FEDERATION COUNCIL

# Engineering Guidelines for Subdivisions and Development Standards

## PART 3
## STORMWATER DRAINAGE DESIGN

NOVEMBER 2018

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# 1. INTRODUCTION

This section of the Engineering Guidelines for Subdivisions and Development Standards outlines Council's recommended practice for the design of stormwater drainage systems. It is in no way a comprehensive 'Design Manual' and it is to be read in conjunction with and as a supplement to referenced standards, notably the current version of Australian Rainfall and Runoff.

The Subdivision and Development Guidelines comprise the following:

Part 1 General Requirements

Part 2 Guidelines for Design of Roads

**Part 3 Guidelines for Stormwater Drainage Design**

Part 4 Guidelines for Design of Water Reticulation

Part 5 Guidelines for Design of Sewerage Reticulation

Part 6 Guidelines for Landscaping, and Measures for Erosion, Sedimentation and Pollution Control

Part 7 Guidelines for Testing

# 2. REFERENCE DOCUMENTS

The format of the guidelines has been simplified by making reference to both National and State Standards where applicable. Where these standards vary from the referenced standards the variations are highlighted and cross-referenced. The current version of the referenced standard will apply. The references below were current at time of publication of this standard. If any of the references are updated refer to the equivalent clause in the updated versions. These guidelines shall take preference over the referenced standards. In addition to the criteria outlined in this manual, any relevant acts, regulations and Australian Standards will apply.

In New South Wales, RMS referenced standards will apply:

- Bureau of Meteorology (BOM)
- Australian Rainfall and Runoff – Books
- AS2439 – Perforated plastics drainage and effluent pipe and fittings
- ARRB Special Report 35

**Abbreviations**

| | |
|---|---|
| ANCOLD | Australian National Committee On Large Dams |
| AEP | Annual Exceedance Probability |
| ARI | Average Recurrence Interval |
| ARRB | Australian Road Research Board |
| AR&R | Australian Rainfall and Runoff |
| BOM | Bureau of Meteorology |
| DCP | Development Control Plan |
| IFD | Intensity Frequency Duration |
| LEP | Local Environmental Plan |
| RCP | Reinforced Concrete Pipe |
| WSUD | Water Sensitive Urban Design |

# 3. GENERAL

Stormwater drainage design is to be based on the current version of Australian Rainfall and Runoff (AR&R). At the date of preparation of this standard the current version of AR&R is 2016. This document is being continually updated.

The urban stormwater drainage system should:

- Convey stormwater runoff to the receiving water such that there is minimal nuisance flooding or flood damage
- Limit stormwater pollutants entering receiving water
- Assist with water conservation
- Allow for the integration of large-scale stormwater infrastructure with the use of the sites for multiple other uses (e.g. recreation, transportation etc)

The following four fundamental guiding principles remain relevant:

- Analysis of stormwater drainage systems should, where data permits, be based on measured or observed real system behaviour
- Stormwater drainage infrastructure must be viewed in relation to the total urban environment
- Stormwater drainage systems should be designed and operated to maximise benefits to the community
- Designers should be influenced by professional considerations such as ethics, standardisation and innovation

The objectives and guiding principles are important considerations that must be taken into account when determining stormwater drainage strategies and plans for subdivisional development. This signals a change in emphasis from the original approach where “the main purpose of the urban stormwater drainage system was to collect and convey stormwater to receiving waters, with minimal nuisance, danger or damage”. Council strongly supports this approach, based on a hierarchical consideration of planning strategies as follows:

- The Planning Scheme
- Land-Use Strategies
- Precinct Strategies
- Stormwater Management Plan for City (Water Quality)
- Stormwater Strategy (Citywide Master Plan)
- Stormwater Catchment Plans
- Stormwater Studies and Investigations
- Overall Subdivision Drainage Master Plan
- Specific Subdivision Stage Drainage Plans

As infrastructure planning for Councils is evolving, Councils will have the strategies developed to varying extents. In the absence of a detailed strategy, the intention is that Council will work with a developer to encourage subdivision and development works that are consistent with an holistic approach to stormwater drainage conveyance, water quality and water sensitive urban design principles.

Infrastructure planning and design for new developments needs to consider riverine flooding conditions (i.e. flooding from natural waterways).  Floodplain risk management plans which have been prepared for towns will define the existing flooding conditions on detailed inundation maps.  Flood based planning controls will apply to the defined flood affected area (Flood Planning Area) generally by way of specific flood based controls which have been incorporated into Council’s LEP (Local Environmental Plan) and DCP (Development Control Plan).

