NEW SOUTH WALES

DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amend-ment Code	Author Initials	Amend-ment Date
1.	Add new references: Department of Housing, Road Manual, 1987 [Ref.23]; AUSTROADS Waterway Design – A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, 1994 [Ref.24]; NAASRA – Guide to the Design of Road Surface Drainage, 1986 [Ref.25].	D5.03	A	GA	Oct 00
2	Replace "Council's current handbook of Drainage Design Criteria" with "Appendix D5" in the Clauses / subclauses indicated In the adjacent column.	D5.04(3) D5.06(4) D5.11(8) D5.12(4)	M	GA	Oct 00
3	Subclause 3 – relating to IFD charts for specific regions of the Shire. Add new note	D5.04	A	GA	Oct 00
4	Subclause 5 – relating to ARI for minor events. Add ARI for different road classes.	D5.04	A	GA	Oct 00
5	Add new subclause 7 – relating to ARI specified by other Authorities.	D5.04	A	GA	Oct 00
6	Subclause 1 – relating to Alternative Models. Replace "is given in Council's current Handbook…" with "can be found in Chapter 14 of AR&R"	D5.07	M	GA	Oct 00
7	Subclause 2 – relating to Computer Analysis Programs. Delete last sentence	D5.07	O	GA	Oct 00
8	Subclause 1 – relating to Calculations. Delete "is given in the Council's….." with "can be found in Chapter 14 of AR&R"	D5.08	M	GA	Oct 00
9	Subclause 5 – relating to pit capacities. Remove dot point 1.	D5.10	O	GA	Oct 00
10	Subclause 1 – relating to pit losses. Replace	D5.11	M	GA	Oct 00

	"given in Council's Current Handbook……" with "or equations such as the Missouri Charts, Hare equations and US Corps of Engineers mitre bend charts. Missouri Charts 2 and 4 from AR&R (Ref.14) can be found in Appendix 5".				
11	Subclause 2 – relating to Benching. Replace existing sentence with new sentence "Reduction in Ke due to benching is allowable".	D5.11	M	GA	Oct 00
12	Subclause 3 – Replace "in Council's Current Handbook….." with "mentioned above".	D5.11	M	GA	Oct 00
13	Subclause 4 – relating to bend losses. Replace "are given in Council's current Handbook……." with "shall be denoted on the hydraulic summary sheets".	D5.11	M	GA	Oct 00
14	Subclause 5 – relating to Service entry losses. "Remove second sentence. Substitute with a note".	D5.11	M	GA	Oct 00
15	Subclause 7 – relating to Pipe junction Losses. Remove last sentence. Substitute with a note	D5.11	M	GA	Oct 00
16	Subclause 2 – relating to Freeboard. Replace "0.3m" with "0.5m"	D5.14	M	GA	Oct 00
17	Subclause 4 – relating to Culverts. Replace "Council's current Handbook….." with Austroads Waterway Design…[Ref.24].". Add new note	D5.14	M	GA	Oct 00
18	Add new subclause 5 – relating to Minimum Pipe Diameter	D5.14	A	GA	Oct 00
19	Add new subclause 6 – relating to Headwalls	D5.14	A	GA	Oct 00
20	Add new subclause 7 – relating to Cutoff Walls	D5.14	A	GA	Oct 00
21	Subclause 1 – relating to Redevelopment. Substitute "City" with "Town"	D5.16	M	GA	Oct 00
22	Subclause – relating to Requirements for Stormwater Detention. Replace "Council's current Handbook….." with "Chapter 3 of the ARRB SR34 Stormwater drainage design….[Ref.21]." Add new note.	D5.16	M	GA	Oct 00
23	Subclause 1 – relating to Materials and Subclause 3 – relating to Jointing. Replace "Council's current Handbook….." with "Council's Engineering Specification for Construction – Pipe Drainage (C221)[Ref.2]	D5.18(1) D5.18(3)	M	GA	Oct 00
24	Subclause 5 – relating to Bulkheads. Replace "5%" with "10%". Add new note with regards to horizontal spacing of bulkheads.	D5.18	M	GA	Oct 00

