TOWN OF AJAX

DESIGN CRITERIA

SECTION C

STORMWATER MANAGEMENT AND STORM DRAINAGE

C 1.00 AJAX STORMWATER MANAGEMENT AND STORM DRAINAGE CRITERIA OVERVIEW

The following represents a general overview of the guiding principles and parameters for the design of stormwater management and drainage systems in the Town of Ajax.

- All newly developing or redeveloping areas must assess their potential impacts on local and regional flooding (minor and major events), and mitigate accordingly,
- All stormwater system design will be in accordance with provincial doctrine on stormwater management (SWM),
- All stormwater system design for water quality shall be in accordance with the 2003 (or most current) Ministry of the Environment Stormwater Management Planning and Design Manual (SWMP),
- Design shall consider the entire uncontrolled drainage area and external flows,
- Minor systems shall incorporate a 5 year return event and shall provide for direct connection of front and rear roof leaders and foundation drains to the minor system,
- Major systems are to be designed to address the 100 year storm or the regulatory flood, whichever is greater,
- For retrofit and brownfields developments, where the minor system has not been designed to accommodate the direct connection of foundation drains and roof leaders, foundation drains are not to be directly connected to the minor system and roof leaders shall be directed to splashpad located in landscaped areas.

C 1.01 STORM DRAINAGE POLICY

C 1.02 QUANTITY CONTROL

FLOOD MANAGEMENT CRITERIA

All newly developing or redeveloping areas must assess their potential impacts on local and regional flooding (minor and major events), and mitigate accordingly.

DESIGN

In areas where no Watershed or Sub-watershed Planning or Sub-watershed Impact Study has been completed, it is the policy of The Town to require that runoff peak flows are controlled to pre-development levels for the 2 year through 100 year events. Before the town will accept any increase in runoff rates, it must also receive endorsement from the other agencies having jurisdiction.

Where the Sub-watershed Plans or Sub-watershed Impact Studies have been completed, the Owner will be required to comply with the recommendations of the specific plan. Any variations will need to be appropriately supported by detailed analysis and also be approved by any agencies having jurisdiction.

All design submissions shall contain a statement from the designer indicating which Best Management Practices have been reviewed and utilized in the design of the Stormwater management system for the proposed development.

Any design of a flood management system involving the determination of peak flows or runoff volume needs to be supported with acceptable hydrologic calculations using rainfall information from the Town. The following criteria would apply:

- Only hydrologic models currently approved by the MNR and/or the local Conservation Authority (CA) will be considered acceptable.
- Consideration will be given to the type of design methodology utilized depending upon the size and type of the site. Generally, approved computer models will be preferred.
- The Town's IDF information and design storms are to be used. Refer to the tables at end of this section.
- Storm sewers and open channels shall be designed using the Rational Formula; all other flood management components will require a hydrograph technique.

C 1.03 EROSION CONTROL

CRITERIA

Depending on the downstream water level and the nature of the soil strata affected, stream banks can be subject to increased erosion potential as a result of development. In these cases the proponent(s) will be required to provide appropriate protection in accordance with the Watershed or Sub-watershed Plans or with local drainage studies, as well as policies of the Conservation Authority and the Town’s Sediment and Erosion Control by-law.

In areas where no Sub-watershed Plan exists, it shall be the responsibility of the Owner to provide adequate erosion protection in accordance with Provincial Guidelines and the Town’s Sediment and Erosion Control by-law.

DESIGN

Erosion Control and management involves:

- Extended Detention storage for the 25 mm rainfall event as outlined in the Provincial Guidelines (refer to SWMP, 2003), in the absence of specific direction from a Sub-watershed or Watershed Plan, in conjunction with the respective Conservation Authority Criteria.
- Assessment of downstream erosion susceptibility and critical flow values in conjunction with event modeling.
- Assessment of downstream erosion critical velocity or shear forces in conjunction with continuous simulation techniques (duration analysis)

In areas where the downstream receiving watercourse is determined to be unstable, or where control/over control of flow rates is ineffective or not feasible, design of channel alterations may be considered, subject to design in accordance with natural channel design principles (refer to Ministry of Natural Resources, 2001, or most current).

Storm sewer outfalls in natural channels shall provide proper protection against erosion which includes appropriate bank scouring protection on either side of the outfall and creek. When storm sewer outfalls outlet to steep and/or deep valleys, drop structures should be designed in such a manner as to provide integral bank stability. Such local erosion protection measures shall be designed so as not to interfere with the natural channel forming processes of the receiving watercourse system. All designs shall incorporate the Ministry of Natural Resources and Conservation Authority criteria

C 1.04 CONVEYANCE SYSTEM (I) MAJOR SYSTEM

CRITERIA

Flows in excess of the minor system capacity (i.e. during periods of surcharging or higher intensity events) are referred to as **major system** flow. The major system inherently comprises the minor system, as well as the overland route followed by runoff not captured by the minor system (i.e. either due to excessive flow or operational failures). Common elements of the major system include natural streams, valleys, swales, ponds, roadways, dedicated blocks and drainage channels.

The level of protection should be established based the nature of the area drained (i.e. risk to loss of life and property damage).

DESIGN

The Town supports the policies of the Conservation Authorities, which generally require that no new building be subject to flood damages from the Regulatory flood as per the revised Technical Guidelines for Flood Plain Management in Ontario (February, 1986). The Regulatory flood is the greater of the Hurricane Hazel flood (transposed), modeled 100 year flood, observed flood, or frequency-based 100 year flood.

No development, other than necessary access or services, should intrude upon Hazard Lands without the approval of the Conservation Authority, and the Town of Ajax. In conjunction with this objective, the Town shall require the Owner to delineate floodplains in a proposed development resulting from the 100 year and Regional Storm for both the pre- and post-development conditions.

Major overland flooding shall be conveyed within the right-of-way (ROW) of the road during a 100 year event. Blocks dedicated through ownership to the Town will be required to convey the 100 year overland flow from roadways to open watercourse systems. These blocks shall be designed for stability and safety to the satisfaction of the Town of Ajax. Piping of the 100 year event is not generally permitted and only under extreme circumstances will the Manager of Engineering permit this.

C 1.05 CONVEYANCE SYSTEM (II) MINOR SYSTEM

CRITERIA

The **minor system**, handles urban drainage from relatively "minor" storms having a frequency (return period) of 5 years. These works typically consist of drainage pipes, roadway gutters and swales, enclosed conduits and roof leaders. Their purpose is to prevent frequent flooding which may "inconvenience" motorists, home and business owners, and pedestrians.

The Town will not allow development to proceed until adequate provision, in the form of storm sewers has been made available. Rural development will also require adequate provision for storm drainage, however it may not require storm sewers.

DESIGN

The minor system, comprising street gutters, catch basins and storm sewers, shall be designed to a 1 in 5 year un-surcharged standard. The pipe shall be designed to not exceed 80% for the

1 in 5 year event. In some higher value commercial areas, the criteria may be increased to 1 in 10 year floods at the direction of the Town of Ajax Engineering Section.

