PART I
Stormwater Management

Part I: Stormwater Management

Contents

1 Introduction

As impervious areas increase due to continuing urban development there is greater pressure on both the natural waterways and the built drainage systems. Our council stormwater drainage systems (including the natural streams and creeks) are operating at full capacity. Apart from environmental and pollution consequences, the increase in impervious surface areas leads to more urban flooding and further costs to maintain and replace council stormwater drainage infrastructure.

To mitigate these impacts, Willoughby City Council requires most new developments to install onsite detention (OSD) systems to reduce and control the extent of stormwater runoff from a site during storm events.

OSD systems control stormwater peak flows from a site by using tanks or other types of storage systems to temporarily store stormwater. This discharges into the council drainage system at a controlled rate.

These systems are required for all developments. However, rainwater reuse tanks may be installed to offset the requirement for OSD in minor developments such as dwellings, dual occupancies, boarding houses not exceeding 300m^2 and 12 persons, and secondary dwellings. The stored rainwater can be used for washing cars, watering lawns and gardens, topping up chemically treated swimming pools, toilet flushing and washing clothes.

There are three technical standards relevant to water management in Attachments 1, 2 and 3 of this part. A summary of the technical standards is in Section 6 of this part.

1.1 Aim

The aim of this part is to increase the number of relatively small low-cost storage systems on individual properties. This will help limit the peak discharge to predevelopment flow rates for all storm intensities and durations, including a 1% annual exceedance probability (AEP) storm event.

1.2 Objectives

The objectives of this part are to:

a. provide a safe and effective framework for the control, reuse and disposal of stormwater

b. reduce flooding risk in urban areas and protect council stormwater drainage infrastructure

c. maintain public health and safety

d. use water resources efficiently

e. encourage water sensitive urban design (WSUD) measures to minimise impacts on the natural water cycle and foster ecological sustainability

f. improve water quality and protect the scenic landscape and recreational values of bushland, natural watercourses and receiving waters

g. prevent, mitigate and control land degradation

2 Minor developments

2.1 Rainwater reuse tanks for minor developments

Minor developments include construction of, and alterations and additions to:

- single dwellings
- attached and detached dual occupancies
- boarding houses not exceeding 300m^2 and 12 persons
- secondary dwellings.

Alterations and additions include ancillary structures such as garages, carports, sheds, studios, swimming pools, studios, gazebos and the like.

Rainwater reuse tanks are an effective method of capturing and disposing of stormwater for minor developments that discharge directly into the council stormwater drainage system. The tanks help reduce the extent of overland flow and the risk of flooding in urban areas. They also provide cost savings for households by reducing the consumption of water from the reticulated system.

To promote the installation of rainwater reuse tanks for minor developments, Willoughby City Council will discount all or part of the OSD storage capacity requirement. This is in cases where the overflow from the rainwater tank can discharge by gravity into the council stormwater drainage system.

Further OSD systems may be required if the at-grade impervious surface areas cannot drain by gravity into the council stormwater drainage system and there is likely to be inundation to downstream properties.

Using rainwater solely for outdoor purposes such as watering the garden is a poor use of the stored rainwater. This is due to mismatches between the seasonal rainfall and outdoor water usage patterns. For example, during extended wet periods the stored rainwater is unlikely to be used for outdoor purposes such as watering gardens or washing cars.

To maximise the reuse of rainwater, the rainwater tank should be plumbed to indoor facilities such as toilets and laundries. This will ensure a steady rate of use regardless of seasonal rainfall. A combination of indoor and outdoor use of stored rainwater optimises the conservation of the potable water supply and provides some capacity for OSD.

This means that all rainwater reuse tanks must be plumbed to bathrooms/WC for toilet flushing and laundries for washing clothes, unless stated otherwise.

2.2 Size of rainwater reuse tanks for minor developments.

Table 1 Size of rainwater reuse tanks for new dwellings

Item	New dwellings	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
1	New dwellings on lots greater than 400m^2.	10kL	10kL
2	New dwellings on lots less than 400m^2.	5kL	5kL

Table 2 Size of rainwater reuse tanks for new dual occupancies and boarding houses

Item	New dual occupancies and boarding houses	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
3	New attached and detached dual occupancy on potential lots greater than 400m^2/dwelling.	10kL per dwelling	10kL per dwelling
4	New attached and detached dual occupancy on potential lots less than 400m^2/dwelling.	5kL per dwelling	5kL per dwelling
5	New attached dual occupancy on potential strata subdivision lots.	5kL per dwelling	5kL per dwelling
6	New boarding houses (not exceeding 300m^2 and 12 persons).	10kL	10kL

Table 3 Size of rainwater reuse tanks for new attached dwellings

Item	New attached dwellings	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
7	New attached dwellings on potential lots greater than 400m^2/dwelling.	10kL per dwelling	10kL per dwelling
8	New attached dwellings on potential lots less than 400m^2/dwelling.	5kL per dwelling	5kL per dwelling

Table 4 Size of rainwater reuse tanks for alterations and additions

Item	Alterations and additions (including attached secondary dwellings)	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
9	Alterations and additions to a minor development that involves significant demolition on lots greater than 400m^2.(i)	10kL	10kL
10	Alterations and additions to a minor development that involves significant demolition on lots less than 400m^2.(i)	5kL	5kL

Item	Alterations and additions (including attached secondary dwellings)	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
11	Alterations and additions to a minor development that will result in more than 60% impervious areas on lots greater than 400m^2.	10kL	10kL
12	Alterations and additions to a minor development that will result in more than 60% impervious areas on lots less than 400m^2.	5kL	5kL
13	Alterations and additions to minor developments with an estimated cost of more than $50,000 and impervious area between 50 – 60%.	5kL	5kL
14	Alterations and additions to a minor development with an estimated cost that is less than $50,000 and impervious area between 50 – 60%.	3kL(ii)	5kL
15	Alterations and additions to a minor development that do not result in impervious areas more than 50%.(iii), (iv)	none	5kL for lots >400m^2 3kL for lots <400m^2
16	Despite items 11, 12, 13 & 14 above, alterations and additions to minor developments that do not result in more than 5% over the existing impervious areas, and the area of works does not exceed 25m^2.(iii), (iv)	none	5kL for lots >400m^2 3kL for lots <400m^2

Table 5 Size of rainwater reuse tanks for detached secondary dwellings

Item	Detached secondary dwelling	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
17	New detached secondary dwellings and alterations and/or additions to convert an existing out buildings/studio to a detached secondary dwelling.	3kL	5kL

Table 6 Size of rainwater reuse tanks for other controls

Item	Other controls	Requirement for sites that fall directly to a street or via an easement	Requirement for sites with a charged system or onsite disposal system
18	Irrespective of the development type, a rainwater reuse tank is not required for sites that drain directly into Middle Harbour or Lane Cove River.(v)	none	none
19	Irrespective of the development type, a 5,000L rainwater reuse tank is required for sites that drain into a natural watercourse, creek or bushland.(v)	5kL	5kL

Notes from tables:

i. Demolition is ‘significant’ if the extent of demolition is more than 50% of the external fabric of the existing building.

ii. The rainwater reuse tank is only required to be plumbed to outdoor facilities.

iii. A 3,000-litre rainwater tank may be required under the State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 for any development with an estimated cost of $50,000 or more or a swimming pool that has a volume of more than 40,000 litres.

iv. Where a rainwater reuse tank is not required, if the site cannot drain by gravity into the council stormwater drainage system, measures such as infiltration and/or onsite detention systems may be needed. These are to ensure downstream properties are not affected by stormwater runoff from the subject property.

v. For more information on approvals and guidelines to drain directly into Middle Harbour, Lane Cove River, natural waterways, creeks or bushland, see technical standard 1 – stormwater management in Attachment 1.

Additional notes:

- Any variation to the size of rainwater tanks must be justified. This will be assessed case by case.
- A written request to vary the size of the rainwater reuse tank and/or the plumbing requirement to indoor facilities must be prepared by a suitably qualified person.
- For more information OSD systems and the installation and discharge of overflow for rainwater reuse tanks, see technical standard 1 – stormwater management in Attachment 1.
- The table in this section provides the minimum size of rainwater tanks for minor developments. Households are encouraged to provide larger rainwater reuse tanks if adequate space is available.

2.3 General submission requirements

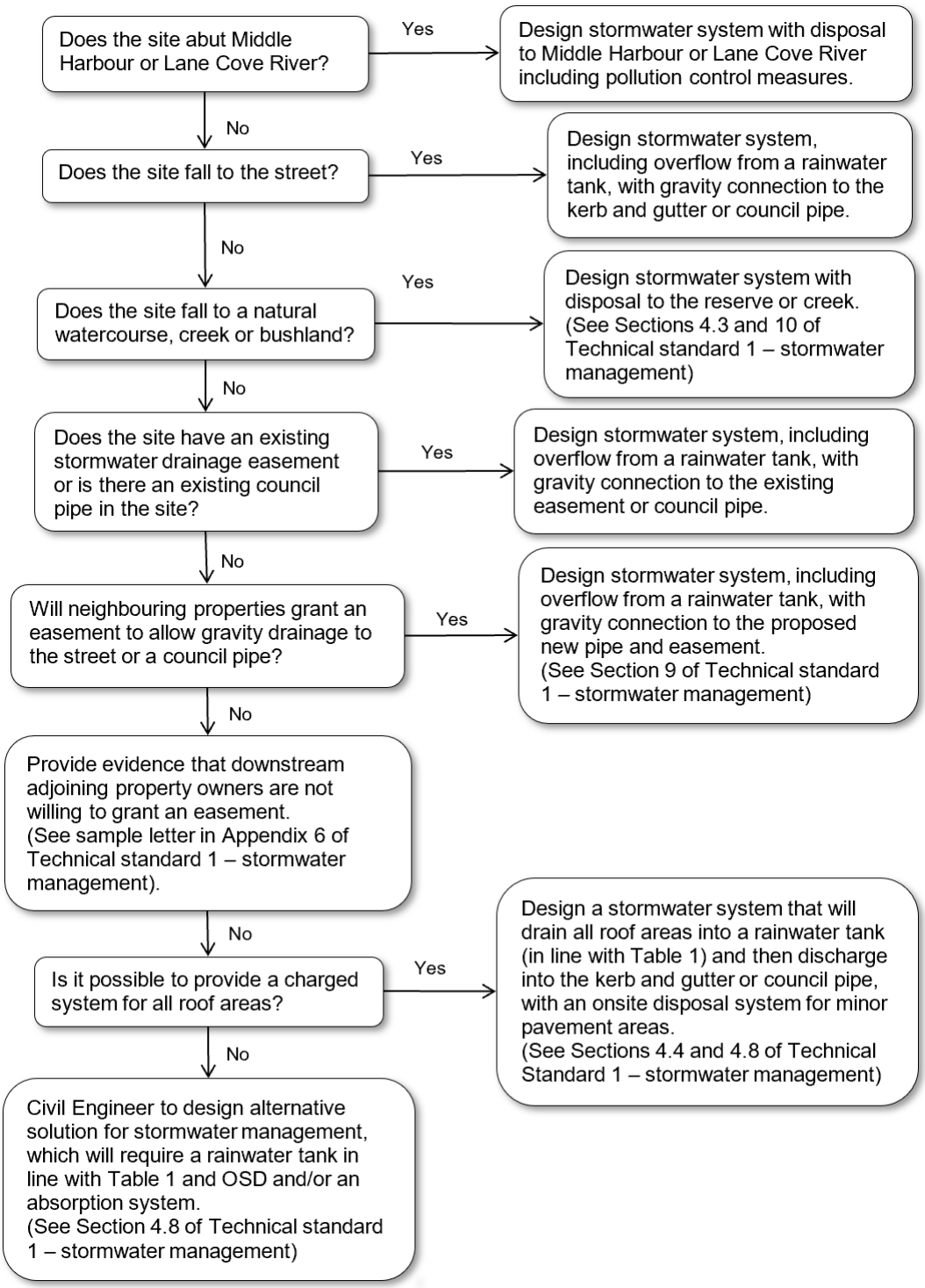
All applications for minor developments must include stormwater drainage details and an impervious area calculation plan prepared by a suitably qualified person. ‘Impervious areas’ include all existing and proposed new built structures such as roofs (measured to the eaves), driveways and paths, and paved areas. Swimming pools are also impervious areas.

Open slatted timber decks may be excluded if the area below the deck is unpaved.

Other partially permeable surfaces such as gravel driveways are included in the impervious area calculation. This is because these areas may be concreted or paved at a later date under State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 without Willoughby City Council approval.

2.4 Flow chart for the design and discharge of stormwater systems for minor developments

Figure 1 Flow chart for the design and discharge of stormwater systems for minor developments



2.5 Controls for rainwater reuse tanks

All development application for minor development or an application for a complying development certificate (CDC) must comply with these controls:

a. above ground rainwater tanks should not exceed 2.4m in height above the existing ground level; this height restriction includes any stand for the tank

b. rainwater tanks must be located at least 450mm from any property boundary

c. rainwater tanks must be positioned or screened so as not to be visible from the street frontage

d. rainwater tanks must be in a neutral, non-reflective colour to ensure tanks are compatible with the character of the locality and do not impact on adjoining buildings

e. above ground tanks must be built to ensure the area directly beneath any outlet tap and/or drainage plug is contained (or bunded) and drained to the nearest stormwater drain

f. rainwater tanks must not be installed over or immediately adjacent to a water pipeline, sewer pipeline or council stormwater pipeline or easement, unless it is installed with approval and in line with any requirements of the public authority that has responsibility for the pipeline

g. rainwater tanks are not to be located within overland flow paths or flood zones

h. minor developments may include OSD systems instead of or as well as the requirement for rainwater reuse tanks; however, the OSD system must be designed by a suitably qualified engineer

i. rainwater reuse tanks may be located below the building footprint, such as voids and below decks, providing they are accessible for maintenance and replacement; any tank located below the building footprint must be designed to ensure that any leakage can drain to a point outside of the building to avoid any flooding of habitable rooms

j. a sign measuring no less than 400mm x 200mm is to be permanently attached and displayed within the immediate vicinity of the rainwater reuse tank/s. The wording should state:

   ‘This rainwater retention and reuse system is required by Willoughby City Council. It is an offence to alter any part of the system without written consent from the council. The registered proprietor should keep the system in good working order by regular maintenance including removal of debris.’

k. a ‘charged system’ for rainwater reuse tanks for minor developments is permissible if the overflow can drain directly into the street or via an easement (see Section 4.4 of technical standard 1 – stormwater management)

l. if the overflow from a rainwater reuse tanks cannot drain directly under gravity into a street, or discharge into a watercourse or bushland, an applicant may need to obtain a downstream easement or connect into an existing inter-allotment drainage easement (see Section 9 of technical standard 1 – stormwater management)

m. if an easement cannot be obtained or the property cannot connect into an existing inter-allotment drainage easement, alternative measures may be needed to mitigate impacts

on downstream properties; this may include installing OSD tanks and rainwater tanks together with other measures such as onsite disposal systems (see Section 4.8 of technical standard 1 – stormwater management)

n. any variation to the controls for the installation of rainwater reuse tanks will need to be justified and assessed on its individual merits; a written request to vary the control must be prepared by a suitably qualified person

o. if multiple rainwater tanks are provided, and are not interconnected, the roof area draining to each tank must be proportionate to the tank size

3 Major developments

3.1 Onsite detention (OSD) for major developments

All developments that are not seen as 'minor' are deemed to be 'major' development, including:

a. residential developments for: multi dwelling housing; attached dwellings; boarding houses exceeding 300m^2 and 12 people; hostels; residential flat buildings; and seniors housing

b. commercial, industrial, institutional, shop top housing and mixed-use developments, and recreation facilities

c. all development that generate a water demand in excess of 5,000 litres per day

Note**:**

- Institutional development includes: community facilities, educational establishments, child care centres, places of public worship, and public administration buildings.

All major developments must provide OSD systems designed to capture and detain stormwater runoff for all storm events up to and including the 1% AEP storm event. The OSD system must be in line with Willoughby City Council's technical standard 1 – stormwater management and AS/NZS3500.3.

The statement of environmental effects (SEE) and stormwater management plan included with a development application must address water sensitive urban design (WSUD) and recycling and pollution control measures (see technical standard 1 – stormwater management).

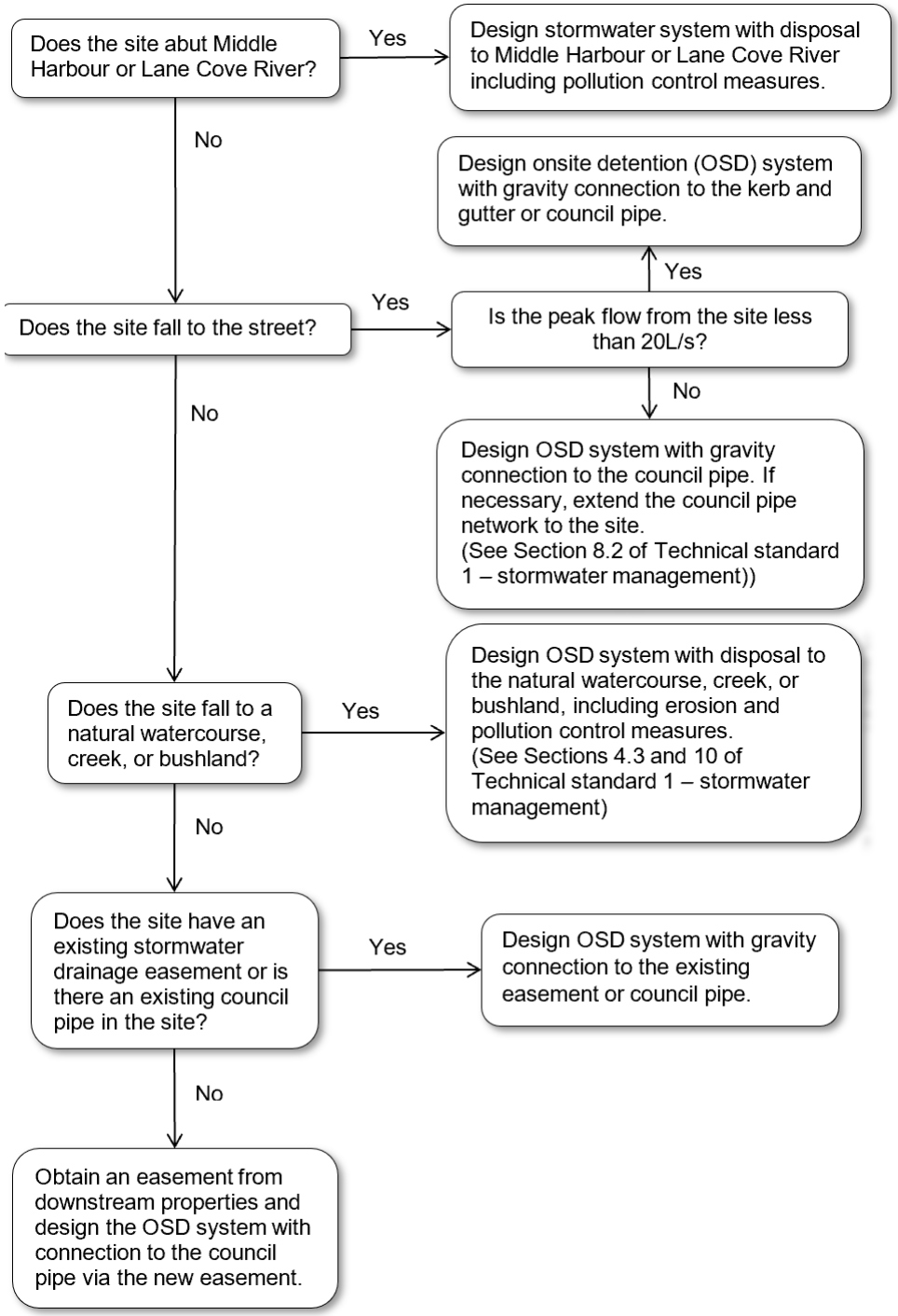
The stormwater management plan must be prepared by a suitably qualified engineer.

