Armidale Dumaresq Council

Armidale Dumaresq

Development Control Plan 2012

Section 2 Site Analysis and General Controls

Chapter 2.7 Floodplain Protection and Stormwater Drainage

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Table of Contents

Part 1 General Provisions

1.1 Introduction

This chapter supplements information provided in Council's Engineering Code, and should be read in conjunction with that document.

The purpose of this chapter is to guide good design that makes provision for the effects of inundation (flooding) from natural watercourses and local stormwater runoff on development; and considers changes over time that have resulted in concentration, increase or redirection of pre-existing or natural flows.

1.2 Objectives

The objectives of this chapter are:

O.1 To provide design solutions that consider the future impacts of flooding and stormwater runoff.

O.2 To provide safety for the public and protection of property in major storm and flood events.

O.3 To provide for the safe passage of minor floods and minimise the inconvenience they cause the public.

O.4 To improve urban amenity through maintenance of natural drainage lines.

O.5 To optimise the land available for urban purposes including community facilities.

1.3 Land to which this chapter applies

This chapter applies to land in the Armidale Dumaresq local government area.

1.4 Addressing the guidelines in this chapter

The guidelines for managing flooding and stormwater runoff are set out in this chapter. These are expressed in the form of objectives which need to be addressed for each development proposal. For each objective (O), 'acceptable solutions' (S) are provided which, if met, will ensure compliance. Alternative approaches may be proposed, provided these adequately address the relevant objectives and comply with legislation. The chapter also provides guidelines which must be addressed where they are relevant to a development proposal.

Part 2 Flood Protection

2.1 Natural Watercourses

Detailed information and advice in relation to flooding from natural watercourses such as Dumaresq Creek, Martin's Gully , Black Gully and Yoogoonda Gully is available in Council's Policy 038 – Armidale Floodplain Management Policy.

Generally, planning restrictions will apply to development on land below the 'flood planning level' of such watercourses. The 'flood planning level' refers to the flood level established by the 1% Annual Exceedance Probability (AEP) flood (commonly referred to as the '1 in 100 year flood') plus 0.5 metres freeboard. The term AEP is commonly used with respect to flooding. The term Average Recurrence Interval (ARI) is commonly used in relation to urban drainage design – e.g 5 year, 10 year, 20 year or 100 year storms.

Urban areas affected are shown on the flood planning maps for Armidale, extending from approximately Lake Zot in the west to Castledoyle Road in the east. Flood planning maps can be viewed at Council.

2.2	**Local Flooding**
O.1	To ensure new buildings are designed to take into account the potential effects of 'local' stormwater run-off from upstream catchments, both natural and impervious, for rainfall events up to and including the 1% Annual Exceedance Probability (AEP) event.
Designs must demonstrate that:	
S.1	Floor levels are elevated above surrounding finished ground levels; where practical, by a minimum of 450mm above the ground level surrounding the sewer gully riser or by 300mm in other cases, with the adjacent ground surface graded to allow effective drainage of surface water away from the building.
S.2	An effective permanent and fail-safe overland drainage system (irrespective of any piped system) allowing unimpeded flow of surface water away from all possible points of stormwater entry to the building (to be identified by design levels and bold arrowed stormwater flowpaths).
S.3	Discharge is to be to an appropriate drainage system and, if above ground, not across the public footpath in a concentrated flow.
S.4	Drainage systems must not cause nuisance to neighbouring properties.

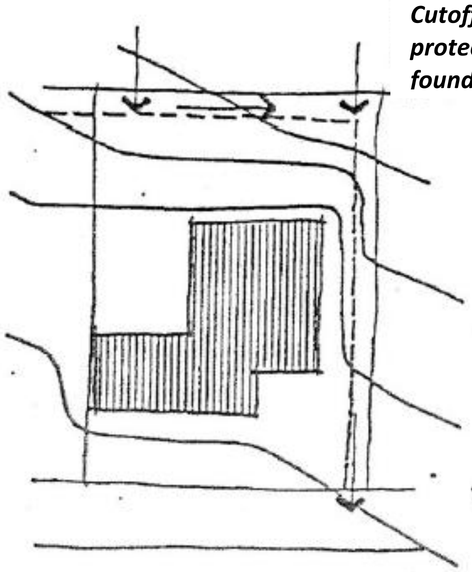


Figure 1: An effective overland flowpath within a development site.

Part 3 Stormwater Drainage Systems for Urban Subdivisions

3.1	**Drainage Systems**
O.1	To ensure stormwater drainage systems are designed to cater for *minor systems* (nuisance flows generated by rainfall events with an Average Recurrence Interval (ARI) of 5 years) and *major systems* (larger flood flows generated by rainfall events with an ARI of 100 years).
O.2	To ensure stormwater is disposed of in a hazard-free and nuisance-free manner within the capacity of the receiving drainage system.
O.3	To minimise hard surface areas to allow for greater absorption of stormwater; and reduce impact on stormwater systems.
O.4	To retain and enhance the natural conditions of natural watercourses.

O.5	To create stormwater easements of adequate dimensions.