Foundation drains are directly connected to the storm sewers when an entirely new system is designed. The system is to be designed to accept the direct connection of front and rear roof leaders, however only the front roof leaders will be connected at the time of construction, unless otherwise directed**.**

Retrofit and brownfields projects will consider direct connection of the roof leaders and foundations drains on a site specific basis, but this generally will not be permitted. For those projects, there will be no direct connection of foundation drains or roof leaders to the minor system. Sump pumps will be required in the basements with the approval of the Manager of Engineering.

C 1.06 QUALITY MANAGEMENT

CRITERIA

Water quality treatment will be required for all new development within The Town. Water quality treatment performance shall conform to Provincial requirements (refer to SWMP, 2003, Water Management Policies, Guidelines Provincial Water Quality Objectives (Blue Book), MOEE, 1994).

In areas of existing development where re-development is proposed, provisions for water quality measures will be evaluated on a site-specific basis, based on the feasibility of implementation. Where on-site measures are considered infeasible, the Town may consider the potential for contributions to off-site improvements (i.e. cash-in-lieu).

In areas where a Sub-watershed Plan has been prepared and approved, the guidelines and criteria cited within the plan shall be adopted by the Owner.

DESIGN

Specific guidelines for Stormwater Management Plan applications have been developed by the Province based on the type of fisheries habitat downstream of the proposed development.

Three levels of protection are given, with the goal to maintain or enhance existing aquatic habitat based on the suspended solids removal performance for the different end-of-pipe stormwater management facilities developed in the continuous simulation modeling. These levels of protection are based on a general relationship between the end-of-pipe stormwater management facilities long-term suspended solids removal and the lethal and chronic effects of suspended solids on aquatic life. All systems shall be designed for the long-term removal of 80% of suspended solids.

As a general consideration, maintenance of the natural hydrologic cycle including infiltration is encouraged where soil conditions permit. Therefore the use of stormwater management practices which enhance or maintain infiltration should be considered for each development. Generally active infiltration measures will be applicable in permeable soils areas only and their use will require supporting soils documentation. Passive measures such as disconnection of rear roof leaders have been historically utilized in many areas and should be implemented as a matter of course in all areas unless specific constraints preclude theses measures.

In all cases the potential for groundwater contamination shall be considered, particularly where infiltration of road runoff is contemplated.

In areas where hydrogeologic concerns are identified and/or critical linkages to fisheries habitat are present, additional study and analysis may be required to determine the appropriate level of mitigation.

OPERATIONS AND MAINTENANCE MANUAL

A separate operation and maintenance report for the stormwater management facility with the following details shall be submitted as part of the engineering submission.

(a) The method and procedure for draining the forebay during maintenance.

(b) The techniques in removing the sediment from the facility including drying location.

(c) The procedure in diverting the storm flow away from the forebay during maintenance.

(d) The annual loading rate and the estimate sediment accumulation in the facility.

(e) The frequency when the facility must be cleaned.

(f) The inspection checklist, procedures and frequency of inspections.

(g) A description of the pond features, draw down time and how the pond operates under the various storm events.

(h) Estimated annual maintenance costs.

PERPETUAL MAINTENANCE FEE

A perpetual fee for the purpose of maintaining the stormwater management facilities shall be submitted to the Town prior to registration of the development. Please refer to the current Town of Ajax Fees By-law for the applicable rate.

C 1.07 STORMWATER QUANTITY AND QUALITY CONTROL TECHNIQUES

GENERAL

Current stormwater management practice advocates the consideration of SWM practices on a hierarchical basis whereby more pro-active techniques are considered first. The SWM practices are grouped under the following headings in order of preferred application.

i. Lot Level Techniques and Source Controls and Alternative Development Standards

ii. Transport or Conveyance Controls

iii. End-of-Pipe Management Techniques

The philosophy behind this hierarchy is that stormwater management techniques are usually more effective when applied at the source. Table C1 constitutes a comprehensive list of currently available techniques associated with each of the foregoing categories. It is recognized that stormwater management remains an emerging science, hence this list will change over time. It will be the responsibility of the proponent to demonstrate that any technique, not currently approved by the Town, will address the intended function within expected maintenance and cost parameters, to the satisfaction of the Town.

The Town currently endorses the Provincial Standards for stormwater management systems unless otherwise noted herein.

C 1.08 SEDIMENT AND EROSION CONTROL DURING CONSTRUCTION

CRITERIA

New urban developments generally produce increased sediment loading to the surrounding streams particularly during construction. In order to avoid the inherent detrimental side effects from development (i.e. poor water quality and aesthetics, restricted channel conveyance etc.), it is recommended that sediment control measures be instituted. Some of these measures typically include, sediment traps (temporary or permanent), vegetation screens, catch basin filter bags and phased stripping of developable lands. In all cases, it is recommended that sediment loading be controlled as per guidelines published by the local Conservation Authority and "Erosion and Sediment Control Guideline for Urban Construction " 2006.

TABLE C1 COMPREHENSIVE LIST OF AVAILABLE STORMWATER MANAGEMENT PRACTICES	
Stormwater Management Technique	**The Town Perspective**
Alternative Development Standards	Site Specific Consideration
ource Controls	
• Stormwater Retention (Water Balance) Minimize storm water that leaves the site.	Retain at least the first 5 mm from each rainfall through rainwater reuse, on-site infiltration, & evapotranspiration
• roof leader discharge to pervious surface at front and rear of dwelling	Front yard roof leader disconnects not currently endorsed for residential lots with less than a 15m frontage. Rear yard roof leader disconnects are subject to site specific considerations
• roof leader and sump pumps discharge to soakaway pits	Site specific consideration
• rooftop storage	Applicable for peak flow control only in industrial/commercial applications
• parking lot storage	Encouraged where applicable
Conveyance Controls	
• pervious pipe systems	Site specific consideration
• pervious catchbasins	Encouraged where applicable
• grassed swales (semi-urban road sections)	Encouraged where applicable, Site specific consideration
• oversized pipes (Superpipes)	Appropriate in redevelopment of existing areas
End-of-Pipe Facilities	
• wetlands[1]	Applicable for water quality/quantity treatment
• wet ponds[1]	Applicable for water quality/quantity treatment
• dry ponds[1]	Applicable for water quantity control only, Site specific consideration
• infiltration basins	Site specific consideration
• infiltration trenches	Site specific consideration
• filter strips	Only considered appropriate for low density, small drainage areas
• buffer strips	Only considered appropriate for low density, small drainage areas
• oil/grit separators and equivalent systems	Applicable; mandatory for Commercial/Industrial land use; required as part of a stormwater treatment train philosophy regardless of gross site area

DESIGN

As a minimum all Sediment and Erosion Control Plans should incorporate recommendations and protection measures pertaining to:

Construction Scheduling
Minimizing soil exposure and re-establishment of vegetative cover
On-site sediment and erosion techniques
Site Supervision
Monitoring and Maintenance
Site Restoration
Special considerations (i.e. in-stream construction/crossings, fisheries timing constraints)
The OPSD drawings in Section 200 may assist in the erosion and sediment control specifications
Location and protection measures of topsoil stockpile
Sediment and Erosion Control by-law
Location of temporary drainage swales and sediment ponds
Site access and mud tracking control

Please refer to Section L of the Design Criteria for further guidance on this aspect of the land development process.