3.2 Exceptions

Onsite detention is not required if Willoughby City Council is satisfied that the discharge of stormwater from a property does not pass through any council owned drainage infrastructure before reaching the receiving waters of Middle Harbour or Lane Cove River. Drainage infrastructure includes any pipe, culvert, lined channel or other restrictive structure. However, certain requirements apply for the discharge of stormwater into natural watercourses or bushland (see Section 4.3 and Section 10 of technical standard 1 – stormwater management).

3.3 Flow chart for the design of stormwater systems for major developments

Figure 2 Flow chart for the design of stormwater systems for major developments



3.4 Discharge of stormwater

Stormwater is required to discharge via gravity, with pipes or channels having a minimum grade of 1% fall. If the overflow from an OSD system cannot drain directly under gravity into a street or an existing easement or discharge into a watercourse or bushland, an applicant must obtain a downstream easement or connect into an existing inter-allotment drainage easement (see Section 9 of technical standard 1 – stormwater management). For flows greater than 20L/s, it may be necessary to extend the council pipe system to the site at the developer's expense.

3.5 Water quality

For all major developments, water quality improvement measures are to be provided in line with technical standard 1 – stormwater management.

3.6 Water Sensitive Urban Design (WSUD)

An integrated approach to the management of stormwater in urban areas is the use of WSUD measures. It is one way we can protect council stormwater drainage infrastructure and make a significant contribution toward sustainability.

WSUD integrates the management of the natural soil and water resources on a development site by retaining or restoring natural site features. All major developments must consider and, where practical, implement appropriate WSUD measures.

A detailed explanation of WSUD by Sydney Water is at sydneywater.com.au.

Landscaping can play an important role in achieving WSUD to help control stormwater pollution and reduce stormwater runoff.

This includes:

- planting native grasses, groundcovers or mulched garden beds
- the use of plants with a high water demand to filter nutrients and reduce runoff
- the construction of depressions, swales, contour banks, rock channels, pebble paths or similar measures to capture and retain runoff

A civil engineer and landscape architect can assist in providing appropriate WSUD measures to include in the landscape design of a proposed development.

3.7 Further information

For some larger or more complex developments, the stormwater management plan should include a comprehensive water cycle management strategy.

This includes developments that:

a. incorporate 15 or more dwellings

b. accommodate 50 or more residents, occupants or employees

c. generate a water demand in excess of 5,000 litres per day

d. involves the creation of 2,500 square metres or more of impervious surface areas

e. involves the subdivision of 2,500 square metres or more of land for commercial or industrial purposes.

The plan should include:

f. the site constraints and the existing environment within its catchment context

g. design principles, objectives and performance standards for water cycle outcomes (post-development stormwater volume discharged from the site during a typical rainfall year should not exceed 90% of the volume that would be expected if no measures were applied to reduce the stormwater volume)

h. water management measures to meet the objectives of this plan and associated guidelines and technical standards or policies adopted by other relevant government agencies

i. an infrastructure program that integrates all aspects of water cycle management

j. strategies to ensure effective ongoing maintenance of onsite water management measures, maintenance and regulatory requirements

k. arrangements to monitor and maintain the water management strategy to satisfy the objectives of this plan

For major and/or more complex developments, applicants are encouraged to have a pre-development application meeting to confirm the level of information required as part of the application.

4 Subdivision

Applications for subdivisions that create a new lot must include a concept stormwater plan. The plan is to show the proposed method of stormwater drainage from each lot in the proposed subdivision. The maximum flow to the kerb and gutter from the un-subdivided lot shall be 20L/s. All lots must have a gravity drainage system, with pipes and channels having a minimum grade of 1%. If easements are required over downstream properties, they are to be shown on the plans, and written advice provided to confirm that the downstream property owner(s) will grant an easement.

For subdivisions that cannot drain directly into the street or via an easement, an OSD system must be provided on the site before the plans are registered. Details of the OSD system must be shown on the concept plans.

Note:

- For subdivision of an approved dual occupancy or attached dwellings where no building or ancillary works are proposed, no further stormwater measures are required.

5 Fences

In areas of overland flow, construction of fences must allow for the natural flow of stormwater. This may require fencing to be an open type construction (eg, palisade, mesh) or raised above the finished ground level to allow the free flow of stormwater. The open style fencing or open area to allow passage of stormwater, must extend from the ground level to a minimum of the 1% AEP flood level. Construction of any such fencing must remain safe

during floods and not obstruct moving debris. Details are to be submitted with the development application.

6 Applications for development

6.1 Site specific requirements

In preparing a development application or an application for a complying development certificate (CDC), please check the relevant technical standards for a stormwater management system. These vary depending on the development and discharge conditions.

The information included with the application should consider these questions:

a. is the development at risk from slope instability, reactive soils, erosion hazards, acid sulphate soils, land contamination or archaeological relics?

b. is the land affected, or potentially affected by flooding from stormwater drains, overland flow paths, drainage easements, watercourses or open channels?

c. does the site drain to adjacent land which is a watercourse, riparian community, bushland or reserve?

d. Does the development propose to cut into the natural surface or change the natural surface levels?

e. does the site fall to the rear and/or into neighbouring properties?

If the answer to any of these questions is ‘yes’, a suitably qualified engineer must be engaged to prepare a stormwater management plan. The design of this plan must:

f. consider ground levels and the location of existing stormwater drains when designing new drainage facilities

g. consider potential site areas which may maximise rainwater and stormwater collection for reuse

h. consider potential recycling facilities and reuse options

i. consider the potential use of existing landscape features as part of the proposed stormwater source controls

j. identify how the design responds to the site constraints and opportunities

Applications for minor developments that drain into a natural waterway or bushland must include all relevant information and a stormwater management plan prepared by a suitably qualified person.

6.2 Soil and water management plan

All applications must address sediment and erosion control measures. A soil and water management plan specifying the proposed measures to control erosion and pollution sources of water both during and after the construction phases will be required where:

a. a proposed development will expose a soil surface area greater than 250 square metres

b. the site adjoins public open space or a watercourse

c. the site is on a slope exceeding 18 degrees

d. involves cut or filling of the land which will alter the rate, volume or direction of overland flow

e. the development contains 10 or more car parking spaces

For more information see technical standard 3 – sediment and erosion control.

7 Technical standards

7.1 General

Willoughby City Council has three technical standards. These include details relating to stormwater management, floodplain management, sediment and erosion control, and water quality. These technical standards deal with the provision of onsite detention (OSD) systems, rainwater reuse tanks, flood mitigation, and erosion and pollution control measures.

The technical standards will assist proponents to provide the appropriate level of information to satisfy the aims and objectives of this plan. These documents are provided in Attachments 1, 2 and 3. A summary of each technical standard is provided below:

7.2 Technical standard 1 – stormwater management (Attachment 1)

This document provides guidelines and requirements for stormwater management systems, including OSD, rainwater tanks and discharge requirements. It also includes requirements for water quality improvement measures.

All developments must provide OSD systems that temporarily store stormwater before this is discharged into the council drainage system.

For minor developments, Willoughby City Council encourages the installation of rainwater reuse tanks to offset the requirement for OSD. Rainwater reuse tanks are required to capture roof water to be used for non-potable purposes such as washing cars, irrigating gardens, topping up chemically treated swimming pools, flushing toilets and washing clothes.

This document includes requirements for the installation and discharge of overflow from a rainwater reuse tank.

Note:

- A Positive Covenant and Restriction on Use of Land is not generally required for rainwater reuse tanks for minor developments. However, some minor developments may require this covenant to ensure any overflow from a rainwater reuse tank or OSD system is retained and maintained to prevent inundation to downstream properties.
- To ensure OSD systems are maintained, the covenant must be put on the title of the subject property for major developments.

Major developments must incorporate pollution control measures to ensure an acceptable level of water quality during and after construction. This is to mitigate the amount of pollutants entering council stormwater drainage systems, which ultimately flow into Middle Harbour or the Lane Cove River.

7.3 Technical standard 2 – floodplain management (Attachment 2)

Applications must address the risk of inundation and flooding if the site is adjacent to a creek, drainage reserve, stormwater pipeline or within a low point. The assessment is based on the 1% annual exceedance probability (AEP) event, also referred to as the 1 in 100 years average recurrence interval (ARI) storm event.

A flood study, prepared by a suitably qualified person, must be submitted for developments deemed to be at risk so that the overland flow volume, depth, velocity and extent of inundation can be ascertained. Applicants of properties identified as floodprone land are encouraged to have a pre-development application meeting to confirm the level of information required with the application.

The flood study should address all requirements and the information under Section 12 of technical standard 2 – floodplain management

Note:

- An applicant can obtain a Section 10.7 Certificate (previously a 149 Certificate) or contact Willoughby City Council's engineering division to confirm if a property is identified as floodprone land.
- If the property is identified as floodprone land, a flood information certificate is available from Willoughby City Council. The application form and fees are at willoughby.nsw.gov.au.

7.4 Technical standard 3 – sediment and erosion control (Attachment 3)

All applications involving earthworks or the generation of additional stormwater runoff must include a site management plan detailing the proposed method for sediment and erosion control measures. This document provides guidelines on simple, practical steps that can be taken to reduce the risk of polluting runoff from construction sites during storm events.

Attachment 1 – Technical standard 1 – stormwater management

1 Introduction

This technical standard provides detailed stormwater management requirements and controls to comply with Part I (Water Management) under Willoughby Development Control Plan (Willoughby DCP).

Willoughby City Council encourages sustainable development to help preserve the natural environment and protect private and public land from the increased probability of being flooded due to upstream development.

The increase in impervious surfaces due to urban development also puts greater pressure and further costs on Willoughby City Council to maintain and replace its drainage infrastructure. To mitigate these impacts, we require most new developments to install onsite detention (OSD) systems to reduce and control the extent of stormwater runoff from a site during storm events.

The requirement for OSD systems for any new development on a site is addressed as part of the development assessment process. The appropriate method of onsite detention depends on the type, size and scale of the proposed development.

This technical standard provides information and controls to help limit the peak discharge to predevelopment flow rates for all storm intensities and durations up to and including a 1% annual exceedance probability (AEP) storm event.

2 Objectives

The objectives of this technical standard are to:

a. regulate development to ensure it does not contribute to increased flood risk

b. manage the change in discharges from development sites by source control

c. minimise adverse environmental impacts caused by increased stormwater runoff by reducing the total volume of runoff being discharged from individual properties

d. minimise the use of mains supplied water by encouraging water conservation through the reuse of rainwater

e. provide an effective framework for the installation and ongoing maintenance of OSD systems and rainwater reuse tanks

f. ensure compliance with all codes, guidelines and legislation relating to OSD and rainwater reuse tanks

g. minimise water pollution from new developments

h. protect the water quality of natural watercourses and receiving waters by preventing further deterioration of the water quality, riparian zones and aquatic ecosystems due to development

i. maintain public health and safety

To achieve these objectives and ensure OSD systems operate correctly, the maximum flow rate allowed to discharge from a particular site (permissible site discharge or PSD) must be controlled by a restriction such as an orifice plate. In this way, the collective use of OSD systems can reduce the peak discharge to try and match the capacity of the downstream drainage system. This will save the community money by not requiring larger pipe systems. It will also reduce damage to the environment and improve water quality by preventing increased levels of scour, erosion and sedimentation being transported downstream towards the estuaries.

3 Application of this technical standard

This technical standard applies to all development/building works that require approval under *Environmental Planning and Assessment Act 1979* or *Local Government Act 1993*.

In line with Part I of Willoughby DCP, development falls into two categories; ‘minor’ development and ‘major’ development. Most minor developments will only be required to install a rainwater reuse tank to offset the requirement for OSD.

4 General water management requirements

4.1 Stormwater design elements

4.1.1 Standards

Stormwater drainage systems are to be designed and constructed in line with AS/NZS 3500.3, Australian Rainfall and Runoff by Geoscience Australia, Willoughby City Council’s Design Standards (AUS-SPEC) and the National Construction Code.

4.1.2 Surface inlet pits and grated trench drains

Surface inlet pits and grated trench drains with flush fitting grates are to be installed where necessary within the site to collect stormwater runoff and direct it to the disposal location. They must be:

a. sized to be capable of accepting the design flows

b. located to prevent runoff from entering buildings and garages

c. located to prevent long term ponding of stormwater

d. located so that runoff does not affect pedestrian access to buildings and so that concentrated stormwater does not flow over any public footpath or adjacent properties

All required grated trench drains are to be a minimum width of 200mm. For driveways falling to the street, a grated trench drain is to be provided across the driveway adjacent to the property boundary.

A stormwater pit is to be provided adjacent to the property boundary, before discharge to the council drainage system or kerb and gutter, to ensure the system can be maintained. For single dwelling properties the pit is to be a minimum of 450 x 450mm internal dimensions. For all other developments the pit is to be 600 x 600mm.

All stormwater junction pits and kerb inlet pits installed in council road reserve and public open space must be designed and installed in line with Willoughby City Council's Design Standards and AS/NZS 3500.3. Pits are to be provided at:

- low points
- every change in pipe size, level, direction or grade
- junction points of multiple pipes

4.1.3 Stormwater pipes

The minimum allowable pipe size across the footway to the street is a 100mm diameter sewer grade UPVC pipe. This should have a converter through the kerb consisting of a 75mm high by 125mm wide by 4mm thick galvanised RHS (rectangular hollow section) steel, with a minimum grade of 1%.

When discharging directly to the kerb and gutter, the maximum velocity is 2.5m/s and the maximum flow is 20L/s. Any site with a discharge of greater than 20L/s is required to connect directly into the council's piped stormwater system via a pit and/or pipe.

All pipes within the council road reserve, other than direct connections to the street kerb and gutter, or public open space must be a minimum of 375mm diameter reinforced concrete pipe.

For stormwater pipes in the road reserve or public open space, the minimum pipe grade is to be 1%. Grades of 0.5% are only acceptable for pipes larger than 225mm diameter, where a grade of 1% is not achievable and the pipe can be shown to be self-cleaning. For pipes within private property, minimum grades shall comply with AS/NZS 3500.3.

Pipes with a gradient greater than 20% must have anchor blocks at the top and bottom of the inclined section and at intervals not exceeding 20m.

The depth of cover on all pipelines is to be in line with AS/NZS 3500.3 and manufacturer's guidelines.

4.2 Surface runoff retention tanks

Water stored in underground tanks that are designed to capture runoff from paved or other ground surfaces may be used for outdoor irrigation and other non-potable uses.

These systems must:

a. incorporate suitable treatment measures before storage in the tank, such as a first flush and filter system

b. be connected to a sub-surface or drip irrigation system rather than a hose tap, unless treatment systems are provided that meet requirements for contact with the water

c. not be connected to indoor water features without suitable treatment in line with the national Australian Guidelines for Water Recycling: Managing Health and Environmental Risks

d. have all fixtures connected to the system marked: 'Not suitable for drinking'

e. have the tank enclosed and all inlets screened to prevent the entry of foreign matter and to prevent mosquito breeding

f. have the tank sited in a location where it will not affect the structural integrity of any nearby buildings

g. have the overflow connected to the onsite detention system (if required) and to the site drainage system

h. be designed by a suitably qualified engineer

4.3 Discharge into natural watercourses or bushland

Approval is required to discharge stormwater, including the overflow from a rainwater reuse tank or OSD system, directly into a natural watercourse, creek or bushland reserve.

Uncontrolled water discharge into natural watercourses and creeks increases embankment erosion and streambed scour. Applicants must ensure that any watercourse or creek bank and bed is protected against erosion and scour at the point of discharge.

Uncontrolled water discharge into bushland increases erosion, weed growth and causes long-term degradation of the bushland. If an applicant has approval to discharge stormwater through bushland, the discharge must be conveyed to the nearest substantial drainage line or watercourse via a natural-looking rock-lined channel or underground pipeline. The construction of the channel can be incorporated into the existing landscape and/or drainage lines and rock outcrops while protecting existing trees and vegetation.

The system for conveying the stormwater or overflow must incorporate:

a. energy dissipation structures that reduce the velocity of the stormwater discharge (see technical standard 3 – sediment and erosion control)

b. facilities for retention of gross pollutants and sediment; these structures and facilities are to be constructed on private property (see Section 11)

Applicants are responsible for the rehabilitation of any disturbed bushland area as a result of the drainage works being undertaken.

A plan detailing any proposed drainage and remedial works within a natural watercourse, creek or bushland must be prepared by a suitably qualified person and submitted to Willoughby City Council for approval.

4.4 Controls for a charged system

Charged systems are permitted to connect downpipes to rainwater tank, where it is not possible to provide a gravity drainage system. They are also permitted for minor development where it is not possible to drain the site via gravity and where it is not possible to obtain an easement.

For a charged system draining to a rainwater tank, these requirements are to be met:

a. hydraulic grade line calculations are to be done by a suitably qualified person demonstrating the proposed system will have sufficient operating head; a freeboard of at least 500mm is to be allowed between the lowest roof gutter level and the hydraulic grade line at the top of the respective downpipe; alternatively, the eaves gutter level is to be a minimum of 1.5m above the top water level in the rainwater tank and a maximum of 2.0m

b. the pipe system is to be fully sealed to a minimum of 500mm above the top water level in the pipe

c. a grated cleanout pit must be established adjacent to all system low-points and provided with a screw-capped sealed extension of the respective main charged drainage line that connects to an onsite dispersal trench system or stormwater pit

d. leaf guards, mosquito mesh and/or an appropriate flap valve must be established over the inlet pipes to the stilling pit to minimise mosquito nuisance

e. exposed aerial drainage will not be approved by Willoughby City Council, except for guttering and vertical downpipes and diagonal lines where they are feeding directly into a rainwater tank

For a charged system within the site that drains to the kerb and gutter, these requirements are to be met:

f. there is a gravity flow (min 1% grade) across the road reserve from the property boundary to the street gutter to preclude the possibility of street water backflow

g. a minimum of 1.5 metres head height must be available from the roof gutter or rainwater tank to the invert of the inlet in the stilling pit and a maximum of 1.5 metres head height between the invert level of the inlet in the stilling pit and the base of the downpipe

h. hydraulic grade line calculations are to be done by a suitably qualified person demonstrating that the proposed system will have sufficient operating head; a freeboard of at least 500mm is to be allowed between the lowest roof gutter level and the hydraulic grade line at the top of the respective downpipe or overflow from the rainwater tank

i. the discharge pipe must be fully sealed to a minimum level of 1 metre above the invert level of the council street gutter or 500mm above the top water level in the system, whichever is greater

j. a grated cleanout pit must be established adjacent to all system low-points and provided with a screw-capped sealed extension of the respective main charged drainage line that connects to an onsite dispersal trench system

k. leaf guards, mosquito mesh and/or an appropriate flap valve must be established over the inlet pipes to the stilling pit to minimise mosquito nuisance

l. exposed aerial drainage will not be approved by Willoughby City Council, except for guttering and vertical downpipes and diagonal lines where they feed directly into a rainwater tank

4.5 Pumps

Generally stormwater drainage from all properties should be by gravity. The use of pumps is generally only permitted for distribution of water from rainwater reuse tanks.