Where floodplain risk management plans have not been prepared, hydrologic and hydraulic investigations will need to be completed for any waterways which may be impacting on the development area.

# 4. WATER SENSITIVE URBAN DESIGN (WSUD)

Stormwater drainage design is to include the principles of Water Sensitive Urban Design in subdivisional works. Include as part of the inception meeting with Council officers, discussion and agreement on Water Sensitive Urban Design and the extent to which these principles can be incorporated into the subdivision master planning and urban landscaping. Integrate the management of the urban water cycle with urban planning and design. Urban stormwater is to be managed as both a resource and for the protection of receiving waters. Encourage outcomes that promote the retention of stormwater runoff on site.

WSUD includes:

- The sustainable management of the Water Cycle
- Principles of water consumption
- Water recycling
- Waste minimisation
- Environmental protection

The environmental benefits of WSUD include:

- Improving the urban landscape
- Reduction of the export of pollution from the site
- Retardation of storm flows
- Reduced irrigation requirements

Council's consideration of water sensitive urban design elements into subdivision design will consider the following:

- Lifecycle cost implications on the maintenance of the infrastructure
- The maintenance period and the success of the initial establishment
- Community safety and the safety of maintenance staff
- The provision of consistent citywide themes that recognise individuality of each locality

Water Sensitive Urban Design is to be undertaken in accordance with the general principals outlined in Australian Rainfall and Runoff.  Information in Book 9, Chapter 4 is provided for the design of detention basins, on-site detention, constructed wetlands or ponds, bioretention basins, rainwater harvesting storages and infiltration system.

# 5. STORMWATER DRAINAGE CALCULATIONS

All drainage design calculations shall be undertaken in accordance with the current version of Australian Rainfall and Runoff. The most appropriate method of calculation should be selected, having regard to the magnitude of flows and the potential for flooding. Book 9 of the current version of Australian Rainfall and Runoff includes guidelines for the management of stormwater volume (Chapter 4) and stormwater conveyance (Chapter 5).

Methods for design flow estimation include flood frequency analysis, regional flood frequency analysis (refer to Australian Rainfall and Runoff – Book 3), the Rational method for estimating peak design flows only, and hydrologic modelling techniques for estimating design event hydrographs (refer to Australian Rainfall and Runoff – Book 5).

The RATIONAL METHOD is highlighted here as it is suited to small subdivisional design where larger magnitude flows are not anticipated.

$Q = CIA/360$

| | |
|---|---|
| Q | is design flow rate cubic metres per second |
| I | is rainfall intensity mm/hr |
| A | is area in ha |
| C | is coefficient of runoff |

Rational method assumptions are based on statistical analysis of data to produce a ‘standard’ design flow rate or discharge for stormwater drainage systems.

## 5.1 MAJOR / MINOR SYSTEM DESIGN APPROACH

Council has adopted a major/minor drainage network philosophy for street drainage in accordance with Australian Rainfall and Runoff.

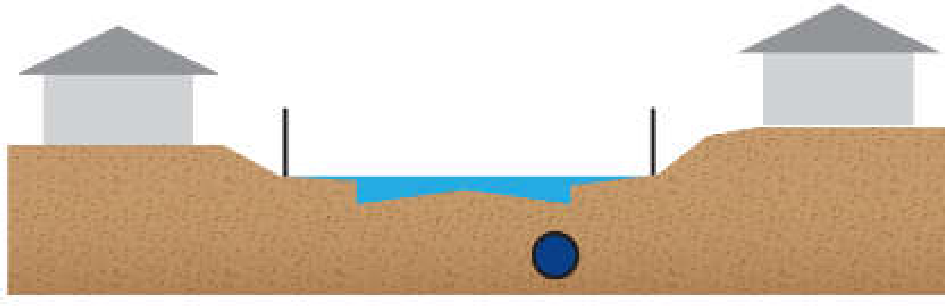

**Figure 1: Major/minor drainage network philosophy**

Example of major / minor system (extract from AR&R) – underground pipe minor system, roadway major system.

It is critical that provision for managing design flows up to the 1% AEP event is incorporated into development designs. The road network can be designed to function as the major system flow carrier up to a point (i.e. until flows start impacting on adjoining allotments and /

or exceeding vehicle and pedestrian stability limits). Once this occurs, dedicated overland flow paths are required which should generally coincide with natural flow paths. Building over natural flow paths instead of reserving these areas for conveying major system flows can lead to serious flooding impacts and also hinder future development in the same catchment.

