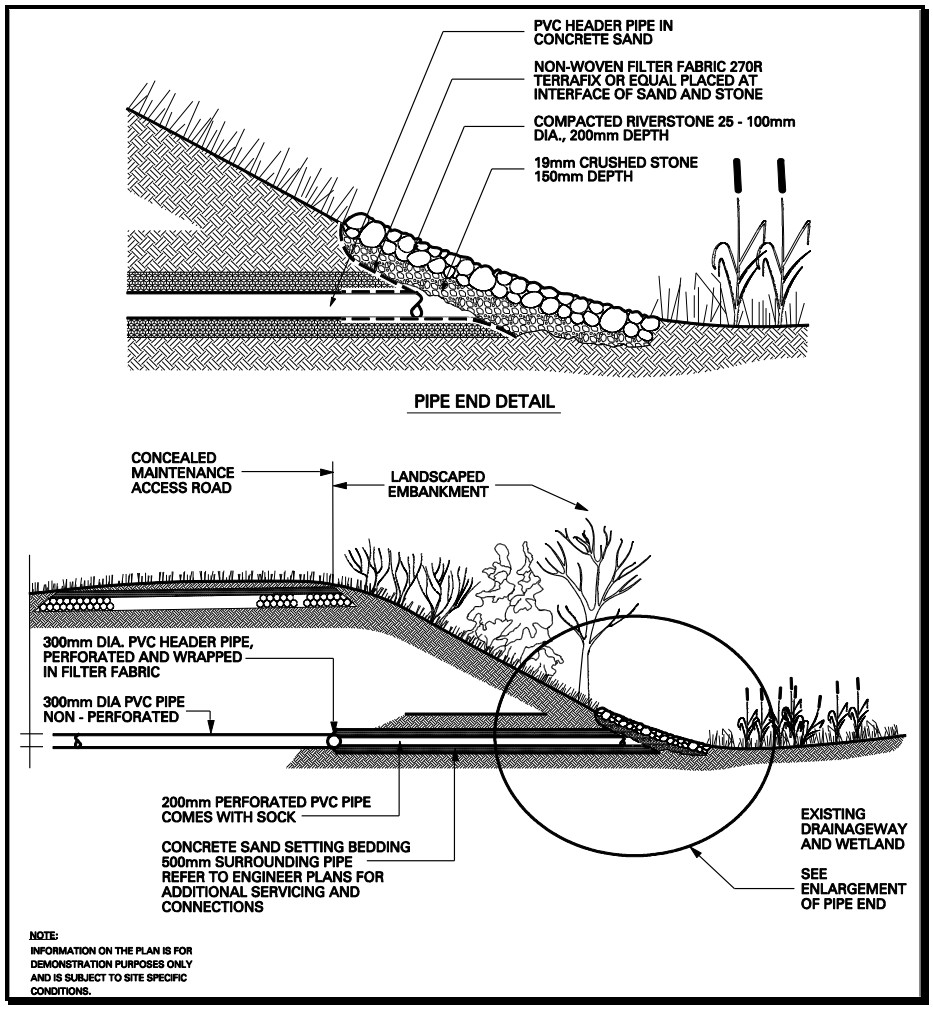

Figure 2-9: Seepage outlet

Seepage outlets are designed to be situated downstream of the facility outlet and are comprised of the following components as shown above in Figure 2-9

- a header pipe that feeds a set of small diameter, clear stone or coarse sand filled outlet pipes

- outlet pipes are spaced apart and are configured to discharge into existing depressions, drainage ways or areas of permeable soil that are set back from the edge of the watercourse

- clean-outs for each header pipe and outlet pipe to facilitate flushing

- a bypass outlet to ensure continous operation of the facility in the event, the seepage outlet system may become compromised over time.

The system should be designed with a degree of redundancy to compensate for potential blockage or reduced rates of discharge from one or more of the outlet pipes that may result from the penetration of root systems or other factors.

Outlet Channels

Long, narrow, well-vegetated outlet channels have proven to be effective in mitigating temperature increases through shading, transferring heat to substrate and by encouraging infiltration. Natural channel design techniques can be used to ensure the channel conforms to the natural characteristics of the valleylands. Outlet channels should be designed

- as narrow tributaries with width to depth ratios approaching 1H:1V, contingent upon gradient and conveyance parameters

- to have a gentle gradient to maximize contact time. Channels should be lined with clear stone substrate with a minimum depth of 200 mm.

- with a continuous band of woody riparian vegetation and a minimum width of 3 m along each side of the outlet channel to facilitate shading and enhance stream stability. Species such as eastern white cedar and red osier dogwood should be planted in combination with fast-growing riparian pioneer species such as poplar, as well as longer lived, large canopy species such as red maple and hemlock.

Vegetated Swales

In situations where the stormwater management facility is located adjacent to an existing vegetated area with high soil moisture conditions or a shallow water table, a swale is an effective tool to filter runoff by distributing stormwater over a broad vegetated area, see Figure 2-10 and Figure 2-11. The swale also provides additional benefits related to water quality improvement and moderation of discharge rates. The configuration and design of swales are determined in large part by existing site parameters including: topography, soil, and vegetation community composition.

The swale should be planted continuously along its length for a distance extending at least 2.5 to 3 m from the crest of the swale on all sides to ensure stability and to create dense shade. An overflow outlet or bypass must be incorporated into the design of the swale to ensure that flows do not result in rilling and erosion within the adjacent vegetated filter area.