Pumps may be used to drain seepage from underground basements and a minor amount of direct runoff from basement driveway ramps. The pumps are required to be dual submersible pumps and sized and constructed in line with Section 9.4 of AS 3500.3.

Wet wells must have a minimum storage capacity of $3m^3$ and be designed and constructed in line with AS/NZ 3500 Part 3.

Direct connection of a pump's rising main to the kerb will not be permitted. The rising main must be directed to an OSD system, at a level above the top water level, or a stilling pit, before discharge.

4.6 Sub-soil drainage

Sub-soil drainage systems may be necessary in certain types of development. These are to be designed and constructed in line with AS/NZ 3500.3. Sub-soil drains should not be directly connected to the street kerb. Instead they should be connected under gravity to an internal stormwater drainage system via a pit.

Water in the system should be disposed of in a way that will not adversely affect adjacent properties. Applicants are advised to consult a hydraulic engineer.

4.7 Overland flow paths

Existing overland flow paths, including flows from adjacent allotments, are to be preserved and retained. Naturally diffuse surface waters (sheet flows) are not to be concentrated.

Catchment flood studies or drainage analysis must be carried out for sites where there is a risk or record of flooding from overland flow.

Approval to straighten, widen, line or pipe open channels may be granted in some instances, subject to environmental and hydrological considerations.

No structure or fill is to be placed within the flow path where it could cause a rise in the flow depth, increase the velocity beyond the allowable safety limit as defined by Australian Rainfall & Runoff (current edition) by Geoscience Australia, or have an adverse effect on adjacent properties.

Fences within overland flow paths are to be open style that allows the passage of floodwaters.

4.8 Onsite disposal systems

Onsite disposal, including dispersion and infiltration, as a primary method of stormwater disposal is generally not permitted as it can cause inundation of downstream properties in built environments. In addition, dispersion at the rear of properties backing onto bushland could change the moisture content in the bushland area and have an adverse impact on the local flora. Onsite disposal is not acceptable for major development.

For minor development only, where it is not possible to obtain a downstream easement, onsite disposal may be used if these controls are met:

a. it is demonstrated that no drainage easement exists either over adjoining properties nor are readily available through negotiation

b. it is demonstrated that all other alternatives, including charged systems, have been comprehensively examined and demonstrated to be inappropriate and ineffective

c. rainwater tank(s) are installed to capture runoff from all roof areas for reuse with an effective capacity in line with Section 2.2 of Part I of Willoughby DCP. The tanks are to be connected to supply non-potable use including toilet flushing, laundry systems, car

washing, and landscape irrigation. Overflow from rainwater tank(s) is to be piped to the onsite dispersion system

d. surface runoff from hard paved areas shall be collected via a filtration system before discharging into the system to prevent blockage by silt and/or debris

e. site conditions are suitable for onsite disposal

The design of onsite absorption systems are to be prepared by a suitably qualified civil or geotechnical engineer. The design must show that the soil and terrain conditions can accommodate an infiltration or soil absorption system and consider the soil types, slope of the land, level of the water table, and contamination and hydraulic conductivity of the soils.

The design must comply with these criteria:

f. the base of the trench is to be at least 1 metre above the underlying water table or rock stratum

g. a minimum of 95% of the total site impervious area is to drain to the rainwater tank; a maximum of 5% of the impervious area, generally driveways and paved areas, may bypass the rainwater tank and be drained directly to the disposal system

h. the system is at least 5 metres from downstream property boundaries and 2 metres from side boundaries

i. the system is at least 3 metres from any buildings

j. the system is not located where it could have an adverse impact on any existing or proposed tree

k. if the system is being constructed in conjunction with any new structure (including residential buildings) the foundations of the structure are to consist of pier and beam. The piers are to be to a solid stratum

l. the system must be at least 1 metre from pavements that are subjected to vehicle traffic

m. a debris/silt collection pit is to be constructed immediately upstream of the absorption system

n. the system is to consist of an Evertrench Jumbo 410 or similar product with 20mm river gravel wrapped with geofabric, with 1 lineal metre of trench for every $10m^2$ of impervious area draining to the trench, including areas draining to the rainwater tank

For dual occupancies and other minor developments where there is variation to these criteria, a detailed soil assessment and test report from a qualified geotechnical engineer confirming that the site is suitably permeable is required.

The design details and hydraulic calculations are to be prepared by a suitably qualified civil/hydraulic engineer. These are to show such a proposal would have no adverse effect on any building, downstream property, soil stability, local vegetation, drainage system or watercourse.

The design must include these details:

- the system will enable infiltration of up to a 5% AEP storm event for all storm durations without surcharging onto neighbouring properties
- the system can completely drain within 72 hours

- the infiltration area shall be the area of the base(s) of the trench(s) only
- a 50% clogging factor is to be added to the trench area
- the trench aggregate fill to have a minimum of 35% void
- installation to allow access pit(s) for cleaning

If test results detail that absorption is not suitable or the minimum trench sizes detailed above cannot be achieved, an onsite stormwater detention (OSD) system is required as well as a rainwater tank. The OSD system is to limit peak flows from the site to the 1% AEP flow from the fully pervious site, before disposal on site. All impervious areas must drain to the OSD system.

4.9 Permeable paving

Permeable paving may be used as part of a water sensitive urban design (WSUD) system provided for a development, and to meet water quality objectives, particularly on major developments or developments draining to reserves, watercourses, bushland or the harbour.

Permeable paving should not be used in areas that:

a. comprise impermeable soils with a hydraulic conductivity of less than 0.36mm/hr
b. have a surface of rock or shale
c. have a slope greater than 5%
d. have a high water table
e. receive high vehicular traffic or regular use by heavy vehicles
f. are downstream of areas likely to contribute significant amounts of silt, sediment, debris or windblown material (due to the potential for such material to result in clogging of permeable paving)

Soil assessment and permeability testing must be done as part of the design process for permeable paving. In the case of shallow soil cover over rock, testing is required to ensure that seepage will not cause negative impacts on downstream properties. Assessment and test results are to be included with the application for any development that includes permeable paving as part of its stormwater management system.

5 Rainwater reuse tanks

5.1 General

Willoughby City Council encourages the installation of rainwater reuse tanks instead of OSD systems for minor developments. Applicants should see the tables in section 2.2 and the flow charts in section 2.4 of Part I of Willoughby DCP to determine the required size of the rainwater reuse tank and discharge method of overflow for particular types of minor development.

Sydney's water supply is treated to drinking water standard. However, approximately 54% of domestic water usage in an average Sydney household could be supplemented by water stored in rainwater tanks.

NSW Health Department does not recommend the use of rainwater tanks for drinking purposes where reticulated potable water supply is available. For more information, contact NSW Health Department or see health.nsw.gov.au/environment/water.

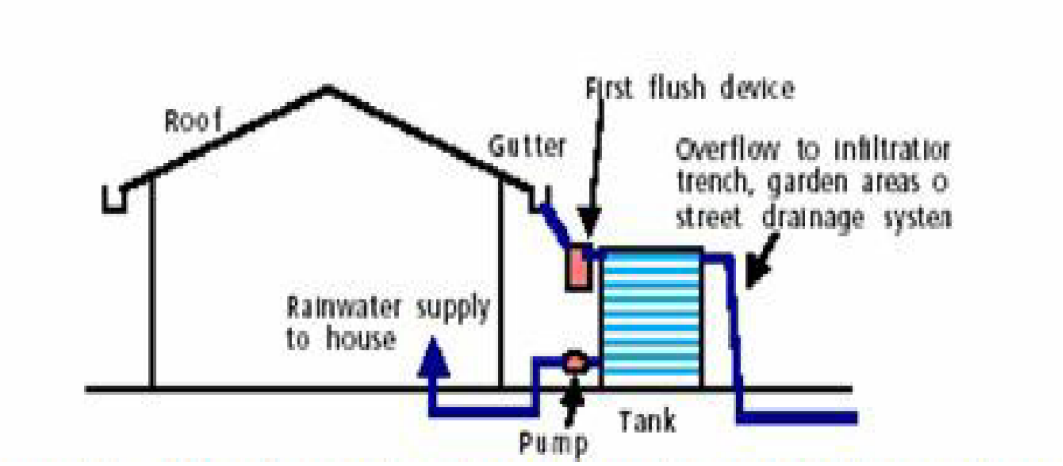
The figure in this section shows the percentage of potable water used in an average Sydney household for domestic purposes.

Figure 3 Typical household water usage

Note:

- Sourced from Sydney Water (2021)

Figure 4 Key elements of a domestic rainwater system



5.2 Exempt development

Subdivision 32 of *State Environmental Planning Policy 2008* (Exempt and Complying Development Codes) allows some above ground rainwater reuse tanks to be installed without a development application. See the policy for detailed requirements.

If an above ground rainwater reuse tank is constructed or installed on or in a heritage item in line with the policy, the tank must be located in the rear yard.

Installation of rainwater ranks that fall under the policy should also consider this technical standard and the provisions in Part I of this plan.

5.3 Bush fire prone land

Rainwater tanks installed on bush fire prone land must comply with these requirements:

a. have a gate valve fitted to the water tank (a 38mm Storz coupling will assist NSW Fire and Rescue)

b. have an additional gate valve fitted to enable the use of a portable pump

c. place a SWS (static water supply) symbol in a conspicuous position at the front of the property

Note:

- Bush fire prone land is identified on the Willoughby City Council Bush Fire Prone Land Map at willoughby.nsw.gov.au.

5.4 Tank construction

a. a rainwater tank must only collect rainwater from roof gutters and downpipes and from a water supply service main

b. underground rainwater tanks are to be fully sealed to prevent runoff from the ground surface and groundwater entering the rainwater tank

c. the rainwater tank must be fitted with a first-flush bypass system; the system is to be designed to cause a minimum of 1mm of the initial run-off from the roof area to bypass the tank thereby acting as a separator to reduce pollutants entering the tank (note that filters are not permitted)

d. the tank must be rigid walled and structurally sound and be prefabricated or constructed from prefabricated materials that are designed and manufactured for use as a rainwater tank; bladder type tanks are not acceptable

e. the tank must be assembled and installed in line with the instructions of the manufacturer or supplier

f. the tank must be placed on a structurally adequate base in line with the manufacturer's or engineer's details

g. the tank, and any stand, must be installed and maintained in line with any requirements of Sydney Water which is responsible for the supply of potable mains water to the premises on which the tank is installed

h. the tank is not to be fixed to any wall of a building unless certified by a practicing structural engineer

i. the tank must be enclosed and any inlet to the tank must be screened to prevent the entry of foreign matter, animals or insects

j. tanks must be designed for ease of flushing, desludging and general maintenance and, where applicable, comply with Australian/New Zealand Standard 2179.1 "Metal shape or sheet rainwater goods, and metal accessories and fasteners"

k. tanks are to be accessible for maintenance and replacement and structurally separate from habitable parts of a building; to cater for leakage or bursting of tanks, an overflow path is to be provided to direct water away from habitable areas

l. tanks must be in a neutral, non-reflective colour that is compatible with the character of the locality and adjoining buildings

m. tanks must be clear of the 1% AEP flood extent. They may be elevated on stands above the flood level, in accordance with Technical Standard No2.

5.5 Interconnected water supply systems and mains top up

To ensure a continuous water supply from the rainwater tank and ensure adequate storage for rainfall events, an interconnection to the potable water supply or a maximum storage volume (mains top-up zone) is to be set when installing the system.

The interconnection to the potable water supply may be via a three-way flow switching system provided that suitable backflow protection is in place. A three-way flow switching system selects water from the rainwater tank for its intended purpose. When the rainwater tank is low or the pump fails, the system automatically reverts to the potable water supply.

For a mains top up, the maximum level is to be based on the daily household usage expected from the tank and set for one day's usage. Reference should be made to the Sydney Water website when calculating the average daily usage patterns for the household. See sydneywater.com.au.

More information on plumbing requirements on backflow prevention for rainwater tanks and interconnected systems is also on the Sydney Water website. See sydneywater.com.au.

5.6 Overflow

Any overflow from the rainwater tank must be drained by gravity directly to an existing council stormwater system, OSD system, bushland or watercourse.

For underground rainwater tanks, the invert level of the discharge pipe must be above the 1% AEP flood level. There must be no other connections to the overflow pipes, such as surface water inlet pits. This is to prevent foreign matter entering the pipelines and flowing back into the rainwater tank.

5.7 Pumps

Any motorised or electric pump used to draw water from the tank or used to transfer water between tanks must:

a. comply with NSW Office of Environment and Heritage guidelines

b. be installed by a licensed electrician if it is a permanent electrical pump

5.8 Signage

A sign must be affixed to the tank clearly stating that the water in the tank is rainwater.

Taps supplied by water from the tank must be clearly labelled indicating the source of water.

Pipes from the tank are to be labelled rainwater/non-potable water in line with current Australian and Sydney Water standards.

6 Onsite stormwater detention

In line with Part I of Willoughby DCP, all developments that are not seen as ‘minor’ are deemed to be ‘major’ development. All major developments must provide onsite stormwater detention (OSD) systems and/or other water management strategies, such as water sensitive urban design (WSUD). A stormwater management plan, with hydraulic and hydrological concept plans, must be prepared by a suitably qualified engineer and included with the development application.

When full or partial redevelopment of a site is proposed, OSD must be provided to cover all the impervious area. No credit will be given for existing impervious areas.

OSD is also required for minor development on sites that fall to the rear, where geotechnical test results detail that absorption is not suitable and an onsite disposal system is required (see Section 4.8 for details).

6.1 Exemptions

OSD is not required where discharge of stormwater from a property does not pass through any council owned drainage infrastructure before reaching the receiving waters of Middle Harbour or Lane Cove River. However, other stormwater management systems are required to maintain water quality and prevent erosion (see Sections 10 and 11 of this technical standard for further details).

6.2 Design requirements

OSD systems must be designed in line with Willoughby City Council's policy as follows:

a. the volume of storage or the site storage requirement (SSR) for a site must be in line with Table 7

Table 7 Site storage required

Zone	Volume of storage required m^3/ha	Volume of storage required $m^3/100m^2$
1	327	3.27
2	360	3.6
3	380	3.8
4	315	3.15

Note:

- See the onsite detention drainage zone map (Appendix 1) for the required zone.

b. the Permissible Site Discharge (PSD) for a site must be in line with Table 8

Table 8 Permissible site discharge (PSD)

Zone	Permissible site discharge L/s/ha	Permissible site discharge L/s/100m2
1	225	2.25
2	170	1.7

Zone	Permissible site discharge L/s/ha	Permissible site discharge L/s/100m2
3	180	1.8
4	136	1.36

Note:

- See the onsite detention drainage zone map (Appendix 1) for the required zone.

c. where flow from impervious area bypasses the detention system, the PSD from the system is to be reduced by a rate equal to the flow from the bypass area in the 1% AEP storm event. Where the area bypassing the system is over 5% of the total impervious area, then a DRAINS model is to be prepared, to confirm that for the 1% AEP storm event the PSD is achieved and confirm the required storage volume for the reduced outflow

d. if the PSD from the entire site is to be reduced to 20L/s to allow discharge to the kerb and gutter, a DRAINS model is to be prepared to confirm the required storage volume

e. a spillway with an overland flow route is to be provided in the event that a storm higher than the design storm occurs, or the OSD system malfunctions. The flow route must be capable of carrying the flows for a 1% AEP storm, assuming that the outlet to the OSD system is fully blocked. Finished ground levels of the route must be shown on the plan. Piped overflow and overflow via an internal weir to an overflow pit / chamber with a piped outlet is not acceptable. The overflow path must be in a visible location at ground level, so any blockage of the system can be rectified

f. all roof and impervious areas shall drain through the OSD system for all storms up to an including the 1% AEP storm event. If the internal major flow path does not drain to the system, then the pipe network, including gutters and downpipes, is to be designed for the 1% AEP storm event

g. all floor levels adjacent to the OSD storage, or the overland flow path/spillway from the OSD storage, are to be a minimum of 300 mm above the maximum design storage water surface level. The freeboard may be reduced to 150mm for garages only

h. maximum above ground storage ponding depths are to be:

   - 200mm deep in areas such as driveways and car parking areas
   - 300mm deep in other storage areas such as landscaping or gardens

   Floatable landscaping material, such as tree bark chips, is not permitted in above ground storage ponding areas. The depth may be increased to 1000mm, if the storage area is fully fenced with pool fencing, it is possible to “walk out” of the ponding area (maximum 1:8 batters) and warning signs provided to indicate sudden rise in water levels

i. volumes of storage in landscaped areas to be increased by 20%, to allow for vegetation growth

j. a minimum of 0.36m^3 of the storage must be provided in the form of below ground storage such as a pit, which is to form the outlet of the OSD system. For storage on car parks, a minimum 25% of the site storage requirement is to be stored underground

k. crate style cell units, such as Atlantis Drainage Cells, are not acceptable to Willoughby City Council for OSD systems, as they are prone to siltation and blockage and are difficult to maintain

l. all below ground OSD tanks must be accessible for maintenance, with the access pit as near to the outlet as possible. Note the provisions of AS 2865 – Safe Working in Confined Spaces. For below ground tanks:

   - step irons are required at the outlet access grate of below ground storage tanks with a depth of 900mm or greater
   - OSD storage outlet discharge flows of 20 l/s or more shall be connected directly to the council underground drainage system or an extension of the system
   - below ground tanks shall be a minimum of 500mm deep
   - all below ground OSD tanks are to have an extra access grate diagonally opposite the outlet for ventilation and cleaning purposes. The minimum size of any access grate is to be 600mm x 900mm
   - the below ground tanks and pits are required to drain completely dry at the cessation of any storm and do not require sediment traps at the outlet point
   - tanks are not to be located beneath habitable floors

m. orifice plates used to restrict the outflow must be machined to the exact dimension as calculated from minimum 3mm thick stainless steel, or 3mm thick steel galvanised after machining. The minimum diameter of any orifice shall be 65mm. They must be bolted to the pit walls or permanently fixed in the pit by some approved method so that they cannot be easily removed. A pipe outlet is not recommended for discharge control

n. a stainless steel or galvanised mesh screen with a minimum area of 75 times the orifice area shall be latched over the orifice plate. To this end, Maxi Mesh (rh3030) is desirable. A handle attached to the screen is desirable

o. all storage outlets must have inverts above the 1% AEP floodway level of any nearby creeks or overland flow routes, or be designed with hydraulic grade line analysis to be above the downstream 1% AEP water level in the case of connection to council's underground system

p. for all OSD systems, a Positive Covenant and Restriction on Use of Land will be required to be placed on the Title in favour of Willoughby City Council. These instruments shall be created under Section 88B for newly created lots or under Section 88E(3) of the Conveyancing Act 1919 where no new lot is created. The purpose of this is to ensure that the registered proprietor has care, control and maintenance obligations of the OSD system

q. a plaque measuring no less than 400mm x 200mm and of a material acceptable to Willoughby City Council is to be permanently attached and prominently displayed close to the OSD system. This plaque will advise occupiers of the property of the existence of the OSD system and that the system must not be altered without written consent from Willoughby City Council

The required wording for the plaque is:

> "This is an onsite detention system. It must not be altered in any way without written consent from Willoughby City Council. The owner shall regularly clean the system."

Where needed for work health and safety requirements, a 'Danger' sign no less than 450 mm x 300 mm is to be displayed at the entrance of the tank advising that only persons with confined space training should enter that tank.