S.1 All stormwater drainage collecting as a result of the erection of, or alterations or additions to, a development must be conveyed by a gravity fed or charged system to:

a) a public drainage system, or

b) an inter-allotment drainage system.

S.2 Major and minor systems must be provided.

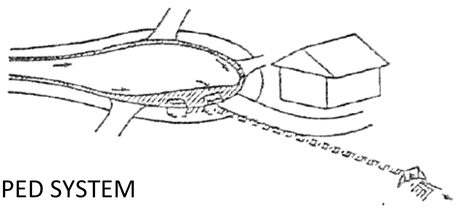
S.3 Minor systems should take the form of a piped system with appropriate stormwater inlet facilities for both road drainage and inter-allotment drainage where sites do not drain directly to the street.

S.4 The major system should take the form of permanently unobstructed failsafe, above ground floodways for both drainage involving roads etc, and inter-allotment drainage. Inter-allotment drainage systems do not always require a defined aboveground floodway, however, a flowpath should be identified.

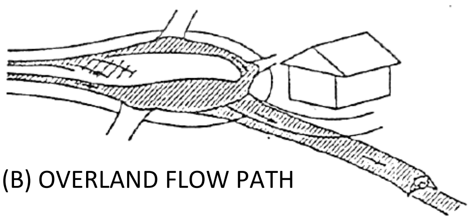
S.5 Both major and minor systems should discharge to a suitable Council approved (natural or engineered) receiving drainage system. The suitability and practicality of connection to such a receiving drainage system must be thoroughly checked by the developer's Chartered Professional (Civil) Engineer (CPE) for the project.

S.6 If the receiving drainage system does not have adequate spare capacity, then some form of retarding system must be provided to limit discharge flow rates to pre-development flow rates. This will be determined by the CPE in consultation with Council’s Development Engineering staff.

The following drawings show a minor road piped drainage system (A) and associated major; ‘failsafe’ aboveground system (B) designed to protect adjacent properties (*Australian Rainfall and Runoff*’, Institute of Engineers Australia, 1998).



(A) PIPED SYSTEM



(B) OVERLAND FLOW PATH

3.2 Stormwater Drainage Easements

S.7 Where the creation stormwater drainage easement through the property of another party is required, the applicant is required to supply details of proposed arrangements when submitting applications.

S.8 The consent of the landholder(s) to be affected must be provided.

S.9 Easements must be of adequate width for the design and maintenance of the drainage system proposed, including any aboveground floodway(s).

3.3 Receiving Drainage Systems

Receiving drainage systems usually occur in the lower part of catchments or downstream of the outflow point of storm water collected from developed areas. Receiving drainage systems can consist of large diameter piped drains, constructed channels or natural watercourses (such as gullies, creeks or streams).

This section outlines Council’s requirements for the capacity, treatment, and if necessary, rehabilitation, of natural watercourses that will act as receiving drainage systems for storm water runoff from developed areas. The relevant requirements also apply to natural watercourses that are situated within a development area, but are located upstream of the stormwater discharge point for the proposed development.

Specific storm water drainage provisions may apply to certain areas. Applicants are advised to check any site specific Strategy Plans in the Locality Specific Precincts section of this DCP that may apply to the land.

3.3.1 Principles

Natural watercourses that act as receiving drainage systems for storm water run-off from developed areas should reflect, or improve, the pre-existing or natural situation in terms of location, quantity, quality and velocity of flows.

Receiving drainage systems shall be designed in accordance with the following general principles:

P.1 the catchment context must be considered in all management decisions and planning processes affecting urban streams;

P.2 in planning and development decisions, all remaining natural features of stream corridors should be protected as far as possible;

P.3 stream management practices should attempt to emulate nature because the ecological functions of natural streams cannot be replaced by engineered solutions;

P.4 no watercourse is so degraded that its ecological functions cannot be improved;

P.5 for Greenfield sites, the values and functions of streams must be evaluated at the earliest planning stage and considered at all decision points.

3.3.2 Provision for Peak Discharge Stormwater Flows

Developers must demonstrate to Council's satisfaction, that either:

S.1 peak discharge from the proposed development site and all land upstream of the proposed development site within the drainage catchment (having regard to likely future development given the existing land use zoning at the date of application) will be disposed of in a hazard-free and nuisance-free manner within the capacity of the receiving drainage system; or