25	Subclause 5 – relating to Advise to developer's Designer. Remove "Council's Handbook" Add "(Council's Engineering Specification for Construction)" after the words "PIPE DRAINAGE".	D5.18	M	GA	Oct 00
26	Subclause 1 – relating to Benching. Remove all sentences from the second one onwards. Substitute with new note.	D5.19	M	GA	Oct 00
27	Add new subclause 2 – relating to Council's Standard Drawing	D5.19	A	GA	Oct 00
28	Add new subclause 3 – relating to Pit Geometry.	D5.19	A	GA	Oct 00
29	Subclause 4 – relating to Other Authorities Requirements. Add new note	D5.20	A	GA	Oct 00
30	Subclause 5 – relating to Council Easements. Replace "width of 3.0m" with "width of 5.0m"	D5 20	M	GA	Oct 00
31	Subclause 1 – relating to Hydrology and Subclause 2 – relating to Hydraulics. Replace "Council's current handbook…." with "AR&R".	D5.24	M	GA	Oct 00
32	Add new Clause D5.26 – relating to Flood studies	D5.26	A	GA	Oct 00
33	Add new Clause D5.27 – relating to Floodways and Low Level Structures.	D5.27	A	GA	Oct 00
34	Add new Clause D5.28 – relating to velocities and scour protection.	D5.28	A	GA	Oct 00
35	Add new Appendix D5		A	GA	Oct 00

INSTRUCTION FOR SPECIFICATION PREPARATION

D5 Stormwater Drainage Design

COUNCIL'S HANDBOOK FOR DRAINAGE DESIGN CRITERIA

This Specification has been designed to be used with Council's own ***"Handbook of Drainage Design Criteria"***. This handbook should be designed by Council to include co-efficients, design requirements, design charts, material standards, and summary sheets for calculations so as to control the data and processes that the Consultant shall use in designs submitted to Council.

For ease of reviewing or preparing this handbook, the following list contains the requirements that are presented in the Handbook of Drainage Design Criteria and the clauses in D5 – STORMWATER DRAINAGE DESIGN where references are cited to the Handbook.

· Design IFD rainfalls for specific locations and individual zonings.	D5.04
· Percentages impervious for specific locations and individual zonings. · Run off co-efficients for specific locations and individual zonings.	D5.06
· Sample summary sheet for hydrological calculations. · Additional requirements for use of specified computer analysis programs.	D5.07
· Sample summary sheet for hydraulic calculations.	D5.08
· Pit capacities.	D5.10
· Pressure change co-efficient "K_e" charts. · Allowable reductions in "K_e" due to benching. · Pit pressure change co-efficients at bends. · Chart for pressure change co-efficient K_p. · Junction pressure change co-efficients K_l and K_u chart. · Sudden expansion and contraction losses.	D5.11
· Road capacity charts and flow adjustment factors to Tech Note 4 Chapter 14 of AR&R 1987.	D5.12
· Culvert Design Charts - inlet and exit losses, inlet and outlet control and scour protection.	D5.14
· Requirements for stormwater detention design.	D5.16
· Conduit and material standards. · Conduit jointing details.	D5.18
· Typical pit designs, and other pit design requirements. · Lists of Standards or Codes relevant to pit design.	D5.19
· Guidelines for scour protection at outlets.	D5.20

DEVELOPMENT DESIGN SPECIFICATION D5
STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

1. The work to be executed under this Specification consists of the design of stormwater drainage systems for urban and rural areas.

D5.02 OBJECTIVES

1. The objectives of stormwater drainage design are as follows:

   (a) To ensure that inundation of private and public buildings located in flood-prone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits.

   (b) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits.

   (c) Retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

2. In pursuit of these objectives, the following principles shall apply: ***Design Principles***

   (a) New Developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in Chapter 14 of Australian Rainfall & Runoff, 1987 (AR&R); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

   (b) Redevelopment - Where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design average recurrence interval (ARI) of the receiving minor system is no greater than that which would be expected from the existing development.

