4 DESIGN ACCEPTANCE CRITERIA

4.1 INTRODUCTION

The following design acceptance criteria are mandatory requirements for the planning and design of stormwater management systems for new urban developments, and for the upgrading of stormwater systems in existing urban areas.

It is recognised that practical limitations, including funding constraints, will limit the rate at which existing urban stormwater systems can be upgraded to meet these requirements. Nevertheless, the requirements shall be adopted as a long-term goal and progressive upgrading shall be directed towards that goal.

The criteria in this Chapter apply generally to *all* urban stormwater systems. Other Chapters in the Manual give more detailed requirements for individual system components.

4.2 PUBLIC SAFETY

Many of the requirements for the planning and design of stormwater systems presented in this manual have either directly or indirectly considered the need to protect public safety. Notwithstanding these requirements, stormwater managers and designers must consider the need or otherwise to implement additional measures to further protect public safety.

Examples of typical measures to improve public safety include:

- safety railings on crossings, headwalls or other locations where the public could fall into drains or waterbodies
- grates over open drains
- limiting the depth of open drains
- gentle side slopes on engineered waterways and on the sides of ponds, wetlands and lakes
- maximum flow velocity criteria for engineered waterways
- maximum velocity-depth criteria for flow on or across roads

4.3 LAND DEVELOPMENT

4.3.1 Site Clearing

Natural vegetation shall be retained wherever possible to minimise erosion within a site. This will also reduce the requirement for erosion and sediment controls during construction.

4.3.2 Land Grading

Wherever practical, the natural slope of the land within the site shall be retained to ensure development lots and roadways are free draining. Grading development sites to a flat platform can result in the stormwater system having very flat grades. The system may then be excessively deep at the site outlet and possibly below the tailwater level of the downstream conveyance system.

The existing topography of some sites, such as in coastal areas, may naturally be very flat and consideration shall be given to regrading the site to introduce slope to promote free drainage.

4.3.3 Subdivision Layouts

Subdivision layouts must be planned in conjunction with drainage engineers, to avoid potential problems. Attention to the layout at this stage can significantly reduce drainage costs. Issues to consider include:

- avoiding trapped low points
- providing suitable flow paths for the major design flood
- providing suitable areas for detention, retention and water quality controls

It is important that subdivision layouts do not result in the concentration and discharge of runoff from upstream lots to adjacent downstream lots in sufficient quantity to cause nuisance conditions.

4.3.4 Special Applications

Some special requirements are stipulated for some types of development.

Hillside Development shall be designed in accordance with Chapter 47. Drainage in Lowland and Tide-affected areas shall be designed in accordance with Chapter 46.

4.4 DESIGN AVERAGE RECURRENCE INTERVALS

A major/minor system approach shall be adopted for the planning and design of urban stormwater systems.

The **minor system** is intended to collect and convey runoff from relatively frequent storm events to minimise inconvenience and nuisance flooding. The **major system** is intended to safely convey runoff not collected by the minor drainage system to waterways or rivers. The major system must protect the community from the consequences of large, reasonably rare events, which could cause severe flood damage, injury and even loss of life. The concept is further described in Chapter 11 (Section 11.6). Note that the definition of major/minor system does not refer to size of the drains.

Event ARIs to be adopted for the planning and design of minor and major stormwater systems shall be in accordance with Table 4.1.

Table 4.1 Design Storm ARIs for Urban Stormwater Systems

Type of Development (See Note 1)	Average Recurrence Interval (ARI) of Design Storm (year)		
	Quantity		Quality
	Minor System	Major System (see Note 2 and 3)	
Open Space, Parks and Agricultural Land in urban areas	1	up to 100	3 month ARI (for all types of development)
Residential:			
• Low density	2	up to 100	
• Medium density	5	up to 100	
• High density	10	up to 100	
Commercial, Business and Industrial – Other than CBD	5	up to 100	
Commercial, Business, Industrial in Central Business District (CBD) areas of Large Cities	10	up to 100	

Notes:

(1) If a development falls under two categories then the higher of the applicable storm ARIs from the Table shall be adopted.