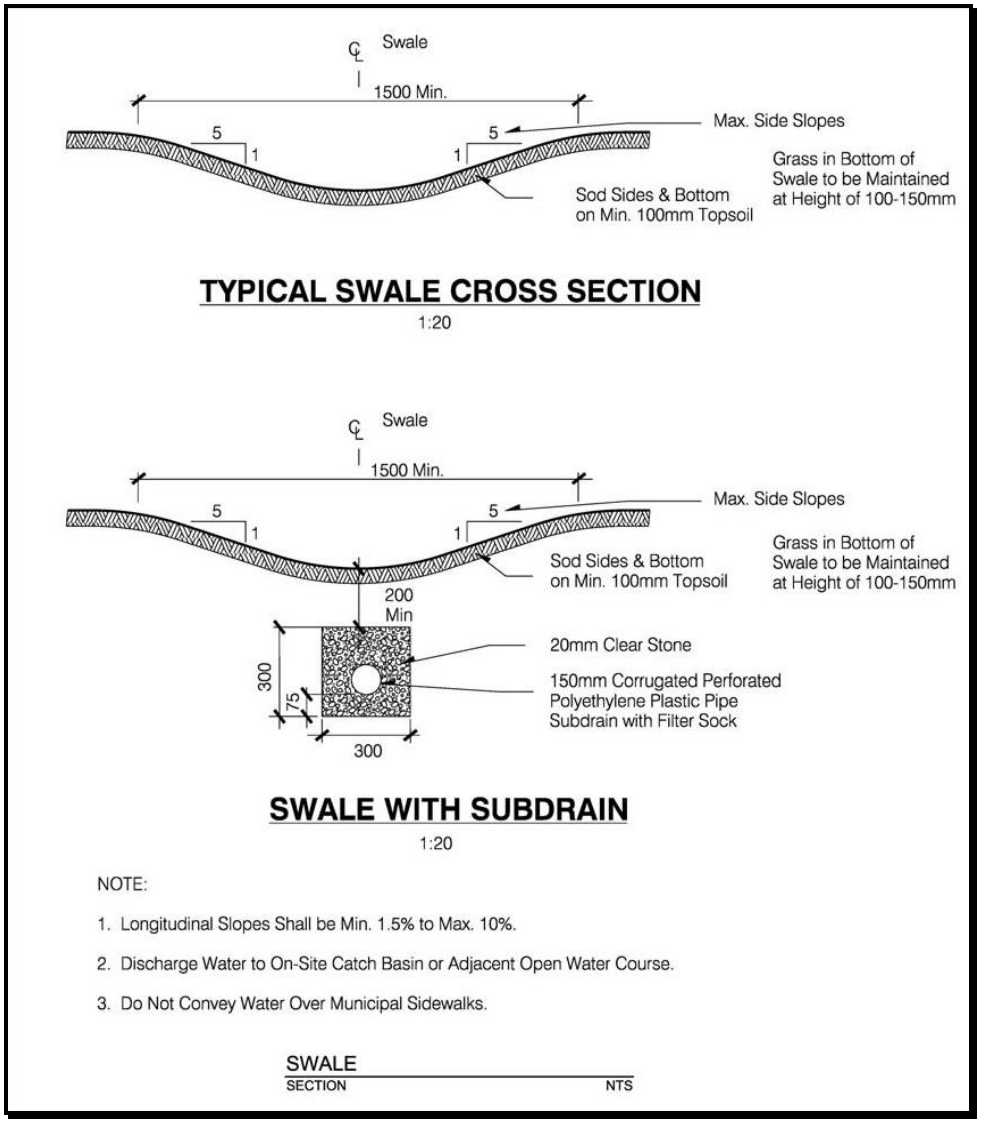

Figure 2-10: Typical swale cross section

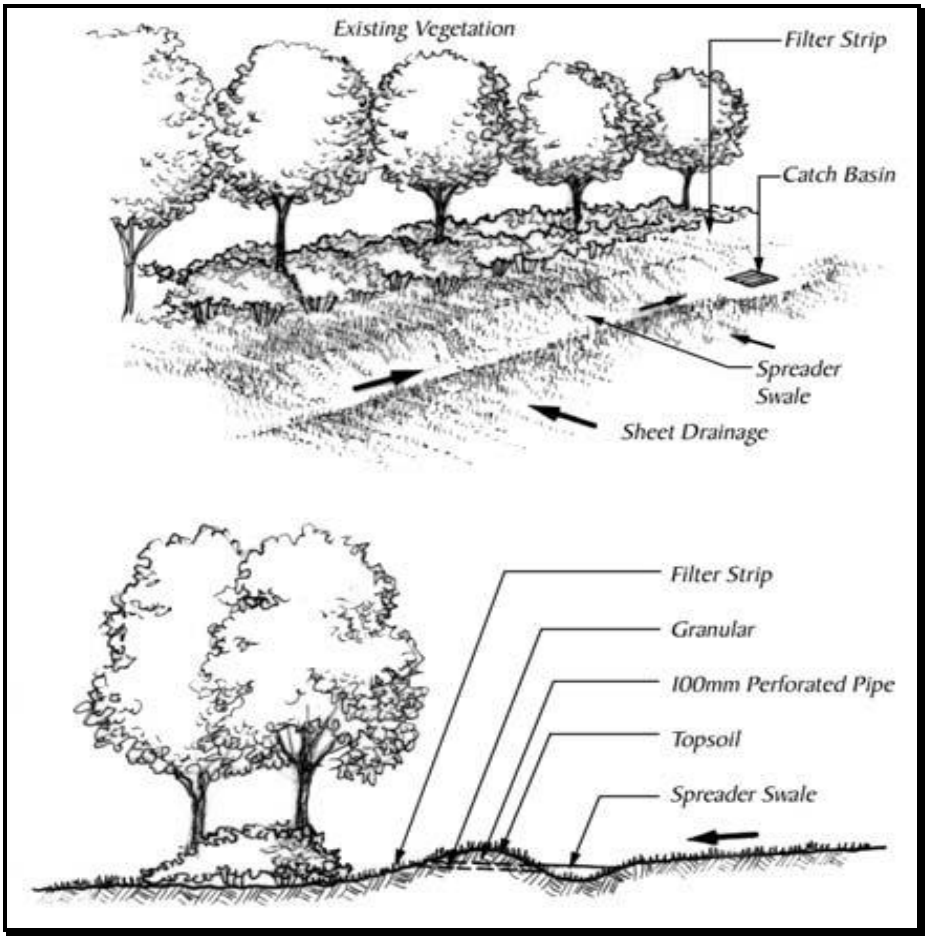

Figure 2-11: Vegetated swale

Constructed Wetlands

Constructed wetlands can be constructed downstream of the outlet from a stormwater management pond to further enhance water quality, control flows and mitigate water temperature impacts. Constructed wetlands should be required as a series of terraced cells separated by level spreader weirs in order to reduce the potential for the eventual formation of a refined channel within the wetland. Constructed wetlands should be heavily planted to increase shade cover and should be designed to incorporate a diverse palate of plant species selected for their ability to withstand the water level fluctuations and flow velocities anticipated to occur downstream of the outlet. In general, the landscape design around the facility would be similar to those of wet ponds except the plant species inside the wetland cells would be specifically chosen to promote plant uptake of nutrients and metals,

Recommended Plant Material

Regardless of the type of the outlet structure, planting material for the outlets should contribute to the concealment of outlet structures. The requirement of details of plantings can be chosen from Zones 3, 4 or 5 according to the different site conditions.

Water tolerant trees and shrubs should be planted in dense quantities between the flow spreader or dissipator at the end of the outlet, and the receiving watercourse, to minimize erosion. If flow spreaders, or equivalent, are not feasible at the end of the outlet, then outlet channels should be native grass lined, meandering swales that extend to the watercourse bank. Tree and shrub planting along the outlet channel is required, with densities sufficient to provide a closed canopy over the outlet. Acceptable native plant species can be found in Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

Sediment controls must be installed prior to construction of the outlet structure and grassed swale.

Spillway

A spillway is recommended for overflow from the pond or emergency spill routines. For example of a spillway design at Morningside stormwater management pond, see Figure 2-12 and Figure 2-13.

A 500 mm thick layer of rip-rap stone on top of Terrafix filter cloth type 270 R or approved equal with a 300 mm layer of topsoil and seed on top of rip-rap stone.

Figure 2-12: Spillway at Morningside stormwater management pond

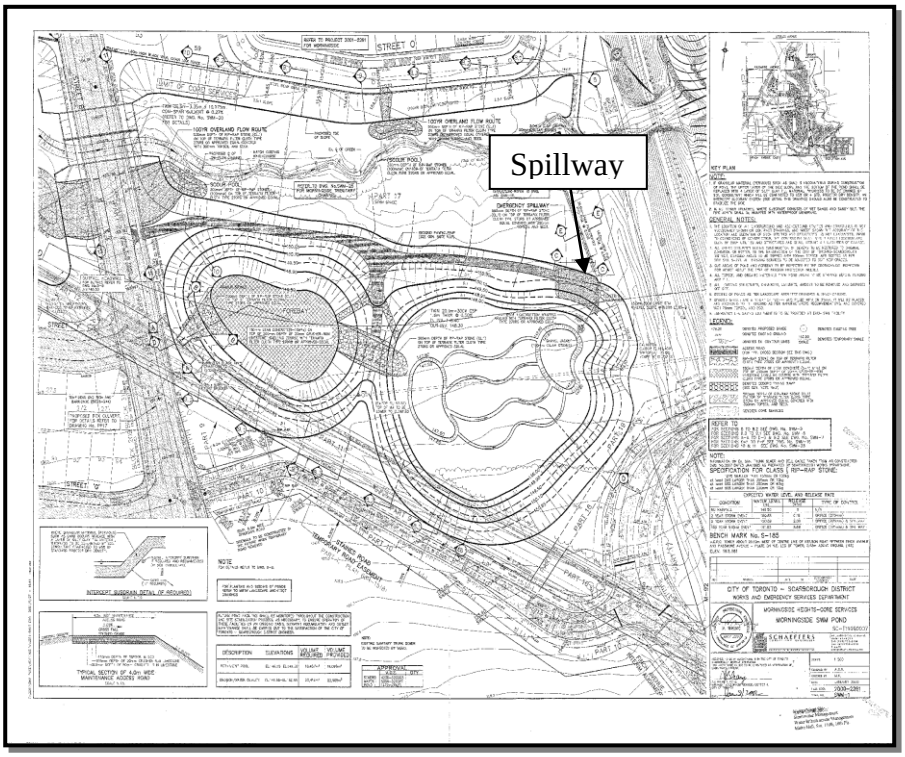

Figure 2-13: Spillway design at Morningside stormwater management pond

Maintenance Access Road

The main purpose of an access road is to facilitate inspection and maintenance. Frequent maintenance usually involves small pieces of equipment such as mowers and light trucks. Access also involves facilitating inspector access to, into and through a stormwater pond or wetland to inspect and identify any items that require repairs. Critical appurtenances should be easily and safely accessed for inspection and minor maintenance, such as lubricating a pond valve. Although dredging and cleaning are less frequent maintenance items, site access will be required for heavy equipment including a steel track heavy excavator, backhoes, dump trucks, and vacuum trucks.