D5.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

C220	-	Stormwater Drainage – General [1]
C221	-	Pipe Drainage [2]
C222	-	Precast Box Culverts [3]
C223	-	Drainage Structures [4]
C224	-	Open Drains including Kerb & Gutter [5]

(b) Australian Standards

AS 1254 - Unplasticised PVC (uPVC) pipes and fittings for stormwater or surface water applications [6].
AS 2032 - Code of practice for installation of uPVC pipe systems [7].
AS/NZS 2566.1 - Buried flexible pipelines, structural design [8].
AS 3725 - Loads on buried concrete pipes [9].
AS 4058 - Precast concrete pipes [10].
AS 4139 - Fibre reinforced concrete pipes and fittings [11].

(c) State Authorities

RTA, NSW - Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings, 1979 [12].

(d) Other

AUSTROADS - Bridge Design Code 1992 [13].

Inst. of Eng. - Australian Rainfall and Runoff (AR&R) - A guide to flood estimation. Aug 1987 [14].

Queensland Urban Drainage Manual, Volumes 1 & 2, 1993 [15].

Sangster, WM., Wood, HW., Smerdon, ET., and Bossy, HG.
- Pressure Changes at Storm Drain Junction, Engineering Series, Bulletin No. 41, Eng. Experiment Station, Univ. of Missouri 1958 [16].

Hare CM. - Magnitude of Hydraulic Losses at Junctions in Piped Drainage Systems. Transactions, Inst. of Eng. Aust., Feb. 1983 [17].

Concrete Pipe Association of Australia
- Concrete Pipe Guide, charts for the selection of concrete pipes to suit varying conditions, 1998 [18].

Henderson, FM. Open Channel Flow, 1966 [19].

Chow, Ven Te - Open Channel Hydraulics, 1959 [20].

John Argue - Australian Road Research Board Special Report 34
- Stormwater drainage design in small urban catchments: a handbook for Australian practice, 1987 [21].

Australian National Conference On Large Dams, Leederville WA.
- ANCOLD 1986, Guidelines on Design Floods for Dams [22].

Department of Housing
- Road manual 1987 [23]

AUSTROADS - Waterway Design A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, 1994 [24]

NAASRA - Guide to the Design of Road Surface Drainage, 1986 [25]

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

1. Design Intensity-Frequency-Duration (IFD) Rainfall – IFD relationships shall be derived in accordance with Volume 1 Chapter 2, of AR&R, for the particular catchment under consideration.

I-F-D Relationships

2. The nine basic parameters read from Maps 1-9 in Volume 2 of AR&R shall be shown in the calculations submitted to Council, except where the Bureau of Meteorology provides a polynomial relationship for the catchment.

3. Where design IFD rainfalls are provided for specific locations these are provided in Appendix D5.

IFD Charts for Specific Regions in the Shire.

NOTE : The IFD charts for Cooma, Nimmitabel, Bredbo and Numerella are provided in Appendix D5. For developments in other regions of the Shire, the Rainfall – IFD relationship can be calculated as stated above or by purchasing the charts from the Bureau of Metereology. The coordinates for the region must be specified to the Bureau.

4. Design Average Recurrence Interval (ARI) – For design under the "major/minor" concept, the design ARIs to be used are given below.

ARI

5. Recurrence intervals for minor events depend on the zoning of the land being serviced by the drainage system. The minor system design ARIs are detailed below:-

- 20 years for Sub-Arterial roads
- 10 years for commercial/industrial area "minor" systems and Collector streets
- 5 years for residential area "minor" systems and Local streets
- 5 years for rural residential area "minor" systems and Access streets
- 1 year for parks and recreation area "minor" systems.

Average Recurrence Interval (ARI) for different classes of roads.

6. In addition, where a development is designed in such a way that the major system flows involve surcharge across private property, then the underground system (both pipes and inlets) shall be designed to permit flows into and contain flows having an ARI of 100 years from the upstream catchment which would otherwise flow across the property. A surcharge path shall be defined for systems even where 100 year ARI flows can be maintained within the system. Easements are to be provided in private property over pipe systems and surcharge paths.

Easements in Private Property

7. Work carried out under the jurisdiction of other Authorities, such as the RTA and other Government Departments, will require the ARI to be in accordance with the requirements of the particular Authority.

ARI Specified by other Authorities.

D5.05 CATCHMENT AREA

1. The catchment area of any point is defined by the limits from where surface runoff will make its way, either by natural or man made paths, to this point. Consideration shall be given to likely changes to individual catchment areas due to the full development of the catchment.