2.00 WATERSHED AREA

The watershed area shall be determined from contour plans and shall include all lands that naturally drain into the system and any fringe areas not accommodated in adjacent storm drainage systems, as well as other areas which may become tributary by reason of regrading. This information shall be confirmed with the Town prior to the start of the design of the internal servicing of the site.

C 2.01 STORM DRAINAGE PLANS

C 2.02 EXTERNAL AREAS

A plan shall be prepared to a scale of 1:1000 or 1:2000, depending on the size of the watershed area, to show the nature of the drainage of the lands surrounding the development site and to show all external drainage areas that are contributory to the drainage system for the development. The external drainage areas shall be divided into smaller tributary areas and the area and the location to which the tributary area is considered in the design shall be clearly shown. The plan shall clearly show all existing contours used to justify the limits of the external drainage area.

In lieu of precise information on development on the whole or any part of a watershed area, the latest zoning by-law and Official Plans issued by the Planning Department shall be used for all external areas in the design and to determine the specific areas to which these values apply.

This external drainage area plan shall be prepared and shall be submitted to the Town at the functional report stage and prior to the commencement of the detailed storm sewer design.

C 2.03 INTERNAL DRAINAGE PLAN

All internal storm drainage plans shall be prepared to a scale of 1:500 or 1:1000 and shall include all streets, lots, blocks and other lands within the development. The proposed storm sewer system shall be shown on this plan with all manholes numbered consecutively from the outlet.

These manholes shall be the tributary points in the design, and the area contributing to each manhole shall be clearly outlined on this plan. The area, in hectares, of each contributing area (to the nearest tenth) and the runoff co-efficient used shall be shown in a circle located within the contributing area. In cases where areas of different runoff coefficients may be tributary to the same manhole, the areas and the coefficients shall be separately indicated on the plan.

In determining the tributary area to each manhole, the proposed grading of the lots must be considered to maintain consistency in the design.

In the case of large areas under single ownership or blocks requiring future site plan agreements, the design shall be prepared on the basis of the whole area being contributory to one manhole in the abutting storm sewer unless more than one private storm connection is necessary to serve the property in which case the appropriate area tributary to each connection shall be clearly shown and taken into account in the storm sewer design.

The length, size and grade of each section of storm sewer shall also be shown on the storm drainage plan.

C 3.00 STORM SEWER DESIGN

C 3.01 DESIGN FLOWS

The design flow, in each length of sewer, shall be computed on the standard Town of Ajax design sheets according to the "rational" formula Q = 2.778 AIR, where

A = contributing drainage area in hectares
I = rainfall intensity mm/hr
R = imperviousness or runoff co-efficient dimensionless
Q = volume of runoff in cubic metres per second

C 3.02 RAINFALL INTENSITY

The Town of Ajax is based on the Toronto IDF curves. The IDF curves found at the back of this section (Tables 1, 2, 3 and/or the information that they represent is to be utilized for all stormwater design).

The equation for the IDF Curve is expressed as:

$$I = \frac{A}{(t_c + B)^C}$$

Where I = intensity of rainfall in mm/hour
t_c = time of concentration in minutes for the cumulative drainage area to the point of interest
A,B and C = see Table 2

For normal residential and industrial developments, the rainfall intensity shall be determined from the formula indicated on the IDF Curve chart for the respective storm for the 5 year Storm.

For developments extending from an existing stormwater system designed using a 2 year storm, a 2 year storm shall also be used.

A 15-minute inlet entry time at the head of the system for all residential developments shall be used. A 5-minute inlet entry time at the head of the system for all industrial and commercial developments shall be used.

For existing heavily developed urban areas, the rainfall intensity shall be determined from the formula indicated on the IDF Curve chart for the respective storm for the 10 year Storm, at the discretion of the Town.

The 25 year Storm Curve, as contained in the Ministry of Transportation - Ontario Manuals, shall be used for all culvert, watercourse and major trunk sewer design unless a higher year storm-duration curve such as the Regional or 100 year Storm is required by the Ministry of Natural Resources or the local Conservation Authority or the Ministry of Transportation - Ontario. Larger storms are used for roads other that local residential, depending upon their function. For example, a 50 year storm is typically used for all Arterial and some Collector roads

C 3.03 OVERLAND FLOW

The depths of flooding permitted on streets while acting as part of the major drainage system are as follows:

(a) On Town of Ajax roads the flooding shall be contained within the road allowance.

(b) On Town of Ajax roads with a four lane cross-section (or greater), flooding shall not exceed 100 mm on the crown of the road.

(c) The overland flow for a 100 year or Regional storm curve, whichever is more stringent, shall be accommodated in road cross sections and/or in blocks of land dedicated to the municipality. The extent and top elevation of any potential 100 year flooding are to be shown on the grading plan drawings, with maximum flooding depth of 300 mm. Complete design calculations and plans shall be prepared and submitted for approval by the Manager of Engineering.

(d) An overland flow route shall be provided within the developed site to direct runoff in excess of the 5 year storm runoff to an approved overland flow outlet.

C 3.04 RUNOFF OR IMPERVIOUSNESS CO-EFFICIENTS

Runoff coefficients to be used in storm sewer design shall be as follows:

a) Based on the description of area

Parks over 4 hectares	0.20
Parks 4 hectares and under	0.25
Single Family Residential	0.60

Single Family Residential (Frontage less than 12.2m)	0.65
Semi-detached Residential	0.65
Townhouses, Maisonettes, Row Houses, etc.	0.75
Apartments	0.75
Schools and Churches	0.75
Industrial	0.90
Commercial	0.90
Heavily Developed Areas	0.90
Paved Areas	0.95

b) based on character of surface:

Pavement: - Asphalt and Concrete	0.95
Stone, brick and precast concrete paving panels:	
- with sealed joints	0.85
- with open joints	0.65
Gravel road and shoulder	0.70
Roofs	0.95

RUNOFF COEFFICIENTS FOR RURAL AREAS

Lawns	**Sandy Soil**	**Heavy Clay Soil**
Flat 0 – 2%	0.05 to 0.10	0.13 to 0.17
Average – 2% - 7%	0.10 to 0.15	0.18 to 0.22
Steep - > 7%	0.15 to 0.20	0.25 to 0.35

The runoff coefficients (C) listed above are applicable for storm 2, 5 and 10-year frequencies. For less frequent storms Antecedent Precipitation Factor (Ca) should be used and Rational Formula to be modified accordingly to:

Q = Ca x C x I x A

'Ca' values are listed below:

2 to 10 year storm - Ca = 1.00
25 year storm - Ca = 1.10
50 year storm - Ca = 1.20
100 year storm - Ca = 1.25

and the product of 'Ca x C' should not exceed 1.00.

C 3.05 TIME OF CONCENTRATION

The preferred method to calculate time of concentration of the overland flow in the pre-development condition, if the runoff coefficient is less than 0.40, is the Airport Formula.