Maintaining ingress and egress points for the facility at all times is important in case of emergency repair or rescue. Without a permanent access route when access is needed, it would be necessary to create a temporary route which would be disruptive to plant life and community aesthetics. Access for major repairs is similar to construction access and involves protecting existing trees, pavement, utilities, and signage against damage while accessing the areas that require repairs. General access requirements are:

- Sufficient width to allow vehicles to turn around and the vehicle size will be determined by the maintenance requirements associated with specific design.
- Access to the riser is to be provided by lockable manhole covers, and manhole steps within easy reach of valves and other controls.
- Be capable of supporting heavy vehicle, such as a steel track heavy excavator.
- Be at least 4 m wide and 2 m on each direction.
- A maximum slope of 15 per cent, and be appropriately stabilized to withstand maintenance equipment and vehicles.

The maintenance access road must extend from street to the forebay, riser, inlet/outlet, as well as longitudinally within the pond along its centreline and should be aligned to avoid overland flow routes. See Figures 2-14 and 2-15.

Figure 2-14: Access road along pond bank at Earl Bales Park pond

Figure 2-15: Access road from pond bank to the centre of the Earl Bales Park pond

Three options are available for the road surface based on the circumstances of the maintenance access route in the context of the overall facility landscape. Landscaping for all access roads shall be concealed from the public except for the access road around the pond where it could be paved to meet specific site circumstances. For example, if the pond is located in the park, the access road around the pond could be considered as a public trail road.

Concealed Maintenance Access Route

Maintenance access routes should provide unimpeded access from the adjacent municipal road right-of way and should be aligned to avoid overland flow routes. General features include:

- Surface treatment: 75 mm of granular, overlain by a surface layer comprised of limestone screenings mixed with free draining topsoil, with a minimum depth of 500 mm with a sub-base of 200 mm or greater contingent on sub-soil condition and load bearing requirements.

- Surface to be seeded and mulched. For the recommended seed mixes for maintenance access routes, see Appendix A, *Acceptable Plant Species for Stormwater Management Ponds*.

- Alignment to be demarcated using boulders placed along both edges of the route with a minimum spacing of 15 m in an alternating pattern or trees planted at a 1.5 m offset from the edge of the route. Demarcation trees should be of a consistent species to aid in identification of the route.

Hybrid Trail or Maintenance Access Route

Where a maintenance access route is intended to form part of a trail network, the hybrid trail design should be utilized. The general features include:

- Base: 50 mm crusher run limestone with a depth of 200 mm or greater as required to address soil conditions based on the recommendations of a geotechnical engineer.

- Surface treatment: 75 mm of granular overlaid with a combination of 50 mm of either clear limestone screenings, to create the trail component, or limestone screenings mixed with sandy topsoil, to conceal the remainder of the roadway.

- Width of the trail portion should be 2.4 m, aligned along the edge of the roadway nearest to the pond or wetland. The edge of the concealed portion of the roadway will be demarcated as described in the previous section.

High Use or Urban Trail

For ponds that are situated in a more urban context or where high levels of trail use are anticipated, a trail should be designed according to the following:

- Surface treatment: asphalt or another appropriate hard surface material as required by Parks, Forestry & Recreation.

- Major linkages in the community wide trail network must be designed in accordance with the requirements of the *Accessibility for Ontarians with Disabilities Act*, with gradients that do not exceed 8 per cent and other barrier free access initiatives implemented as required based on site-specific conditions.

Vehicle Access Barriers

Where maintenance access routes and trails intersect road right-of-ways, barriers are required to restrict unauthorized vehicular access to the facility. Barriers are to be implemented in accordance with the following:

- Removable metal bollards should be installed.

- Maximum spacing of 1.5 m.

- Where vehicle access is required for maintenance purposes, fixed bollards should be installed at 3 m apart with a removable bollard installed at the mid-point between the two.

- Boulders and plantings in strategic locations across the frontage of the facility to block or discourage off-road access around the bollards.

Provision for Algae Control

Excessive algae growth can be a problem in some stormwater management ponds, particularly in catchment areas subject to high nutrient loads. Excessive algae growth can compromise the quality of water within the pond as well as the functional effectiveness of the pond. Algae can clog outlet structures and can render a pond unsightly. Dead and decaying algae can yield an odour which is offensive to neighbouring residents.

To control algae growth, barley straw bags should be installed around the perimeter of the pond prior to commissioning. In the process of decomposition, barley straw releases a chemical that is converted to hydrogen peroxide in the presence of sunlight. Low levels of hydrogen peroxide inhibit the rate of growth of algae but will not harm fish or other aquatic plants. It is important to note that hydrogen peroxide does not eliminate existing algae but does inhibit the growth of new algae.

A kilogram of barley straw is required for each 1000 square metres of pond surface area. The straw should be distributed at a minimum rate of three kilograms per bag. The bags should be installed off shore of the pond edge and anchored with concrete blocks. Fresh barley straw bags are to be installed in the pond in the spring of each of the two years prior to assumption and finally upon assumption of the facility.

Public Safety

Public safety must be carefully accounted for when planning, designing, and maintaining urban stormwater detention and retention facilities, including inlet and outlet structures. The potential risks are numerous, but they can be managed, in general, by safety design features, signage, and fencing and proper maintenance practices. Indeed, the great paradox of designing safe stormwater detention and retention facilities that are attractive, interesting, well maintained, and inviting, will encourage regular use in a safe environment.

The following are some general considerations to reduce safety risks:

- Grade the overall site with safety in mind. For example, provide mild side slopes leading to and within the pond and minimize the use of vertical walls. Use safety railings when vertical walls or overly steep slopes are used.

- Although it is recognized that permanent pools and fluctuating water levels are potential drowning hazards, risk can be minimized through the implementation of design techniques that deter public access to specific hazard areas. The installation of fencing around the perimeter of the pond block will deter public access.

- Blocks reserved for stormwater management ponds must be of adequate size to ensure that side slopes do not exceed the allowable maximum slopes and there is room to accommodate safety design features. For example, signs, graduated side slopes, vegetative and barrier plantings, and safety ledges along the pond perimeter. It is good practice to integrate a "safety ledge" also referred to as a safety bench around the perimeter of the permanent pool of a pond. This recommendation is also consistent with another technique related to stormwater quality enhancement: integrating a littoral zone of emergent vegetation around the pond perimeter. Integrating a safety bench with emergent vegetation will help to discourage people from wading into the pond.

- Outlets pose particular risks and merit special attention. Do not utilize open, unprotected pipes as outlets; instead, integrate the outlet pipe into an outlet structure that has smaller openings or utilize a sloping trash/safety rack at the pipe entrance. The rack should have a surface area that is many times larger than the surface area of the outlet pipe to reduce entrance velocities—which is necessary to minimize the risk of a person being pinned against the rack and to assure that if debris is a factor, at least some of the surface area of the rack will be open during flooding to enable the pond to drain.

- Proper grates should be installed on inlet and outlet structures to restrict public access to the storm sewer system. The grates at inlet or outlet structures are shown in Figures 2-5 and 2-6.

- For outflow grates in the pond, these grates should be parabolic not flat. The reason for this is both safety and for retrieval of debris. Specify a parabolic grate or bird cage grate such as OPSD 400.120.