Catchment Definition

2. Where no detailed survey of the catchment is available, 1:4000 orthophoto maps are to be used to determine the catchments and to measure areas.

3. Catchment area land use shall be based on current available zoning information or proposed future zonings, where applicable.

D5.06 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Volume 1, Chapter 14, of AR&R and the requirements of this Specification.

2. All calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design. ***Qualified Person***

3. Co-efficients of Run-off shall be calculated as per Volume 1, Chapter 14.5 of AR&R and full details of co-efficients utilised shall be provided. ***Run-off Co-efficients***

4. Details of percentage impervious and Co-efficients of Run-off are given in Appendix D5. These can be used in lieu of more detailed calculations.

5. The time of concentration of a catchment is defined, as the time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment. ***Times of Concentration***

6. Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately. ***Different Flow Characteristics***

7. The maximum time of concentration in an urban area shall be 20 minutes unless sufficient evidence is provided to justify a greater time.

8. Flow paths to pits shall be representative of the fully developed catchment considering such things as fencing and the likely locations of buildings and shall be shown for each collection pit on the catchment area plan. Consideration shall be given to likely changes to individual flow paths due to the full development of the catchment. ***Flow Paths to Pits***

9. Surface roughness co-efficients "n" shall generally be derived from information in Volume 1, Chapter 14 of AR&R. Values applicable to specific zoning types and overland flow path types are given below: ***Overland Flow Retardance***

Flow across Parks	0.35
Flow across Rural Residential land	0.30
Flow across Residential (2a)	0.21
Flow across Residential (2b)	0.11
Flow across Industrial	0.06
Flow across Commercial	0.04
Flow across Paved Areas	0.01
Flow across Asphalt Roads	0.02
Flow across Gravel Areas	0.02

D5.07 OTHER HYDROLOGICAL MODELS

1. Other hydrological models may be used as long as the requirements of AR&R are met, summaries of calculations are provided and details are given of all program input and output. A sample of a summary sheet for hydrological calculations can be found in Chapter 14 of AR&R. ***Alternative Models***

2. Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to Council and with the final drawings after approval by Council. ***Computer Analysis Programs***

HYDRAULICS

D5.08 HYDRAULIC GRADE LINE

1. Hydraulic calculations shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all programme input and output. A sample of a summary sheet for hydraulic calculations can be found in Chapter 14 of AR&R.

Qualified Person

Calculations

2. The "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

3. Downstream water surface level requirements are given below:-

Downstream Control

(a) Known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event.

(b) Where the downstream starting point is a pit and the hydraulic grade line is unknown, a level of 0.15m below the invert of the pit inlet in the downstream pit is to be adopted.

(c) Where the outlet is an open channel and the design storm is the minor event the top of the outlet pipe shall be the downstream control.

(d) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, the top of the outlet pipe shall be the downstream control.

(e) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are known, the downstream control shall be the 1% probability flood level.

4. The water surface in drainage pits shall be limited to 0.150m, below the gutter invert for inlet pits and 0.150m below the underside of the lid for junction pits.

Water Surface Limits

D5.09 MINOR SYSTEM CRITERIA

1. The acceptable gutter flow width in the 20% probability event is 2.5 metres maximum. Wider flow widths may be approved on roads with flat grades.

Gutter Flow Widths

2. Minimum conduit sizes shall be as follows:

Conduit Sizes

- Pipes - 375mm diameter.
- Box culverts - 600mm wide x 300mm high.

3. Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/sec and 6m/sec respectively.

Velocity Limits

D5.10 PITS

1. Inlet Pits shall be spaced so that the gutter flow width is limited in accordance with this Specification and so that the inlet efficiency is not affected by adjacent inlet openings. Preference shall be given to the location of drainage pits at the upstream side of allotments.

Spacing

2. Other pits shall be provided:

- To enable access for maintenance.
- At changes in direction, grade, level or class of pipe.
- At junctions.

3. The maximum recommended spacing of pits where flow widths are not critical are given in Table D5.1 below:

	Pipe Size (mm)	Spacing (m)
Generally	less than 1200	100
	1200 or larger	150
In tidal influence	All	100

Table D5.1 Pit Spacing

Inlet Capacity

4. Kerb inlet lengths to side entry pits are to be a preferred maximum of 3.0m, with an absolute maximum of 5.0m where the grade is 10% or more, and an absolute maximum of 4.0m where the grade is less than 10%.