Airport Formula

Tc = 3.26 * (1.1 - C) * L^.5 /Sw^.33

Tc = Time of Concentration (minutes)
C = Runoff Coefficient (dimensionless)
L = Watershed Length (metres)
Sw = Watershed Slope % (m/m)

C 3.06 PIPE CAPACITIES

Manning's formula shall be used in determining the capacity of all storm sewers. The capacity of the sewer shall be determined on the basis of the pipe flowing full. The Region of Durham's tables for "Capacity and Velocity of Circular Pipes by Manning's Formula" shall be used in conjunction with the design criteria.

The value of the roughness co-efficient 'n' used in the Manning's formula shall be as follows:

(a)	Concrete Pipe all sizes	0.013
(b)	Concrete Box Culverts	0.013
(c)	Corrugated Metal 13 mm corrugations	0.024
(d)	Corrugated Metal 25% paved invert	0.020
(e)	All smooth walled pipe materials	0.013

C 3.07 FLOW VELOCITIES

Minimum acceptable velocity = 0.75 m/sec.
Maximum acceptable velocity = 4.60 m/sec.

C 3.08 MINIMUM SIZES

The minimum size for a main line storm sewer shall be 300 mm. For sites requiring outlet controls, orifice plates are to be used. Minimum orifice plate outlet is 100 mm.

C 3.09 MINIMUM GRADES

Regardless of flow velocities obtained, the minimum design grades for pipe storm sewers shall be as follows:

Sewer Size	Minimum Grade
Up to 1050 mm	0.50%
1050 mm and over	0.30%

The first leg of any sewer regardless of size shall be 1.0%.

Minimum grades may be reduced depending on site conditions with the approval of the Manager of Engineering.

C 3.10 MINIMUM COVER

The depth of the storm sewer shall be sufficient to provide a suitable outlet for the building foundation weeping tiles. The minimum cover to the top outside pipe barrel of a shallow storm sewer system shall be designed in no case be less than 1.3 m from the centre line of the roadway.

If this cannot be achieved the proposed system has less than 1.3 m cover, then the proper insulation shall be provided in accordance with MOE guidelines. Supporting calculations must be provided.

C 3.11 CALCULATION OF THE HYDRAULIC GRADE LINE

The Town of Ajax requires that all foundation drains must be located a minimum of 0.3 m above the 25 year hydraulic grade line. The hydraulic grade line shall be calculated using the sample calculation format provided

C 3.12 LOCATION

The storm sewers shall be located as shown on the Standard Town of Ajax Road Cross Section Drawings. This standard location shall be generally 1.5 m off the centre line of the roadway. In the case of crescents, looped and curvilinear streets, this standard location may be varied to the extent that the storm sewer remains on the same side of the centre line of the street (i.e. left or right) to avoid crossing the sanitary sewer trenches at the changes in direction of the street.

Any relocation from the standard location must have the approval of the Town before construction.

C 3.13 DEEP AND SHALLOW STORM SEWERS IN RURAL SUBDIVISIONS

For Estate Subdivisions in the rural areas, a shallow storm sewer system shall be permitted provided the lot sizes are equal to or in excess of 0.20 hectares. (i.e. partial storm systems in roads with ditches).

For lot sizes less than 0.20 hectares in the rural subdivisions, a deep storm sewer system shall be constructed to provide a suitable outlet for the building foundation weeping tiles.

The design criteria is largely intended for greenfield development and is to be adhered to in those instances. For retrofit projects in existing areas, the criteria has to be considered but these retrofit developments will be constructed on a most practicable basis.

Catchbasin manholes will be permitted in shallow storm sewer systems.

C 3.14 CURVED SEWERS

Manufactured radial pipe shall be allowed for all storm sewers 1050 mm in diameter and larger, providing that a manhole is located at the beginning or at the end of the radial section. The minimum centre line radius allowable shall be 15 times the pipe diameter.

C 3.15 LIMITS

All sewers shall be terminated at the subdivision limits using manholes when external drainage areas are considered in the overall design of the storm sewer system. These manholes shall be designed to allow for the future extension of the sewer.

When external areas are not included in the sewer design, the sewer shall extend at least halfway across the frontage and/or flankage of any lot or block in the subdivision.

C 3.16 SEWER ALIGNMENT

All storm sewers shall be laid in a straight line between manholes unless radial pipe has been designed. The maximum change in direction of flow in manholes for sewer sizes 1050 mm diameter and over shall be 45 .

C 3.17 PIPE CROSSINGS

A minimum clearance of 0.15 m shall be provided between the outside of all pipe barrels at all points of crossing. In cases where the storm sewer crosses a recent utility trench at an elevation higher than the elevation of the utility, a support system shall be designed to prevent settlements of the storm sewer, or alternatively the original trench shall be re-excavated to the top of the utility and backfilled with compacted crushed stone or concrete to adequately support the storm sewer. When the storm sewer passes under an existing utility, adequate support shall be provided for the utility during and after construction to prevent damage to that utility.

C 3.18 CHANGES IN PIPE SIZE

No decrease of pipe size from a larger upstream to a smaller size downstream shall be allowed regardless of the increase in grade.

C 3.19 HEAD LOSSES

Suitable drops shall be provided across all manholes to compensate for the loss in energy due to the change in flow velocity and for the difference in the depth of flow in the sewers.

Hydraulic calculations shall be submitted for all junction and transition manholes on sewers where the outlet is 1050 mm or greater. In addition, hydraulic calculations may be required for manholes where the outlet pipe is less than 1050 mm diameter if, in the opinion of the Manager of Engineering, there is insufficient invert drop provided across any manhole.

Regardless of the invert drop across a manhole as required by calculations, the obvert of the outlet pipe shall not be higher than the obvert of the inlet pipes at any manhole location.
The minimum drop across manholes shall be as follows:

Change of Direction	Minimum Drop
0	20 mm
1 to 45	50 mm
46 to 90	80 mm

C 4.00 SEWER PIPE

C 4.01 MATERIALS

Storm sewers shall be constructed of concrete or PVC pipe meeting OPSS standards. Concrete pipe is preferred for Storm Sewers however PVC will be accepted for sizes up to 450 mm diameter. The type and classification of all storm sewer pipe, and the sewer bedding type shall be clearly indicated on all profile drawings for each sewer length.

All sewers shall be designed for an embankment condition.

PVC pipe shall be of the solid wall type construction, grade SDR 35 minimum, and may be used for all main line sewer up to 375 mm diameter and for rear lot catchbasin leads. The ribbed dual wall HDPE pipe, grade SDR 35 minimum, up to and including 750 mm diameter may be used with permission of the Town.

Concrete pipe shall conform to the requirements of CSA Specification A-257 for the particular classes as shown below:

a) Extra strength non-reinforced concrete pipe, CSA Specification A-257-1

b) Reinforced concrete pipe, CSA Specification A-257-2

c) Concrete pipe to have a three bearing test completed on the pipe supplied to the site at the rate of 0.5% of the total length per class per size of pipe. There will be a minimum of 2 pipe lengths tested per class per size.