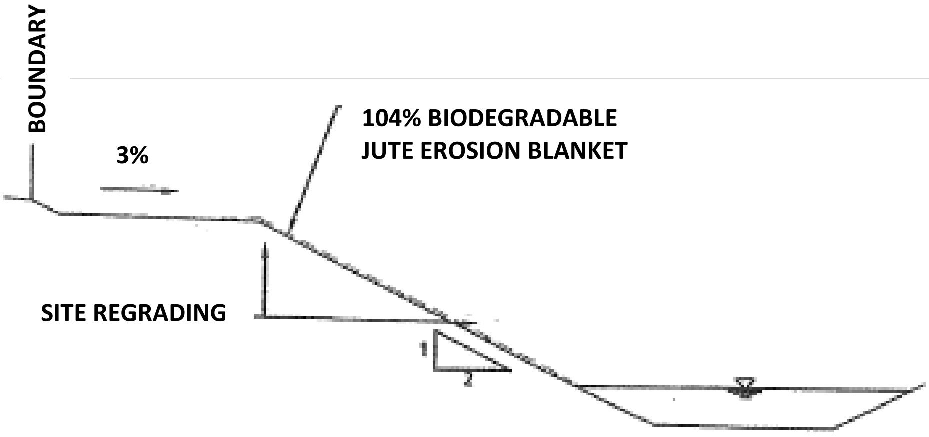
S.2 the proposed development will be designed to attenuate peak discharge flows from the drainage catchment so that, at all points along the receiving drainage system downstream of the development site, stormwater discharge from the proposed development will be disposed of in a hazard-free and nuisance-free manner within the capacity of the receiving drainage system.

S.3 Council may require, where relevant, an easement or riparian area reserve to be established by the developer over all or part of the receiving drainage system, and for the feasibility of such (including the consent of any affected downstream owners) to be demonstrated in the development application for the proposed development.

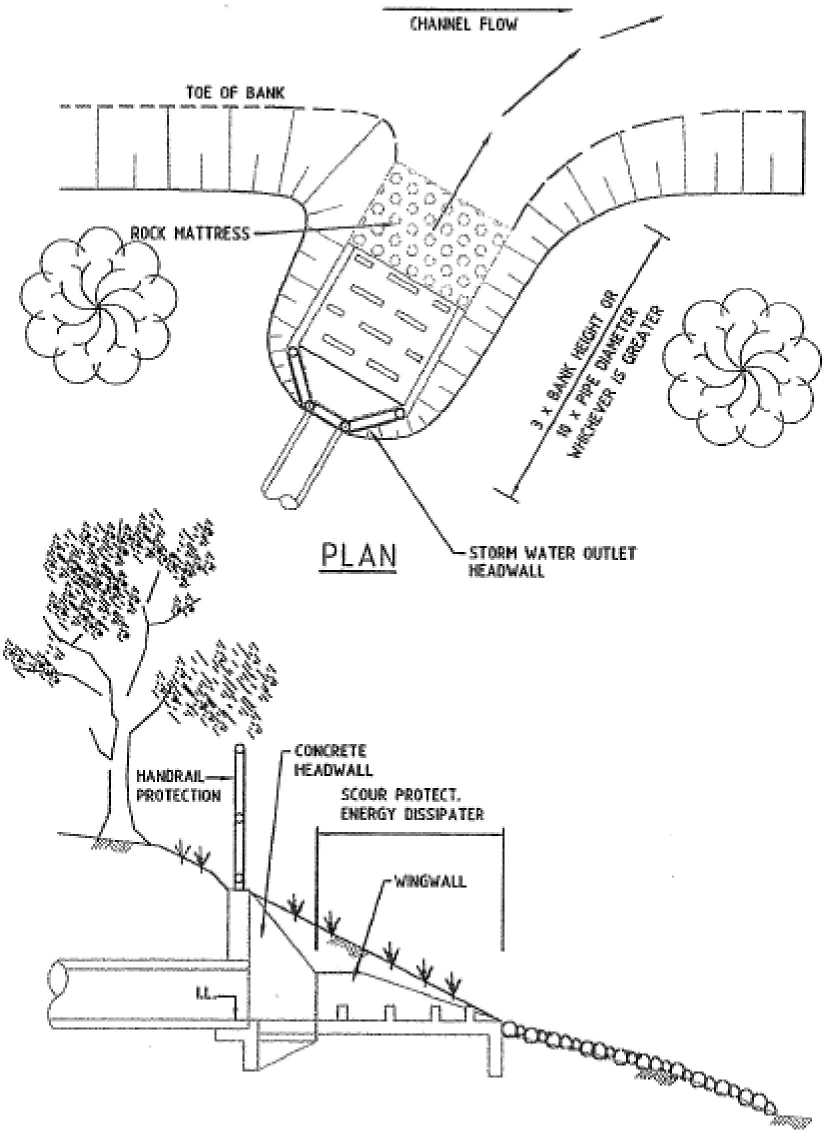
3.3.3 Formation/Rehabilitation of Natural Watercourses

The retention and rehabilitation/enhancement of natural conditions is the underlying theme for the treatment of natural watercourses. Receiving drainage systems that act as 'living streams' can be developed to provide native flora and fauna with areas for feeding, reproduction and migration, and can act as 'stepping stones' or corridors through the urban landscape. Storm water drainage systems that mimic or replicate nature are also more aesthetically pleasing than traditional systems such as straight drains and large, deep detention ponds or sumps.

S.1 Council will generally require natural watercourses within development areas, and receiving drainage systems downstream of development sites that cater for run-off from development, to be formed and/or rehabilitated in accordance with the following diagrams. Site specific variations may be required having regard to the nature of the watercourse.