5. Information on pit capacities is available in the following sources:-

- (deleted).
- Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings", with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.
- Pit relationships given in Volume 1, Chapter 14 of AR&R.

Allowance for Inlet Blockage

6. None of these pit charts include any blockage factors. The percentage of theoretical capacity allowed in relation to type of pit is given in Table D5.2 below:-

Condition	Inlet Type	Percentage of Theoretical Capacity Allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%

Table D5.2 Allowable Pit Capacities

D5.11 HYDRAULIC LOSSES

Pit Losses

1. The pressure change co-efficient "Ke" shall be determined from the appropriate charts or equations such as the Missouri Charts, Hare equations, and US Corps of Engineers mitre bend charts. Missouri Charts 2 and 4 from AR&R (Ref.14) can be found in Appendix 5..

Benching

2. Reduction in “Ke” due to benching is allowable.

3. Computer program default pressure change co-efficient "Ke" shall not be acceptable unless they are consistent with those from the charts mentioned above. . The chart used and relevant co-efficients for determining "Ke" value from that chart shall be noted on the hydraulic summary sheet provided for plan checking and included on the final design drawings.

Bend Losses

4. Bends may be permissible in certain circumstances and discussions with Council regarding their use are required prior to detailed design. Appropriate values of pit pressure change coefficient at bends shall be denoted on the hydraulic summary sheets..

Service Entry Losses

5. Where possible design should try to avoid clashes between services.

NOTE: When designing a new system, drop pits should not be used as high-energy losses and unacceptable turbulence can occur.

6. Requirements for private pipes entering Council's system are given below:-

   (a) All pipe inlets, including roof and subsoil pipes, shall where possible, enter the main pipe system at junction pits. These shall be finished off flush with and be grouted into the pit wall.

   (b) If a junction has to be added which is larger than 225mm then a junction pit shall be built at this location in accordance with this Specification.

   (c) For smaller inlets, the drainage pipes may be broken into to allow interconnection with the main line. In this case the sideline shall be finished flush with and be grouted into the main line.

Pipe Junction Losses

7. Construction of a junction without a structure should be avoided where possible. Permission to do this is required by Council prior to detailed design.

NOTE: In the absence of a structure at a junction, pressure change co-efficients Ku, for the upstream pipe shall be calculated using Missouri Chart 4 given in Appendix D5 with a reduction of 0.1 from the Ku value obtained to allow for the absence of a junction pit. Assume a minimum Ku value of 0.05.

Contraction / Expansion Losses.

8. Going from larger upstream to smaller downstream conduits is not permitted without approval of Council prior to detailed design. In going from smaller to larger pipes benching shall be provided in pits to enable a smooth flow transition. Losses in sudden expansion and contractions are given in Appendix D5.

Pipe Friction Losses

9. Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall generally be designed as gravity systems flowing full at design discharge, but may be pressurised with the use of appropriate pits and joints. Pipe friction losses and pipe sizes in relation to discharge shall be determined using the Colebrook-White formula with the acceptable roughness co-efficients being 0.6mm for concrete pipes and 0.06mm for FRC pipes.

D5.12 MAJOR SYSTEM CRITERIA

Surcharging

1. Surcharging of drainage systems which would provide for water depth above the top of kerb will not be permitted except:

(a) Surcharging of drainage system for storm frequencies greater than 5% probability may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property.

(b) Flow across footpaths will only be permitted in situations specifically approved by Council, where this will not cause flooding of private property.

Velocity/ Depth Criteria

2. The velocity x depth product of flow across the footpath and within the road reserve shall be such that safety of children and vehicles is considered. The maximum allowable depth of water is 0.2 metres and the maximum velocity x depth product of $0.4m^2/s$ is permitted. Where the safety of only vehicles can be affected, a maximum velocity x depth product of $0.6m^2/s$ is permitted. In open channels the above velocity x depth product criteria will be followed where possible or the design shall address the requirements for safety in relation to children by providing safe egress points from the channel or other appropriate methods.