C 4.02 PIPE BEDDING

The class of pipe and the type of bedding shall be selected to suit loading and proposed construction conditions. All pipes are to be designed assuming an embankment condition. Details of the types of bedding are illustrated in the Town of Ajax Standard Drawings. All storm sewers shall be installed using Type 'B' bedding using crusher run limestone conforming to OPSS Granular 'A' as the granular material with 300mm of sand cover as shown in the OPSD.

C 5.00 MANHOLES

C 5.01 MAXIMUM SPACING

The maximum spacing between manholes shall be as follows:

Pipe Size	Maximum Manhole Spacing
300 mm to 1200 mm	120 metres
>1200 mm	150 metres

Manholes are required at all mainline pipe junctions, changes in grade or changes in alignment

C 5.02 MANHOLE TYPES

Manholes may be constructed of precast or poured concrete. OPSD details shall be used for manhole design where applicable. Although these Standard Drawings provide details for manholes up to certain maximum depths and sizes, the Consulting Engineer shall individually analyze each application of the standards related to soil conditions, loading and other pertinent factors to determine structural suitability. In all cases where the OPSD Detail Drawings are not applicable, the manholes shall be individually designed and detailed by a competent person.

A reference shall be made on all profile drawings to the type and size of all storm manholes. In the case of the standard 1200 mm precast manhole, the size of the manhole may be omitted and reference need only be made to the OPSD Standard Detail Drawing number.

Precast manholes shall conform to A.S.T.M. Specification C-478M latest revision.

C 5.03 MANHOLE DESIGN

All manhole chamber openings shall be located on the side of the manhole parallel to the flow for straight run manholes, or on the upstream side of the manhole at all junctions.

(a) The direction of flow in any manhole shall not be permitted at acute interior angles.

(b) Safety gratings shall be provided in all manholes when the depth of the manhole exceeds 5 m. The maximum spacing between safety gratings shall not exceed 4.5 m. All incoming pipes are to be below safety gratings, where possible.

(c) The obvert on the upstream side of manholes shall not be lower than the obvert of the outlet pipe.

(d) The maximum change in direction of flow in manholes, for sewer sizes 1050 mm diameter and over, shall be 45.

(e) Where the difference in elevation between the obvert of the inlet and outlet pipes exceed 0.6 m a drop structure shall be placed on the inlet pipe with the invert of the drop pipe located at the spring line of the outlet pipe. Design should be in conformity with OPSD 1003.010 and OPSD 1003.020. For sewers greater than 375 mm diameter the drop pipe shall be one size smaller then the inlet pipe.

(f) All storm sewer manholes shall be benched as per OPSD 701.021.

(g) The minimum width of benching in all manholes shall be 230 mm.

(h) Manholes in boulevards shall be located, wherever possible, a minimum of 1.5 m distant from the face of curb or other service.

(i) Minimum size of any manhole stack shall be 685 mm x 685 mm.

C 5.04 GRADES FOR MANHOLE FRAME AND COVERS

All manholes located within the travelled portion of roadway shall have the rim elevation set flush with the surface of the base course asphalt. The bricking and setting of the frame and cover shall be completed in accordance with the details provided in the Ontario Provincial Standard Drawings. Frames and covers shall be raised to surface course asphalt elevation just prior to paving

The manholes are to be raised using concrete adjustment rings prior to placement of top course asphalt.

C 6.00 CATCHBASINS

C 6.01 LOCATION AND SPACING

Catchbasins shall be selected, located and spaced in accordance with the conditions of design. The design of the catchbasin location and type shall take into consideration lot areas, lot grades, pavement widths, road grades and intersection locations. The recommended maximum catchbasin spacing is as follows:

Pavement Width	Road Grade	Recommended Spacing
Up to 10.0 m	Up to 4%	85 m
Up to 10.0 m	Over 4%	65 m
10 m – 13 m	Up to 3.5%	75 m
10 m – 13 m	Over 3.5%	50 m
Over 13 m	Up to 3%	60 m
Over 13 m	Over 3%	45 m

Catchbasins shall be generally located upstream of sidewalk crossings at intersections and upstream of all pedestrian crossings. Catchbasins shall not be located in driveway curb depressions if at all possible.

Double catchbasins shall be normally required when the catchbasin intercepts flow from more than one direction. Single catchbasins may be used in the case where the total length of drainage to the catchbasin, from both directions, is less than 50 m.

C 6.02 CATCHBASIN TYPES

All catchbasin structures shall be constructed in accordance with all Ontario Provincial Standard Specifications and Drawings.

Special catchbasins and inlet structures may be used with permission of the Manager of Engineering, but shall be fully designed and detailed by the Owners Consultant.

C 6.03 CATCHBASIN CONNECTIONS

For single catchbasins, the minimum size of connection shall be 250 mm and the minimum grade shall be 1.0%.

For double catchbasins, the minimum size of connection shall be 300 mm and the minimum grade shall be 1.0%.

For rear lot catchbasins, the minimum size of the connection shall be 250 mm and the minimum grade shall be 1.0%.

C 6.04 GRATINGS

The "bike-proof" catchbasin grate shall be required for all catchbasins located in roadway, walkway areas, manicured park areas, and the beehive type shall be used in all other areas. The pyramidal type shall be used only when directed by the Manager of Engineering.

C 6.05 GRADES FOR CASTINGS AND ADJUSTMENTS

All catchbasins located within the travelled portion of roadway shall have the rim elevation set flush with the surface of the base course asphalt. The bricking and setting of the frame and cover shall be completed in accordance with the details provided in the Ontario Provincial Standard Drawings. Frames and grates shall be raised to surface course asphalt elevation just prior to paving. All other catchbasins are to be raised to final grade at time of installation.

The catchbasins are to be raised using concrete adjustment rings prior to placement of top course asphalt.

C 6.06 CATCHBASINS AT INTERSECTIONS

All catchbasins at street intersections shall be located on the tangent section of the curb, a minimum of 0.6 m distant from the beginning or the end of the radial portion of the curb, and the grading of the intersection shall provide for drainage to the catchbasin's location.

C 7.00 INLETS, OUTFALLS AND SPECIAL STRUCTURES

C 7.01 GENERAL

Inlet and outlet structures shall be fully designed on the engineering drawings. The details provided shall include the existing topography, proposed grading and the work necessary to protect against erosion.

C 7.02 INLETS

For other than minor swales, where catchbasins with beehive tops are used, inlet structures shall be fully designed.

Inlet grates shall consist of inclined parallel bars or rods set in a plane at approximately 45 with the top, away from the direction of flow. Gabions, rip-rap or concrete shall be provided at all inlets to protect against erosion and to channel the flow to the inlet structure.

C 7.03 OUTLETS

The OPSD Headwall Drawing shall be used for all storm sewers up to 1800 mm diameter. For sewers over 1800 mm in diameter, the headwalls shall be individually designed. Alternate outlet designs will be considered on a specific basis. All headwalls shall be equipped with a grating over the outlet end of the pipe with a safety railing across the top of the headwall for the protection of the public.

All outlets shall blend in the direction of flow of the watercourse with the directional change being taken up in the sewer rather than the channel.