The suggested wording for the sign is:

> "Danger. Confined space. No entry without confined space training."

r. the constructed OSD installation must be certified by a suitably qualified and competent professional engineer, (generally CP Eng qualification) and state that it complies with Willoughby City Council's Design Standards (AUS-SPEC), all relevant codes and technical standards, and is in line with the approved plans

6.3 Submission requirements

All plans, calculations and details submitted must include this information:

a. total impervious area in m^2. Separately show the total roof area and total paved area including all driveways, carports and pathways. Swimming pools will be considered impervious where the high-level overflow is not connected to the sewer. Details of the proposed high-level overflow system are to be included in the submission when seeking exemption from the impervious area calculation

b. floor levels of all existing and proposed buildings and structures on the site

c. existing and proposed surface levels and contours. These contours shall extend 5 metres outside the property

d. location of all existing and proposed trees

e. the volume of storage being provided, with dimensions and level shown so that the storage volume can be easily calculated. This volume must be in line with the figures in Table 7

f. show that stormwater flows up to the 1% AEP storm event from all impervious areas (including roofs) are conveyed to the OSD system, either by a major flow path or an appropriately sized pipe network

g. should the permissible site discharge be reduced or throttled calculations showing the outflow versus storage relationship will be required for the critical storm calculations of the size of the orifice plate or other approved outlet control system will be required

h. show adequate details of an overflow spillway and overland flow path. Willoughby City Council may require calculations to show that the flow path can cope with the 1% AEP storm event

i. all levels are to be given to Australian Height Datum (AHD). Benchmark information is available from the Survey Control Branch of the Department of Lands (Land & Property Information Section) and Sydney Water

j. show the invert level of the proposed discharge outlet point at the street kerb or council trunk drainage system, and that all connections from OSD systems are above the 1% AEP water surface level

k. the OSD checklist (Appendix 5) is to be completed, signed and included in the application

The standard of presentation required for ease of checking the plan should indicate a north point, reduction ratios, existing and finished floor levels, construction dimensions, details and cross-sections.

6.4 Post-development documentation

a. the construction of the OSD installation must be supervised and certified by a suitably qualified engineer, which must state that it complies with Willoughby City Council's OSD policy, all relevant codes, standards and also that it is in line with the approved plans. Appendix 2 contains a draft certificate of hydraulic / hydrological compliance

b. on completion of the OSD system, a registered surveyor must verify critical levels and storage volumes. A suitably qualified engineer must prepare the works-as-executed plan with any changes shown in red, and complete the attached OSD record of installation

7 Maintenance of stormwater management systems

7.1 Maintenance

Regular maintenance of stormwater management systems, including rainwater tanks and OSD systems, is to be done to ensure they are working effectively.

Rainwater tanks are to be checked for sludge every two to three years. Gutters, leaf screens or guards are to be inspected and cleaned on a regular basis. Discharge control pits and the associated trash rack of OSD systems are to be inspected and cleaned on a regular basis, not exceeding six-monthly intervals.

7.2 Legal requirements

To ensure the continued effectiveness of stormwater water management systems, the applicant must place a restriction on the property title in favour of Willoughby City Council. This must be in the form of a Positive Covenant and/or Restriction on Use of Land under the *Conveyancing Act 1919* for onsite detention systems. Examples of Section 88B and 88E Instruments for the legal protection of stormwater management systems are in Appendix 3 of this standard.

8 Controls for discharge from a property into the council drainage system

8.1 General

All surface water, roof water not connected to a rainwater tank, and the overflow from a rainwater tank must be conveyed by gravity to the council drainage system, a watercourse or the harbour. All methods of discharge into or through public open space require the approval

of Willoughby City Council. Public open space includes road reserves, drainage reserves, public car parks, public parks, public reserves and bushland).

Work, including new connections, may not be done on the council drainage system without approval from Willoughby City Council, and it may only be done in line with current Australian Standards and AUS-SPEC specifications. Willoughby City Council must be given a minimum of two working days' notice before any works are done on public roadways or involving council owned or operated structures, including new pipe systems.

Development sites that discharge less than 20 litres per second are permitted to discharge directly to the street kerb using 125x75x4 galvanised rectangular hollow section (RHS). Only one discharge line is permitted across the nature strip from each property.

The pipe discharging to the street kerb should be within the frontage of the subject property at an angle no less than 60^{o} to the kerb line. If drainage is beyond the subject property frontage, council's street drainage system is to be extended using a minimum 375mm diameter reinforced concrete pipe (RCP) with a kerb inlet pit to a point near the frontage of the property.

In exceptional circumstances and only for minor developments, Willoughby City Council may consider the extension of property drainage line for a maximum of 20m or the frontage of one property. The drainage line is to cross the nature strip perpendicular to the kerb with two 45^{o} bends to turn the pipe running directly behind, and parallel to the street kerb.

For any stormwater pipeline proposed to discharge directly into a council-owned stormwater drainage system such as a pipeline, channel or kerb inlet pit, the application may need to include hydrological and hydraulic analyses. These must confirm that there will be no surcharges due to backwater effects from the system.

For any connection to a council pit, pipe, channel etc., the pipe connection must be flush with the pit or pipe wall, and not extend into the pipe or pit.

When connecting to a council pipe, pit or drainage channel, a minimum of two working days' notice must be given to Willoughby City Council before starting the work. This is to allow for an inspection of the works when the connection is made.

8.2 Construction of a public pipeline

The proposed stormwater management system may include a public pipeline or other stormwater infrastructure built by the developer in the council road reserve or public open space as a condition of approval. Usually such infrastructure should be designed for all storm events up to and including a 5% AEP storm event, with a minimum pipe size of 375mm and a minimum grade of 1%. However, where the existing road may be unable to carry excess flows in larger storm events and where there may be danger to persons or risk of property damage, Willoughby City Council may require a larger storm event as a basis for the design. More information on public stormwater drainage infrastructure design requirements is in Willoughby City Council's AUS-SPEC.

Plans for any proposed public pipeline are to be submitted to Willoughby City Council for approval under the *Roads Act 1993*. Specific conditions for construction, including inspection requirements and work-as-executed drawings are to be provided as part of the approval of any plans.

8.3 Discharge to roads or lands controlled by other statutory authorities (integrated development)

An applicant who proposes connecting the site discharge to a stormwater drainage system under the control of another statutory authority must have the authority's written approval for the work. The approval must be submitted to Willoughby City Council before applying for a construction certificate.

9 Controls for discharge into a new inter-allotment drainage easement and into an existing drainage easement or drainage reserve

9.1 New inter-allotment drainage easements

The acquisition of downstream easement(s) may be necessary if the site is unable to discharge into the council stormwater drainage system by gravity. Documentary evidence of the registration of the drainage easement(s) must be provided to Willoughby City Council before issue of a construction certificate. Any easements required for a development must be shown on the linen plan for any subdivision.

The proposed pipeline in the inter-allotment drainage easement must have adequate capacity to convey the 1% AEP uncontrolled runoff from the development site. This pipeline must be constructed before starting any other works. At completion, the applicant must provide certification to Willoughby City Council from a suitably qualified engineer and works-as-executed drawings from a registered surveyor that the installation of the pipeline has been completed and complies with the approved drawings, the current Australian Standards and Willoughby City Council's AUS-SPEC. The registered surveyor must also certify that all drainage structures are constructed wholly within the drainage easement(s).

If the downstream property owner does not grant the necessary easement, the developer may be required to apply to the Supreme Court under Section 88K of the *Conveyancing Act 1919* for the matter to be adjudicated.

9.2 Existing inter-allotment drainage easement

An applicant may propose discharging runoff through an existing pipeline across an adjoining property. In this case the applicant must provide evidence that the property being developed has the right to use the inter-allotment drainage easement.

The applicant may also need to provide a hydrologic and hydraulic assessment indicating that the existing pipeline has adequate capacity to carry the 1% AEP uncontrolled runoff from the development site.

If the pipeline is unable to convey the additional discharge from the development, the applicant will have to upgrade the pipeline. In this case, the applicant will have to supply these documents to Willoughby City Council for approval:

a. evidence in the form of a legal agreement showing that the property has the right to drain via the existing easement

b. design details of the proposed upgraded stormwater pipeline

The applicant must construct the approved upgraded pipeline in the easement before the starting of any works. At completion, the applicant must provide certification to Willoughby City Council from a suitably qualified engineer and works-as-executed drawings from a registered surveyor that the installation of the pipeline has been completed in line with the approved drawings, current Australian Standards and Willoughby City Council's AUS-SPEC. The registered surveyor is to certify that all drainage structures are constructed wholly within the drainage easements.

9.3 Connection to a council drainage easement or drainage reserve

For any proposed stormwater pipeline discharging directly into a council-owned stormwater drainage system such as a pipeline, channel, inlet pit or discharge onto a vegetated drainage reserve, the applicant may need to submit hydrological and hydraulic analyses. These are to confirm that there will be no surcharges due to backwater effects within the system or adverse impacts to neighbouring property.

9.4 Drainage easement widths

These easement widths are required for inter-allotment (or private) drainage pipelines:

Table 9 Easement width for private drainage pipelines

Pipe (mm diameter)	Drainage easement width (m)
<300	1.25
300	1.50
375, 475	2.00
525, 600,675	2.50
750, 825, 900, 1050	3.50
1200, 1350, 1500	4.00
1650, 1800	4.50

An inter-allotment drainage pipeline is to be contained within an easement of not less than a 900mm width.

The following easement widths are required for council pipelines:

Table 10 Easement width for council drainage pipelines

Pipe (mm diameter)	Drainage easement width (m)
<300	2.50
300	2.50
375, 475	2.50
525, 600,675	2.50
750, 825, 900, 1050	3.50
1200, 1350, 1500	4.00
1650, 1800	4.50

When installing pits in a drainage easement, the easement boundaries must be a minimum of 300mm clear of the pit. This also applies to any other drainage structure.

In exceptional circumstances and subject to Willoughby City Council approval, for example where the existing width between a house and fence is limited, drainage easements may be of variable width.

9.5 Structures within easements

Willoughby City Council will not approve the construction of any permanent structure or the placing of fill over a drainage easement if the structure or fill will prevent or hinder overland flows, construction, reconstruction, maintenance, cleaning or access to the pipeline or easement. Permanent structures include habitable dwellings, eaves, balconies, garages, impervious fences, swimming pools and retaining walls.

Paving and demountable carports over a drainage line or easement may be approved subject to Willoughby City Council assessment. Structures adjacent to pipelines must be sufficiently clear of easement boundaries or independently supported to avoid placing any load within the zone of influence of pipeline elements. Footings must be extended to a minimum of 100mm below the invert of the pipe or to solid rock.

10 Controls for discharge from a property into natural watercourses, bushland or the harbour

Stormwater systems on properties draining to natural watercourses, bushland or the harbour must include:

a. water quality improvement systems (see Section 11 Water Quality for further details)

b. energy dissipation systems

For properties draining to a watercourse over natural bushland, a rock lined channel is to be provided from the site to the watercourse, or other measures as agreed with Willoughby City Council.

For major developments draining to bushland or natural watercourses, a rainwater reuse tank or appropriate WSUD measures are to be incorporated in the stormwater management system, to reduce water velocities and minimise erosion.

For minor developments draining to bushland or natural watercourses, a 5kL rainwater tank is to be provided.

Permission is required from Willoughby City Council to discharge stormwater directly into a natural watercourse, creek or bushland reserve. A plan detailing any proposed drainage and remedial works on council land must be submitted to Willoughby City Council for approval.

11 Water quality

All major developments must address water quality during and after construction. Under *the Protection of the Environment Operations (POEO) Act 1997*, allowing pollutants to enter any watercourse is an offence.

11.1 Water quality during construction

Construction sites have the potential to significantly affect water quality and contribute to the degradation of the natural environment through poor management of soil, water and materials on the site.

Good management practices on a construction site for the control of water quality includes erosion and sediment control as well as other construction materials such as chemicals and waste.

See Willoughby City Council's technical standard 3 – sediment and erosion control and, for larger sites to Managing Urban Stormwater, Soils and Construction – Landcom 2004, for information on managing sediment and erosion during the construction phase.

11.2 Permanent post development water quality controls

For all developments draining to bushland, creeks or the harbour and for all major development, stormwater runoff is to be treated before leaving the site.

11.2.1 General controls

a. all stormwater flows from regular rainfall events up to and including the 1:2 year annual recurrence interval (ARI) are to be captured and treated before discharge to the council stormwater drainage system

b. the treatment measure may include one or more of these features:
   - retention – pond, wetland or basin
   - retention and filtration – bioretention system, sand filter, rain garden
   - retention and volume loss –rainwater tank, surface runoff retention tank, infiltration system
   - filtering and conveyance – grassed swale, filtration system
   - Gross Pollutant Trap (GPT) – offline diversion system, inline diversion system, trash rack, centrifugal displacement systems, pit basket
   - any system that can capture and retain the specified pollutant load
   - any other appropriate technique suitable to the needs of the site

c. the treatment measure is to be placed as close as possible to the pollution source within the development site

d. the pollution retention efficiency must be maintained up to the design discharge and should not decrease with the build-up of materials

e. in storm events greater than that of the design discharge or if the storage capacity of captured material is exceeded, the storage system must not allow any release of the previously captured material

f. the system must be designed to be able to bypass flows greater than the design discharge without blocking or overtopping

g. the system must be designed to meet appropriate public health and safety standards

h. the design should ensure that there is minimal risk of mosquito breeding within the system

11.2.2 Performance objectives and criteria

Objectives

Table 11 Water quality performance objectives

Issue	Objectives
Runoff volumes and flow rates / stormwater quality	1. minimise impervious areas connected to the stormwater drainage system without causing uncontrolled property runoff 2. maximise reuse of roofwater for non-potable uses 3. maximise use of vegetated flow paths 4. use stormwater pollutant traps 'at source' where appropriate
Riparian vegetation and aquatic habitat	5. protect and maintain natural wetlands, watercourses and riparian corridors 6. protect and maintain all natural (or modified) drainage channels within the site that possess either baseflow, defined bed and/or banks, or locally occurring native riparian vegetation
Flow	7. ensure alterations to natural flow paths, discharge points and runoff volumes from the site are negligible – generally no increase in the 50% and 1% AEP storm event peak flows 8. the frequency of bank full flows should not increase as a result of development
Natural bushland	9. minimise the impact of stormwater discharge on bushland areas

Requirements

Table 12 Water quality requirements

Pollutant	Average annual pollutant load reduction (%)
Gross pollutants	90%
Total suspended solids (TSS)	85%
Total phosphorus (TP)	60%
Total nitrogen (TN)	45%
Hydrocarbons	See below

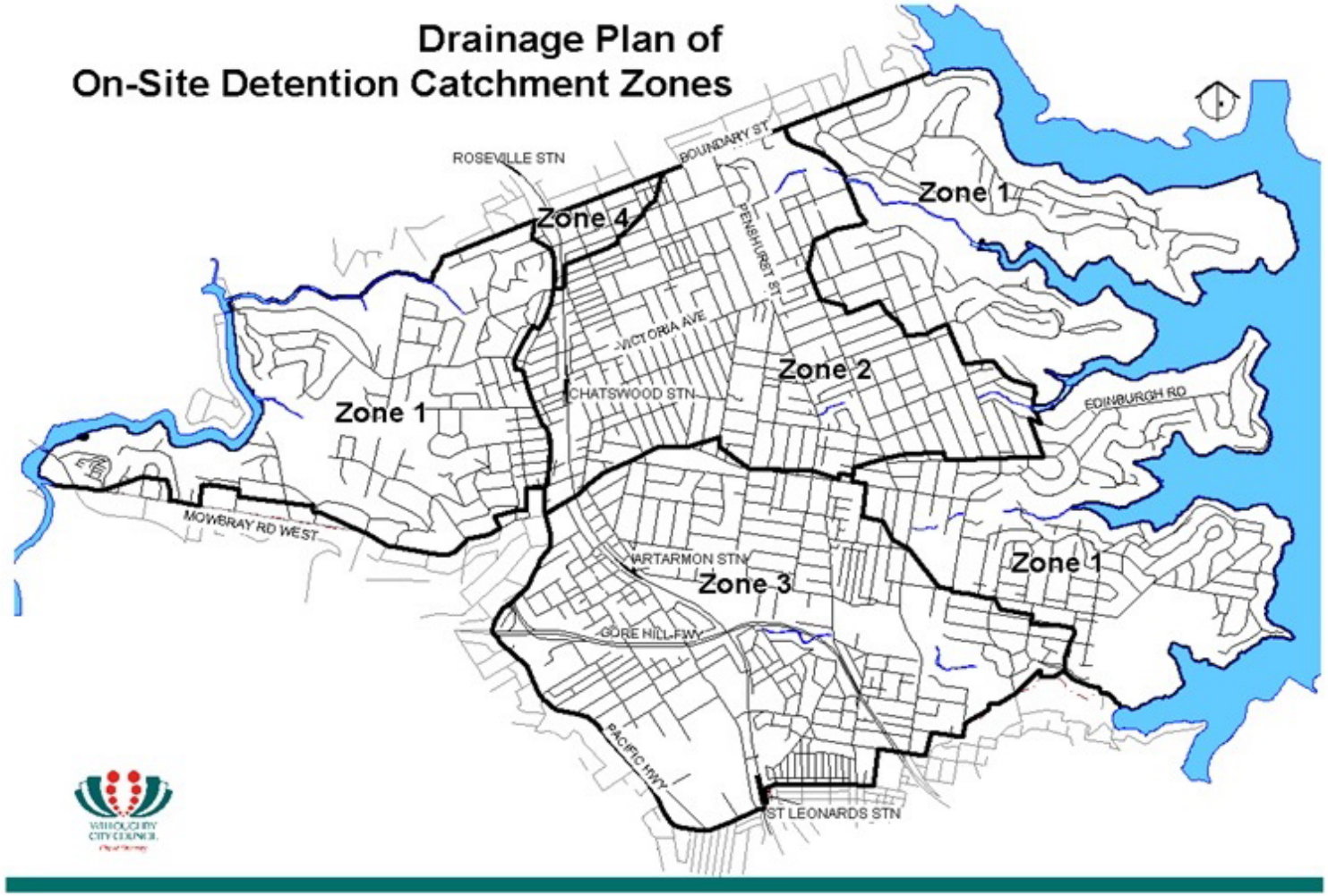
Determination of water quality targets are to be achieved in line with Sydney Water guidelines or using a MUSIC model. If the MUSIC model is used, parameters are to be in

line with the parameters in Sydney Catchment Authority's document 'Using MUSIC in Sydney's Drinking Water Catchment'.

Developments with more than 5 parking spaces and commercial and industrial development are to provide a treatment system that specifically targets hydrocarbons or incorporates a raingarden / bio-retention basin. Runoff from all parking areas, driveways or access roads must drain to the treatment system or raingarden / bio-retention basin.

Appendix 1 – Onsite detention catchment zones

Figure 5 Drainage plan of on-site detention catchment zones



Appendix 2 – Onsite stormwater detention record of installation and certificate of hydraulic/hydrological compliance

Record of installation of onsite stormwater detention

Job number:

Development application number:

Drawing number:

Project at:

Table 13 On-site stormwater detention installation parameters

Attributes	Designed parameters	Constructed parameters
Tank dimensions (LxWxH) (m)		
Orifice size (mm)		
Orifice plate type		
Hydraulic head (m)		
Storage volume (m^3)		
Permissible site discharge (l/s)		
Debris screen type		
Debris screen area (m^2)		
Overland flow provided		
Number of access grates		
Plaque(s) attached to wall		
Step irons provided (over 0.9m grate-invert)		
Plumber's certificate number for rainwater tank installation		

Comments:

Certificate of hydraulic/hydrological compliance

I _____of _____(a professional engineer competent to practise in the field of stormwater drainage design) have inspected the above completed onsite stormwater detention system. This includes verification of the generally + or -10% acceptable limits and tolerances of the system in this policy.