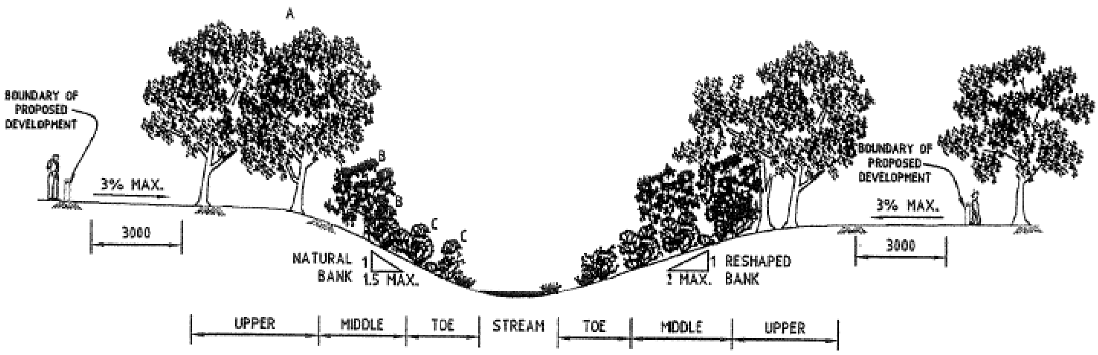


Erosion control and soil stabilisation on regraded channel banks



Typical storm water outlet protection detail

Source: Tierney & Partners, 2004



Typical re-planted cross section (not to scale)

Source: Tierney & Partners, 2004

A planting schedule and species list can be found at Appendix 1.

Part 4 Stormwater drainage systems for urban lots

4.1 System design

S.1 The most effective, and therefore preferred, means of minor stormwater drainage from ‘improved’ areas is by a gravity system directing stormwater to an approved receiving system (eg natural watercourse, Council drain, or property inter-allotment drain, etc).

S.2 On site dispersal trenches will only be accepted where no other practical alternatives are available. Each system will be considered on its merits.

S.3 On site disposal arrangements will not be approved for commercial or industrial development and ‘pump out’ systems will not be allowed in any urban location.

S.4 Where alternative systems are proposed, the developer’s CPE shall demonstrate to Council that run off from rainfall events up to and including the 100 year ARI event shall be adequately retained and run off controlled in a fail safe manner.

S.5 In cases where the receiving drainage system does not have adequate spare capacity to accept the development discharge, a retarding system must be provided to limit discharge flow rates to pre-development flow rates. This will need to be determined by the CPE in consultation with Council’s Development Engineering staff.

S.6 The CPE must demonstrate that post-development flows arising from any new work will not be concentrated or exceed the level of pre-development flows at any time. Moreover, the design must not allow any appreciable nuisance to other property owners in the circumstances of each case, including by reason of any excessively extended duration of stormwater flow.

4.2 Charged Line Systems

A Charged-Line System (sometimes referred to as an Inverted Syphon system) is a sealed pipe system which conveys stormwater from roof guttering under gravity pressure, but where the outlet to an approved drainage system is actually above the level of the subject site.

S.1 A charged-line system will only be considered for a single residential dwelling and associated Class 10a buildings under the Building Code of Australia (BCA), or alterations and additions to existing small commercial/industrial buildings where a property falls away from the drainage system (eg road gutter), and where it can be clearly demonstrated that to permit access to a legal point of discharge for stormwater:

	a) an inter-allotment drainage easement cannot be obtained, or b) where inter-allotment drainage is not practical.
S.2	Each such site-specific system must be designed in accordance with *AS 3500 – National Plumbing and Drainage Code* and the BCA.
S.3	Charged-line system designs and specifications must be supported by clear information which fully demonstrates the proposed drainage system will function effectively in a nuisance free manner.
S.4	The charged-line system must be completely watertight from the roof gutter level to the proposed outlet at street level, with an appropriate (capped) inspection/cleaning facility at the lowest point of the stormwater system.
S.5	Any such system which has an outlet to a road drainage system shall have a suitable kerb adaptor that is to be installed to minimise the potential for impact on the designed gutter flow within the road.
S.6	Building roof gutter(s) should be installed with an effective leaf guard arrangement to reduce the potential for blocking the gutters.
S.7	As a charged-line system is designed to convey roof stormwater only, provision must also be made in the drainage design to effectively manage surface stormwater from any impervious areas such as driveways and paved areas within the subject site without nuisance to other properties.
Part 5	**Stormwater drainage systems for rural lots and large lot residential lots**
5.1	**On-site stormwater disposal systems**
S.1	On-site stormwater disposal systems for new development activity on rural (RU1, RU3 and RU4), Environment Protection (E1, E3 or E4) or large lot residential (R5) zoned land may be permitted where: a) the lot size is not less than 1 hectare (10,000 m^2); b) no suitable Council approved drain or suitable natural watercourse exists in the vicinity of the site; and c) Council is satisfied that on-site dispersal is not likely to adversely affect the environment, including neighbouring properties, roads etc. (eg by concentration of flow); and d) the Applicant has submitted a report prepared by a CPE to address: i) suitability of soil and site conditions for on-site disposal (eg absorption capacity of site); and ii) any necessary measures to be taken to prevent soil erosion or sedimentation or soil instability and water nuisance of any type; and iii) scenarios of water-related nuisance and/or possible complaint of any type, with a view to protect Council against avoidable claims or loss.
S.2	In some circumstances, particularly in the E3 and E4 zones, drainage easements over downstream properties may be required. Consent from the owner(s) of the downstream properties is to be submitted with the development application.