Gabions, rip-rap, concrete or other erosion protection shall be provided at all outlets to prevent erosion of the watercourse and the area adjacent to the headwall. The extent of the erosion protection shall be indicated on the engineering drawings and shall be dependent upon the velocity of the flow in the storm sewer outlet, the soil conditions, the flow in the existing watercourse, and site conditions and the requirements of the Conservation Authority, if applicable.

The weep holes placed in the structures shall be left unobstructed to allow drainage from behind the structure. Weepers to extend into the sewer bedding.

C 7.04 OPEN CHANNELS

Open channels shall only be considered at the discretion of the Town when the design flow exceeds 14.2 m^3/s. All open channels should be designed to convey a 5 years flow flood event with free board of 0.15 times the depth.

The proposed criteria for an open channel design shall be submitted by the Consulting Engineer to the Town for their approval, prior to the actual design being undertaken. The Consulting Engineer shall also be responsible for obtaining the approval of the design from the Ministry of Natural Resources, the Ministry of the Environment and the local Conservation Authority if the open channel concept is favourably considered.

C 8.00 CONSTRUCTION

Construction of all storm sewers and appurtenances shall be in accordance with the OPSS and OPSD specifications and the Standard Drawings of the Town of Ajax at the time of approval of the Design Drawings by the Town. All pipes, regardless of size, including rear lot catchbasin leads shall be televised and DVD's presented to the Town for their review and acceptance before any maintenance dates can be set.

C 9.00 STORMWATER MANAGEMENT FACILITY DESIGN GUIDELINES

This section sets out guidelines to direct the configuration of various types of Stormwater Management (SWM) facilities with a focus on integrating ponds, wetlands, and other types of non-structural facilities into the landscape.

In general, basic functional design configurations will be based on the criteria set out in the MOE SWMP and the Town of Ajax Design Criteria. However, to achieve Town objectives, the following design guidelines are set out related to facility configuration, landform, orientation, site design, and the design of specific components of various SWM facilities. This section sets out the following guidelines to direct the design of elements common to various types of SWM facilities:

Landform and Grading
Orientation
Planting
Soil Preparation
Inlet Structures
Outlet Structures
Shoreline Treatments
Public Safety
Maintenance

C 9.01 GUIDELINES FOR COMMON ELEMENTS

This section provides guidelines to direct the design of elements that are common to various types of SWM facilities, including elements related to grading, planting and ensuring public safety.

C 9.02 Landform and Grading

Grading should be designed to reflect the landform character of the surrounding natural landscape.

Retaining walls will not be permitted in pond blocks.

All pond blocks shall have a 1.5 m minimum strip around the perimeter not to exceed 5%.

C 9.03 Orientation

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 SWM facility is a tributary to an existing or proposed coldwater aquatic community.

C 9.04 Planting

Planting designs for SWM facilities should be developed based on the following principles:

Utilize native species indigenous to the bioregion;

Select plant species based upon an understanding of hardiness and habitat requirements, including soil type, soil chemistry, soil moisture, frequency of flooding and microclimatic conditions;

Select species in consideration of ancillary benefits, including provision of shelter and nesting habitat for birds and wildlife, potential as a source of food for species present in the area, or rooting characteristics to enhance slope stability or mitigate erosion;

Design plant communities to replicate natural associations with regard for natural successional processes;

Design planting plans with an appropriate mix of trees and shrubs as well as native perennials, wildflowers and aquatics;

Utilize native grasses and wildflowers to restore all disturbed and degraded areas;

The use of sod and turf grass seed with a high percentage of non-native species and Kentucky Bluegrass is discouraged; and

Illustrate the extent of seeded areas as a component of the planting plan for the SWM facility.

C 9.05 Inlet Structures

Two alternative approaches may be adopted to facilitate the design of inlet structures:

1. Inlet structures designed as discrete elements within the overall design of the pond.

2. Inlet structures designed as features within the overall design of the pond.

In all cases, inlet structures should employ a plunge pool as a means to dissipate energy and moderate 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 plunge pools is to be 1.5 m. The water level should be maintained using a riverstone control weir. Plunge pools should be lined with riverstone 300 mm deep. Riverstone size gradations should be determined based upon anticipated discharge velocities.

i. Design Recommendations for Concealing Inlet Structures

For SWM facilities that are proposed as an extension of a natural system, the landscape design should be focused on concealing the inlet structure from view. 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.

In situations where the installation of a barrier is required to provide fall protection, a 1.2 m black vinyl coated chainlink fence or OPSD handrails coated with black epoxy should be used. Extensive coniferous planting should be installed to conceal fences and barriers.

ii. Design Recommendations to Integrate Inlet Structures as Landscape Amenities

For facilities proposed in an urban context, the opportunity is presented to design the inlet structure as a key element in the overall landscape through the application of the following:

Consider the relationship between the maintenance access route/trail system and the location of the proposed inlet structure to identify opportunities to position the inlet structure as a node along the trail system or at the terminus of a walkway leading into the facility.

Design the inlet structure as an overlook, seating area, interpretive station or outdoor classroom. Regardless of the design approach adopted, inlet structures should be serviced by maintenance access routes to facilitate inspection, debris removal and periodic cleaning.

Note: Inlet structures must not be designed as submerged below the permanent pool. This design has several drawbacks:

surcharging or backwater effect on the upstream stormwater conveyance system;
scour/re-suspension of the pond bottom near the inlet;
clogging of the inlet by sedimentation near the inlet; and
sediment deposition in the upstream conveyance system.

A design which incorporates a submerged inlet requires a greater level of analysis at the design stage due to these potential drawbacks.

Submerged inlets for pipe systems should be avoided due to the potential for upstream surcharging. If design constraints are demonstrated, the Manager of Engineering may consider a submerged inlet of up to a length of 10 metres up the storm system with no connection within the 10 metre submerged length.

C 9.06 Outlet Structures

Design outlet structures to achieve water quality and quantity control objectives as well as ecological targets in the receiving watercourse and downstream watershed. In response, designs should be developed in consideration of a range of parameters beyond those related to the regulation of flows discharged from the SWM facility, including the following:

Aquatic habitat and fish community targets for the receiving watercourse and sub-watershed:

- Outlet structures must be designed at a minimum to achieve objectives related to 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.
- If outlet structures are to be placed within environmental lands, then the placement and design of such structures should be determined through a site meeting held prior to submission of the engineering drawings.

Groundwater interflow and discharge patterns.

- 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:

- Influences on adjacent vegetation communities and ecosystems should be understood to ensure that the implementation of outlet structures does not impact adjacent habitats.

The Town of Ajax recognizes the need for flexibility to address environmental considerations. The following guidelines are set out to address specific ecological objectives.

C 9.07 Alternative Outlet Designs

SWM facilities that are tributary to first order streams, streams that support coldwater species or streams that are targeted to support coldwater communities are to be fitted with outlet structures that are designed to achieve water temperature targets. These water temperature targets have been identified by the Toronto and Region Conservation Authority (TRCA), the Central Lake Ontario Conservation Authority (CLOCA), or the Ministry of Natural Resources (MNR), or identified in Master Environmental Servicing Plans or sub-watershed studies. The following alternative outlet designs should be considered to achieve temperature targets.