I certify the works have been constructed in line with the approved design details for the project, subject to satisfactory maintenance. This is except for any variations that do not affect the performance of the system, which are highlighted in the works-as-executed drawings.

Signature:

Qualifications:

Position:

Membership number:

Telephone:

Appendix 3 – Samples of draft terms for positive covenant and restriction on use of land

Detention system

To be used when a deposited plan is being registered

Terms of positive covenant _____referred to in the above-mentioned plan

The registered proprietor of the land (the 'proprietor') will ensure the onsite stormwater detention system (the 'system') on the land is:

- cleaned, maintained and repaired for all pits, basins, tanks, pipelines, orifice plates, trench barriers, walls, earth banks and other structure, gutters, leaf gutter guards, down pipes, pipe connections and any associated systems to the system
- regularly kept clean and free from grass clippings, silt and other debris to ensure efficient operation at all times

The proprietor agrees to provide Willoughby City Council access to the system with necessary materials and equipment at all reasonable times and on reasonable notice, and without notice in the case of an emergency.

The proprietor agrees access will be provided for Willoughby City Council to:

a. view the state of repair of the system

b. ascertain if there has been any breach of the terms of this covenant

c. do any work required to remedy a breach of the terms of this covenant if the proprietor has not, within 14 days of receiving written notice from Willoughby City Council of a breach, taken steps to remedy this

In the case of point c) above, Willoughby City Council may recover the cost of this remedial work from the proprietor on demand as a liquidated debt.

Name of authority empowered to release, vary or modify the positive covenants referred to: **Willoughby City Council**.

Terms of section 88b instrument for the legal protection of onsite stormwater

To be used when a deposited plan is being registered

Terms of restriction on the use of land:_____ **referred to in the above mentioned plan**

The registered proprietor of the land (the 'proprietor') agrees, with respect to the onsite stormwater detention system (the 'system') on the land, to:

a. not erect or permit any building, structure or erection on the whole or erection on this part of the land except:
    - dividing fences
    - buildings, structures and erections that are required to maintain the system
    - other structures approved by Willoughby City Council
b. not carry out any alterations to the system including, detention levels, controlled outflows, grates, pipes, orifice plate, mesh screen, gutters, leaf gutter guards, downpipes, pipe connections and any associated systems of the system without first gaining consent in writing Willoughby City Council

Name of authority empowered to release, vary or modify the restriction on the use of land referred to: **Willoughby City Council**.

Terms of section 88e(3) instrument for the legal protection of onsite stormwater detention system

To be used with Form 13PC from the Department of Lands

Terms of positive covenant

The registered proprietor of the land (the 'proprietor') will ensure the onsite stormwater detention system (the 'system') on the land is:

- cleaned, maintained and repaired for all pits, basins, tanks, pipelines, orifice plates, trench barriers, walls, earth banks and other structure, gutters, leaf gutter guards, down pipes, pipe connections and any associated systems to the system
- regularly kept clean and free from grass clippings, silt and other debris to ensure efficient operation at all times

The proprietor agrees to provide Willoughby City Council access to the system with necessary materials and equipment at all reasonable times and on reasonable notice, and without notice in the case of an emergency.

The proprietor agrees access will be provided for Willoughby City Council to:

a. view the state of repair of the system

b. ascertain if there has been any breach of the terms of this covenant

c. do any work required to remedy a breach of the terms of this covenant if the proprietor has not, within 14 days of receiving written notice from Willoughby City Council of a breach, taken steps to remedy this

In the case of point c) above, Willoughby City Council may recover the cost of this remedial work from the proprietor on demand as a liquidated debt.

Name of authority empowered to release, vary or modify the restriction on the use of land referred to: **Willoughby City Council**.

Terms of section 88b instrument for the legal protection of onsite stormwater detention system

To be used with Form 13RPA from Department of Lands

Terms of restriction on the use of land

The registered proprietor of the land (the 'proprietor') agrees, with respect to the onsite stormwater detention system (the 'system') on the land, to:

a. not erect or permit any building, structure or erection on the whole or erection on this part of the land except:
    - dividing fences
    - buildings, structures and erections that are required to maintain the system
    - other structures approved by Willoughby City Council
b. not carry out any alterations to the system including, detention levels, controlled outflows, grates, pipes, orifice plate, mesh screen, gutters, leaf gutter guards, downpipes, pipe connections and any associated systems of the system without first gaining consent in writing Willoughby City Council

Name of authority empowered to release, vary or modify the restriction on the use of land referred to: **Willoughby City Council.**

Appendix 4 – Rainfall intensity

Table 14 Rainfall intensity in mm/hr for various durations and return periods

Duration (hours)	1 year	2 years	5 years	10 years	20 years	50 years	100 years
0.083	97.9	125.	159.	178	204.	237.	262.
0.100	91.8	118.	149.	167.	192.	223.	247.
0.167	75.2	96.7	124.	139.	159.	186.	206.
0.333	54.9	70.9	91.7	104.	120.	141.	156.
0.500	44.7	57.9	75.3	85.6	99.0	117.	130.
1.000	30.5	39.6	52.0	59.4	69.1	81.8	91.5
2.000	20.2	26.2	34.8	39.9	46.5	55.3	62.0
3.000	15.7	20.5	27.2	31.3	36.5	43.5	48.8
6.000	10.2	13.4	17.9	20.6	24.1	28.7	32.3
12.000	6.72	8.79	11.8	13.6	16.0	19.1	21.5
24.000	4.45	5.82	7.86	9.10	10.7	12.8	14.5
48.000	2.90	3.80	5.16	6.00	7.07	8.48	9.59
72.000	2.19	2.88	3.92	4.56	5.38	6.47	7.32

List of coefficients to equations for calculation of intensity frequency duration (IFD)

$\ln(I)=a+b(\ln(T))+c(\ln(T))^2+d(\ln(T)^3+e(\ln(T))^4+f(\ln(T))^5+g(\ln(T))^6$

I = Intensity in millimetres per hour

T = Time in hours

Table 15 Values of coefficients for IFD calculation

Years	a	b	c	d	e	f	g
1	3.4171	-0.5782	-0.0314	0.00714	0.000801	-0.0001313	-0.0000369
2	3.6781	-0.5738	-0.0320	0.00726	0.000784	-0.0001541	-0.0000311
5	3.9521	-0.5605	-0.0350	0.00702	0.001072	-0.0001620	-0.0000370
10	4.0849	-0.5537	-0.0365	0.00708	0.001194	-0.0001887	-0.0000353
20	4.2350	-0.5485	-0.0378	0.00720	0.001314	-0.0002139	-0.0000347
50	4.4041	-0.5427	-0.0392	0.00746	0.001396	-0.0002625	-0.0000286
100	4.5167	-0.5382	-0.0400	0.00733	0.001460	-0.0002589	-0.0000302

Values of $(t.I^{0.4})$

Where I = Intensity in millimetres per hour

Table 16 Rainfall duration intensity in minimum mm/hr for various return periods

Dur (hr)	Dur (min)	1 year	2 years	5 years	10 years	20 years	50 years	100 years
0.083	5	31.16	34.36	37.83	39.57	41.79	44.37	46.19
0.100	6	36.58	40.45	44.40	46.48	49.14	52.18	54.35
0.167	10	56.41	62.38	68.90	72.12	76.11	81.04	84.41
0.333	20	99.18	109.86	121.77	128.06	135.60	144.64	150.61
0.500	30	137.17	152.12	168.98	177.87	188.53	201.56	210.23
1.000	60	235.44	261.35	291.44	307.37	326.54	349.34	365.36
2.000	120	399.32	443.10	496.38	524.29	557.39	597.41	625.37
3.000	180	541.54	602.52	674.68	713.66	758.91	814.08	852.39
6.000	360	911.47	1016.59	1141.42	1207.40	1285.61	1378.65	1445.38
12.000	720	1542.70	1717.62	1932.35	2045.26	2182.63	2342.86	2456.45
24.000	1440	2616.41	2912.94	3284.97	3483.21	3716.34	3992.51	4196.72
48.000	2880	4409.12	4912.54	5552.04	5897.30	6297.39	6772.53	7114.10
72.000	4320	5911.01	6595.39	7461.02	7926.28	8468.31	9116.86	9578.29

Note:

- For use with kinematic wave equation (equation 14.2 in Australian Rainfall and Runoff, 1987 – see technical note 3).

Appendix 5 – Onsite stormwater detention system design checklist

Table 17 Onsite stormwater detention system design checklist

Item	Description	Response
1	Has a spillway with an overland flow route been provided?	yes / no
2	Has the minimum freeboard been provided between habitable floor levels and the 1:100yr flood level? See Section 10 of Willoughby City Council's Floodplain Management – technical standard 3 for freeboard requirements.	yes / no
3	Has a minimum of 300mm freeboard been provided between the habitable floor levels and the OSD design storage topwater level?	yes / no
4	Above ground storage maximum depth • over driveways and carparking (mm) • maximum depth over landscaping or garden areas (mm) • minimum below ground storage (m^3)	 ____mm ____mm ____m^3
5	Below ground OSD tanks must be accessible for maintenance in line with AS 286,5 – Safe Working in Confined Spaces. Have step irons been provided for tanks deeper than 900mm?	yes / no
6	Total impervious area including driveways, carports, pathways and swimming pools not incorporating high-level overflow system (m^2)	____m^2
7	Existing, and proposed surface levels and contours have been provided (contours extend 5m beyond property boundary)	yes / no
8	Location of all trees has been provided	yes / no
9	Calculated volume of storage according to Part I Section 2.2 (m^3)	____m^3
10	Calculated permissible site discharge according to Table 8 (l/s)	____l/s
11	Calculated orifice diameter (65mm minimum) (mm)	____mm
12	Type of mesh screen provided	____
13	Does the major overland flow path within the site for runoff from all impervious areas drain to the OSD system or has the pipe network been designed for the 1% AEP storm event?	yes / no
14	Direct connections to the council drainage system have been checked against backwater effect and drowned orifice?	yes / no
15	Is the base of the OSD tank graded flush with the orifice invert level?	yes / no
16	Has a minimum 1125mm × 75mm × 4 RHS been provide for a discharge through the street kerb?	yes / no
17	All levels have been given to Australian Height Datum (AHD)	yes / no

Name of design engineer:

Qualifications of the design engineer:

Appendix 6 – Standard easement request letter

Date:

Street address:

Postcode: NSW

Dear:_____

I/we are proposing to redevelop our property at:_____

Before we can proceed with this proposal Willoughby City Council has advised us that we have two options for the drainage of stormwater.

Option 1 – drainage easement

This option is the preferred method and is to obtain a drainage easement to convey the stormwater runoff from our property. This would convey our stormwater under your property via a pipe to :_____

This option requires you to grant us a drainage easement through your property. We would be responsible for all costs for creating the easement, together with any consideration for the use of your property determined by an independent valuation or later agreement. Alternatively we are prepared to offer you $_____* as compensation for the right to drain our stormwater under your property.

Option 2 – onsite disposal system

An alternative option is to install an onsite disposal system on our property. This discharges stormwater into an underground trench and allows absorption of the stormwater flow into the ground, with overflow over the ground surface and into downstream properties.

However, the runoff and seepage from this system may flow towards your property and could cause some dampness and overland flow issues because of the slope of the land.

Could you please indicate your position on this matter so we can advise Willoughby City Council to enable our application to progress.

Yes: I/we are willing to grant you a drainage easement:

Name:

Address:

Signature:

No: I/we are not willing to grant you a drainage easement. We understand that our property will be subject to some overland flow and that we do not want to accept any compensation for a drainage easement as

Name:

Address:

Signature:

* compensation amount offered to be in line with market value for easements, and not a nominal amount.

Attachment 2 – Technical standard 2 – floodplain management

1 Background

Like many other major cities of the world, Sydney and in particular Willoughby have been subjected to intense development and redevelopment pressures, including development on areas that are affected by flooding. These areas are mainly near the creek and drainage systems in the City of Willoughby local government area.

There are economic and other pressures for potential developers to build on these flood affected lands. However, Willoughby City Council has to ensure that the community and its assets are protected from future flooding. This technical standard is designed to manage these competing demands.

This standard provides consistent guidelines and criteria for property development of flood affected land. We will assess development applications in line with these guidelines. This will help maximise the value of these flood affected properties and minimise the potential environment impacts from the development.

Stormwater catchments in the local government area are generally dissected by the Pacific Highway, which forms a ridge of the area. Catchments to the west of the Pacific Highway drain into pipes, open drains and creeks which eventually flow into the Lane Cove River. Catchments to the east of the highway drain into several complex manmade channels, pipes and creeks before discharging into the Middle Harbour.

Due to the complex creek system and the limited capacities of an aging drainage network, some land adjoining to these systems may experience stormwater inundation during times of heavy rainfall. In most cases, these drainage systems cannot fully convey the runoff when there is heavy rainfall. Land adjoining these systems may experience overland flow when the capacity of the drainage network is exceeded. Similarly, most of the lands adjoining the natural creek systems also experience overflow during these events.

1.1 Historical flood records

According to our historical flood record, major rainfall events have previously caused serious flooding in parts of the area.

These storms are:

- 1955: the event recorded in Chatswood was a 1 in 20-year average recurrence interval (ARI) or (5% AEP) event
- 1986: the event was between the 1 in 20 and 1 in 50 (2% and 5% AEP) year event
- 10 April 1998: the event exceeded the 1 in 100 year ARI (1% AEP) in a critical storm duration

Because extreme storms do not occur regularly, computer modelling is used to ascertain flooding from these events. We have done detailed flood studies on most of the local government area to ascertain the risk and extent of flooding. The results have been used to

determine the extent of the flood affected properties in the area that should be subject to development controls.

1.2 Floodplain risk management studies

Willoughby City Council has completed these flood studies and floodplain risk management plans:

Floodplain risk management studies and plan

- Flat Rock Creek
- Sugarloaf Creek

Full catchment flood study

- Blue Gum Creek
- Sailors Bay Creek
- Swaines Creek

Mainstream flood study only

- Scotts Creek

Lyall & Associates also assessed local overland flooding in the City of Willoughby area using TUFLOW, a two-dimensional hydraulic computer model. Together with site assessments of the affected properties, areas of local overland flooding were identified. Recommendations from this study are used in the Scotts Creek catchment. All flood studies are available at willoughby.nsw.gov.au.

2 Flooding mechanisms

This technical standard generally conforms with the principles for the development of floodprone land in the NSW Government's Floodplain Development Manual (2005) and the revised ministerial direction by Department of Planning on 31 January 2008 under Section 117 of *Environmental Planning and Assessment Act 1979*.

In line with the 2005 floodplain manual there are two main types flood producing mechanisms which result in flooding of properties in the City of Willoughby local government area: main stream flooding and local overland flooding.

2.1 Main stream flooding

This type of flooding can occur when the trunk drainage/creek system surcharge and flows inundate the surrounding floodplains. In the Willoughby area, the trunk drainage systems comprise sections of lined and unlined open channels of the main arms of the creeks and their major tributaries. They also include major pipelines along the routes of the natural channels, put in place as the catchments became urbanised.

Depths and velocities of flooding are sufficiently high as to cause provisional high hazard conditions to develop in at least part of the extent of land inundated. Depths of inundation of up to 2m and flow velocities up to 4m/s could typically occur in the lined sections of the channels during major storm events. The catchments are up to several square kilometres in area.

Depending on the extent and complexity of the floodwater, the location of structures in main stream flood paths can impact and alter the flow regime to the detriment of adjoining properties.

2.2 Local overland flooding

This type of flooding results from runoff that travels as sheet flow over grassed and paved surfaces in individual allotments, or along roads on the way to the trunk drainage system. It can also be from overland surcharges from the minor pipes in the catchment headwaters and the lateral sub-catchments bordering the trunk drainage systems. This type of flooding is further divided into two categories: major drainage and local drainage.

In line with the 2005 floodplain development manual, this technical standard distinguishes these two sub-categories by their characteristic depths of flooding and the potential danger to personal safety.

Usually, the depths and velocities of flow are not enough to create high hazard conditions. However, the discharge along overland flow paths increases with increasing catchment areas. Depending on local topographic conditions, high hazard areas may develop along the major overland flow paths before they reach the creek. Overland flooding also occurs with little warning time.

Structures located in the path of local overland flow could cause the water to be redirected or deflected to other adjoining properties. These impacts have to be mitigated in the design of proposed developments.

3 Objectives

The objectives of this standard are to:

a. provide consistent guidelines and criteria for developers and other land users of overland flow/floodprone properties in the City of Willoughby local government area when preparing development applications

b. ensure land identified by Willoughby City Council as subject to a flood related development control has a flood impact statement or flood risk study done before approval of new development

c. reduce the potential risks to property damage and loss of life arising from the development of overland flow and floodprone land, as well as minimise damage to private property during flooding events

d. prevent development intensification on land that is subject to a high risk of flood (H4 to H6)

e. ensure development on floodprone properties have to adopt measures to not exacerbate flooding on other properties

f. increase public awareness through education of the potential adverse impacts of development on properties adjoining overland flow/floodprone properties

4 Applications of this technical standard

This technical standard applies to all development that involves construction works on the site and located on private or public flood affected land in the Willoughby local government area. It

applies to development where approval is needed and development that is exempt from approval.

Flood affected lands are categorised into main stream flooding and local overland flooding (see Section 2).

If there is insufficient information within Willoughby City Council to determine the flood planning level or the minimum habitable floor level of a flood affected property, development on flood affected land must submit a flood study or overland flow assessment.

The study/assessment should determine the pre and post maximum water levels, depths at critical locations, velocity and extent of the flooding at the property. An experienced civil or hydrological engineer should be consulted.

The development application is also subject to:

- *Environmental Planning and Assessment Act 1979*, Section 79c
- NSW Government Floodplain Development Manual 2005
- Willoughby Local Environmental Plan
- other applicable planning instruments adopted by Willoughby City Council or NSW Government

The 2005 floodplain development manual defines floodprone lands as lands affected by the Probable Maximum Flood (PMF) – the largest flood that could physically occur in a location. From the perspective of an urban council, it is not feasible or economically desirable to alienate land in these areas from development. However, basement car parking must take this into account due to the risk present.

The flood planning levels adopted for this policy is generally the 1% annual exceedance probability (AEP) event, sometimes known as the 1 in 100 year average recurrence interval (ARI) flood plus a freeboard. This freeboard depends on the type of development, location, land usage and continuing risk.

5 Controls

5.1 General controls

For all development that is flood affected, a flood impact statement as a minimum must be provided to Willoughby City Council. This must be prepared by a suitably qualified engineer in line with the NSW Government's Floodplain Development Manual and address the various controls.

A detailed flood study is required for sites where Council has no detailed flood study, the footprint of the building is changing or overland flow paths are being altered. All major developments (works other than single dwellings and dual occupancy developments) will require a site specific flood study if the site is a flood affected lot or if the site is adjacent to a major drainage path or mainstream flooding.

To assist in preparing a flood impact statement or a flood study, a flood information certificate is available from Willoughby City Council for most flood affected properties. Details of the fees and application process are available at willoughby.nsw.gov.au.