Freeboard

3. Freeboard requirements for floor levels and levee bank levels from flood levels in roadways, stormwater surcharge paths and open channels are given below:

In Roadways:-

(a) A minimum freeboard of 0.3m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.

(b) Where the road is in fill or overtopping of kerbs and flow through properties may occur a 100mm freeboard shall be provided between the ponding level of water in the road and the high point in the footpath. Driveway construction in these instances needs to consider this requirement.

In Stormwater Surcharge Paths:-

(c) A minimum freeboard of 0.3 shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

In Open Channels:-

(d) A minimum freeboard of 0.5m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Roadway Capacities

4. Road capacity charts are provided in Appendix D5 for some standard road designs. For other road designs flow capacities of roads should be calculated using Technical Note 4 in Volume 1, Chapter 14 of AR&R with a flow adjustment factor

D5.13 OPEN CHANNELS

Safety

1. 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.

2. Design of open channels shall be in accordance with Volume 1, Chapter 14, of AR&R. Open channels will be designed to contain the major system flow less any flow that is contained in the minor system, with an appropriate allowance for blockage of the minor system.

Channel Roughness

3. 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 Chapter 14 of 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

4. 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 Volume 1, Chapter 14, of AR&R..

Side Slopes

5. 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 Flows

6. 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.

Hydraulic Jumps

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

D5.14 MAJOR STRUCTURES

Afflux

1. All major structures in urban areas, including bridges and culverts, shall be designed for the 100 year ARI storm event without afflux. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is minimal and does not inundate private property.

Freeboard

2. A minimum clearance of 0.5m between the 100 year ARI flood level and the underside of any major structure superstructure is required to allow for passage of debris without blockage.

3. Certified structural design shall be required on bridges and other major culvert

structures and may be required on some specialised structures. Structural design shall be carried out in accordance with the Specification for STRUCTURES BRIDGE DESIGN.

4. Culverts (either pipe or box section) shall be designed in accordance with charts provided in Austroads – Waterway Design, A Guide to the Hydraulic Design of Bridges, Culverts and Floodways [Ref.24] , with due regard being given to inlet and exit losses, inlet and outlet control and scour protection. ***Culverts***

NOTE: A sample design form from the Austroads Guide can be found in Appendix D5

5. Pipe diameter for road crossings shall not be less than 450mm and the structure should be designed to pass the whole of the design flood beneath the road. ***Minimum Pipe Diameter***

6. All culverts to be provided with headwalls. Reinforced concrete headwalls to be designed to Roads and Traffic Authority standards or alternatively approved precast units may be used. Grouted stone headwalls may be permitted on minor culverts. ***Headwalls***

7. Cutoff walls will be required on culverts and causeways. ***Cutoff Walls***

D5.15 RETARDING BASINS

1. For each ARI a range of storm events shall be run to determine the peak flood level and discharge from the retarding basin. Storm patterns shall be those given in Volume 1, Chapter 11 of AR&R. Sensitivity to storm pattern should be checked by reversing these storm patterns. ***Critical Storm Duration***

2. The critical storm duration with the retarding basin is likely to be longer than without the basin. A graph showing the range of peak flood levels in the basin and peak discharges from the basin shall be provided for the storms examined.

3. Flood Routing should be modelled by methods outlined in AR&R. ***Routing***

4. The high level outlet to any retarding basin shall have capacity to contain a minimum of the 100 year ARI flood event. Additional spillway capacity may be required due to the hazard category of the structure. The hazard category should be determined by reference to ANCOLD. ***High Level Outlet***

5. The spillway design shall generally be in accordance with the requirements for Open Channel Design in this Specification.

6. 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. ***Low Flow Provision***

7. The low flow pipe intake shall be protected to prevent blockages.

8. Freeboard – Minimum floor levels of dwelling shall be 0.5m above the 100 year ARI flood level in the basin. ***Freeboard at Dwellings***

9. Public Safety Issues - Basin design is to consider the following aspects relating to public safety. ***Safety Issues***

- 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 1.2m in the 20 year ARI storm event. Where neither practical or economic greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered.