C 9.08 Bottom Draw Outlets

Reductions in the temperature of water discharged from SWM ponds, wetland and hybrid facilities can be achieved through the implementation of a bottom draw outlet. To be effective, bottom draw outlets must discharge water from a depth in excess of 2.0 m below the normal water level. Deeper outlet depths are desirable, however, at greater depths the potential for water to become anoxic increases. Consequently, with very deep outlets provision should be made to re-aerate water prior to discharge into the receiving watercourse. Cascades, drop structures, or step pool sequences can be used for this purpose.

The effectiveness of bottom draw outlets is contingent upon a number of factors including depth of intake, volume and size of permanent pool, duration of detention, ambient temperature and temporal factors.

C 9.09 Contact Cooling Trenches

Contact cooling trenches are designed to be located downstream of the pond outlet discharging cooled water to the watercourse downstream. The required dimensions of the trench are determined by:

facility size;
release rates;
temperature of water discharged from the facility;
downstream temperature targets;
distance from the receiving watercourse.

C 9.10 Seepage Outlets

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

Heat transfer with filter medium (similar to the contact cooling trench);

Gradual discharge to densely shaded, well vegetated buffer strips;

Provision of groundwater recharge and discharge to the watercourse through subsurface interflow.

Seepage outlets are designed to be situated downstream of the facility outlet and are comprised of the following components:

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 that the function of the facility is not affected should the function of the seepage outlet system be 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.

C 9.11 Outlet Channels

Long, narrow, well-vegetated outlet channels have proven to be effective in mitigating temperature increases through shading, transferring heat through substrate and by encouraging infiltration. Outlet channels should be designed:

To replicate natural channels in appearance and function;

As narrow tributaries with width to depth ratios approaching 1:1, 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 with a minimum width of 3.0 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.

C 9.12 Vegetated Spreader Swales

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

topography;
soil composition;
vegetation community composition.

The spreader swale should be planted continuously along its length for a distance extending a minimum of 3.0 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 spreader swale to ensure that flows do not exceed the conveyance capacity of the level spreader, which would in turn result in riling and erosion within the adjacent vegetated filter area.

C 9.13 Upwelling Outlets

Upwelling outlets are designed to achieve temperature mitigation objectives while enhancing fish habitat by establishing spawning areas for Salmonid species such as Brook Trout. Upwelling outlets are designed to discharge water beneath the substrate of the receiving watercourse. Like the seepage outlet system, a header pipe is linked to a series of outlet pipes, which are designed to distribute flow to various strategically located areas within the receiving watercourse. Typically, pool areas are preferred. Each outlet pipe is fitted with clear stone and its outlet is installed below the invert of the existing watercourse and covered with appropriately sized gravel and cobble to create an upwelling area. The feasibility of implementing upwelling outlets is determined by a number of considerations including:

Stability and morphology of the receiving watercourse

Existing fish community characteristics and species targets

Availability of suitable locations for upwelling outlets related to both stream morphology and the ability to achieve habitat enhancement objectives

Potential for the impact on existing environment, including riparian vegetation community and fish habitat, which may result from the construction of the upwelling areas

Difference in elevation between the SWM facility and the proposed upwelling area functions as intended As well as the above, it is essential that water discharged from the SWM facility through the upwelling area be of adequate quality and temperature to ensure that aquatic habitat benefits are achieved.

C 9.14 Shoreline Treatments

Shoreline areas for SWM ponds require special consideration during the design process to address the influences of fluctuating water levels while achieving objectives related to public safety, nuisance waterfowl deterrence and enhancement of the performance of the facility. The establishment of a dense community of moisture tolerant vegetation around the entire perimeter of the pond is the key to achieving these objectives.

Habitat modification is the most practical approach to manage nuisance waterfowl, since it requires a reduced commitment of resources on an ongoing basis and can largely be addressed in the process of designing the shoreline areas of SWM facilities. Accordingly, shoreline areas should be designed based upon the following guidelines:

Shoreline areas should be undulating and non-uniform to encourage colonization by a range of vegetation types. This will limit access; constrain movement and obscure views of potential predators.

A minimum 3.0 m wide bank of continuous, dense, low branching, woody vegetation should be established around the entire perimeter of the pond. This will constrain goose movement and obscure sightlines while limiting public access, providing additional shade and enhancing stability.

In situations where a more formal pond edge is desired to achieve aesthetic or urban design objectives, an alternative shoreline treatment is comprised of stacked boulders with a minimum diameter of 600 mm and a minimum vertical installation height of 450 mm. Where views are desirable, shoreline areas should be planted with a minimum 6.0 m wide band of wildflowers or native meadow grasses. Under no circumstances should areas immediately adjacent to the water's edge consist of maintained turf grass.

In ponds with an open water area of less than 0.25 ha, the planting plan for the shoreline area should be developed with the objective of establishing a continuous tree canopy around the perimeter of the pond to obstruct flight paths and deter geese from landing on the pond. An angle of ascent from the water's edge of greater than 13 degrees is required to impede flight.

Below normal water level, the 7:1 terrace should be planted with emergent species to enhance stability and impede waterfowl movement and sightline to potential predators.

Plant material for shoreline areas should be determined with recognition of anticipated water level fluctuations and soil moisture regimes.

C 9.15 Public Safety

The installation of full fencing around the perimeter of the pond block to deter public access eliminates the potential to achieve recreational and interpretive objectives for the benefit of the community. 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 are focused on mitigating access to specific hazard areas. Dense communities of moisture-tolerant vegetation are key to achieving water quality objectives. Risk can be minimized through the application of design techniques to mitigate access to hazard areas. Blocks reserved for SWM facilities must be of adequate size to ensure that side slopes do not exceed the allowable maximum slopes and that safe public access can be achieved. The following guidelines are set out to address public safety objectives at the site specific scale:

C 9.16 Fencing

Fencing of the entire perimeter of SWM facilities is discouraged.

1.8 m black vinyl coated chainlink fencing should be installed along the property line where the SWM 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 SWM block, and chainlink mesh should be affixed to the SWM facility side of the posts and rails.

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

Subject to the approval of the adjacent landowners and the Town of Ajax, a “Living Fence” with boundary delineation markers may be substituted for chainlink fencing where SWM facilities abut commercial, industrial, institutional or high density residential land uses.

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

C 9.17 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 will conform with AS-335.

C 9.18 High Water Level Indicators

High 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. High water indicators shall include the following:

Permanent markings on headwalls.

If the planned flooding level will inundate the headwall, 150 mm diameter cedar posts installed to a depth of 1200 mm and protruding above ground to a height of 900 mm shall be installed.

C 9.19 Barrier Plantings

Barrier plantings are to be used to deter public access to inlets, outlets and outfalls, plunge pools and deep water areas

C 9.20 Provisions for Maintenance and Assumption

Regular maintenance is critical to ensure the long-term performance of SWM facilities. Routine maintenance, such as litter removal, as well as more extensive long term maintenance requirements, including sediment removal from wet pond facilities and repair or replacement of flow control structures, should be accommodated in the planning and design processes. The Town will not assume responsibility of a SWM facility until all sediment is removed to design grade elevation and a survey is provided to the satisfaction of the Town.