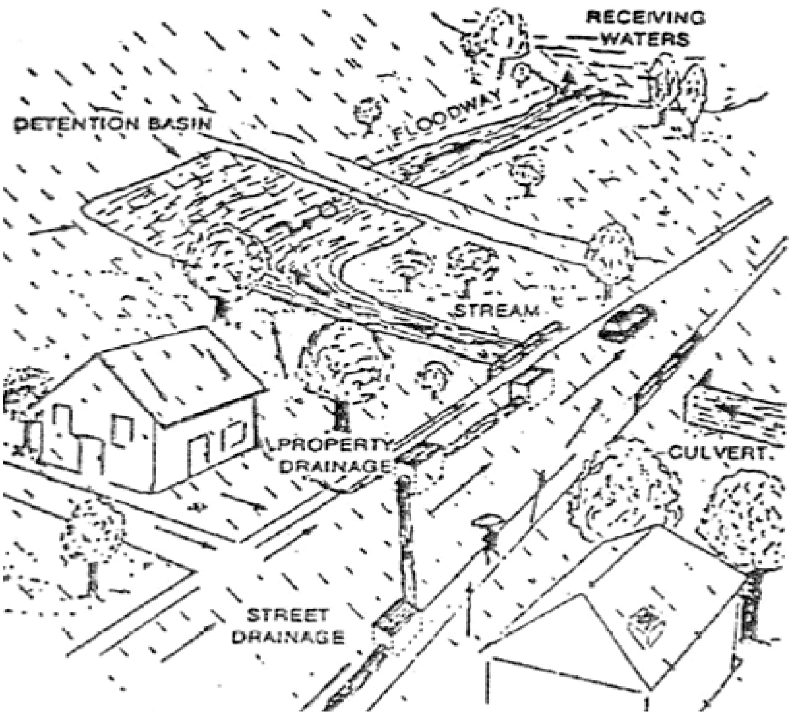
Part 6 Stormwater Drainage Design Considerations

6.1 Basis of Design

The basis of design for all stormwater drainage systems is '*Australian Rainfall and Runoff*' (Institute of Engineers Australia). More detailed information is available from Council's Engineering Code and from our Development Engineering Staff.

6.2 Minor/Major Stormwater Flows

Stormwater drainage systems typically consist of two distinct, but inter-related networks. Some typical components of the systems, which are described in the following text, are illustrated in the diagram below reproduced from '*Australian Rainfall and Runoff*' (Inst of Engineers Australia, 1998, Book 8 Urban Stormwater Management):



6.2.1 Minor Flow Systems

A minor flow system is designed for the collection of stormwater flows from properties (including roofs, paved/impervious surfaces and gardens), roads and any other land that produces stormwater discharge. This is typically achieved by directing stormwater via road gutters, inlet pits and pipes to an approved receiving system.

In general, Council requires new development to incorporate minor systems with capacity for a 5 year ARI rainfall event in residential areas and 10 year or 20 year ARI in more densely developed areas such as the Central Business District. Minor systems should direct flows to a Council approved drainage system (eg the Council's underground stormwater mains). Flows which are above the specified minor ARI level or which arise from the failure or blockage of minor drainage systems are to be directed to a major system.

In addition, as indicated above, if the receiving drainage system does not have adequate spare capacity, then some form of retarding system (see 5.3 below) must be provided to limit discharge flow rates to pre-development flow rates, or existing Council infrastructure augmented. This will need to be determined by the CPE in consultation with Council's Development Engineering staff.

6.2.2 Major Flow Systems

The purpose of the major system is to protect the health and safety of the community and to prevent property damage arising from major rainfall events or failure of the minor system (e.g. by pipe blockage).

Major systems are to be designed to accommodate at least a 100 year ARI event, and provide for fail-safe operation. These systems would typically take the form of above ground flowpaths, including retarding systems/basins where necessary to augment the capacity of the receiving system. Again, if the receiving drainage system does not have adequate spare capacity, then some form of retarding system must be provided to limit discharge flow rates to pre-development flow rates.

The major flow function of natural depressions on sites must also be recognised. Deviation of flows away from such natural flowpaths by intersecting roads should not be automatically assumed.

6.3 On-site Stormwater Detention (OSD)

On sites where adjoining public drainage infrastructure has little or no excess capacity, developments which would generate stormwater run-off beyond that equivalent to 35% impervious area site cover (or beyond that presently generated by the site, if greater) should provide for stormwater drainage mitigation or upgrading of the local drainage system.