### 5.2 CATCHMENT DISCHARGE

Developments shall be designed such that the rate of discharge will not increase as a result of development, unless otherwise approved by Council in accordance with an integrated catchment wide drainage strategy. This shall consider events that include the 1% AEP event.

This is particularly important where development is occurring within catchments where there are existing known downstream flooding problems (e.g. in older urban areas where development has occurred over overland flow paths leading to flooding impacts once the minor drainage system capacity is exceeded). New development upstream of known existing flooding problems will need to incorporate stormwater drainage measures which as a minimum do not exacerbate the downstream flooding problems. The options for achieving this are largely limited to detention and / or flow diversions.

### 5.3 STANDARDS OF PERFORMANCE

The design discharge capacity of the pipe drainage network (minor system) is given in Table 1. The design standard for the major system is the 1% AEP event (100 year ARI).

**Table 1: Stormwater Pipe Network – Design Capacity Standards**

| Type of Development | Design Discharge Capacity |
|---|---|
| Residential Areas | 20% AEP (4.5 year ARI) |
| Industrial and Commercial Areas | 10% AEP (9.5 year ARI) |

### 5.4 PROPERTY DRAINAGE

Roof drainage systems are to be sized by rules based on a simplified Rational Method applied to roof surfaces:

- Provide minimum 450 mm concrete pit with metal grate connected to Council pipe system with 100 mm connection. Approved precast pits are acceptable
- Provide easements in rear of block drainage that are in favour of Council
- Individual properties may drain to the kerb and gutter or alternatively to a piped underground drainage system where provided
- Identify and protect overland flow path with easements and the provision of unimpeded flow

### 5.5 PIPE SYSTEM DRAINAGE

The minor system is the gutter and pipe network capable of carrying runoff from minor storms. Pipes are sized to carry frequent flows, which in residential areas is up to a 20% AEP event to prevent nuisance flooding of streets. In rarer events, overflows are conveyed within the street network and drainage reserves (major system). Hydraulic capacities of overland flow paths are to be checked for their adequacy to convey the 1% AEP design flow. Designers need to determine the route for conveying overland flows whilst ensuring that hazardous situations do not arise on streets and footpaths, and that buildings are protected from flooding in a 1% AEP design event.

## 5.6 STORMWATER DRAINAGE PITS - LOCATION

- Provide stormwater drainage pits at intervals to limit gutter flow spread to 2 to 2.5m on any section of road other than a kerb return where the width is limited to 1m
- The maximum spacing between pits is approximately 90m subject to hydraulic calculations demonstrating acceptable flow widths and stormwater velocity
- Provide extended double grated gully pits at sag points
- Check inlet capacity of stormwater drainage pits match or exceed the design pipe capacity

## 5.7 STORMWATER DRAINAGE PITS - DESIGN

Standard pits should be provided in drainage lines at all changes in grade, level or direction and at all pipe junctions:

- The minimum clearance from the top of the pit to the design water level in the pit should be 150mm
- Pipe junctions where the deflection angle of the major flow exceeds 90º should be avoided

Pipe grading across pits should be designed on the following basis:

- No change in direction or diameter – minimum 50 mm drop
- No change in diameter but direction change – minimum 70 mm drop
- Changes in diameter shall be graded obvert to obvert
- Every endeavour is to be made to maintain flow velocities through pits and excessive drops will not generally be permitted
- Precast pits are acceptable subject to Council approval
- Minimum size drainage pits that require physical access are to be 1050mm

## 5.8 SURFACE RUNOFF AND TRAVEL TIMES

### 5.8.1 KINEMATIC WAVE EQUATION

Stormwater design shall account for overland flow prior to discharge to the pipe network.

The recommended formula to determine time of overland flow is the ‘Kinematic Wave’ equation. There are restrictions on the use of this formula as this expression applies to planar or sheet flow of water. The maximum length applicable should not exceed 60m. Consider a supposedly flat playing field, where water would concentrate into rivulets. A surface roughness or retardance coefficient ‘n*’ is used which is not to be confused with Manning’s ‘n’.

$$t = 6.94\,(L.n^*)^{0.6} / I^{0.4}\ .\ S^{0.30}$$

where

$t$ = overland flow time (minutes)

$L$ = flow path length (m)

$n^*$ = a surface roughness or retardance coefficient

$I$ = rainfall intensity (mm/h)

$S$ = slope (m/m)

**Note:**

The lower the value of n*, the more conservative or the greater the flows. n* is normally taken as varying for 0.15 to 0.20 for residential overland flow.