(2) The required size of trunk drains within the major drainage system, varies. According to current practices the trunk drains are provided for the areas larger than 40 ha. Proceeding downstream in the drainage system, a point may be reached where it becomes necessary to increase the size of the trunk drain in order to limit the magnitude of "gap flows" as described in Section 4.6.2.

(3) Ideally, the selection of design storm ARI should also be on the basis of economic efficiency. In practice, however, economic efficiency is typically replaced by the concept of the level of protection. In the case where the design storm for higher ARI would be impractical, then the selection of appropriate ARI should be adjusted to optimise the ratio cost to benefit or social factors. Consequently lower ARI should be adopted for the major system, with consultation and approval from Local Authority. However, the consequences of the higher ARI shall be investigated and made known. Even though the stormwater system for the existing developed condition shall be designed for a lower ARI storm, the land should be reserved for higher ARI, so that the system can be upgraded when the area is built up in the future.

(4) Habitable floor levels of buildings shall be above the 100 year ARI flood level.

(4) In calculating the discharge from the design storm, allowance shall be made for any reduction in discharge due to quantity control (detention or retention) measures installed as described in Section 4.5.

The main reason for adopting a higher standard for the minor system in CBD areas is because of the much greater potential for damage and disruption in a flood, which exceeds the minor system capacity.

4.5 RUNOFF QUANTITY CONTROL

Stormwater facilities for the control of the quantity of surface runoff shall be planned, analysed and designed in accordance with:

Part C	Planning
Part D	Hydrology and Hydraulics
Part E	Runoff Quantity Control

The level of runoff control required is dependent on the type of development proposed. Flow control requirements are stipulated for the following categories of development:

- new development
- redevelopment of existing sites

Runoff control requirements for the above development categories are summarised in Table 4.2.

4.5.1 New Development

New development is defined as the conversion of natural or rural areas into residential, commercial, and/or industrial development.

For new development proposals, the post-development peak flow from the outlet point(s) of the site to the downstream public drainage system or receiving water shall not exceed the pre-development flow for both the minor and major system design storm ARI. Pre-development peak flow shall be the estimated flow from the site based on known or estimated catchment conditions prior to the new development. Design storm ARIs for the minor and major drainage systems shall be selected in accordance with Table 4.1.

4.5.2 Redevelopment

Redevelopment is defined as the reconstruction of an existing residential, commercial or industrial area. The degree of runoff control required will depend on the scale of the development and the net change in impervious area. The scale of development includes lot redevelopment (comprising single or multiple lots) and subdivision development.

Flow control will be required for any redevelopment where:

- the density of the redevelopment, measured as the total equivalent impervious area of the redevelopment, is greater than that of the existing development and/or
- the capacity of the existing stormwater system does not meet the design storm ARIs given in Table 4.1

(a) Lot Redevelopment

Lot redevelopment is defined as redevelopment of single or multiple adjacent lots where all of the stormwater system will be privately owned.

The post-redevelopment peak flow rate from a lot redevelopment shall not exceed the pre-redevelopment rate for the minor system design storm (usually 5 year ARI). This will generally require the provision of on-site stormwater detention and/or retention if the equivalent impervious area is increased (refer to Chapters 19 and 21).

(b) Subdivision Redevelopment

Subdivision redevelopment is defined as redevelopment where all or part of the stormwater system will be handed over to a government authority and become part of the municipal drainage system.

Post-redevelopment peak flows from the outlet point(s) of the redevelopment area to the existing downstream public conveyance system or receiving water shall not exceed the existing development flows for both the minor and major system design storm ARIs. Existing development peak flow *(the pre-redevelopment flow)* shall be the estimated flow from the site based on the developed catchment conditions prior to redevelopment.

The *minimum* responsibility of the developer is to ensure that the redevelopment does not create or worsen any capacity problems in the existing public drainage system. This will require the construction of community detention or retention, either on its own or in conjunction with on-site detention.

Notwithstanding the above, it may be advantageous in some areas (where upgrading of the existing municipal stormwater system is physically or economically impractical) for the developer to provide additional flow control.