- Inflow and outflow pipes should be separated by sufficient distances and assure that the pipes are not directly across from each other. This will avoid the creation of a continuous flow stream, that is to say current, which could pose dangers for the

public. If this is not feasible, utilize an energy dissipator at the outlet where it discharges into the facility.

- In general, stormwater management ponds are not considered to significantly increase the surrounding area's risk of West Nile Virus. Multiple agencies are in agreement on this topic, including Health Canada, Ontario Ministry of Health, Ontario Ministry of the Environment and Climate Change, and Toronto Public Health. This risk is low because mosquitoes generally require a stable, shallow, and stagnant water surface for more than seven days to allow larvae to reach maturation. In order to promote water movement—cause the larvae to drown and avoid standing water greater than seven days old—the ponds should be designed as being constantly recharged during each rainfall event to drain the captured water within 48 hours. During dry weather conditions, the water surface is also exposed to wind turbulence. Therefore, it is important to take steps to eliminate shallow-stagnant water in the bottom of any "dry" basins that can be conducive to mosquito breeding. For example, determine maximum groundwater table elevations prior to design, consider the use of gravity underdrains and avoid the use of outlet structure designs that are subject to plugging.

Fencing

Fencing of the entire perimeter of stormwater management ponds is discouraged. The need for fencing is also determined by slope. A steeply sloped pond is more hazardous than a gently sloped pond.

Black-vinyl-coated chainlink fencing 1.8 m high, based on OPSD 972.130, should be installed along the property line where the stormwater management facility block abuts private property, and it should be continuous with no gates permitted. The fence should be located at an offset distance of 0.15 m from the property line within the stormwater management block, and chainlink mesh should be affixed to the stormwater management facility side of the posts and rails.

Fencing is not required along the property line where a stormwater management facility abuts a public park, open space, natural area, or road right-of-way.

Subject to the approval of the adjacent landowners and the City, a living fence with boundary delineation markers may be substituted for chainlink fencing where stormwater management facilities abut

commercial, industrial, institutional or high density residential land uses.

Safety barriers should be installed along the top edge of headwalls, retaining walls and other structures where the change in vertical elevation exceeds 600 mm in height.

Signage

Install identification signage in a prominent location along the municipal road frontage or in an appropriate location along the interface between the pond block and the adjacent open space or park block. Signage should indicate

- the name of the pond or facility
- the City of Toronto name plate and logo.

Public awareness signage should be erected at the entrances to the pond block or maintenance access route at prominent locations that are highly visible to the public. The purpose of this signage is to identify the site as a stormwater management facility and raise public awareness of the functional aspects and related potential hazards of the facility.

Public awareness signage will be provided by Toronto Water. An example of dry pond signage is shown in Figure 2-16, and wet pond signage is shown in Figure 2-17.

Figure 2-16: Dry pond signage – City of Toronto

Contact Transportation Services, Signs and Markings supervisor of sign manufacturing located at 40 Toryork Drive to order a sign.

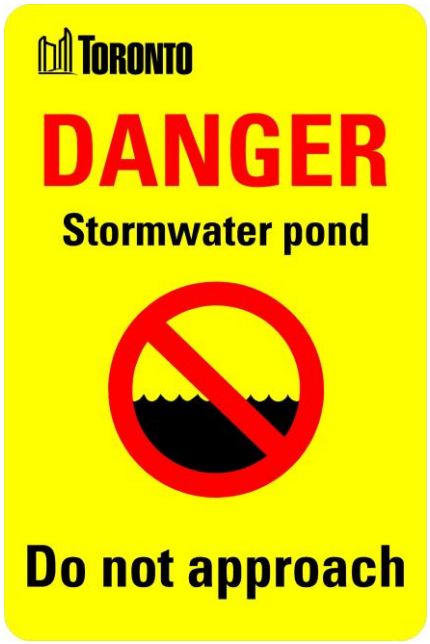

Figure 2-17: Wet pond signage – City of Toronto

Water Level Indicators

Water level indicators are required around the perimeter of the detention or retention facilities to make the public aware of the extent of area subject to inundation during storm events. For examples of water level indicators, see Figure 2-18 and Figure 2-19. Especially high water indicators should include

- strategically located trees of a specific species
- boulder clusters
- permanent markings on headwalls.

Figure 2-18: Water level markings on outlet structure – Conlins pond

Figure 2-19: Water level markings on inlet structure – Malvern 10A pond

Barrier Plantings

Barrier plantings are to be used to deter public access to inlets, outlets and outfalls, plunge pools and deep water areas as shown in Figure 2-20.

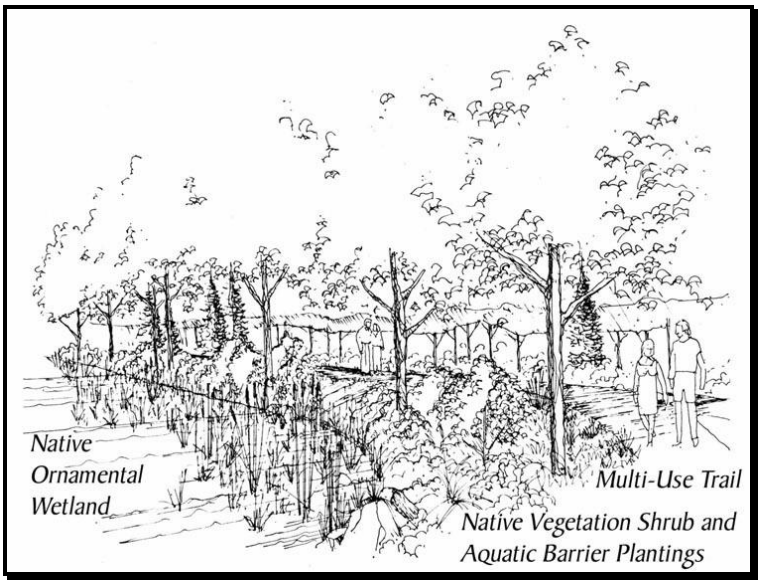

Figure 2-20: Barrier planting [1]

1. City of Hamilton, Landscape Design Guidelines for Stormwater Facilities – May 2009.

Chapter 3 – Design Review and Pond Assumption Procedure

In order to build a stormwater pond to meet the City's perspectives, it becomes necessary that developers and consultants understand the design review and post construction assumption procedure. The general development application process is described in the *Building Toronto Together – A Development Guide*, which is on the City's website. The specific procedure for the design review and assumption of stormwater management ponds is addressed in this chapter.

Submission and Approval of Landscaping Plans

Submission Requirements

Landscape plan submissions must be prepared in accordance with the following requirements:

The engineering drawings, calculations and stormwater management report submission is described in the Building Toronto Together – A Development Guide. The landscaping plan submission is the main focus of this document.

1 All landscape plans are to be prepared and sealed by a landscape architect having full membership in the Ontario Association of Landscape Architects.

2 All landscape grading is to be coordinated with the site grading, subdivision grading and drainage plans.

3 All landscape plans are to be prepared in metric and folded to 8.5 x 11 inches.

Information on landscape site plans will include the following:

- key plan
- north arrow
- scale
- existing and proposed contours
- surveyed top of bank
- bottom of bank
- limits of TRCA floodline
- ravine and naural features protection boundary
- adjacent roads and properties
- finished floor elevations of adjacent buildings
- location and extent of underground structures and services
- surveyed locations and descriptions of all trees on site and within 15 m on adjacent lands
- surveyed locations and descriptions of all trees including dripline and tree protection zone on site and within 15 m on adjacent lands
- surveyed locations and descriptions of all natural features on site and within 15 m on adjacent lands
- existing trees including dripline and tree protection zone to be protected on site and within 15 m on adjacent lands
- location and design details including cross-sections and profiles for all proposed watercourses realignments if applicable
- location of proposed tree protection hoarding
- existing trees to be transplanted
- existing trees to be removed
- new plantings keyed to plant list
- seeded areas and seed mixed
- locations of barley straw bag installation for algae control
- locations of all ground signs
- details for all planting, paving, fencing, structures and railings, and so on
- location and description of seed bank including donor and recipient sites
- vegetation monitoring plan, and
- receiving watercourse erosion mitigation contingency plan

The detailed landscape plan submission will be reviewed by City staff to ensure conformity with the guidelines set out in this document and once approved; the drawings will be incorporated into the subdivision agreement.