C 9.21 Maintenance Access Routes

Access routes for maintenance vehicles shall be provided to inlet and outlet structures and the base of sediment forebays. Maintenance access routes should provide unimpeded access from the adjacent municipal road right-of way and should be aligned to avoid overland flow routes.

Two options are available for the road surface contingent upon the situation of the maintenance access route in the context of the overall facility landscape.

i. Hybrid Trail / Maintenance Access Route

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

Width of the trail portion shall be 4.0 m minimum, aligned along the edge of the roadway nearest to the pond or wetland.

The access route shall meet the minimum requirements of the local road design for GBE equivalency, and it may be built to greater requirements to address soil conditions based on the recommendations of a geotechnical engineer.

Surface treatment: granular, mulch or another appropriate surface material as required by the Parks, Recreation and Culture Department.

All linkages in the community wide trail network must be designed in accordance with the requirements of the Ontario Disabilities Act, with gradients that do not exceed 8% and other barrier free access initiatives implemented as required based on site-specific conditions to ensure that the requirements of the Act are achieved.

ii. High Use / 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:

Width of the trail portion shall be 4.0 m minimum.

The access route shall meet the minimum requirements of the local road design for GBE equivalency, and it may be built to greater requirements to address soil conditions based on the recommendations of a geotechnical engineer.

Surface treatment: asphalt or another appropriate hard surface material as required by the Parks, Recreation and Culture Department.

All linkages in the community wide trail network must be designed in accordance with the requirements of the Ontario Disabilities Act, with gradients that do not exceed 8% and other barrier free access initiatives implemented as required based on site-specific conditions to ensure that the requirements of the Act are achieved.

C 9.22 Provision for Algae Control

Excessive algae growth can be a problem in some SWM facilities, 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. A kilogram of barley straw is required for each 1,000 m2 of pond surface area. The straw should be distributed at a minimum rate of 3 kg/bag. The bags are to 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.

C 9.23 Vehicle Access Barriers

Where maintenance access routes and trails intersect road rights-of-way, 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 3.0 m apart with a removable bollard installed at the mid-point between the two (at 1.5 m from each fixed bollard).

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

C 9.24 MONITORING

The Developer shall undertake a monitoring program for all SWM Ponds until Assumption of the Subdivision to the satisfaction of the Town. The purpose of the monitoring is to ensure the stormwater management pond is operating as per the original objectives or design. The program shall include the following components:

1. Installation of water samplers upstream and downstream of the pond;

2. Installation of a rain gauge near the flow logger;

3. The water shall be sampled 4 times annually and shall be tested for the following parameters:

   a) E. coli;
   b) pH, conductivity, alkalinity;
   c) Turbidity;
   d) dissolved, suspended and total solids;
   e) TKN, total phosphorus;
   f) dissolved phosphorus;

An annual report shall be submitted to the Town and shall include a statistical analysis (average) of the results, as well as a comparison of the analysis. If it is found that the water quality is not meeting the original objectives as per the MOE SWMP, then the Developer shall make changes to the pond to ensure the facility is operating as designed. The Town will not assume responsibility until this is achieved.

TABLE 1
INTENSITY-DURATION-FREQUENCY VALUES
TORONTO BLOOR STREET

Duration (min)	Rainfall Intensity (mm/hr) 2	5	10	25	50	100
5	109.0	149.5	174.6	209.1	235.0	260.1
10	78.2	107.7	127.1	152.1	170.6	188.7
15	61.8	85.2	101.0	120.7	135.2	149.5
30	39.2	53.9	64.0	76.4	85.2	94.2
60	23.7	32.4	38.3	45.6	50.7	56.0
120	14.0	18.9	22.1	26.3	29.2	32.2
360	5.9	7.8	9.0	10.6	11.7	12.9
720	3.4	4.4	5.0	5.9	6.5	7.2
1440	1.9	2.5	2.8	3.3	3.6	4.0

TABLE 2
IDF PARAMETERS – TORONTO

Parameter	2	5	10	25	50	100
A	696.484	1022.724	1331.164	1606.048	1831.947	2031.456
B	4.875	5.256	6.006	6.006	6.012	6.006
C	0.81	0.826	0.847	0.85	0.856	0.857

TABLE 3.1
3 HOUR CHICAGO DISTRIBUTION DESIGN STORM HYETOGRAPHS
TORONTO BLOOR

Time Step (min)	Rainfall Intensity (mm/hr) 2	5	10	25	50	100
10	2.85	3.90	4.57	5.46	6.03	6.61
20	3.20	4.41	5.20	6.23	6.89	7.57
30	3.67	5.10	6.04	7.26	8.04	8.89
40	4.32	6.07	7.23	8.74	9.69	10.77
50	5.29	7.55	9.06	11.02	12.24	13.70
60	6.93	10.08	12.20	14.96	16.65	18.78
70	10.32	15.37	18.80	23.26	25.95	29.53
80	21.58	32.79	40.38	50.04	56.09	63.97
90	73.99	103.04	122.29	146.10	164.61	181.81
100	22.24	33.80	41.62	51.58	57.82	65.94
110	10.92	16.31	19.98	24.74	27.61	31.44
120	7.38	10.77	13.06	16.04	17.86	20.17
130	5.64	8.09	9.72	11.85	13.16	14.76
140	4.60	6.51	7.76	9.41	10.44	11.62
150	3.91	5.47	6.48	7.82	8.66	9.59
160	3.42	4.73	5.58	6.70	7.42	8.17
170	3.04	4.18	4.91	5.87	6.49	7.13
180	2.75	3.75	4.39	5.24	5.79	6.33

Pipe Data					**Head Losses**													
Station	**Node ID**	**Discharge**	**Diameter**	**Length**	**V**	**$V^2/2g$**	**Friction slope**	**Friction Head loss**	**K**	**$KV^2/2g$**	**Tailwater**	**Invert**	**EGL**	**HGL**	**Obvert**	**Gutter**	**Remarks**
		m^3/s	**m**	**m**	**m/s**	**m**	**Sf %**	**m**		**m**	**m**	**m**	**m**	**m**	**m**	**m**	
1a	1b	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Step 1: Design the storm system for the design storm
Step 2: Start in column 1a/1b the storm sewer outfall or most downstream manhole
Step 3: Enter in column 2 the design discharge
Step 4: Enter in column 3 the diameter of the pipe
Step 5: Enter in column 4 the diameter of the outfall pipe
Step 6: Enter the loss coefficients K in columns 10
Step 7: Enter the average flow velocity in column 5 V=Q/A
Step 8: Enter the velocity head in column 6
Step 9: Find the friction slope Sf= Q2n2/D8/3
Step 10: The friction head loss is column 4 x 10
Step 11: Enter all the Structure Loss coefficients K= KoCDCdCQCPCB
Step 12: Total manhole losses are column 9 x 6
Step 13: Enter the tailwater elevation (assume pipe obvert if unknown)
Step 14: Enter the pipe invert
Step 15: EGL is velocity head plus tailwater elevation, plus friction head loss plus manhole losses
Step 16: HGL is column 13 minus column 6
Step 17: Enter lowest gutter elevation and compare to HGL