These standards are summarised in Table 4.2. The minor and major system design storm ARIs referred to shall be those appropriate for the existing development in accordance with Table 4.1. Note that these are the ARIs that the existing municipal drainage system should have been designed for, not the as-constructed capacity of the system.

4.6 CONVEYANCE SYSTEMS

Stormwater conveyance systems shall be planned, analysed, and designed in accordance with the following in

order to provide acceptable levels of safety for the general public and flood protection for private and public property:

Part C Planning
Part D Hydrology and Hydraulics
Part F Runoff Conveyance

4.6.1 Minor System Design

All new urban development shall be provided with a minor drainage system with a capacity not less than the design ARI as specified in Table 4.1. The minor system may comprise any combination of piped or open drains or engineered waterways to suit planning requirements (for a discussion of the alternatives, see Chapter 10).

4.6.2 Major Flood Protection

Flood levels in all new urban development and redevelopment shall be protected against flooding up to the 100 year ARI flood.

This flood protection may be achieved by a combination of measures including a "major drainage system" of trunk drains and flow paths in open space and local roads; increasing the size of the minor system; the setting of minimum platform levels; providing levees or other flood protection; and restrictions on building in the floodplain (defined as the extent of the 100 year ARI flood).

An important concept in the major storm is the "gap flow", defined as the difference between the major storm flow and the capacity of the drainage system.

In large urban catchments it may be necessary to increase the capacity of the trunk drainage system above that shown in Table 4.1 in order to limit the magnitude of the "gap flow". This condition will typically occur when the catchment area is larger than 40 hectares.

4.6.3 Local Stormwater Flooding

Restrictions on development of flood-liable land shall generally apply to land affected by flooding from stormwater drains, as well land affected by river flooding.

However, it is recognised that the duration of stormwater flooding is shorter and therefore some short-duration disruptions (such as to road traffic) can be accepted.

4.6.4 Natural Drainage Paths

Both the minor and major systems shall be planned and designed so as to generally conform to natural drainage patterns and discharge to natural drainage paths within a catchment. However the minor system is often modified to conform with road and lot layouts.

Runoff must be discharged from the development in a manner that will not cause adverse impacts on downstream properties or stormwater systems. In general, runoff from development sites within a catchment shall be discharged at the existing natural drainage outlet or outlets. If the developer wishes to change discharge points he or she must demonstrate that the change will not have any adverse impacts on downstream properties or stormwater systems.

Table 4.2 Flow Control Performance Criteria for Detention and Retention

Development Category	Minimum Standard
New Development	Peak flow ≤ pre-development peak flow for minor and major system design storm ARI of new development (1)
Redevelopment (2)	
Lot	Peak flow ≤ pre-redevelopment peak flow for minor system design storm (1), and storage ≥ Site Storage Requirement (SSR) in accordance with Chapter 19.
Subdivision	Peak flow ≤ pre-redevelopment peak flow for minor and major system design storm ARI of existing development (1)

Notes: (1) Minor and major system design storm ARIs are to be determined from Table 4.1.

(2) These are minimum standards, greater reductions are preferable if the downstream system is under-sized.

Diverting runoff from other catchments or sub-catchments can cause adverse impacts on downstream properties and stormwater systems due to greater runoff volumes than would otherwise occur from the natural drainage catchment. Therefore, the diversion of runoff to or from other catchments or sub-catchments is not permitted.

4.6.5 Surface Flow Criteria

Within a catchment, a range of surface flow criteria must be applied to minimise both nuisance flooding and major hazards from flooding of roadways, buildings, and other areas, which have regular public access. The criteria apply to *both* major and minor flows.

The surface flow criteria comprise four basic limits:

- *an overland flow velocity x depth limit*, which governs the stability of vehicles and the ability of pedestrians to 'walk out' of flood flows
- *a flow width limit*
- *a ponding depth limit*
- *an ARI limit*, which is a probability/risk limit based on consideration of issues of immunity/damage from flooding, safety, construction costs and community costs and benefit

The surface flow criteria to be adopted for drainage design are provided in Tables 4.3 (roads) and 4.4 (waterway).