Approval Process

Stormwater management ponds have the potential to be integral and complementary components of a community. Planning approaches that address stormwater management ponds as potentially valuable components of the community open space system are consistent with the vision and principles of the City. A well executed open space network that includes stormwater management ponds has been proven to enhance the marketability of a development by establishing a character for the community and increasing the range of available amenities. In considering the design and landscape of the open space network, emphasis should be placed on establishing a seamless system of spaces with complementary uses built upon the existing natural features of the site.

Consistent with the general submission requirements, opportunities to explore landscape-based stormwater management ponds should be addressed as part of various types of development applications including:

- official plan amendment, secondary plan and large infill development applications
- plans of subdivision
- site plan applications

The general development submission and approval process is addressed in *Building Toronto Together – A Development Guide*. The stormwater management pond design and stormwater management report shall be submitted and reviewed by following the process as illustrated in Figure 3-1.

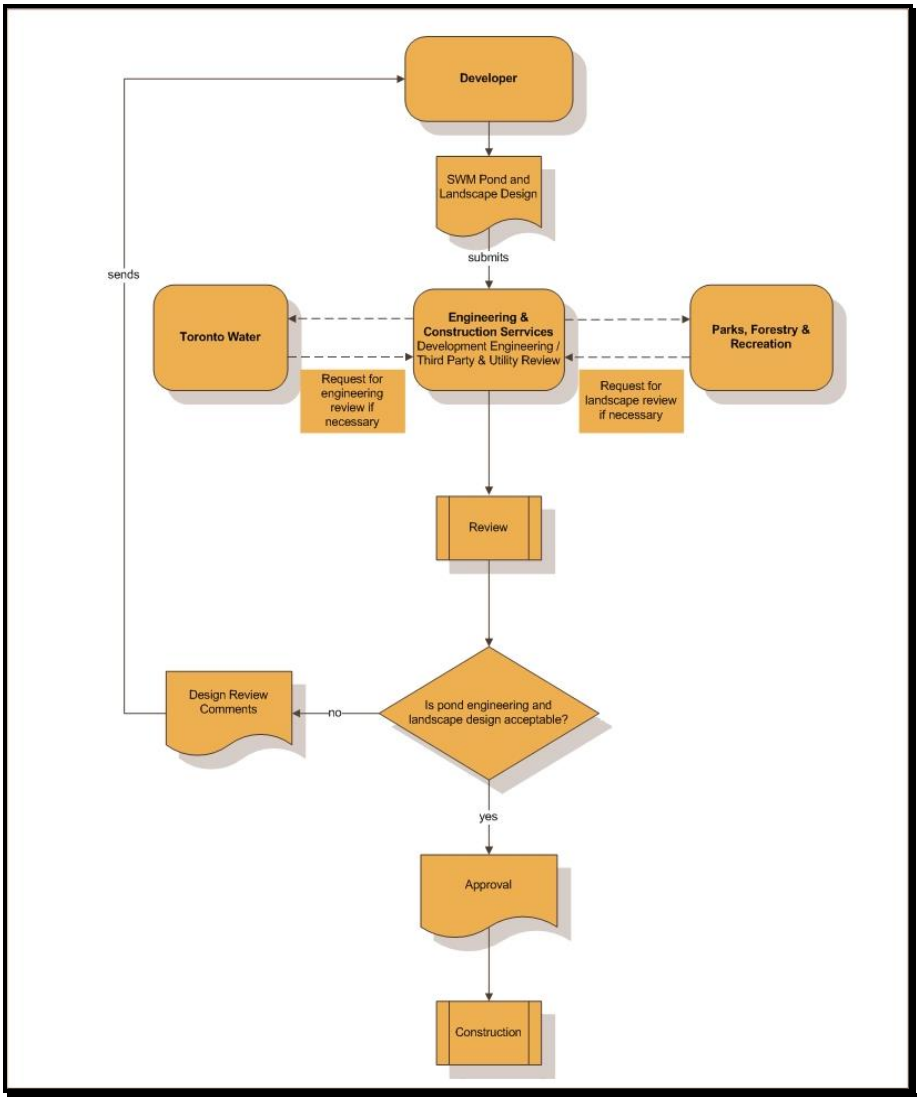

Figure 3-1: Landscaping design review process

Assumption of Stormwater Management Ponds

The developer is required to maintain the stormwater management pond until the time of assumption by the City. The entire assumption procedure for ponds and landscaping is shown in the Figure 3-2.

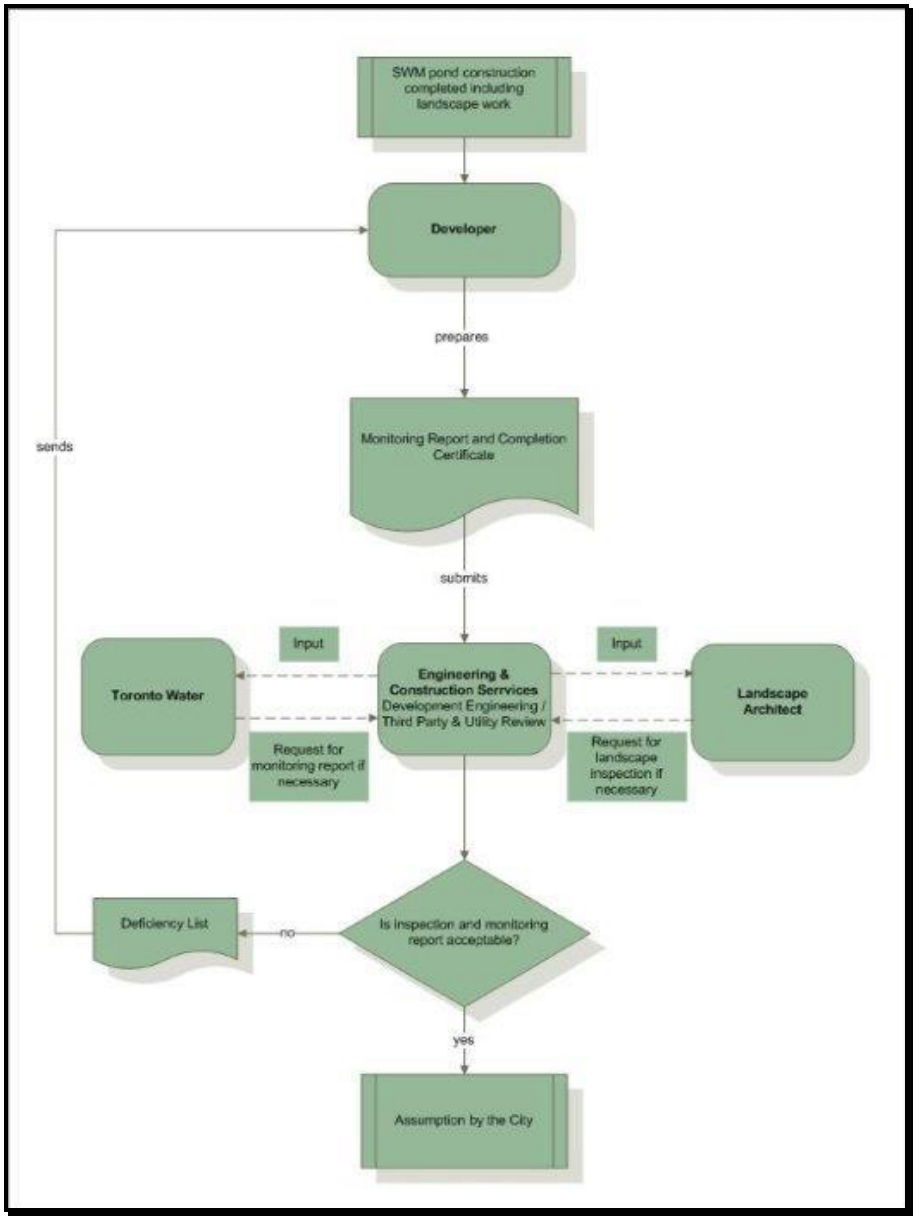

Figure 3-2: Stormwater management pond assumption process

There are five main steps to the process for assumption of stormwater management pond landscaping as follows:

1 Once landscaping is in place, a Completion Notification Certificate must be submitted by the landscape architect and a monitoring program must be completed within the first year. Monitoring reports must be submitted to the Engineering Review section for review on an annual basis.