**Table 2: Surface Roughness or Retardance Factors**

| Surface Type | Roughness Coefficient n* |
|---|---|
| Concrete or Asphalt | 0.010 - 0.013 |
| Bare Sand | 0.010 - 0.016 |
| Gravelled Surface | 0.012 - 0.030 |
| Bare clay-Loam Soil (eroded) | 0.012 - 0.033 |
| Sparse Vegetation | 0.053 - 0.130 |
| Short Grass Prairie | 0.100 - 0.200 |
| Lawns | 0.170 – 0.048 |

Where overland flow is concentrated, naturally or by design, into an earth or grass lined channel, Manning's Formula for open channel flow can be used to estimate velocities and subsequently flow times:

$$Q = A.V = AR^{2/3} S^{1/2}/n$$

| | | |
|---|---|---|
| Where | $Q$ | is flowrate ($m^3/s$) |
| | $A$ | is the cross-sectional area of flow ($m^2$) |
| | $V$ | is velocity (m/s) |
| | $P$ | is the wetted perimeter of flow (m) |
| | $R$ | is hydraulic radius (m), equal to A divided by P |
| | $S$ | is longitudinal slope (m/m) |
| | $n$ | is Mannings roughness coefficient |

Alternatively gutter flow times can be estimated from design aids. Estimates of overland flow times are not highly accurate and gutter flow times added to these flow times need not be calculated precisely.

In applying the Rational Method note that the minimum duration for which rainfall intensity data applies is five minutes. The approximate travel for a typical residential block with a 2% fall from the rear to the front calculated via the Kinematic Wave equation will be approximately 15 minutes.

**Table 3: Manning's Roughness Coefficients**

| **Manning's Roughness Coefficients 'n' for Open Channels** | |
|---|---|
| **Surface Type** | **Suggested n Values** |
| Concrete Pipes or Box Sections | 0.011 - 0.012 |
| Concrete (trowel finish) | 0.012 - 0.015 |
| Concrete (formed, without finishing) | 0.013 - 0.018 |
| Sprayed Concrete (gunite) | 0.016 - 0.020 |
| Bricks | 0.014 - 0.016 |
| Pitchers or Dressed Stone in Mortar | 0.015 - 0.017 |
| Random Stones in Mortar or Rubble | 0.020 - 0.035 |
| Masonry | 0.025 - 0.030 |
| Rock Lining or Rip-Rap | 0.020 - 0.033 |
| Corrugated Metal (depending on size) | 0.018 - 0.025 |

| Manning’s Roughness Coefficients ‘n’ for Open Channels | |
|---|---|
| **Surface Type** | **Suggested n Values** |
| Earth (clear) | 0.025 - 0.035 |
| Earth (with weeds or gravel) | 0.035 - 0.040 |
| Short grass | 0.030 - 0.035 |
| Long grass | 0.035 – 0.05 |

## 5.9 DIMENSION OF FLOW

- Limit flow width to 2 to 2.5m, along kerb and gutter and 1m around kerb returns for a 20% AEP storm

- Gutter flows are not to overtop the kerb

- Provide 300mm of freeboard above the 1% AEP flood level for floor levels of habitable rooms

- Product of depth and velocity in a 1% AEP event 0.4m$^2$/s for safety of pedestrians or 0.6 to 0.7m$^2$/s for the stability of parked vehicles

- Bypass flows shall not exceed 15% of total pit approach flow

## 5.10 PIT ENTRY CAPACITIES

Hydraulic design calculations must demonstrate adequate capacity of the stormwater drainage network to accept the design flows.

## 5.11 ESTIMATION OF FLOW RATES BY THE RATIONAL METHOD

A peak flowrate for a particular time of concentration is calculated. While this is adequate for design, the model is unsuitable for the simulation of drainage system behaviour in actual storms.

## 5.12 PARTIAL AREA EFFECTS

The time of concentration most commonly used is the full area time, which is the travel time for runoff from the longest flow path. Partial area calculations may be approximated by obvious partial catchment areas and for partial areas based on the concentration times of impervious zones directly connected to the pipe system.