- The depth indicators should be provided indicating maximum depth in the basin.
- Protection of the low flow intake 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 to 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.
- Submission of design Drawings to the Dam Safety Committee is required where any of these guidelines are not met or Council specifically requires such submission.

STORMWATER DETENTION

D5.16 STORMWATER DETENTION

1. Installation of Stormwater Detention is required on redevelopment sites within the Town 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.

Re-development

2. The requirements for Stormwater Detention Design are outlined in Chapter 3 of the ARRB SR 34 – Storm Drainage Design in Small Urban Catchments [Ref.21].

Requirements for Stormwater Detention.

NOTE: Council's Engineers will have to be consulted prior to design.

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

1. Interallotment Drainage shall be provided for every allotment which does not drain directly to its frontage street or a natural watercourse.

2. Interallotment drainage shall be contained within an easement not less than 1.0m wide , and the easement shall be in favour of the upstream allotments.

3. Pipe Capacity – The interallotment drain shall be designed to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the "minor" street drainage system.

4. In lieu of more detailed analysis, the following areas of impervious surface are assumed to be contributing runoff to the interallotment drain:-

Impervious Area

Development Type	**% of Lot Area Impervious**
• Residential (2a)	40
• Residential (2b)	70
• Industrial	80
• Commercial	90

5. Pipes shall be designed to flow full at the design discharge without surcharging of inspection pits.

Pits

6. Interallotment drainage pits shall be located at all changes of direction. Pits shall be constructed of concrete, with 100mm thick walls and floor and have a minimum 600 x 600 internal dimensions. Pits shall be with a 100mm concrete lid finished flush with the surface of works. Depressed grated inlets are acceptable.

Grade

7. Pipes - Minimum Grade - The interallotment drainage shall have a minimum longitudinal gradient of 0.5% .

Pipe Type

8. Interallotment Drainage Pipe Standards - The interallotment drainage shall be constructed from rubber ring jointed pipes of either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254. In public road and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only, shall be used.

Sewer

9. Interallotment Drainage Pipe - Relationship to Sewer Mains. Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced 1.5 metres between pipe centrelines (where the pipe inverts are approximately equal).

10. Where there is a disparity in level between inverts the spacing is to be submitted for approval.

11. Where sewer mains are in close proximity to interallotment drainage lines they are to be shown on the interallotment drainage plan.

DETAILED DESIGN

D5.18 CONDUITS

Materials

1. Conduits and materials shall be in accordance with the standards detailed in Council's Engineering Specification for Construction – Pipe Drainage (C221) [Ref.2]

Bedding and Cover

2. Pipe bedding and cover requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association "Concrete Pipe Guide" or AS 3725. For uPVC pipes, the requirements shall be to AS 2032.

Jointing

3. Conduit jointing shall be in accordance with Council's Engineering Specification for Construction – Pipe Drainage (C221) [Ref.2].

Location

4. Drainage lines in road reserves shall generally be located behind the kerb line and parallel to the kerb. Drainage lines in easements shall generally be centrally located within easements.

Bulkheads

5. Bulkheads shall be designed on drainage lines where the pipe gradient exceeds 10 per cent. The design details shall address the size, and position in the trench as well as spacing along the line.

NOTE: A minimum horizontal spacing of 6 times the trench depth shall be adopted for the bulkheads along the slope.

ADVICE TO THE DEVELOPER'S DESIGNER
BURIED FLEXIBLE DRAINAGE PIPES

Particular situations may be identified during the design of a development for the use of buried flexible pipes instead of the pipes specified in AUS-SPEC Specification C221 for

PIPE DRAINAGE (Council's Engineering Specification for Construction).

In such cases, the Developer's Designer will be required to select the flexible pipe type appropriate for the particular application and prepare the relevant technical specification clauses for supply and construction with reference to AS/NZS 2566.1, Buried flexible pipelines Part 1: Structural design. The proposed additional clauses would then be submitted by the Developer, as a variation to the development consent, for approval by Council. If use is approved, then the supply and construction specification clauses shall be inserted in the Special Requirements section of the AUS-SPEC Specification C221 for PIPE DRAINAGE (Council's Engineering Specification for Construction).

D5.19 PIT DESIGN

Benching

1. Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding.