   Following the developer's submission of a request for assumption and monitoring report, the Engineering Review section will arrange for an inspection of the landscaping to verify that the landscaping has been installed in conformity with the approved site and landscape plans.

2 A list of deficiencies noted during the site inspection will be forwarded to the landscape architect.

3 The developer and landscape architect will rectify the deficiencies and notify the Engineering Review section that such work is complete.

4 The Engineering Review section will coordinate a final inspection of the stormwater management pond landscaping and sign-off on the stormwater management pond landscape component if all identified deficiencies are rectified.

5 Note that final landscape inspections will only be conducted between June 1 and September 30 to ensure that vegetation can be inspected when it is in leaf.

Inspection and Maintenance Activities

After any pond maintenance activities, the plantings shall be maintained or replaced according to the original design. The following list describes the inspection and maintenance activities for stormwater management pond landscape components at the time of assumption and for the regular inspection and maintenance routine:

Routine Inspection

After every major storm event to ensure stability and function of the facility, approximately four times annually.

Litter Removal

Remove all litter from the site on a monthly basis during the period from March to December. This task includes the removal of litter and debris from the permanent pool and sediment forebay.

Vegetation Communities

Tree and Shrub Maintenance

- Ensure rodent protection remains in contact with the ground.
- Prune out any dead or damaged limbs.
- Water trees as required to maintain health considering meteorological, soil and site conditions as well as species requirements.

Seeded Area Maintenance

- Monitor after initial seeding to ensure that adequate cover density has been achieved.
- Overseed as required to eliminate bare patches.
- Repair and reseed any rills or gullies which may form during the grow-in period.
- Remove weeds which may have become established during the germination and grow-in periods.
- Monitor to ensure that established species correspond with specified seed mix species composition. Overseed as required to achieve specified composition and distribution.
- For areas designed to be maintained, mow to maintain a height of 60–75 mm.
- Irrigate seeded areas as required to ensure germination and establishment.

Shrubs and Shrub Bed Maintenance

- Prune out dead or damaged branches.
- Remove weeds from mulched beds.
- Water shrubs as required to ensure healthy growth in consideration of soil, meteorological and site conditions as well as species requirements.

Algae Control

Install barly straw bags in spring of each year and year of assumption.

Other Landscape Components

Rock works and natural stone flow control structures and spillways:

- Overseed as required ensuring that adequate vegetation cover is established in the voids between the stone.
- Adjust grades if required to achieve specified water levels.

Fences, Signage and Furnishings

Repair activities are to include the following as necessary, such as removal of graffiti, touch up painting, replacement or tightening of loose hardware, ensuring all elements are securely anchored, inspect and repair as required.

Monitoring Requirements

With respect to the landscape components of stormwater management facilities, the monitoring program is focused on gauging the sustainability, performance and evolution of the vegetation community to identify remedial maintenance activities that may be required. A description of the recommended monitoring program is provided in the following section.This recommendation applies to monitoring by the developer before assumption and ongoing monitoring by the city after assumption.

Vegetation Community Monitoring Program

Tree and shrubs shall be inspected visually to identify dieback, stress or presence of disease every two years. One inspection in spring after leaf out and one inspection in fall after leaf drop.

Aquatic vegetation shall be inspected visually to confirm desired species composition bi- annually, in the middle of the summer.

Ground cover shall be inspected visually to confirm adequate cover and desired species composition, bi-annually, once in spring and once in late summer.

Undesirable species shall be inspected visually bi-annually in the middle of summer and in early fall.

Erosion Monitoring Program

The erosion and displacement shall be inspected visually by bi-annually, once in spring, and once in fall at the components below:

- spillway
- trails, if any
- maintenance access roads

Photographic Inventory

Photographs should be taken twice yearly corresponding with the spring and fall monitoring sessions. Photographs should be taken from fixed locations that are identified on a site map and should include photographs of the inlet and outlet structures, overflow spillway, trails and maintenance access routes and key components of the vegetation community as well as any noted deficiencies.

Subsequent photographic sessions should include areas where deficiencies were previously identified to document the effectiveness of the remedial works. Each photograph should be annotated with a description of the subject matter.

The photo inventory package should be bound with a key map and digital photographs on a compact disc. This documentation should form part of the monitoring report for the site that will be submitted to the City as a condition of assumption of the facility.

Reporting

Monitoring reports must be submitted to the Engineering Review section for review on an annual basis. Reports should include the following information:

- pond name, location, street address and reference number
- date of completion of construction
- date of expiration of warranty period
- general description of the facility
- observations related to water quality, presence of wildlife
- general pond conditions
- statement of water quality

- summary of findings of monitoring inspections
- comparative analysis of data and evaluation in comparison to original design objectives and previous monitoring findings
- summary of physical status of various components of the facility including vegetation community, inlet and outlet structures, maintenance access routes and other components
- summary of facility performance including explanation of any discrepancies between performance of the vegetation community, that is survival, degree of invasive colonization, and so on
- photographic inventory
- key map that documents photograph locations and the locations of any issues of concern identified

Where the performance of a vegetation community or other landscape components such as the establishment of groundcover remains deficient over an extended time period, recommendations for remediation of deficencies to the facility should be made and submitted for review and approval by the City along with an estimate of the cost of the improvements. The improvements should be implemented immediately upon receipt of approval from City, and must be compeleted prior to assumption of the facility. The monitoring program must continue after the improvements are implemented until it is confirmed that targets are being achieved over two successive monitoring years.

Effective monitoring is essential to ensure that stormwater management objectives are achieved. This will in turn contribute to the sustainability of the Don River, Humber River, Etobicoke Creek, Highland Creek and Rouge River watersheds.

Data Inventory

The proponent should conduct the monitoring program until assumption of the facility by the City. All the information including as-built drawings, monitoring reports and wellness report will be collected and submitted to Toronto Water, Water Infrastructure Management section and added into the Division's stormwater management pond geodatabase.

After Assumption

Once the stormwater management pond is assumed, Toronto Water will carry on an operations and maintenance program. The specific landscape activities will follow what is described in the "Inspection and Maintenance Activities" section on page 50. The remaiing operation and maintenance activities will follow the stormwater pond operation and mainenance manual submitted as part of the final submission or as-built package. If any landscape monitoring program is required to continue, the detailed procedure will be the same content as the "Monitoring Requirements" section on page 52.