Table 4.3 Surface Flow Criteria for Roads

Criteria	Road Classification		
	High Volume Road (Single or Dual Carriageway)	Collector Road	Local Road
Locations other than sag points			
Design ARI	10 year	10 year	5 year
Where the kerbside lane is not a through lane (i.e. used for parking)	Not applicable	W < 2.5 m	W < 2.5 m
Where the kerbside lane is a through lane	>70km/h: no spread >70 km/h: W < 1.0m	W < 1.5 m	Not applicable
Where parking lane becomes an acceleration, deceleration or turn lane	>70km/h: no spread >70 km/h: W < 1.0m	W < 1.0 m	Not applicable
At pedestrian crossings or bus stops	Not applicable	W < 0.45 m	W < 0.45 m
At intersection kerb returns	>70km/h: no spread >70 km/h: W < 1.0m	W < 1.0 m	W < 1.0 m
Sag points			
Design ARI	50 year	10 year	5 year
All locations	W < 1.0 m	W < 2.5 m	W < 2.5 m
Major storm check (100 year ARI)	One lane in each direction open to traffic	One lane open to traffic	(not required)
Safety			
Pedestrian safety (1)	$V.D$ < 0.4 m^2/s	$V.D$ < 0.4 m^2/s	$V.D$ < 0.4 m^2/s
Vehicular safety (1)	$V.D$ < 0.6 m^2/s	$V.D$ < 0.6 m^2/s	$V.D$ < 0.6 m^2/s

Notes: (1) Safety limit based on V.D, the product of average flow velocity and gutter flow depth.

(2) W = flow width on road from gutter invert.

(3) The standard for high volume roads depends on the design speed of the road.

(4) For illustrations of these requirements, refer to Chapter 24.

Table 4.4 Major System Surface Flow Criteria for Engineered Waterways

Waterway Type	Peak Average Flow Velocity Limit
Soft lined waterways and overland flow paths	< 2.0 m/s
Hard lined channels	< 4.0 m/s

4.6.6 Property Drainage

If pipe drainage is provided within a development, each lot to be serviced by a pipe system shall have an individual stormwater service tie to provide for the connection of drainage from buildings to the public stormwater conveyance system.

A public stormwater conveyance shall only be located within a lot where it is intended solely for the purpose of providing drainage for the lot or adjacent lots. Such conveyances shall be located such that access can be readily achieved and restrictions imposed on the use of the land due to the presence of the service are minimised.

4.6.7 Drainage Reserves

A drainage reserve shall be provided for stormwater conveyances located within private lots to provide access for maintenance. As drainage reserves can restrict flexibility in locating buildings and other structures on a lot, conveyance system alignments which minimise the need for such reserves shall be considered wherever possible.

To meet the intent of the major/minor stormwater drainage philosophy, only minor system conveyances may be contained within drainage reserves in private lots. The major drainage system shall be contained within separate drainage reserves located completely outside private land.

4.6.8 Rights of Other Authorities

Where a stormwater conveyance is proposed to be located within close proximity to another service, the designer shall ensure that the requirements of the authority responsible for that service are met.

Where there is significant advantage in placing a stormwater conveyance on an alignment reserved for another authority, it may be so placed provided that both the authority responsible for maintenance of the stormwater conveyance and the other authority concerned agree in writing to release the reservation.

4.6.9 Extreme Flood Events

Design of stormwater systems to pass or safely contain a flood of a given frequency implies that a surcharge will occur during a larger flood. There is also a risk that surcharge will occur during a smaller storm due to blockage of some drains, culverts or inlets. All hydraulic works sized by a flood estimate are designed on a risk basis as discussed in Chapter 11.

If failure of conveyance systems and/or major structures such as detention basins occurs during an extreme storm event, the risk to life and property could be significantly increased. This risk must be balanced against the probability of the extreme event. In most urban stormwater drainage systems the provision for a major storm as described in Section 4.4 will provide adequate security. However in unusual situations the designer must consider the element of risk in a flood larger than 100 year ARI.