## 5.13 RUNOFF COEFFICIENTS ‘C’

The probabilistic interpretation covers the whole range of events involving different combinations of rainfalls and antecedent conditions using the equation below, which determines a runoff coefficient for the catchment for any ARI based on the 10-year ARI runoff coefficient for the entire catchment ($C10$ ) and a conversion factor known as a ‘frequency factor’ (F) for that ARI.

$$C_y = F_y \times C_{10}$$

Where: $C_y$ = y - year ARI runoff coefficient for the entire catchment

$F_y$ = y - year ARI frequency factor (see Table 4 for values)

$C_{10}$ = 10 - year ARI runoff coefficient for the entire catchment

**Table 4: Urban Frequency Factors**

| AEP (%) | ARI (years) | Frequency Factor (Fy) |
|---|---|---|
| 63 | 1 | 0.8 |
| 50 | 1.4 | 0.85 |
| 20 | 4.5 | 0.95 |
| 10 | 9.5 | 1.0 |
| 5 | 20 | 1.05 |
| 2 | 50 | 1.15 |
| 1 | 100 | 1.2 |

Given this, in order to determine the runoff coefficient for the entire catchment it is necessary to use the following equations to determine the 10-year ARI runoff coefficient ($C10$). This value is determined by combining the runoff coefficient of the pervious and impervious areas of the catchment, and is as such largely dependant on the fraction impervious ($f$).

$$C_{10} = (0.9 \times f) + \left[C^1{}_{10} \times (1 - f)\right]$$

$$C^1{}_{10} = 0.1 + \left[0.0133 \times ({}^{10}I_1 - 25)\right]$$

Where: $C_{10}$ = 10 - year ARI runoff coefficient for the entire catchment

$f$ = Impervious fraction of the catchment (value must be between 0.0 and 1.0)

$C^1{}_{10}$ = 10 - year ARI pervious area runoff coefficient

${}^{10}I_1$ = 10 - year ARI, 1-hour rainfall intensity for the location (obtained from locations IFD data)

## 5.14 FRACTION IMPERVIOUS

Typical fractions for impervious areas are:

| | |
|---|---|
| Open Space/Parkland | 0.05 |
| Residential Areas (Ultimate Development) | 0.40 |
| Normal House Block | 0.45 |
| Duplex Block | 0.60 |
| Road Reserve Including Roads and Footpath | 0.85 |

In situations where more accurate estimates of impervious area fractions can be determined the accurate estimates should be used in preference to the typical fractions given above

## 5.15 DESIGN RAINFALL DATA

Design rainfall information is documented in Book 2, Chapter 3 of AR&R.

Design intensity – frequency – duration (IFD) for a particular site or catchment can be obtained from the following Bureau of Meteorology (BOM) web site:

http://www.bom.gov.au/water/designRainfalls/ifd/

To generate an IFD table for a subject catchment, the approximate centroid coordinates of the catchment should be specified. Using the township of Corowa as an example (indicative Easting 444000, indicative Northing 6016000, Zone 55), the following 2016 AR&R IFD table is generated by accessing the above BOM web site:

**Table 5: Corowa Township – 2016 IFD Data (rainfalls are in mm/hr)**

| | Annual Exceedance Probability (AEP) | | | | | | |
|---|---|---|---|---|---|---|---|
| Duration | 63.2% | 50% | 20%* | 10% | 5% | 2% | 1% |
| 1 min | 93.3 | 107 | 148 | 176 | 203 | 239 | 266 |
| 2 min | 78.6 | 89.7 | 125 | 149 | 172 | 200 | 221 |
| 3 min | 71.3 | 81.5 | 113 | 135 | 156 | 181 | 200 |
| 4 min | 65.9 | 75.3 | 105 | 124 | 143 | 167 | 185 |
| 5 min | 61.3 | 70.1 | 97.4 | 116 | 133 | 156 | 173 |
| 10 min | 46.3 | 53.0 | 73.8 | 87.7 | 101 | 119 | 132 |
| 15 min | 37.3 | 43.2 | 60.1 | 71.5 | 82.5 | 97.1 | 108 |
| 30 min | 25.1 | 28.6 | 39.9 | 47.4 | 54.8 | 64.5 | 71.8 |
| 1 hour | 15.8 | 18.1 | 25.0 | 29.7 | 34.3 | 40.3 | 44.9 |
| 2 hour | 9.81 | 11.1 | 15.3 | 18.1 | 20.9 | 24.5 | 27.3 |
| 3 hour | 7.39 | 8.37 | 11.4 | 13.5 | 15.6 | 18.3 | 20.4 |