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Appendix A – Acceptable Plant Species for Stormwater Management Ponds

Item	Plant Type	Common Name	Scientific Name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Notes
TERRESTRIAL	**Tree**	Red Maple	*Acer rubrum*			•	•	•	
		Silver Maple	*Acer saccharinum*			•	•	•	
		Sugar Maple	*Acer saccharum spp.saccharum*					•	
		Bitternut Hickory	*Carya cordiformis*					•	
		Shagbark Hickory	*Carya ovata*					•	
		American Larch	*Larix laricina*				•	•	not *L. decidua*
		White Spruce	*Picea glauca*				•	•	
		Eastern White Pine	*Pinus strobus*					•	
		Balsam Poplar	*Populus balsamifera*				•	•	
		Trembling Aspen	*Populus tremuloides*					•	
		Wild Black Cherry	*Prunus serotina*					•	
		Bur Oak	*Quercus macrocarpa*				•	•	
		Northern Red Oak	*Quercus rubra*					•	
		Peach-leaved Willow	*Salix amygdaloides*			•	•	•	not *S. alba* or *S. fragilis*
		Black Willow	*Salix nigra*			•	•		not *S. alba* or *S. fragilis*
		White Cedar	*Thuja occidentalis*			•	•	•	
	Shrub	Speckled Alder	*Alnus incana*		•	•	•		not *A. glutinosa*
		Downy Serviceberry	*Amelanchier arborea*				•	•	not *A. canadensis*
		Allegheny Serviceberry	*Amelanchier laevis*				•	•	not *A. canadensis*
		Common Buttonbush	*Cephalanthus occidentalis*		•	•	•		
		Gray Dogwood	*Cornus racemosa*				•	•	
		Red Osier Dogwood	*Cornus sericea (stolonifera)*			•	•	•	
		Common Winterberry	*Ilex verticillata*			•	•		
		Black Chokeberry	*Photinia (Aronia) melanocarpa*			•	•		
		Common Ninebark	*Physocarpus opulifolius*			•	•		

Item	Plant Type	Common Name	Scientific Name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Notes
TERRESTRIAL	**Shrub (continued)**	Chokecherry	*Prunus virginiana*					•	
		Staghorn Sumac	*Rhus typhina*					•	
		Bebb's Willow	*Salix bebbiana*			•	•		
		Pussy Willow	*Salix discolor*			•	•		not *S. caprea*
		Heart-leaved willow	*Salix eriocephala*			•	•		
		Sandbar Willow	*Salix exigua*			•	•		
		Shining Willow	*Salix lucida*			•	•		
		Slender Willow	*Salix petiolaris*			•	•		
		Common Elderberry	*Sambucus canadensis*			•	•	•	
		Narrow-leaved Meadowsweet	*Spiraea alba*			•	•		
		Nannyberry	*Viburnum lentago*				•	•	not *V. opulus*
		Highbush Cranberry	*Viburnum trilobum*			•	•		not *V. opulus*
	Herbaceous	New England Aster	*Symphyotrichum (Aster) novae-angliae*			•	•		
		Canada Wild Rye	*Elymus canadensis*			•	•		
		Joe Pyeweed	*Eupatorium maculatum*			•			
		Common Boneset	*Eupatorium perfoliatum*			•			
		Blue vervain	*Verbena hastata*			•			
AQUATIC	**Submergent**	Water Starwort	*Callitriche hermaphroditica*	•					
		Common Hornwort	*Ceratophyllum demersum*	•					
		Broad Waterweed	*Elodea canadensis*	•					
		Northern Water-milfoil	*Myriophyllum sibiricum*	•					not *M. spicatum*
		Slender Pondweed	*Potamogeton pusillus*	•					
		Tape Grass	*Vallisneria americana*	•					
	Floating	Yellow Pond Lily	*Nuphar lutea ssp. variegata*	•					
		White Water Lily	*Nymphea odorata ssp. odorata*	•					not *N. odorata* cultivars
		Large-leaved Pondweed	*Potamogeton amplifolius*	•					
		Floating Pondweed	*Potamogeton natans*	•					

Item	Plant Type	Common Name	Scientific Name	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Notes
AQUATIC	**Robust Emergent**	Bulrushes	*Schoenoplectus spp.*		•				
			Scirpus spp.		•				
		Broad-leaf Cattail	*Typha latifolia*		•				not *T. angustifolia or T. x glauca*
	Broadleaved Emergent	Common Water Plantain	*Alisma plantago-aquatica*		•				
		Broadleaf Arrowhead	*Sagittaria latifolia*		•				
	Narrowleaved Emergent	Sedges	*Carex comosa*		•				
			Carex crinita		•				
			Carex lacustris		•				
			Carex pseudocyperus		•				
			Carex retrorsa		•				
			Carex stricta		•				
			Carex vulpinoidea		•				
		Grasses	*Calamagrostis canadensis*		•				
			Glyceria spp.		•				not *G. maxima* or *G. plicata*
			Leersia spp.		•				
		Burreed	*Sparganium spp.*		•				

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Appendix B – Wet Ponds: Summary of Design Guidance

Table: Wet ponds: summary of design guidance[1]

Design element	Design objective	Minimum criteria	Preferred criteria
drainage area	volumetric turnover	5 ha	$\geq$ 10 ha
treatment volume	provision of appropriate level of protection (see Section 3.3.1.1)	as per table 3.2	1. Permanent pool volume increase by expected maximum ice volume. 2. Active storage increased from 40 m^3/ha to 25% of total volume.
active storage detention	suspended solids	24 hrs (12 hrs if in conflict with minimum orifice size)	24 hrs
forebay	pre-treatment	minmum depth: 1 m sized to ensur non-erosive velocities leaving forebay maximum Area: 33% of total permanent pool	mimimum depth: 1.5 m maximum volume: 20% of total permanent pool
length-to-width ratio	maximize flow path and minimize short-circuiting potential	overall:minimum 3:1 (may be accomplished by berms, etc) forebay: mimimum 2H:1V	from 4H:1V to 5H:1V
permanent pool depth	minimize resuspension, avoid anoxic conditions	mimimum depth: 3 m mean depth: 1 m – 2 m	mimimum depth: 2.5 m mean depth: 1 m – 2 m

Table: Wet ponds: summary of design guidance (continued) [1]

Design element	Design objective	Minimum criteria	Preferred criteria
active storage depth	storage/flow control	water quality and erosion control: maximum 1.5 m total (including quantity control): 2 m	water quality and erosion control: maximum 1 m total (including quantity control): 2 m
side slopes	safety maximize the functionality of the pond	5H:1V for 3 m on either side of the permanent pool maximum 3:1 elsewhere	7H:1V near normal water level plus use of 0.3 m steps 4H:1V elsewhere
inlet	avoid clogging/ freezing	mimimum: 450 mm preferred pipe slope: > 1% if submergent, obvert 150 mm below expected maximum ice depth	
outlet	avoid clogging/ freezing	minimum: 450 mm pipe reversed sloped pipe should have a minimum diameter of 150 mm preferred pipe slope: > 1% if orifice control used, 75 mm diameter minimum	minimum 100 mm orifice
maintenance access	access for backhoes or dredging equipment	provided to approval of municipality	provision of maintenance drawdown pipe

Table: Wet ponds: summary of design guidance (continued) [1]

Design element	Design objective	Minimum criteria	Preferred criteria
sediment drying area	sediment removal	while preferable, should only be incorporated into the design when it imposed no additional land requirement	to be provided above maxium water quality water level drainage returned to pond
buffer	safety	minimum 7.5 m above maximum water quality/erosion control water level minimum 3 m above high water level for quantity control	