This may be achieved by:

a) constructing on-site stormwater detention with delayed release into the stormwater system; or

b) designing the site to minimise impervious areas so increased run-off does not reach the stormwater system; or

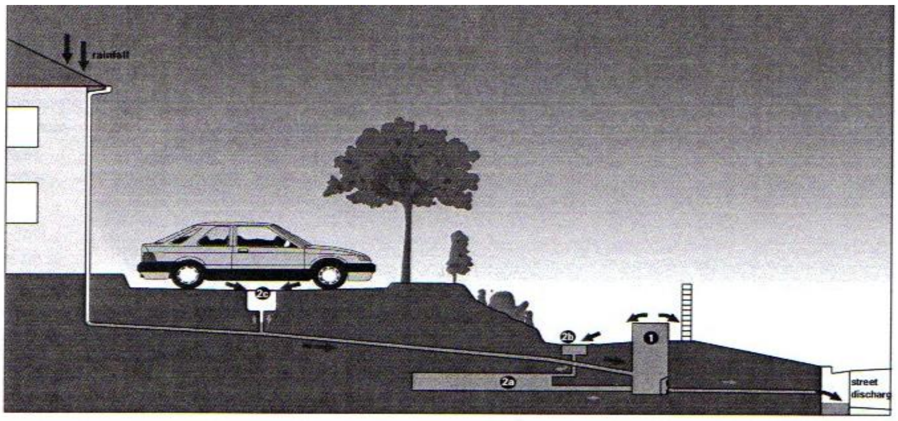
c) payment of a set drainage levy to Council in accordance with any adopted *Drainage Contributions Plan* or

d) incorporating an onsite water recycling system.

The objective of providing on-site stormwater detention is to capture and temporarily store (detain) water arising from up to and including 100 year ARI rainfall events, and then slowly release this water to an approved point of discharge to replicate pre-development flows from the subject site. This artificially forced storage and restricted release of stormwater flow significantly minimises the potential for flooding in local stormwater drainage systems.

An on-site detention facility can be in the form of a depression in a paved/landscaped area, an underground tank, above ground basin or a combination of these, integrated into the overall stormwater drainage system for the site.

The illustration overleaf shows a cross sectional view of a typical OSD System with (1) being a Discharge Control Pit at the street frontage and a 3-stage storage that fills progressively – (2a) small underground tank, (2b) storage in front setback, and (2c) car-park storage.



Cross section of typical OSD System *(Source - Upper Parramatta River Catchment Trust publication 'What is On-site Stormwater Detention?')*

The design of an OSD System shall be undertaken by the developer's CPE. The methods and principles of the proposed OSD System design shall be in accordance with the guidelines and procedures contained in the current versions of both Australian Rainfall and Runoff and the Upper Parramatta River Catchment Trust publication titled 'On-site Stormwater Detention Handbook'.

A copy of the latest Upper Parramatta River Catchment Trust Handbook, as well as further information on OSD, can be downloaded in PDF format from the following website –

www.uprct.nsw.gov.au

For relevant Development Applications submitted, a Stormwater Concept Plan is required to identify the drainage constraints/opportunities and demonstrate that any OSD System can be integrated into the proposed layout for the site. Detailed design should follow at the Construction Certification stage.

The ongoing maintenance and operation of a site OSD System is the responsibility of the land owner, and shall be subject to Positive Covenants and restrictions on Land Title(s) to ensure that this occurs.

Part 7 Water Sensitive Urban Design (WSUD)

WSUD provides an approach to urban water management that is sensitive to natural hydrologic and ecological processes. WSUD emphasizes on site collection, treatment and utilisation of water flows as part of an integrated treatment train. WSUD can reduce infrastructure costs and reduce environmental degradation

Development that is sensitive to its impact on the water cycle is an alternative approach to drainage design, which enables a more 'sustainable' solution aimed at improving and protecting the local environment.

Water Sensitive Urban Design (WSUD) contributes to urban sustainability by helping to provide the desirable conditions for environments that are pleasant to live in. This is achieved through the integration of urban planning and design with management, protection and conservation of the whole water cycle, from rainfall, initial treatment/capture in developed areas, and ultimate discharge back to natural watercourses.

7.1.1 Principles and applications of WSUD

As outlined in the publication *Urban Stormwater: Best Practice Environmental Guidelines (CSIRO 1999)*, the key principles of WSUD from a stormwater management and land use planning perspective are:

a) Protect natural systems – protect and enhance natural water systems such as creeks, rivers and wetlands, within urban environments.

b) Protect water quality - improve the quality of water draining from urban developments into natural watercourses.

c) Integrate stormwater treatment into the landscape – use stormwater treatment systems in the landscape by incorporating multiple uses that will provide multiple benefits, such as water quality treatment, wildlife habitat, public open space, recreational and visual amenity for the community.

d) Reduce runoff and peak flows – reduce peak flows from urban development by on site temporary measures (with potential for reuse) and minimise impervious areas.

e) Add value while minimising development costs – minimise the drainage infrastructure cost of development.

f) Reduce potable water demand - use stormwater as resource through capture and reuse for non-potable purposes, for example - toilet flushing, garden irrigation and laundry use.