4.7 RUNOFF QUALITY CONTROL

Source and treatment controls to enhance the quality of surface runoff shall be planned, analysed, and designed in accordance with:

Part C	Planning
Part D	Hydrology and Hydraulics
Part G	Post Construction Runoff Quality Controls
Part H	Construction Runoff Quality Controls
Part I	Landscaping and Watercourse Management

4.7.1 Post Construction Control Criteria

One of the aims of an ecologically-based stormwater management and planning approach is to identify the sustainable pollutant exports from a site to protect the environmental values of the receiving water that receives discharges from the site. Ideally the identification of sustainable pollutant loads on a receiving water is based on the magnitude of overall catchment exports, the contribution of each landuse to the overall levels of pollutant export and the reduction in overall pollutant loads are required in order to achieve the water quality objectives that are linked to the environmental values.

If reductions in pollutant exports from new development or redevelopment have not been identified by a Catchment Management Study, then the target for minimum retention

(new development) or for reduction in pollutant loads (redevelopment) shall be in accordance with Table 4.5.

The form of the minimum criteria in Table 4.5 is different for new development, and for redevelopment. For new development a minimum overall *percentage removal efficiency* is specified. This efficiency is achievable with current Best Management Practices (BMPs), as described in Part G. For redevelopment or drainage system upgrading, the criteria are set in terms of a *reduction in average annual pollutant load* compared with the load under existing conditions.

To achieve these goals it is expected that around 90% of the average annual runoff volume will need to be treated. This is approximately equivalent to treating the 3 month ARI event.

4.7.2 Source Control

Where applicable, source control measures shall be provided on residential, commercial, and industrial development sites. Filtration and infiltration devices shall be provided where appropriate, in accordance with Chapters 31 and 32.

Oil separators are mandatory for the sites specified in Chapter 33. They may also be used in other situations where there is a likelihood of high loading of oil entering the stormwater system.

4.7.3 Treatment Trains

Treatment trains shall be provided in all new development, redevelopment, or stormwater system upgrading. Each component shall be designed to provide the minimum retention *or* reduction in average annual pollutant load as appropriate, in accordance with Table 4.5.

4.7.4 Treatment Control Measures

The following additional requirements apply to individual treatment control devices:

(a) Gross Pollutant Traps

Gross pollutant traps (GPTs) shall be sized to retain 100% of all litter and debris greater than 1mm in size and a minimum of 70% of coarse sediments greater than or equal to 0.04 mm, for all storms up to and including the 3 month ARI event.

The GPTs must be designed so as to prevent any additional surcharge in the stormwater system in the event of partial or complete blockage. Tidal influence and backwater effects must be considered (Chapter 46).

The pollutant reduction performance must be maintained up to the design discharge. If design flows are exceeded, the GPTs shall not allow any significant remobilization of trapped material.

(b) Water Quality Control Ponds or Wetlands

Water quality control ponds (wet ponds) or constructed wetlands must be protected from excessive sediment loads by upstream GPTs.

Wet ponds shall be sized in accordance with Chapter 35 to achieve the pollutant capture set out in Table 4.5, and to minimise the remobilization of deposited pollutants.

Table 4.5 Pollutant Retention or Load Reduction Targets

Pollutant	New Development	Land Redevelopment (see note)	Drainage System Upgrading
	Annual Average Pollutant Removal Efficiency (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)	Reduction in Annual Average Pollutant Load from Existing Conditions (%)
Floatables	90	90	30
Sediment	70	50	20
Suspended Solids	60	40	20
Nitrogen	50	30	20
Phosphorus	50	30	20

Note: Local Authorities may set lower targets for redevelopment to take account of land constraints.

Ponds shall be fitted with spillways able to discharge at least the 100-year ARI flow. The relevant dam safety regulations may impose more stringent requirements.

The designer must be guided by the frequency of the storm events and their peak discharge rates when determining the risk that high velocities will wash out the epiphytes and biofilms. Velocities > 0.1 m/s may cause washout. Infrequent washout (say 1 event per year or less) may be acceptable provided that the epiphytes and biofilms can re-establish over time.

4.7.5 Housekeeping and Education

Housekeeping and community education or non-structural source control measures shall be implemented after occupancy of residential, commercial, and industrial sites and need not be addressed as part of the land development process.