| | Annual Exceedance Probability (AEP) | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 hour | 4.58 | 5.16 | 7.01 | 8.28 | 9.54 | 11.3 | 12.6 |
| 12 hour | 2.83 | 3.19 | 4.33 | 5.13 | 5.94 | 7.07 | 7.98 |
| 24 hour | 1.73 | 1.95 | 2.67 | 3.19 | 3.74 | 4.50 | 5.11 |
| 48 hour | 1.02 | 1.15 | 1.61 | 1.95 | 2.32 | 2.81 | 3.22 |
| 72 hour | 0.737 | 0.833 | 1.17 | 1.43 | 1.71 | 2.08 | 2.39 |
| 96 hour | 0.580 | 0.656 | 0.921 | 1.13 | 1.36 | 1.65 | 1.90 |
| 120 hour | 0.481 | 0.543 | 0.760 | 0.930 | 1.11 | 1.36 | 1.56 |
| 144 hour | 0.412 | 0.465 | 0.646 | 0.787 | 0.939 | 1.14 | 1.32 |
| 186 hour | 0.361 | 0.406 | 0.561 | 0.679 | 0.805 | 0.981 | 1.13 |

## 5.16 PIPE SYSTEM HYDRAULICS

Hydraulic grade line calculations should be used for the design of pipe systems.

## 5.17 LIMITING VELOCITIES

The minimum allowable velocity for design is taken as 1 m/s. Council may consider alternative design velocities where this is not achievable, although no consideration will be given to design velocities less than 0.6 m/s.

This minimum velocity requirement is different to the minimum grade requirement. The basis of the minimum grade approach relates to construction problems and tolerances. Minimum grades of 1/300 are acceptable for normal pipeline design.

## 5.18 CALCULATION OF PIPE FRICTION

The Colebrook-White Equation is recognised as the best relationship for the full range of turbulent pipe flows. It follows the curved lines shown on the Moody Diagram. Manning's formula is valid in the completely turbulent section only; but prone to error in the transition zone. Subject to approval by Council, Manning's calculations may be accepted.

The Colebrook-White Equation:

$$V = -0.87\sqrt{(2g.D.S)}\ loge\ [k/3.7\ D + 2.51v/D\sqrt{(2g.D.S)}]$$

Where g = gravitational acceleration (m/s$^2$)

D = diameter (m)

S = energy line slope (m/m)

K = pipe wall roughness (m), sometimes given as e, and is the kinematic viscosity (m2/s).

v = normally 1.0 x 10-6

**Table 6: Colebrook-White Equation Pipe Friction**

| Pipe Material | Hydraulics Research Recommendations ‘k’ value (mm) for pipe conditions: | | | SAA Recommendations ‘k’ value (mm) for pipes concentrically |
|---|---|---|---|---|
| | Good | Normal | Poor | Joined and clean |
| Concrete | | | | |
| • Spun precast, ‘O’ Ring Joints | 0.06 | 0.15 | 0.3 | 0.03 to 0.15 |
| • Monolithic construction against rough forms | 0.06 | 1.5 | - | |
| Asbestos cement | 0.06 | 0.03 | - | 0.015 to 0.06 |
| uPVC | | | | |
| • With Chemically Cemented Joints | - | 0.03 | | |
| • with Spigot and Socket Joints | - | 0.06 | | 0.003 to 0.015 |

The design wall roughness value adopted should reflect conditions well into the service life of the pipe. Thus for concrete pipes a value of K = 0.3 mm is suitable, i.e. somewhere between ‘good’ and ‘poor’.

## 5.19 PIPE CONSTRUCTION

- Pipes are to be reinforced concrete pipe (RCP) rubber ring jointed with a minimum diameter of 300mm
- Twin – walled corrugated polypropylene pipes may be used on Council’s approval. All fittings and repairs to manufacturers details only. Cover on pipe to be supplied as per manufacturer’s specifications or designed by a qualified engineer
- The minimum cover under road pavements is 300mm below subgrade level or 600mm below pavement surface level whichever is greatest
- The minimum diameter of inter-allotment drainage pipes is 225mm with the exception of one lot where 150mm pipes may be provided. Inter-allotment drainage pipe materials may be other than concrete but are subject to Council approval
- The minimum cover over inter-allotment drainage is 300mm
- No reduction in pipe diameter is allowed for pipe reaches progressing downstream. Council will consider other materials on a case by case basis

# 6. SUBSURFACE DRAINAGE DESIGN

## 6.1 SCOPE

The work to be executed under this Specification consists of the design of the subsurface drainage system for the road pavement and/or subgrade.