WSUD relies on sensitive responses by designers, subdividers, home owners and builders to maximize and enhance the use of rainwater/stormwater to reduce potable supply requirements.

Careful consideration must be given to site characteristics such as soil type, slope, water table, rainfall characteristics, potential salinity and the scale and density of development.

Council is keen to work with developers on individual proposals which incorporate water sensitive urban design features. However, the minimisation of costs of Council ownership/maintenance and demand on both natural and financial resources shall be a high priority in the consideration and operations of works and associated community assets.

One commonly used WSUD element is Vegetated Swales. These consist of a grassed or vegetated channel used to convey stormwater run off as an alternative to constructed kerb and gutters in suitable areas. Potential contaminants from the road surfaces runoff are filtered as they pass through the vegetation. Further treatment can also be achieved with the integration of Bioretention Systems into the base of swales

Swales can be incorporated into urban designs along streets (within the median strip or footpaths), in parklands and between lots where maintenance access can be preserved. In addition to their treatment function, these systems can add to the aesthetic character of an area.

Practical examples of what can be achieved with Vegetated Swales are shown in the photographs below:

Examples of Grass Swales used in Urban Streetscapes

(Source – Association of Bayside Municipality Areas, (Melbourne, Victoria) publication 'Delivering Water Sensitive Urban Design')

Some examples of WSUD features are outlined below –

a) Bioretention Swales

b) Sedimentation Basins

c) Bioretention Basins

d) Infiltration Measures

e) Sand Filters

f) Rainwater Tanks

7.2 Bioretention Swales

Bioretention swales (or biofiltration trenches) are treatment systems that are located at the downstream end of a swale cell (i.e. immediately upstream of the swale overflow pit). Bioretention swales provide efficient treatment of stormwater through fine filtration, extended detention treatment and some biological uptake, and are particularly efficient at removing nitrogen and other soluble or fine particulate contaminants. They also provide a conveyance function (i.e. along the swale).

Bioretention swales can form attractive streetscapes and provide landscape features in an urban development. They are commonly located in the median strip of divided roads, in carparks and in parkland areas.

Runoff is 'filtered' through a prescribed filter media as it percolates downwards under gravity. The 'filtered' runoff is then collected at the base of the filter media via perforated pipes and flows to downstream waterways or to storages for potential reuse. Unlike infiltration systems, bioretention systems are well suited to a wide range of soil conditions, including low hydraulic conductivity 'clay' soils and areas affected by soil salinity and saline groundwater, as their operation is designed to minimise or eliminate exfiltration from the filter media to surrounding in-situ soils.

Any reductions in runoff volumes are primarily attributed to maintaining soil moisture of the filter media (which is also the growing media for the vegetation) and evapotranspiration losses. Should in-situ soil conditions be favourable, infiltration can be encouraged from the base of a bioretention system to recharge local groundwater and to reduce surface runoff volumes.

Vegetation that grows in the filter media of bioretention swales is an integral component of these treatment elements. Both the vegetation and the filter media have functional roles in stormwater treatment and it is the intrinsic relationship between the two that ensures the long term functional performance of the system.

7.3 Sedimentation Basins

Sediment basins are used to retain coarse sediments from runoff, are typically the first element in a 'treatment train', and are frequently used for trapping sediment in runoff from construction sites. Within a 'treatment train' they play an important role by protecting downstream elements from becoming overloaded or smothered with sediments, thus optimising treatment performance and minimising ongoing maintenance costs.

Sediment basins operate by reducing flow velocities and encouraging sediments to settle out of the water column. They rely on the creation of quiescent flow conditions and the prevention of 'short circuit' flow paths between the inlet and outlet. Sediment basins are typically constructed with sufficient depth (usually 1.5 m to 2.0 m) to allow for sediment accumulation and to prevent colonisation by fringing aquatic macrophytes (which is undesirable due to the requirement for regular desilting of sediment basins). They can also be designed as ephemeral systems, allowing them to drain during periods without rainfall and refill during runoff events.

Sediment basins can have various configurations including hard edges and base (e.g. concrete), or a more natural form with edge vegetation creating an attractive urban element. They are, however, typically turbid and maintenance usually requires significant disturbance of the system.

Maintenance of sediment basins involves dewatering and dredging/ excavating accumulated sediments. This is required approximately every five years, but depends on the nature of the catchment. For construction sites that can produce very large loads of sediment, desilting may be required more frequently.

7.4 Bioretention Basin

Bioretention basins operate with the same treatment processes as bioretention swales except do not have a conveyance function. High flows are either diverted (bypassed) away from the basin or are discharged into an overflow structure.

Like bioretention swales, bioretention basins can provide efficient treatment of stormwater through fine filtration, extended detention treatment and some biological uptake, particularly for nitrogen and other soluble or fine particulate contaminants.