Willoughby City Council has flood related planning controls for various categories of development within flood affected properties.

5.1.1 New development in areas subject to mainstream flooding or major drainage, including sites adjacent to flow paths

a. minimum floor level for buildings = 1% AEP water level + 500mm
b. minimum garage floor level = 1% AEP water level + 300mm
c. minimum crest level for driveway to basement parking = PMF water level or 1% AEP water level + 500mm, whichever is higher
d. minimum floor level for carport = 1% AEP water level + 100mm
e. underside of any structure to be 300mm above 1% AEP flood level
f. flood evacuation route at the PMF level to be provided for sensitive developments, including hospitals, aged care, childcare and seniors living
g. flood evacuation route at 1% AEP +500mm level for all development other than sensitive developments
h. flood study required

5.1.2 New development in areas subject to local drainage or overland flow

a. minimum floor level for buildings = 1% AEP water level + 500mm
b. minimum garage floor level = 1% AEP water level + 300mm
c. minimum crest level for driveway to basement parking = PMF water level or 1% AEP water level + 500mm, whichever is higher
d. minimum floor level for carport = 1% AEP water level + 100mm
e. underside of any structure to be 300mm above 1% AEP flood level
f. construct on high side of property
g. flood evacuation route at 1% AEP +500mm level
h. flood impact assessment required; a flood study may be required where works potentially impact flood levels.

5.1.3 New pools and minor structures (such as a shed or pergola)

a. no pool or shed to be located in H4 to H6 hazard rating zones
b. structure is not to impede flood flows
c. minimum floor level for minor structures = 1% AEP water level + 100mm
d. flood impact assessment required for local drainage areas and flood study for mainstream flooding or major drainage areas

5.1.4 Alterations and additions in areas subject to mainstream flooding or major drainage, including sites adjacent to flow paths

a. minimum floor level for buildings = 1% AEP water level + 300mm

b. minimum floor level for buildings with sensitive use, including hospitals, aged care, childcare and seniors living = 1% AEP water level + 500mm

c. minimum garage floor level = 1% AEP water level + 100mm

d. minimum crest level for driveway to basement parking = PMF water level or 1% AEP water level + 500mm, whichever is higher

e. minimum floor level for carport = 1% AEP water level + 100mm

f. flood proof existing habitable areas where practical

g. underside of any structure to be 300mm above 1% AEP flood level

h. flood evacuation route for new works at 1% AEP +500mm level

i. flood study required

5.1.5 Alterations and additions in areas subject to local drainage or overland flow

a. minimum floor level for buildings = 1% AEP water level + 300mm or 500mm above existing natural ground

b. minimum floor level for buildings with sensitive use, including hospitals, aged care, childcare and seniors living = 1% AEP water level + 500mm

c. minimum garage floor level = 1% AEP water level + 100mm

d. construct works on high side of property

e. flood proof existing habitable areas where practical

f. flood evacuation route for new works at 1% AEP +300mm level

g. flood impact assessment required

5.2 Further requirements

For all developments on main stream or local overland flooding property, these further requirements should be considered:

a. compliance with requirements of other existing environmental planning instruments and relevant statutory authorities

b. obstruction to main stream or local overland flow path

c. cumulative effect of any encroachment and analysis on the impact to adjacent areas and the catchment as a whole

d. effect of proposed works on flood detention storage

e. future maintenance and upkeep of difficult to access locations or Stormwater systems

f. control of soil erosion of disturbed surfaces within the property

g. any other controls specific for the development recommended by a suitably qualified engineer or Willoughby City Council engineer

These developments will be treated case by case on their merits and the general principles of this technical standard.

5.3 Land subdivision, consolidation and rezoning

Proposals for subdivision/consolidation/rezoning of land in flood affected or high hazard properties must include a flood or overland flow study by an experienced civil or hydraulic engineer.

The intended land use of the allotments must be appropriate and in line with Willoughby City Council's flood related controls and other environmental planning instruments.

Willoughby City Council will not support any subdivision/rezoning unless in all subdivided/rezoned lots the proportion of flood free land is more than 50% of the proposed lot size and other planning requirements are complied with. Plans also need to show that there is sufficient flood free land, which will allow a building to be approved and constructed in line with the requirements of this section.

Generally, filling of the land is not supported by Willoughby City Council and filling of flood affected land or land in the flood path is strictly prohibited. Any minor filling/regrading of unaffected land is subject to Willoughby City Council's relevant environmental planning Instruments.

6 Redevelopment

When redevelopment of a flood affected property is proposed, the extent of the floodwater and the location of structures within flood paths which can alter the flow regime to the detriment of adjoining properties must be considered. Structures in the path of overland flow would cause the water to be redirected or deflected to other adjoining properties. The flood water could also cause 'afflux' (a rise in water level) upstream of the structure.

To reduce the impact of flooding on flood affected properties, all redevelopment must be located within the footprint of the existing structures, preferably clear of the 1% AEP event or the overland flow path. Any encroachment on these paths is not permissible unless a cumulative impact study of the floodwaters to both upstream and downstream properties is done by the applicant. Willoughby City Council must also be satisfied that there is no adverse impact to other land owners. A flood study, including an aflux analysis, will be required for any works beyond the existing building footprint.

Willoughby City Council will generally not support the filling of main stream or overland flow path on flood affected land unless it is shown that other upstream and downstream property owners are not affected by similar cumulative filling of adjoining and adjacent properties. Willoughby City Council must also be satisfied there are no adverse effects to other land owners.

7 Protection of properties and human lives

This technical standard also deals with the protection of human lives especially the safety of people who are young or frail. To achieve this, it is necessary that the velocity and depth of flow ratio within developments be within acceptable limits and that a safe flood evacuation route is provided for the occupants.

New development on flood affected properties must not only be sited away or above the standard flood level but also be analysed to include the cumulative effect of blockage if any of the flow and its effect to other adjoining and adjacent properties.

It may be necessary to flood proofed existing structures if these structures are significantly affected by overland flow, especially where people who are old and frail are to be accommodated in these buildings.

Residential development on land subject to flood risk categorised as H4 – H6 will not be permitted without a detailed flood study that clearly shows the development can be done without jeopardising public safety and access, property damage or adverse ramifications on the pre-developed flood regime.

8 Application of technical standard

This technical standard applies primarily to flood affected areas in the City of Willoughby area. Property affected by flooding is subject to flood related planning controls. Some properties within these areas will need to submit a flood study so that an accurate assessment regarding the level, depth, velocity and extent of the overland flow within the property can be determined. An experienced civil/hydrological engineer shall be consulted. In areas where Willoughby City Council has completed formal flood studies, a flood study (Appendix A) may not be required.

This standard also applies to properties subject to local overland flooding within the City of Willoughby area. Developments located on major drainage flooding areas must submit an overland flow study but developments on local drainage flooding areas do not in general require a flood study.

The assessment of a development application is subject to Section 79c of *Environmental Planning Assessment Act 1979*. Where relevant, compliance with this standard also will form part of the assessment.

9 Special requirements

Applicants of a development affected by main stream or major drainage flooding must provide satisfactory environmental, hydrological, hydraulics information including on mitigating adverse impacts to Willoughby City Council. It is highly unlikely we will consider structures in areas of high hazard, where depth, velocity and nature of the flow contribute risks to human lives and property damages without satisfactory mitigating measures.

Willoughby City Council will require supporting evidence to show that the development will not increase the hazards or risks to future owners or occupants and to adjoining properties.

For some developments, we may require additional flood planning control such as safe evacuation from the site and flood proofing of the existing structure. We will also consider the cumulative impact and effects of the development to adjoining properties.

Willoughby City Council has adopted the 1% AEP event as the standard flood in this policy. The largest flood that could conceivably occur is known as the probable maximum flood (PMF). The PMF is estimated from the probably maximum precipitation. Some developments may need to consider the effects of the PMF especially if the development may house young children, older people and people who are frail, and if the development is on or near the major drainage system.

Additionally, the effect of climate change has not been included in this standard.

Climate change relates to the generation of greenhouse gases due generally to the activities of humans. An accumulation of such gases in the atmosphere is understood to cause the planet to gradually warm up and bring about changes to the climate. These climatic changes are predicted to have significant impacts on temperature, air quality, sea levels, water temperature, evaporation rates and rainfall intensities.

In the Sydney metropolitan region, current modelling shows a trend towards an increase in both extreme rainfall frequencies and storm events, which increase the severity of the main stream and local overland flow and/or flood.

This means what is currently the 1% AEP (1 in 100 year ARI) rainfall event may become more frequent to say the 1.1% AEP (1 in 90.91 year ARI). This has serious implications for flooding frequencies.

Willoughby City Council may consider imposing a higher flood level than the current flood planning level if the nature and circumstances affecting the development warrants such consideration in the future.

10 The merit approach

When considering a development application, Willoughby City Council as consent authority uses the merit approach. It considers the environmental, technical, economic, sociological and flooding impacts of a development. This includes minimum flood planning levels, location of structures within the site, access, stability, safety, legal obligations and community responsibilities.

Environmental Planning and Assessment Act 1979 lists matters the consent authority must also consider.

11 Submission requirements

The applicant must show the proposed development is consistent with the objectives outlined in this standard.

The information below must be provided to support the development application on lands affected by overland flow and/or flooding:

- a detailed survey plan of the site and /or adjoining properties to Australian Height Datum (AHD) at 1:100 scale (or 1:200 for larger sites), prepared by a registered surveyor, showing all existing buildings/structures that will affect the extent, depth and velocity of overland flow/flooding
- a flood or overland flow study (Appendix A) prepared by a suitably qualified engineer with suitable experience and eligible for Chartered Professional Engineer status with Engineers Australia

The flood or overland flow study must include:

a. a hydrological analysis (including plans and calculations) of the upstream catchment area for the 1% AEP and 20% AEP storm events.[1]:

[1] Willoughby City Council is in the process of modelling a number of catchments within the city and may be able to provide flow rates to consulting engineers where and when they become available. Where these flow rates are provided, Willoughby City Council will not accept lower flow rate values unless it can be clearly demonstrated that the nominal value is correct.

the hydrological analysis is to include a catchment plan highlighting full upstream catchment area that generate the overland stormwater flows travelling through the site.

the hydrological analysis model must be based on[2]:

- for upstream catchment areas of less than 3 hectares, Rational Method is acceptable
- for upstream catchment areas of 3 hectares and larger, a suitable runoff routing computer model, such as DRAINS or RAFTS shall be used
- the estimation of time of concentration (Tc) must be justified – this may be done through the Kinematic Wave Equation
- the fraction impervious (f) of the upstream catchment must be between 0.7 (for low density residential area) to 1.0 (for high density residential area, industrial and commercial area) unless it can be proven that other values are appropriate for a particular site

b. a hydraulic analysis (including plans and calculations) of overland flow path through the site for both pre-developed and post-developed scenarios.

1. The overland flow path must be based on:
   - for open channel and natural creek: 1% AEP storm event of upstream catchment area
   - for enclosed drainage system (such as pipes and culverts), the larger of:
     - 1% AEP storm event of upstream catchment area with 50% blockage to the enclosed drainage system
     - 20% AEP storm event of upstream catchment area with 100% blockage to the enclosed drainage system
   - for basement car parking: PMF event with 50% blockage to the enclosed drainage system
2. The hydraulic analysis model must be based on:
   - for local drainage or overland flow, Mannings Equation or HEC-RAS may be used
   - for mainstream flooding or major drainage, a Tuflow model or other model appropriate model as agreed by Willoughby City Council shall be used
3. 1:100 scaled site plans showing the extent and levels of the flood/overland flow path for both pre-developed and post-developed scenarios
4. longitudinal sections (at vertical scale 1:50, horizontal scale 1:100) showing the surface levels, flood/overland flow levels, flow profiles, hydraulic data, changes in grade and critical levels (such as finished floor levels) for both pre-developed and post-developed scenarios
5. cross-section details at 1:50 scale taken at the right angle to the flood/ overland flow path with a maximum spacing of every 5m for both pre-developed and post-developed scenarios and must include at least these locations:

[2] Runoff coefficients tables and Intensity Frequency Duration (IFD) tables are provided in Appendix B of this standard.

- at the immediate upstream of the property boundary
- where the existing and proposed development/structure is closest to the flood/overland flow path
- at the immediate downstream of the property boundary
- other cross-sections as required where the flow path and/or drainage system being affected
- note all levels shown on drawings and details must be to the Australian Height Datum (AHD).

6. Calculations of the velocity-depth product of the overland flow path. If the result exceeds $0.4m^2/s$, suitable open type fencing or other appropriate measures must be used to restrict access to such areas affected by hazardous overland flows.
7. Boundary fence details if they are within the extent of flood/overland flow path.

c. Finished floor levels for the proposed development must be nominated in the report, taking into account the freeboard requirements specified in this standard.

d. The flood/overland flow study must demonstrate that the proposed development will not impede the passage of floodwater to cause a rise (afflux) in the flood level upstream and/or increase the downstream velocities of flow for the flood standard. No structures and/or filling are permitted to be placed over the 1 in 100 year ARI overland flow path.

e. The study must include a hazard risk assessment for the site. The determination of the hazard and the assessment shall be in line with the current edition of Australian Rainfall and Runoff by Geoscience Australia.

f. The flood/overland flow study must be signed by the engineer declaring that the study has been done in line with Australian Rainfall and Runoff, the NSW Government's Floodplain Development Manual and Willoughby City Council's floodplain management technical standard.

12 Creation of restriction on the use of land

The applicant shall create a restriction over the land of the subject property for the affected overland flow path (Appendix C). This must be placed on the land title at NSW Land Registry.

The suggested wording for the restriction is:

> 'Do not place any unauthorised structure, wall, fence, fill or other item that may impede the 1% AEP flood event.'

The extent of the flood, in relation to the building footprint, must be shown on a scaled sketch attached as an annexure to the request forms.

13 Glossary

Afflux – the rise in water level (above normal) on the upstream side of an obstruction caused when the effective overland flow area at the obstruction is less than the natural width of the overland flow path immediately upstream of the obstruction.

Annual exceedance probability (AEP) – the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood

discharge of 50 m3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a peak flood discharge of 50 m^3/s or larger occurring in any one year (see average recurrence interval).

Average recurrence interval (ARI) – the average period in years between the occurrences of a flood of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a 1% chance (a one-in-100 chance) of occurrence in any one year.

In the economic life of structures, there is a 23% chance of the 100 year ARI event or greater occurring in a 30 year period, a 50% change of occurrence in a 70 year period and a 60% chance within a 100 year period.

Catchment – the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

Consent authority – the council, government agency or person having the function to determine a development application for land use under the *Environmental Planning and Assessment Act 1979*. The consent authority is most often the council, however there are instances where legislation or an environmental planning instrument (EPI) specifies a minister or public authority (other than a council), or the Director General of the Department of Planning, as having the function to determine an application.

Flood – relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tidal waves.

Flood affected properties – properties that are either encompassed or intersected by the flood.

Floodprone / liable land – land which is subject to inundation. Floodprone land is synonymous with flood liable land and floodplain.

Flood risk zone – the division of the floodplain into areas of varying flood risk according to the nature of flooding and the depth and velocity of floodwaters.

Flood study – detailed hydrologic and hydraulic assessment usually undertaken using modelling programs such as RAFTS, DRAINS, MIKE 11 or HECS-RAS to determine with more certainty the extent, velocity, volume and height of overland flows.

Freeboard – a factor of safety typically used when setting floor levels and levee crest levels. It is usually expressed as the difference in height between the adopted flood planning level and the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as “greenhouse” and climate change. Freeboard is included in the flood planning level.

Garage – structure designed primarily for the storage of vehicles. Can be either a fully enclosed detached structure or a fully enclosed space separated from the main habitable floor area of a building.

Habitable – in a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. In an industrial or commercial situation:

an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

Hazard – a source of potential harm or a situation with a potential to cause loss. In relation to this technical standard, the hazard is flooding which has the potential to put life at risk or cause damage to property and local environment.

Hydraulics – term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.

Hydrology – term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods in a particular catchment or site.

Local drainage – local drainage problems in local overland flooding zones typically include direct surface runoff, surcharges and overflows from low points in kerbs, or overflows from the smaller pipes in the stormwater drainage system. Local drainage problems involve shallow depths of flooding up to 300 mm with generally little danger to personal safety. Problems generally arise because of deficiencies in building practice where floor levels are near finished ground levels.

Local overland flooding zone –area where flooding problems occur due to overland flow. Within those zones there may be two categories of flow based on increasing depth and velocity of inundation: local drainage and main drainage.

Main stream flooding – this type of flooding occurs when the trunk drainage systems surcharge and flows inundate the surrounding floodplains. In Willoughby City, the trunk drainage systems comprise sections of lined and unlined open channels of the main arms of the creeks and their major tributaries, as well as major pipelines which have been laid along the routes of the natural channels as the catchments became urbanised.

Major drainage flooding – major drainage problems in local overland flooding zones are categorised as the upper end of the scale of local overland flooding. Water depths are generally in excess of 300 mm (in the storm event used to derive FPLs). These conditions may result in provisional high hazard conditions.

Non-habitable – all other areas of a building not mentioned under the definition of ‘habitable’.

Overland flow – inundation by catchment runoff rather than overflow from a stream, river, estuary, lake or dam due to rising water level.

Provisional high hazard area – where land in the event of a 100-year ARI flood is subject to depths of inundation greater than 0.8 to 1 metre with little or no velocity associated with the flow. Wading would be unsafe for able bodied adults. This area may also be subject to local catchment flash flooding when the street system acts as floodways conveying relatively fast moving overland flow.

Probable maximum flood (PMF) – the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The probable maximum flood defines the extent of floodprone land, that is, the floodplain.