1. Ontario Ministry of the Environment, Stormwater Management Planning and Design Manual, Table 4.6, 2003.

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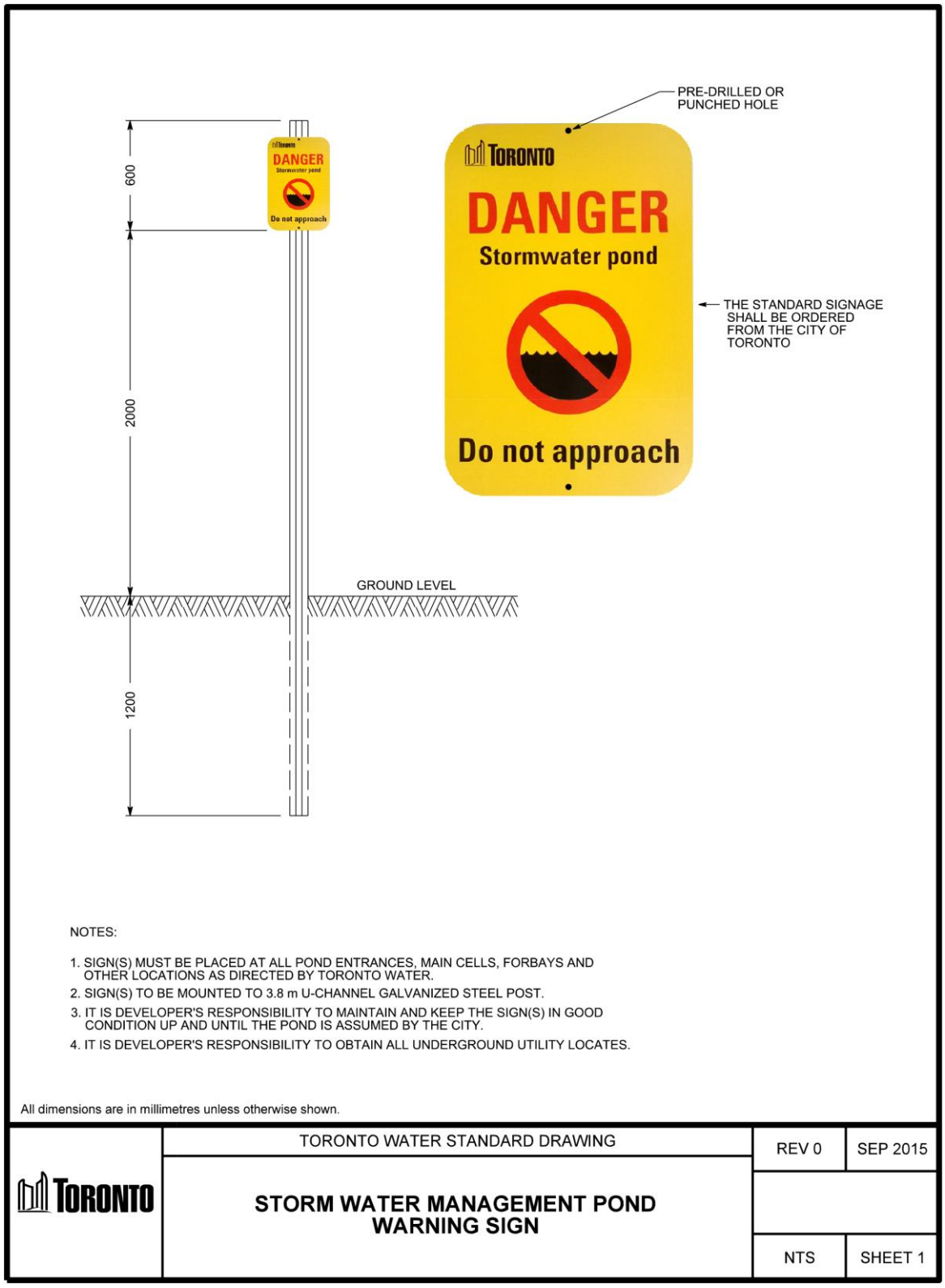
Appendix C – Pond Warning Sign



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By A.J. Clarke and Associates Limited. Published by City of Hamilton, 71 Main Street West, Hamilton, Ontario, L8P 4Y5, 2006.

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By Strategic Communications, City Manager's Office. Published by City of Toronto, 55 John Street, Toronto, Ontario, M5V 3C6, 2009.

Glossary

Aquatic – Relating to or consisting of or being in water.

Applicant – The owner of lands or his or her authorized agent requiring services.

BMP or Best Management Practices – State of the art methods or techniques used to manage the quality and improve the quality of wet weather flow. BMPs include source controls, conveyance controls and end-of-pipe controls.

City – The City of Toronto—the corporation—and will be referred to as the City for the purposes of this document.

Consulting Engineer – A professional engineer or firm of engineers retained by the City or a developer, skilled, and experienced in municipal work and land development projects and registered with the Professional Engineers of Ontario.

Dry Pond – An extended pond is dry during the period without rainfall or snow melt. During rainfall or snowmelt period, the pond will be flooded to store the surface runoff.

Developer – The owner of land upon which municipal services will be located and ultimately owned by the City.

Ecosystem – A community of living organisms such as human, plants, animals and microbes in conjunction with the non living components of their environment, for instance air, water and mineral soil, interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can come in any size but usually encompass specific, limited spaces—although some scientists say that the entire planet is an ecosystem.

End-of-Pipe – A structural Best Management Practice that is located at the end of a flow conveyance route, before stormwater enters into the natural water systems, such as creeks, rivers, lakes, groundwater. End-of-Pipe controls on surface and below ground but are not limited to wet ponds, constructed wet lands and other similar systems.

Erosion – The wearing away of the land surface by running water, wind, ice or other geologic agents, including such processes as gravitational creep or detachment and movement of soil or rock fragments by water, wind, ice or gravity.

Fluvial – is used in geography and Earth science to refer to the processes associated with rivers and streams and the deposits and landforms created by them.

General Manager – The person appointed by the City from time to time as the General Manager of Toronto Water and his or her successors or his or her duly authorized representative.

Geomorphology – is the scientific study of landforms and the processes that shape them. Geomorphologists seek to understand why landscapes look the way they do, to understand landform history and dynamics, and to predict future changes through a combination of field observations, physical experiments, and numerical modeling. Geomorphology is practiced within geography, geology, geodesy, engineering geology, archaeology, and geotechnical engineering, and this broad base of interest contributes to a wide variety of research styles and interests within the field.

Groundwater – Underground water that is held in the soil and in pervious rocks.

Habitat – The type of environment in which an organism normally lives.

Indigenous – produced, growing, living, or occurring naturally in a particular region or environment.

Inlet Structure – a device which controls the volume of discharge to the municipal storm water pond.

Inundation – The rising of a body of water and its overflowing onto normally dry land.

Invasive Species – Any non-indigenous species, or non-native, plants or animals. They adversely affect the habitats and bioregions they invade economically, environmentally, or ecologically, or both,

Landscape Design – is an independent profession and a design and art tradition, practised by landscape designers, combining nature and culture. In contemporary practice landscape design bridges between landscape architecture and garden design.

Landscape Architect – A professional registered in the province of Ontario, who develops land for human use and enjoyment through effective placement of structure, vehicular and pedestrian ways, and plantings, also landform, grading, surface treatment.

MOECC – Ministry of Environment and Climate Change

Offical Plan – The Offical Plan adopted by the City. It is a blueprint for how the City will grow over the next 30 years.

OPSD – Ontario Provincial Standard Drawing

Owner – A person who has any right, title, estate, or interest in a property, other than that of only an occupant and, where that person is a corporation, shall include the officers, directors and shareholders of that corporation, and shall include any person with authority or power over or control of that property on the behalf of an owner. An owner includes a developer.

Pruning – Pruning is a horticultural practice involving the selective removal of parts of a plant, such as branches, buds, or roots. Reasons to prune plants include deadwood removal, shaping by controlling or directing growth, improving or maintaining health, reducing risk from falling branches, preparing nursery specimens for transplanting, and both harvesting and increasing the yield or quality of flowers and fruits. Pruning must be undertaken in accordance with current arboricultural standards, and to the satisfaction of Urban Forestry.

Riparian Vegetation – Riparian is also the proper nomenclature for one of the fifteen terrestrial biomes of the earth. Plant habitats and communities along the river margins and banks are called riparian vegetation, characterized by hydrophilic—water loving— plants.

Stormwater – Surface runoff resulting from rain or snowmelt events.

Stormwater Management Pond – A land depression or impoundment created for the detention or retention of stormwater runoff.

Subwatershed – The drainage area of one or more contributing watercourses to a river.

Swales – An open conveyance system designed to carry minor flows, usually lined with shrubs, grasses or rip-rap or both.

Watershed – The drainage area of a river, stream, creek and so on.

Wet Ponds – The most common end-of-pipe stormwater management facility employed in the province of Ontario. Wet ponds can be designed to efficiently provide for water quality, erosion and quantity control, reducing the need for multiple end-of-pipe facilities. Wet ponds can be designed with extensive landscaping and associated recreational amenities, contributing to the character of the community and enhancing its marketability.

Wetland – is an area of land whose soil is saturated with water either permanently or seasonally. A vegetated area such as a bog, fen, marsh, or swamp, where the soil or root zone is saturated for part of the year.

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