Bioretention basins have an advantage of being applicable at a range of scales and shapes and therefore have flexibility for locations within a development. They are equally applicable to redevelopment sites and greenfield sites. Smaller systems may take the form of ‘planters’ that can be located within lots (e.g. gardens) and along roadways at regular intervals (e.g. in traffic calming devices) to create a boulevard aesthetic. All of these systems treat runoff near to its source and prior to entry into an underground drainage system.

Larger bioretention basins may be located at outfalls of a drainage system (e.g. in the base of retarding basins) to provide ‘end-of-pipe’ treatment to runoff from larger subcatchments where ‘at source’ applications may not be feasible. Large size bioretention basins need to consider the delivery of runoff into the basin to avoid scour and to ensure even distribution over the full surface area of the filter media.

A wide range of vegetation can be used within bioretention basins, allowing them to be easily integrated into the landscape theme of an area. Vegetation that grows in the filter media of bioretention basins is an integral component of these treatment devices. Both the vegetation and the filter media have functional roles in stormwater treatment and it is the intrinsic relationship between the two that ensures the long term functional performance of the system. They are however, sensitive to any materials that may clog the filter medium or damage the vegetation and therefore vehicles, building materials and construction washdown wastes should be kept away from bioretention basins.

7.5 Sand filters

Sand filters operate in a similar manner to bioretention systems with the exception that they have no vegetation growing on their surface. Therefore, they have a reduced stormwater treatment performance due to the absence of a biologically active soil layer typically created around the root zone of vegetation planted in bioretention systems. Sand filters lack vegetation because the filter media does not retain sufficient moisture to support vegetation growth or they are installed underground (therefore light limits vegetation growth).

Prior to entering a sand filter, flows are generally subjected to pretreatment to remove litter, debris and coarse sediments (typically via a sedimentation chamber). Following pretreatment, flows are spread over the sand filtration media and water percolates downwards to perforated pipes located at the base of the sand media. The perforated pipes collect treated water for conveyance downstream. During higher flows, water can pond on the surface of the sand filter increasing the volume of water that can be treated. Very high flows are diverted around sand filters to protect the sand media from scour.

Sand filters are particularly useful in areas where space is a premium and treatment is best achieved underground, such as in high density developments with little to no landscape areas. Due to the absence of vegetation, they require regular maintenance to ensure the surface of the sand filter media remains porous and does not become clogged with accumulated sediments. This typically involves regular routine inspections and tilling or removing any fine sediments that have formed a ‘crust’ on the surface.

7.6 Rainwater tanks

Rainwater tanks are sealed tanks designed to contain rainwater collected from roofs to provide the following main functions:

a) allow the reuse of collected rainwater as a substitute for mains water supply, for use for toilet flushing, laundry, or garden watering;

b) when designed with additional storage capacity above the overflow, provide some on-site detention, thus reducing peak flows and reducing downstream velocities; and

c) where it may be permissible to use rainwater tanks for internal hot water supply.

The water collected can be reused as a substitute for mains water supply either indoors (toilet flushing and laundry) or outdoors (garden watering).

Rainwater tanks can be either above ground or underground. Above ground tanks can be placed on stands to prevent the need of installing a pump to distribute the water. Such systems are referred to as gravity systems. Pressure systems require a pump and can be either above or below ground tanks. Tanks can be constructed of various materials such as Colorbond™, galvanised iron, polymer or concrete.

Part 8 Definitions

peak discharge means the maximum stormwater discharge associated with at least a 100 year ARI Storm Event, calculated in accordance with *'Australian Rainfall and Runoff'*.

Concept Planting Schedule

A	Upper	larger trees with deep root systems	*Acacia dealbata, Acacia filicifolia, Casuarina cunninghamiana, Eucalyptus nova anglica, Eucalyptus pauciflora, Eucalyptus Stellulata, Eucalyptus viminalis, Leptospermum brevipes*
B	Middle	medium sized plants with good root systems and larger canopies which shade the stream	Acacia Melanoxylon, *Acacia rubida, Acacia siculiformis, Banksia Integrifolia, Bursaria spinosa, Cassinia quinquefaria, Dillwynia juniperina, Eucalyptus, stellulata, Eucalyptus pauciflora, Grevillia juniperina, Hakea microcarpa, Lomandra longifolia*
C	Toe	low growing, multi-trunked plants with matter roots to bind the toe (best species for erosion control)	Callistemon Sieberi, *Juncus usitatus, Leptospermum polygalifolium, Lomandra longifolia,* Carex Gaudicmaudiana, Schoenoplectus Validas
	Stream	Damp edges	*Carex Gaudicmaudiana, Stellaria angustifolia, Lythrum salicaria, Hemarthria uncinata, Pennisetum alopecuroides*
		Submerged species	*Vallisneria gigantean, Potamogeton crispus, Potamogeton ochreatus, Triglochin procerum*
		Deep-water emergents	*Eleocharis sphacelata, Typha dominghensis, Phragmites australis, Schoenoplectus mucronatus, Typha orientalis, Schoenoplectus validus*
		Shallow water emergents	*Eleocharis acuta, Ranunculus inundatus*
		Floating-leaved species	*Ottelia ovalifolia, Ludwigia peploides*