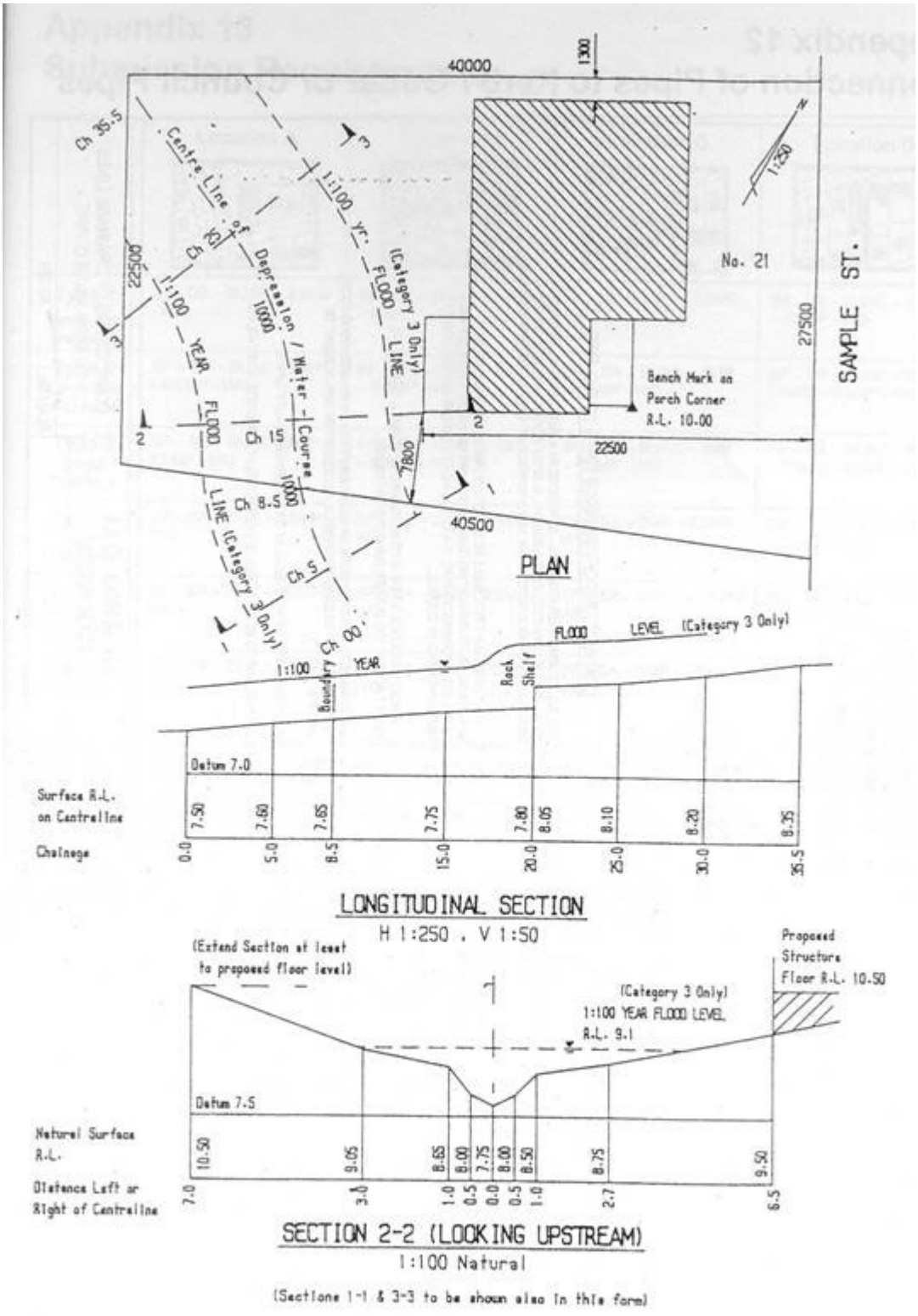
Probable maximum precipitation (PMP) – the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World

Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.

Survey plan – plan prepared by a registered surveyor that shows the information required for the assessment of a development application.

Appendix A – Sample flood study

Figure 6 Typical flood study survey information



Typical Survey Information

Appendix B – Intensity–Frequency–Duration (IFD) tables

Table 18 Rainfall intensity in mm/hr for various durations and return periods

Duration (hours)	1 year	2 years	5 years	10 years	20 years	50 years	100 years
0.083	97.9	125.	159.	178	204.	237.	262.
0.100	91.8	118.	149.	167.	192.	223.	247.
0.167	75.2	96.7	124.	139.	159.	186.	206.
0.333	54.9	70.9	91.7	104.	120.	141.	156.
0.500	44.7	57.9	75.3	85.6	99.0	117.	130.
1.000	30.5	39.6	52.0	59.4	69.1	81.8	91.5
2.000	20.2	26.2	34.8	39.9	46.5	55.3	62.0
3.000	15.7	20.5	27.2	31.3	36.5	43.5	48.8
6.000	10.2	13.4	17.9	20.6	24.1	28.7	32.3
12.000	6.72	8.79	11.8	13.6	16.0	19.1	21.5
24.000	4.45	5.82	7.86	9.10	10.7	12.8	14.5
48.000	2.90	3.80	5.16	6.00	7.07	8.48	9.59
72.000	2.19	2.88	3.92	4.56	5.38	6.47	7.32

List of coefficients to equations for calculation of intensity frequency duration (IFD)

$\ln(I)=a+b(\ln(T))+c(\ln(T))^2+d(\ln(T)^3+e(\ln(T))^4+f(\ln(T))^5+g(\ln(T))^6$

I = Intensity in millimetres per hour

T = Time in hours

Table 19 Values of coefficients for IFD calculation

Years	a	b	c	d	e	f	g
1	3.4171	-0.5782	-0.0314	0.00714	0.000801	-0.0001313	-0.0000369
2	3.6781	-0.5738	-0.0320	0.00726	0.000784	-0.0001541	-0.0000311
5	3.9521	-0.5605	-0.0350	0.00702	0.001072	-0.0001620	-0.0000370
10	4.0849	-0.5537	-0.0365	0.00708	0.001194	-0.0001887	-0.0000353
20	4.2350	-0.5485	-0.0378	0.00720	0.001314	-0.0002139	-0.0000347
50	4.4041	-0.5427	-0.0392	0.00746	0.001396	-0.0002625	-0.0000286
100	4.5167	-0.5382	-0.0400	0.00733	0.001460	-0.0002589	-0.0000302

Values of $(t.I^{0.4})$

Where I = Intensity in millimetres per hour

Table 20 Rainfall duration intensity in minimum mm/hr for various return periods

DUR (hr)	DUR (min)	1 year	2 years	5 years	10 years	20 years	50 years	100 years
0.083	5	31.16	34.36	37.83	39.57	41.79	44.37	46.19
0.100	6	36.58	40.45	44.40	46.48	49.14	52.18	54.35
0.167	10	56.41	62.38	68.90	72.12	76.11	81.04	84.41
0.333	20	99.18	109.86	121.77	128.06	135.60	144.64	150.61
0.500	30	137.17	152.12	168.98	177.87	188.53	201.56	210.23
1.000	60	235.44	261.35	291.44	307.37	326.54	349.34	365.36
2.000	120	399.32	443.10	496.38	524.29	557.39	597.41	625.37
3.000	180	541.54	602.52	674.68	713.66	758.91	814.08	852.39
6.000	360	911.47	1016.59	1141.42	1207.40	1285.61	1378.65	1445.38
12.000	720	1542.70	1717.62	1932.35	2045.26	2182.63	2342.86	2456.45
24.000	1440	2616.41	2912.94	3284.97	3483.21	3716.34	3992.51	4196.72
48.000	2880	4409.12	4912.54	5552.04	5897.30	6297.39	6772.53	7114.10
72.000	4320	5911.01	6595.39	7461.02	7926.28	8468.31	9116.86	9578.29

Note:

- For use with kinematic wave equation (equation 14.2 in Australian Rainfall and Runoff, 1987 – see technical note 3).

Appendix C – Section 88(E)3 Instruments

Terms of restriction of use of land

To be used with Form 13RPA from Department of Lands.

The registered proprietors of the land enters into this covenant with the Willoughby City Council and agrees:

a. not to place any unauthorised structure such as a wall, fence, fill or other item that may impede the 1% AEP flood event on the land, with the exception of structures approved by Willoughby City Council.

Name of authority empowered to release or vary or modify restriction on the use of land referred to: **Willoughby City Council**

Attachment 3 – Technical standard 3 – sediment and erosion control

Definitions

Activity – the erection of a building; the carrying out of any work in, on, over or under land; or the subdivision of land.

Approval – a licence or permission or any authorisation under Part V of the *Environmental Planning and Assessment Act 1979*.

Authority – in relation to a development application, means: the Council having the function to determine the application; or the Minister or public authority or the Director where an environmental planning instrument specifies as having the function to determine the application.

Building works includes buildings or structures or part thereof.

Catchment – is that area within which rainfall will contribute to runoff at a particular point. The area included in catchment is determined by topographic features which on many buildings sites can range from a few square metres to several thousand square metres.

Construction site – is that portion of a site disturbed by the development and/or building and includes the areas where building materials are placed and access traversed by vehicles.

Development – in relation to land, means; the erection of a building on that land; the carrying out of a work in, on, over or under that land; the use of that land or of a building or work on that land, the subdivision of that land.

Diversion banks and catch drains – a bank is a ridge or embankment of compacted earth or blue metal aggregate. A catch drain is an excavated earth drainage ditch or path used to intercept and direct runoff to a desired location.

Erosion – is the process whereby gravity, rain, wind or wave action detaches soil particles and provides energy to move the particle. Types of erosion are:

Soil erosion – is the wearing away of the soil surface material by wind, water or gravitational effects. Natural rates of erosion are accelerated by some human activities such as removal of vegetation for building work exposing the underlying soil.

Stream bank erosion – occurs as a result of flooding or saturation of bank materials due to tidal movement or wave action.

Environmentally sensitive land – is land that is steeper than 18° of slope; liable to degradation due to erosion, sedimentation, inundation by sand/soil or water, salinity/acidity, invasion by exotic vegetation; or native vegetation and wetlands.

Flocculation – reverses the processes that cause dispersion of soil by causing finer particles to clump together into larger units or ‘flocs’ that can settle in a reasonable time or can be filtered. Flocculation is usually carried out in ponds or tanks with the most commonly used flocculation agents being gypsum or alum.

Geotextiles – are synthetic fabrics used to filter sediment or stabilise disturbed surfaces, there are several proprietary types of geotextile for a wide range of applications.

Landscape plan – is a plan showing the location, type and quantity of vegetation and structural elements to be placed on the site to gain visual amenity and screen sections of the site from public view or use.

Receiving waters – either natural water bodies, including rivers, streams (perennial or intermittent), flowing in natural channels with natural beds or in artificially modified channels or wetlands, either naturally formed or artificially modified, or tidal waters, including bays, estuaries or inlets, or constructed water bodies including waterways, ponds, or wetlands, bays or inlets, whether permanently or intermittently inundated with water.

Sediment – mineral or organic material that is being, or has been, moved from its site of origin by transporting agents such as water, wind and gravity to a lower position in the catchment, either above or below sea level. Types of sediment include:

Clay – are soil particles consisting of mineral particles less than 0.002 mm in diameter. Many of the properties of soil depend on the type and quantity of clay particles in the soil.

Sand – consists of particles consisting largely of quartz grains between 0.02 mm and 2.00 mm in diameter. Fine sand is defined as particles between 0.02 mm and 0.2 mm and coarse sand as those between 0.2 mm and 2.0 mm.

Silt – are particles between 0.002 mm and 0.02 mm in diameter.

Soil – is the loose aggregate of various sized small particles that covers the surface of the land. It consists of approximately 90% inorganic mineral material and 10% decayed plant and animal matter.

Sedimentation – the deposition of sediment, usually in locations such as a channel, along a fence, in an area of low slope or a sediment trap, dam or water body.

SEE – Statement of Environmental Effects as prescribed by the *Environmental Planning and Assessment Act 1997* which addresses matters such as any potential environmental impacts of the development, how they have been identified and what steps will be taken to protect the environment or to lessen the expected harm to the environment.

Site management plan – is a plan showing how potential erosion and sedimentation on a site resulting from approved building work, development or landscaping activity will be minimised or controlled.

Soil and water management plan – describes the planned measures to be undertaken at an activity site which will mitigate soil transport and control pollution to down slope lands and receiving waters.

Subdivision – ‘subdivision’, ‘subdivide’, and similar expressions see dividing land into parts.

Topsoil– is a part of the soil profile, typically the first soil layer (called the A1 horizon) below the ground surface that is darker in colour, more fertile and better structured than underlying layers.

Vegetation – means native and exotic trees, shrubs, understorey, ground cover and grasses.

1 Overview

1.1 Introduction

This technical standard is a code of practice for all building, construction and landscaping activity in the Willoughby City Council area. It covers all activity that involves the disturbance of the earth's surface, placement of fill or changes in the rate or volume of runoff entering a natural or built drainage system or flowing overland.

In pristine environments, soil erosion and sedimentation naturally occurs and our ecosystems have evolved over time to cope with this natural process. However, urban development and building activity causes significant land disturbance. This disturbance has resulted in tonnes of soil being eroded and deposited into nearby creeks and waterways at an accelerated rate causing severe environmental problems.

Building, construction and landscaping activities have a major impact on the downstream catchment receiving waters (Lane Cove River and Middle Harbour) when not properly managed.

Removal of vegetation as well as pollutants such as sand, silt, clay, soil and gravel (sediment) and other construction and landscape materials can cause these environmental impacts:

- increased stormwater flooding due to reduced capacity in waterways and blocked stormwater drainage systems
- increased degradation of terrestrial and aquatic ecosystems and habitats, especially aquatic habitat
- reduced air quality and traffic hazards due to increased dust problems
- reduced water quality in creeks, estuaries, river and harbour
- reduced aesthetics and recreational activities due to the infilling of creeks and estuaries

Due to the large number of construction sites within Willoughby City Council area at any given time, even small amounts of pollution from the individual sites can have significant cumulative effects.

Those involved in building and construction must be diligent in managing soil and water on construction sites to minimise soil erosion and sediment pollution and reduce the risk of environmental degradation.

1.2 Objectives

The aim of this technical standard is to ensure that developers/builders:

a. manage environmental and public safety risks during earth and construction works

b. control erosion and stabilise exposed soil surfaces

c. reduce the potential for the transportation of pollutants off site

d. provide a safe and effective framework for the installation and ongoing maintenance of sediment and erosion controls during earthworks, construction, building and landscaping activities

e. prevent the pollution of stormwater runoff draining into bushland, stormwater drainage systems and waterways.

1.3 Legal requirements

The *NSW Protection of the Environment Operations Act 1997* makes it an offence to pollute waters.

The term 'pollutes' means: to place in or on, or introduce into or onto, the waters (whether through act or omission) any material that changes the condition of the water. This includes soil, earth, mud, stones, sand, clay, or washing of such material.

The term 'waters' also has a broad definition, and includes not just harbour, river and creeks but also such things as artificial drains, channels and gutters designed to transport stormwater runoff, which are theoretically the headwaters of such water bodies.

A person may commit an offence if they place any matter (such as sand or soil) in a position where it is likely to fall, descend, wash or blow into any waters.

Severe penalties exist for offences under the Act, ranging from on-the-spot fines through to court imposed fines for each day the offence continues. The Act imposes liability on anyone who participated or contributed to the offence.

Willoughby City Council may also serve a cleanup or prevention notice to install or maintain erosion and sedimentation controls which carries an administration fee. Failure to comply with the cleanup or prevention notice may also result in a penalty.

1.4 Basic principles of erosion and sediment control

You must plan ahead when proposing to carry out any demolition, excavation, construction, building or landscaping works or installation of services.

Even if the proposed works are minor, a site plan showing where you intend to do carry out the works and store construction and building materials including spoil, sand and soil, should be drafted before starting any work. This is to decide where sediment and erosion control measures may be needed.

You should follow these principles when dealing with erosion and sediment control measures:

a. the most effective way of minimising soil erosion is to limit the area of soil disturbance and removal of existing site vegetation and controlling site activities throughout the project

b. establish sediment controls on the site before any earthworks commence or materials are stockpiled

c. control stormwater runoff on the site by reducing water volumes that need to be treated by site controls. This can be achieved by diverting surface water and rainwater away from the work and stockpile areas and reducing water velocities to minimise the potential for scour and sediment pollution

d. cover roof frames as soon as possible, install roof water drainage and connect to rainwater storage, onsite detention tank or the council drainage system to remove clean water from the site

e. conserve and cover topsoil on the site to reuse in revegetation works

f. cover disturbed soil with tarpaulin, straw or cut vegetation

g. stabilise the site through revegetation immediately construction work has been completed. Revegetation can be done in a staged way using temporary cover crops to provide short-term soil protection until permanent vegetation can be established

h. inspect and maintain erosion and sediment control measures throughout the project to reduce the potential for environmental degradation to occur

1.5 Other pollutants from construction sites

As well as pollutants such as sediment, there are several other potential sources of construction pollution. These include the following with suggested management techniques:

a. operations such as washing concreting tools and painting equipment, washing the cement residue from paved surfaces being prepared with an exposed aggregate finish and the cutting of bricks and tiles or other masonry should be done within the property boundary with suitable controls in place

b. potential pollutants such as building litter and waste, dust, fuels and oils and landscape inputs (like fertilisers and herbicides) need to be properly managed onsite

c. incorrect storage of chemicals used in the building process should also have suitable controls in place to minimise the risk of spillage and pollution incidents

2 Standards

Managing Urban Stormwater: Soils and Construction Volume 1, March 2004, by Landcom, NSW Government (The Blue Book) provides detailed information on sediment and erosion control management for construction sites. It includes information on the preparation of plans and techniques to be used to minimise sediment loss and control erosion.

Sediment and erosion control measures on construction sites within Willoughby local government area must be in line with the recommendations of The Blue Book.

3 Submission requirements

The total site area that will be disturbed during the course of the building and construction activity generally defines the minimum submission requirement for a development site.

This includes areas of cut and fill, removal of vegetation, unpaved driveways and access ways and stockpiling of building materials and soil.

Development applications for sites next to or near sensitive areas such as steep escarpments, public open space and waterways, may need to include more detailed management plans. This is at the discretion of Willoughby City Council.

The table below is a guide for submission requirements for site management of soil and water based on exposed surface area and the proposed development activity.

Table 21 Guide to submission requirements

Disturbed area	Typical activities	Submission requirements
<250m^2	Alterations and additions such as house extensions, small driveways, carports and garages which are not: Adjacent to public open space or a water course. Located on a slope greater than 18°. Involve cutting or filling the land which may alter the rate, volume or direction of overland flow.	Include a brief written statement on the proposed water management measures and expected performance levels in the SEE provided with the development application. Before disturbing any land or stockpiling any building materials appropriate sediment and erosion controls are to be installed and continually maintained to prevent pollution of downstream waterways.
250 to 2000 m^2	New house, commercial, dual occupancies, multi unit residential, small industrial complexes, subdivision and infrastructure construction. Alterations and additions that are: Adjacent to public open space or a water course. Located on a slope greater than 18°. Involve cutting or filling the land which may alter the rate, volume or direction of overland flow	A site management plan is to be provided to Willoughby City Council for approval before issue of any construction certificate. The plan should specify proposed sediment and erosion control measures for each stage of the construction activity such as demolition, excavation and construction. See Section 2.1 of this technical standard for submission details.
>2000 m^2	Large multi unit residential, commercial, institutional, industrial developments or development containing more than 10 car parking spaces	Include a soil and water management plan with the development application specifying proposed measures for the control of erosion and pollution of water both during and after construction. Calculations as to the need for a sediment basin should be included. See section 3.2 of this technical standard for submission details.

3.1 Site management plan

Willoughby City Council may require a site management plan to be lodged for consideration before issuing a construction certificate for a proposed development.

All development applications must include a site management plan if the proposed development will expose a soil surface area:

a. greater than 250m^2 up to 2000m^2

b. less than 250m^2 if the site:

- immediately adjoins public open space or a watercourse
- is on a slope exceeding 18 degrees
- involves cut or filling of the land which will alter the rate, volume or direction of overland flow
- where a new residential, commercial or industrial building is proposed to be demolished and/or constructed

The site management plan is to consist of a plan and written specification of proposed soil erosion minimisation and sediment control measures for the site during the demolition, excavation, construction and landscaping stages.

The plan must also consider these issues:

- truck routes to and from the site
- location and description of “all weather access and egress for vehicles” for the site
- location and type of diversionary drains and any other form of sediment and erosion control system
- sediment containment and/or dewatering methods including flocculation and monitoring program
- location and construction of temporary protective fencing/hoardings to the perimeter of the site
- location of site storage areas/sheds/equipment
- location of building materials/stock piles for construction
- dust suppression measures
- details of methods of temporary storage and disposal for demolition/waste materials
- protective measures for tree preservation
- schedule of proposed site stabilisation
- provisions for temporary sanitary facilities
- location and size of waste containers/bins
- frequency and nature of any maintenance program
- complaint management system including contact details of the person responsible for site management 24 hours a day, 7 days a week

If Willoughby City Council deems that the proposed building and construction activity poses a higher risk of erosion or polluting downstream waterways, the applicant may need to supply this information:

- soil characteristics such as depth, erodibility and dispersibility for all proposed exposed soil horizons
- topography such as ground slope and upstream catchment
- location relative to existing drains and waterways
- extent of cut and fill
- downstream vegetative buffer zones

3.2 Soil and water management plan

Development applications must include a soil and water management plan if:

a. the proposed area of soil surface exposure is 2000m^2 or more

b. the development contains 10 or more car parking spaces

c. new commercial, industrial or institutional development

The soil and water management plan must specify proposed measures to control erosion and pollution sources of water both during and after the construction phases.