## 6.2 OBJECTIVES

The objective in the design of the subsurface drainage system is to control moisture content fluctuations in the pavement and/or subgrade to within the limits assumed in the pavement design.

## 6.3 REQUIREMENTS FOR SUBSURFACE DRAINAGE

Subsoil or sub pavement drains shall be provided at all locations where kerb and gutter is installed.

## 6.4 LAYOUT, ALIGNMENT AND GRADE

Typical cross sections of sub-pavement drains are shown in the Council Standard Drawings. As indicated in these drawings, sub-pavement drains extend into or adjacent to the pavement layers to facilitate drainage of the pavement layers in addition to the subgrade. Subsoil drains are only required when directed by Council in special circumstances.

## 6.5 FILTER MATERIAL

The types of filter material covered by this Specification shall include:

(a) Type A filter material for use in subsoil, foundation, and sub-pavement (trench) drains and for Type B drainage mats

(b) Type B filter material for use in subsoil, foundation and sub-pavement (trench) drains

(c) Type C filter material comprising crushed rock for use in Type A drainage mats

(d) Type D filter material comprising uncrushed river gravel for use in Type A drainage mats

The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) shall depend on the permeability of the pavement layers and/or subgrade and the expected flow rate. Generally, Type A filter material is used for the drainage of highly permeable subgrade or pavement layers such as crushed rock or coarse sands, while Type B filter material is used for the drainage of subgrade and pavement layers of lower permeability such as clays, silts or dense graded gravels. Further guidance to the selection of appropriate filter material is contained in ARRB (Australian Road Research Board) Special Report 35.

## 6.6 GEOTEXTILE

To provide separation (i.e. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material, geotextile shall be designated to encapsulate the filter material. Geotextile shall also be designated for both Type A and Type B Drainage Mats.

## 6.7 SUBSOIL AND SUB PAVEMENT DRAIN PIPE

Pipes designated for subsoil, foundation and sub-pavement drains shall be 100mm dia. slotted pipe.

Corrugated plastic pipe shall conform with the requirements of AS2439.1. The appropriate class of pipe shall be selected on the basis of expected live loading at the surface. Joints, couplings, elbows, tees and caps shall also comply with AS2439.1.

Slotted rigid UPVC pipe shall be of a type and class approved by Council.

All pipe shall be slotted, and fitted with a suitable geotextile filter tube, except for cleanouts and outlets through fill batters which shall be unslotted pipe.

DRAWING AND CALCULATIONS

The proposed location of all subsurface drains shall be clearly indicated on the Drawings, including the nominal depth and width of the trench, and the location with respect to the line of the kerb/gutter or edge of pavement. The location of outlets and cleanouts shall also be indicated on the Drawings.

Assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this Specification shall be submitted to Council for approval with the Drawings.

## 6.8 OPEN CHANNELS

Generally, open channels will only be permitted where they form part of the trunk drainage system and shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where Council permits the use of an open channel to convey flows from a development site to the receiving water body, such a channel shall comply with the requirements of this Specification.

Design of open channels shall be in accordance with AR&R (Australian Rainfall and Runoff). Open channels will be designed to contain the major system flow that is contained in the minor system, with an appropriate allowance for blockage of the minor system.

Friction losses in open channels shall be determined using Mannings ‘n’ values given below:- Mannings ‘n’ Roughness Co-efficients for open channels shall generally be derived from information in AR&R. Mannings ‘n’ values applicable to specific channel types are given below:

| | |
|---|---|
| Concrete Pipes or Box Sections | 0.011 |
| Concrete (trowel finish) | 0.014 |
| Concrete (formed without finishing) | 0.016 |
| Sprayed Concrete (gunite) | 0.018 |

| | |
|---|---|
| Bitumen Seal | 0.018 |
| Bricks or pavers | 0.015 |
| Pitchers or dressed stone on mortar | 0.016 |
| Rubble Masonry or Random stone in mortar | 0.028 |
| Rock Lining or Rip-Rap | 0.028 |
| Corrugated Metal | 0.027 |
| Earth (clear) | 0.022 |
| Earth (with weeds and gravel) | 0.028 |
| Rock Cut | 0.038 |
| Short Grass | 0.033 |
| Long Grass | 0.043 |

Where the product of average Velocity and average flow Depth for the design flow rate is greater than $0.4m^2/s$, the design will be required to specifically provide for the safety of persons who may enter the channel in accordance with AR&R.