4.7.6 Construction Quality Control Criteria

Erosion and sediment controls shall be provided on all land development and building projects to prevent, to the maximum extent possible, the transport of sediment from the project site resulting from clearing and grading or other land-disturbing activities. Erosion and sediment controls shall be maintained in good working order at all times and shall be kept in place until such time as disturbed areas have been permanently stabilised.

(a) Sediment Retention

Surface water collected from disturbed areas shall be routed through a sediment pond or sediment trap prior to release from the site. Sediment retention facilities shall be installed prior to the grading or disturbance of any contributing area.

Sediment basins shall be sized in accordance with Chapter 39 to retain a minimum of 70% of coarse sediments greater than or equal to 0.04 mm for all storms up to and including:

- 3 month ARI for construction projects that will take 2 years or less to complete
- 6 month ARI for construction projects that will take longer than 2 years to complete

(b) Erosion and Sediment Control Plan (ESCP)

An ESCP providing details of construction activities and practices, timing and staging of works, and the range of erosion and sediment practices and measures to be implemented shall be prepared in accordance with Chapter 41.

Other requirements for erosion and sediment control on land development and building construction sites include:

- identification of clearing limits and buffers prior to any site clearing or grading.
- surface water controls to intercept and convey all surface water from disturbed areas to a sediment pond or trap and discharge it downhill of any disturbed areas. Surface water upstream of the site shall be intercepted and diverted away from the site.
- temporary and permanent cover measures if necessary to protect disturbed areas.
- perimeter protection to filter sediment from sheet flow downhill of all disturbed areas when necessary.
- stabilisation or surfacing of entrances, roads, and parking areas used by construction traffic to minimise erosion and tracking of sediment off-site.

A range of control measures to achieve the above requirements is provided in Chapters 39 and 40.

4.8 ECOLOGICAL CRITERIA

4.8.1 Aesthetics

The stormwater drainage system shall be designed so that it enhances the appearance of the area, and maximises its use by the community.

4.8.2 Landscaping

Landscaping is intended to ensure that a stormwater drainage system will enhance an area while not resulting in an increase in flooding.

The stormwater system design shall take into account and be part of the overall land development landscape design.

The design shall:

- allow for landscaping or future changes in landscaping to enhance the visual appeal of the system
- enhance open space links through development areas
- retain existing trees if possible
- respect the functional use of the space
- form part of and be sympathetic with the landscape character of the surrounding neighbourhood

4.8.3 Watercourse Management

The requirements for engineered waterways are intended to ensure that a stormwater drainage system will enhance the appearance of an area while ensuring that tree planting does not result in an increase in flooding or blockage of drainage systems. Allowance shall be made for the effects of landscaping in the hydraulic calculations for engineered waterways.

To minimise ongoing maintenance:

- no trees other than those with clean boles, strong crown structure, and no propensity for root suckering may be planted in overbank areas of engineered waterways
- minimum spacing of trees shall be 3 m
- maintenance free 'thicket' zones used for hydraulic reasons shall have a minimum 3 m clearance from lot boundaries to provide access for grass cutting
- no vegetation other than grass shall be planted within 3 m of a concrete invert in an engineered waterway

4.9 OPERATION & MAINTENANCE

The design of a stormwater drainage system needs to take into account the continuing maintenance requirements of the system after it has been constructed. The drainage system shall provide for ease of maintenance and include adequate access for maintenance equipment. Consequently, designers will need to familiarise themselves with the capacity and capabilities of the authority responsible for maintaining the stormwater infrastructure in order to provide facilities, which can be readily and economically maintained.

The purchase of special maintenance equipment and plant requires considerable lead-time by the maintenance authority for approvals and funding. As a consequence, any design incorporating the need for special or unusual equipment shall not be prepared without the prior written approval of the maintenance authority. This approval also extends to the use of special techniques and the hire of special equipment.

A stormwater drainage system must also be designed such that maintenance activities can be performed without the risk of inadvertent damage to the assets of other authorities. Other authorities include those responsible for gas, electricity, telecommunications, water supply and sewerage services.