Details on how to prepare a soil and water management plan are described in Chapter 2 of Managing Urban Stormwater: Soils and Construction Volume 1, March 2004, published by Landcom, NSW Government.

The soil and water management plan is to be provided to Willoughby City Council before issue of any consent for the proposed development.

4 Sediment and erosion control techniques

Each site will need to be individually assessed to ensure effective containment of sediment and erosion control during each stage of the development activity, particularly on large development sites.

These controls aim to ensure only clean water enters council stormwater drainage systems and natural waterways by:

a. diverting surface water around the site

b. minimising the volume of rainwater falling/flowing onto the site by installing the roof covering material and roof water drainage system as soon as possible

c. slowing down the surface water flows through the site

d. covering any exposed soil and stockpiles of soil, sand and spoil

e. placing erosion and sediment control systems at regular intervals on the site

f. preventing soil from leaving or entering the site on the wheels of vehicles or falling from the trays of vehicles

Erosion and sediment control measures on construction sites are to be in line with the requirements of The Blue Book. Techniques to be used include:

- sediment fences
- filter traps
- filter strips
- sediment basins
- diversion banks and catch drains
- stabilised site access
- site stabilisation

5 Maintenance

Proper maintenance of erosion and sediment controls is vital in protecting the environment from construction pollutants. Every rainfall event that generates runoff could reduce the effectiveness of the controls or expose problems that must be rectified before the next storm.

Consider these points in the maintenance of site controls:

a. the site should be actively managed to minimise potential pollution hazards at all times. A number of simple, cost effective methods are available to achieve this and delays due to wet weather or incurring fines can be expensive.

b. maintenance of controls should also account for changes to the site as construction proceeds. Drainage path locations and runoff velocities will change, site slopes, catchment size, type of runoff (sheet or concentrated flows) can be dramatically altered by site work. Additional controls or modifications to existing controls may be required to prevent soil loss off site

c. revegetation or other surface treatments like paving, heavy mulching or landscaping of the site must be done as soon as construction activities cease. It is vital that temporary sediment controls are not removed until the site has been effectively stabilised

d. current legislation requires that discharges from the site are of an acceptable standard and penalties will be imposed if pollution events occur. It is important to remember that the law does not recognise your inexperience or inability to meet acceptable water quality standards, the difficulties experienced on a specific site or how you feel on the day

5.1 Responsibilities of the site supervisor

A site supervisor must be nominated to regularly inspect site controls and initiate any repairs or maintenance activities. Inspections must be carried out daily when there is activity on the site and after any rainfall event that causes runoff.

The nominated site supervisor must supervise the installation of erosion and sediment controls, carry out maintenance inspections and initiate repairs if required.

This person will be Willoughby City Council’s contact for the maintenance of erosion and sediment controls at the site.

On large-scale development sites, the supervisor must keep a logbook to document site conditions and actions taken throughout the project. The book should be kept on the site and made available to any authorised person on request. Entries in the logbook should be made at least weekly, and immediately before forecast rain and after rainfall. Entries should include:

a. volume or intensity of rainfall

b. condition of soil and water management measures

c. condition of stabilisation material or vegetation

d. need for implementation of dust prevention measures

e. remedial works to be done

If the nominated supervisor is temporarily unable to perform inspections, another suitably experienced person should carry out and record the inspection. The nominated supervisor still has overall responsibility for the integrity of erosion and sediment controls on the site.

If the nominated supervisor is no longer involved in the project, a new supervisor is to be nominated by the applicant and Willoughby City Council notified in writing.

The site supervisor should be someone with a working knowledge of erosion and sediment control and preferably have overall responsibility for the site. The person could be the project

or area manager, a clerk of works, a builder, an owner/builder (depending on their experience) or specialist sub-contractor.

5.2 When to undertake maintenance inspections

The site supervisor will be required to inspect site controls every day before the start of any work and at the end of each day that activity occurs on site and after any rain event that causes runoff.

It is recommended that controls are inspected during rain events that threaten to exceed the capacity of the sediment controls so emergency measures can be put in place to reduce the potential for soil loss.

Appendix A – Guidelines for stormwater control in bushland areas

1 Introduction

Stormwater runoff from urban areas, particularly runoff from houses and roads, is a major cause of degradation in urban bushland areas.

Some of the problems created by uncontrolled runoff into the bushland reserves include:

- native vegetation is less able to cope with greater volumes of stormwater runoff and higher concentrations of nutrients, which causes dieback
- the extra nutrient and sediment pollution loads reduce water quality in the receiving waters
- stormwater transports seed and vegetative material from gardens and road edges which causes weed infestation
- stormwater outlets historically consist of a pipe outlet that allows stormwater discharge to spread across the bushland areas that do not have natural drainage lines. The stormwater flows to the receiving waters by spreading out across the slope and encouraging weed growth or by finding the quickest path and causing soil erosion problems

To protect the integrity of bushland reserves and their receiving waters it is essential to efficiently manage stormwater discharge outlets in bushland areas.

Approval is required from Willoughby City Council's infrastructure services division before any works is done in bushland reserves. Each site has individual characteristics that need to be addressed to ensure the effective capture and containment of stormwater runoff. We recommend having a preliminary meeting with a Willoughby City Council bushland manager to discuss options.

2 Procedure for managing stormwater in bushland areas

To reduce the impact of stormwater runoff on bushland areas and receiving waters, these guidelines apply:

a. construct an energy dissipation structure at the pipe outlet to reduce the velocity of the stormwater and reduce the incidence of scour

b. construct a pit or basin within private property for the retention of gross pollutants and sediment and to reduce the velocity of the stormwater flow

c. construct a well-defined, natural looking rock-lined channel. The channel should be incorporated into the existing landscape, drainage lines and rock outcrops

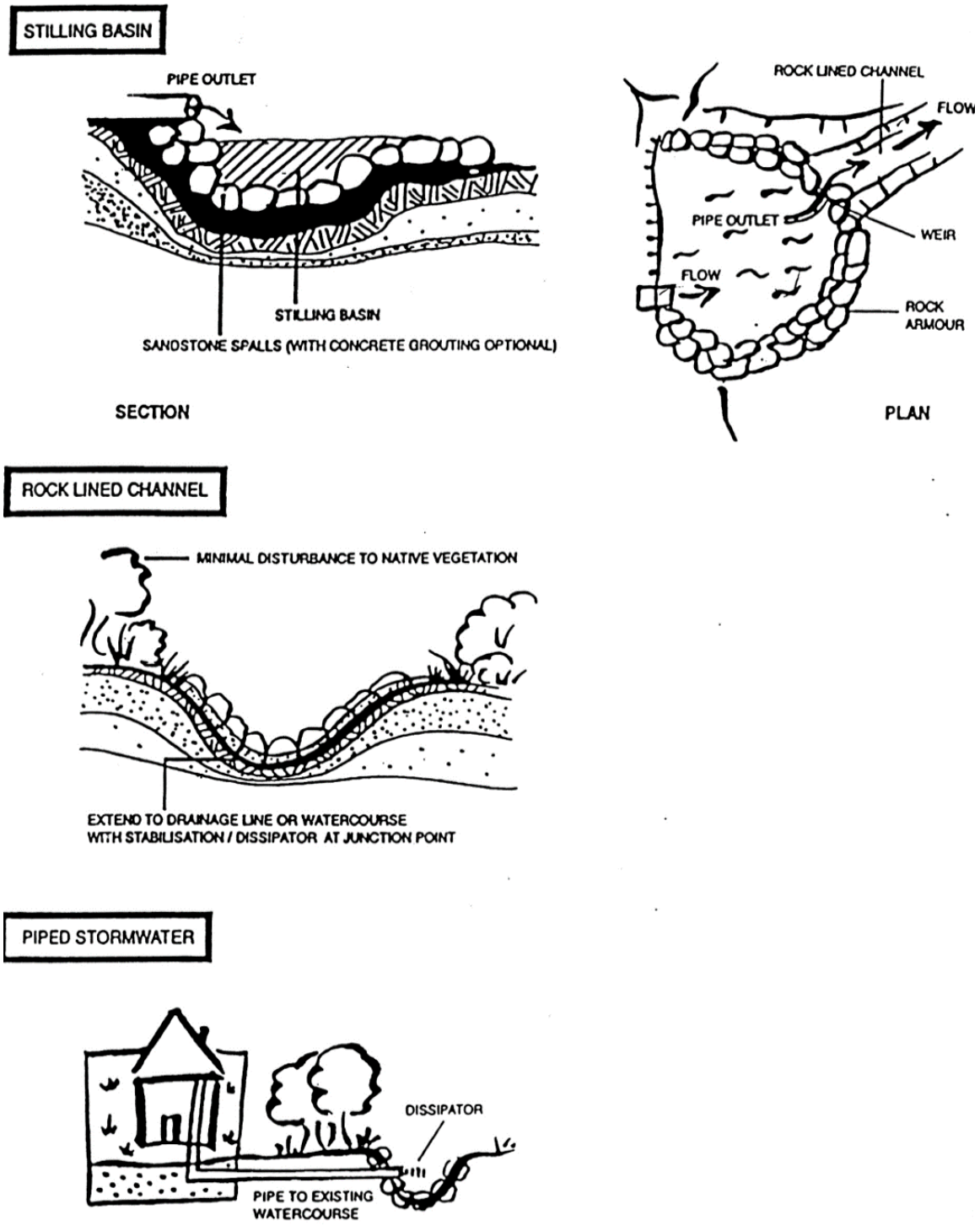
d. construct a sediment pond(s) along the channel to reduce the velocity of the flow, capture sediment and create habitat for local fauna

e. ensure the channel discharges into the nearest substantial drainage line or watercourse

f. rehabilitate any bushland area disturbed as a result of the stormwater channel works as soon as possible when works are complete

g. continually maintain the pit, channel and ponds

Figure 7 Methods for managing stormwater in bushland



2.1 Preliminary design work

When designing for stormwater discharge through bushland reserves, consider these issues:

a. determine the size of the catchment discharging through the channel and the scale of the channel required. The channels must be wide and deep enough to incorporate rock lining whilst maintaining the capacity of the peak flow. For example, an average household discharge pipeline is usually 90mm dia. so the internal sectional area of the rock-lined

channel should be around 0.5m^2 or 5 times the diameter of the pipeline. For large pipe diameters the channel size will need to be hydraulically and hydrologically assessed

b. determine the location of the channel which should include:

c. the location of the closest natural drainage line or watercourse that the proposed channel will discharge into and details on:

- the incorporation of the channel into the existing landscape, drainage lines and rock outcrops while protecting existing trees and vegetation
- the optimum route for the channel containing a minimal number of bends
- the most degraded area of bushland that will suffer least from construction disturbance

d. determine the most suitable location(s) for energy dissipation systems such as a pond(s). Ponds reduce the velocity of the water discharging from the stormwater pipeline. The size and capacity of the pond will depend on the volume and velocity of the peak flows

e. ponds must be located in areas where there is easy access for regular maintenance, such as the removal of any caught litter or sediment from the pond

Figure 8 A rock lined channel from a stormwater pipe outlet

2.2 Visual appearance of the rock-lined channel

There are a few techniques to keep in mind when designing a rock-lined channel that can improve the visual appearance of the construction. These include:

a. constructing channels and ponds below ground level as much as possible so that they blend into the natural landscape and allow surface runoff from the surrounding areas to also use the channel and ponds

b. using natural materials for the construction of the channel and ponds such as a combination of different sized rocks

c. using locally sourced materials (other than bush rock) where possible as they are more likely to blend in to the natural landscape

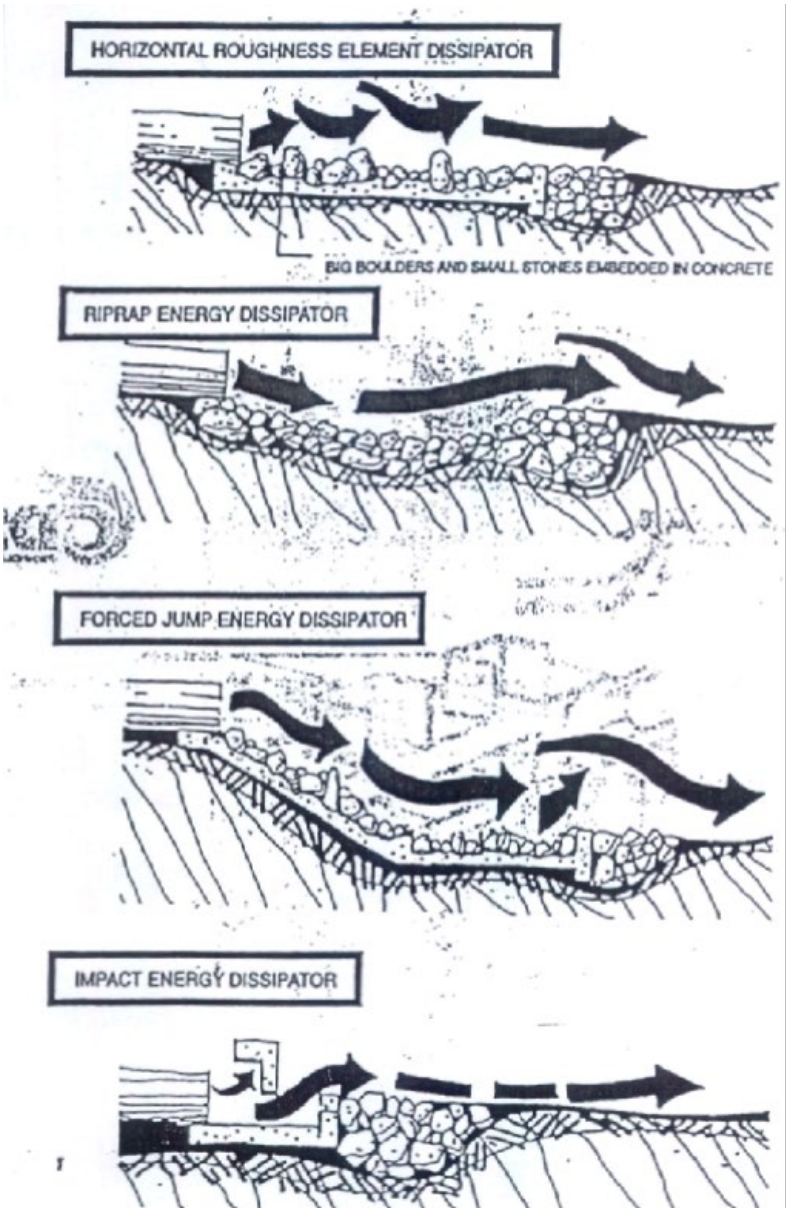
d. using the topography to direct the water. Channelling the water along the path of least resistance wherever possible gives it the appearance of being a natural drainage line and makes construction easier

2.3 Construction of energy dissipators

An energy dissipator must be constructed within the property boundary at the discharge point of the stormwater pipeline to reduce the velocity of the stormwater and for the retention of gross pollutants and sediment. Protection of the opposite bank of the system from scour may also be necessary dependant on the bank materials and the “jet” effect from the discharge pipe. This would also apply where the stormwater pipeline is discharging directly into a natural drainage line or watercourse.

Examples of systems that can be used for energy dissipation are shown below.

Figure 9 Four kinds of energy dissipators



2.4 Construction of rock-lined stormwater channels

To stop the spread of stormwater runoff across the bushland reserve, the water is to be directed or channelled to the nearest existing significant drainage line or watercourse. This may either involve digging a trench to the next layer of bedrock or constructing a rock-armoured channel.

These are the minimum requirements for any rock-lined channel works:

a. channels must be dug into the ground wherever possible so that the sides of the channel do not protrude above ground level. Where this is not possible, the sides of the channel may be mounded

b. when significantly changing the direction of the flow along the channel a pond must be incorporated at the bend

c. erosion control fabric should be laid along the base of the channel ensuring it overlaps the sides

d. the erosion control fabric should not be reinforced with plastic mesh and must not be exposed on completion of the channel construction

e. the base of the channel must be armoured with interlocking sandstone rock capable of withstanding high flows

f. spoil from the channel excavation should be used to form berms along the edges of the channel to divert overland flows from the surrounding area into the channel

Barriers such as large rocks should not be placed across the channel. While a barrier may slow the water to some degree it may also divert the water. This can place pressure on the sides of the channel causing the sides to erode and displace or the water may leave the channel entirely.

If it is necessary to slow the velocity of the water in the channel another pond should be incorporated into the structure. This will not only slow the velocity but will also create habitat for native fauna.

Figure 10 Rock-lined stormwater channel through bushland

2.5 Construction of sediment ponds

A sediment pond is used to slow the rate of flow of the stormwater and allow it to pool. As the water slows down, the energy of the water is dissipated causing the sediment carried in the water to settle to the bottom of the pond.

Requirements for building a sediment pond:

a. there must be a flat base lined with flat rocks free of obstructions such as protruding rocks, exposed erosion control fabric, roots etc to facilitate the removal of sediment

b. the pond walls may be constructed of mounded earth re-enforced with erosion control fabric and covered with sandstone boulders

c. the erosion or weed control fabric should not be exposed on completion of the pond construction

d. the pond outlet point should be located below the invert of the stormwater inlet pipeline but lower than the top of the pond walls. This ensures that the water is directed into the channel below. It also ensures that sediment doesn't cause the discharge pipeline to block and water to back-up the pipeline

2.6 Stabilisation of disturbed area

Any disturbed area must be stabilised on completion of the construction work. Berms should be covered with organic weed mat and planted out with a local native groundcover species to bind the soil.

3 Maintenance

Regular inspections and maintenance of the drainage systems long after the systems have been installed are essential for their continuing efficient operation. The property owner is responsible for regular monitoring and maintenance of any system in their property boundary.

Below is a general guideline for maintenance:

a. the pond will need regular inspections and removal of trapped sediment and gross pollutants. As the pond fills with sediment and gross pollutants it becomes less efficient during future storms

b. the channel should be regularly checked for signs of excessive erosion and blockages and cleared when necessary

Appendix B – Example method of site stormwater filtration before discharge

1 Introduction

This method may be useful for development sites that require substantial excavation works as part of the development and may need to be dewatered after rainfall events. This method is useful for shale and fine clay soils.

Figure 11 shows a site water filtration method based on a standard steel waste skip. This is provided with an outlet pipe fitted to one end near the base and filled with blue metal or clean gravel aggregate in five layers separated by a suitable geotech filter fabric so as to completely contain the contents.

In operation, a settlement pit or tank within the site is used to settle the major sediment content of the site water by use of a proprietary flocculent over 24 hours before it is pumped into the top of the filter skip. The skip should be installed before starting excavation.

The water is filtered through the five layers of filter cloth before being discharged. In most cases the water should be of satisfactory clarity at that stage but it must be monitored regularly.

If the clarity is not satisfactory – it must be completely clear to the eye – or if the quality deteriorates over a period, a final filter such as a Filterite Memtec filter must be fitted between the skip filter and the final discharge point.

Figure 11 One method of site water filtration before discharge into the stormwater system