Maximum side slopes on grassed lined open channels shall be 1 in 4, with a preference given to 1 in 6 side slopes, channel inverts shall generally have minimum cross slopes of 1 in 20.

Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. Subsurface drainage shall be provided in grass lined channels to prevent waterlogging of the channel bed. The width of the concrete lined channel section shall be the width of the drain invert or at least sufficiently wide enough to accommodate the full width of a tractor.

Transition in channel slopes to be designed to avoid or accommodate any hydraulic jumps due to the nature of the transition.

## 6.9 RETARDING BASINS

For each AEP / ARI, a range of storm event durations shall be run to determine the peak flood level and discharge from the retarding basin induced by the critical duration storm (i.e. duration inducing the highest peak outflow and highest peak basin flood level).

Flood Routing for the assessment of retarding basins should be modelled by methods outlined in AR&R.

The high level outlet to any retarding basin shall have capacity to contain a minimum of the 1% AEP flood event. Additional spillway capacity may be required depending on the consequences of the retarding basin failing. The consequence assessment and subsequent spillway design should be determined by reference to the current ANCOLD (Australian National Committee on Large Dams) guidelines.

Pipe systems shall contain the minor flow through the Retarding Basin wall. Outlet pipes shall be rubber ring jointed with lifting holes securely sealed. Pipe and culvert bedding shall be specified to minimise its permeability, and cut off walls and anti-seepage collars installed where appropriate. The pipe inlet shall be protected to prevent blockages.

Freeboard - Minimum floor levels of dwellings shall be 0.5m above the 1% AEP (Annual Exceedance Probability) flood level in the basin.

Public Safety Issues - Basin design is to consider the following aspects relating to public safety:

- Side slopes are to be a maximum of 1 in 6 to allow easy egress. Side slopes of greater than 1 in 4 may require handrails to assist in egress
- Water depths shall be, where possible, less than 1.2 m in the 10% AEP storm event. Where neither practical nor economic greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered
- Depth indicators should be provided indicating maximum depth in the basin
- Protection of the inlet zone to the outflow pipe shall be undertaken to reduce hazards for people trapped in the basin
- Signage of the spillway is necessary to indicate the additional hazard
- Basins shall be designed so that no ponding of water occurs on adjoining private property or roads
- No planting of trees in basin walls is allowed
- No basin spillway is to be located directly upstream of urban areas

The maximum water level in a retarding basin shall be designed such that the backup in the pipe system is limited to below the invert level of any affected road culvert to minimise damage to road pavement.

## 6.10 STORMWATER DETENTION

Installation of Stormwater Detention is required on redevelopment sites where under capacity drainage systems exist. A redevelopment site is defined as a site which used to have or was originally zoned to have a lower density development than is proposed.

## 6.11 STORMWATER PUMPS

Where there is insufficient grade for the stormwater system to function by gravity alone, pumps may be installed of a size and type approved by Council. All pump wells are to be fitted with non-return valves.

All lockable components of pump stations are to be on Council’s master key system.

Stormwater pump station will only be considered by council once all other methods have been proven to be inadequate.

# 7. STANDARD DRAWINGS

| No. | Description | Drawing No. |
|---|---|---|
| 1 | Side Entry Pit Details – To Suit Barrier & Roll Over Kerb Types | SD 200 |
| 2 | Side Entry Cover Details - To Suit Barrier & Roll Over Kerb Types | SD 201 |
| 3 | Grated Gully Pit Details | SD 202 |
| 2 | Grates and Frames for Grated Gully Pits | SD 203 |
| 3 | Grated Pit Details – To Suit Roll Over Kerb Types | SD 204 |
| 4 | Junction Pit Details | SD 205 |
| 5 | Rural Letterbox Pit | SD 206 |
| 6 | Grated Catch Pit – For Use in Paved Areas | SD 207 |
| 7 | Grated Catch Pit – For Use in Unpaved Areas | SD 208 |
| 8 | Pipeline Anchor Block | SD 209 |
| 9 | Pipeline Trench Detail | SD 210 |
| 10 | Property House Connections | SD 211 |