NOTE:
Typical pit designs and other pit design requirements can be found in NAASRA Guide to the Design of Road Surface Drainage [Ref.25] and the Department of Housing Road Manual [Ref23]. Design Safety and safe access are important considerations in pit design. Step irons shall be detailed where required and grates shall be of "bicycle safe" design

Council's Standard Drawing

2. Council's Standard Drawing (Plan C40) gives details of a type of pit used widely in the Shire. This can be found in Appendix D5

Pit Geometry

3. At a junction with a deflection pit, the intersection of the centre-lines should always occur at the downstream face of the pit in order to minimise turbulence in the pit.

D5.20 STORMWATER DISCHARGE

Scour Protection

1. Effective measures must be taken to limit outlet velocities and/or provide sufficient protection and energy dissipaters to prevent scouring of receiving waterways.

Kerb & Gutter Termination

2. Kerb and gutter shall be extended to drainage pit or natural point of outlet. Where outlet velocity is greater than 2.5m per second or where the kerb and gutter discharge causes scour, then protection shall be provided to prevent scour and dissipate the flow.

Easements, Adjoining Owners

At points of discharge of gutters or stormwater drainage lines or at any concentration of stormwater from one or on to adjoining properties, either upstream or downstream, Council will require the Developer to enter into a Deed of Agreement with the adjoining owner(s) granting permission to the discharge of stormwater drainage and the creation of any necessary easements with the cost of the easement being met by the Developer.

Other Authorities' Requirements

4. Where the drainage is to discharge to an area under the control of another statutory authority eg, Public Works, the design requirements of that Statutory Authority are also to be met.

NOTE: Proposals to carry out works in or adjacent to natural watercourses may require permits from the Department of Land and Water Conservation under the Rivers and Foreshores Act. The NSW Department of Fisheries should also be contacted if fish passage is likely to be affected.

Council Easement

5. The minimum drainage easement width shall be 5m for drainage systems to be taken over by Council. The overall width of the easement in Council's favour will be such as to contain the full width of overland flow or open channel flow in the major system design event.

6. Piped stormwater drainage discharging to recreation reserves is to be taken to a natural water course and discharged in an approved outlet structure or alternatively taken to the nearest trunk stormwater line.

Recreation Reserves

D5.21 TRENCH SUBSOIL DRAINAGE

1. Subsoil Drainage shall be provided in pipe trenches as follows:

   In cases where pipe trenches are backfilled with sand or other pervious material, a 3m length of subsoil drain shall be constructed in the bottom of the trench immediately upstream from each pit or headwall. The subsoil drain shall consist of 100mm diameter agricultural pipes, butt jointed with joints wrapped with hessian, or slotted PVC pipe. The upstream end of the subsoil drain shall be sealed with cement mortar, and the downstream end shall discharge through the wall of the pit or headwall.

DOCUMENTATION

D5.22 DRAWINGS

1. Catchment Area Plans shall be drawn to scales of 1:500, 1:4000 or 1:25000, unless alternative scales are specifically approved by Council and shall show contours, direction of grading of kerb and gutter, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system.

Catchment Areas

2. The Drainage System Layout Plan shall be drawn to a scale of 1:500 and shall show drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system.

Drainage System Layout

3. The plan shall also show all drainage easements, reserves and natural water courses. The plan may be combined with the road layout plan.

4. The Drainage System Longitudinal Section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS 3725 or AS 2032 as appropriate, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.

Longitudinal Section

5. Open Channel Cross Sections shall be drawn to a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be to Australian Height Datum (AHD), unless otherwise approved by Council where AHD is not available. Cross sections may alternatively be provided on floppy disk in HEC2 format as a data input file for the design flow rates.

Open Channels

6. Details including standard and non-standard pits and structures, pit benching, open channel designs and transitions shall be provided on the Drawings to scales appropriate to the type and complexity of the detail being shown.

Details

7. Work-as-Executed Drawings shall be submitted to Council upon completion of the drainage construction and prior to the issue of the subdivision certificate. The detailed Drawings may form the basis of this information, however, any changes must be noted on these Drawings.

Work-as-Executed Drawings

D5.23 EASEMENTS AND AGREEMENTS

1. Evidence of any Deed of Agreement necessary to be entered into as part of the drainage system will need to be submitted prior to any approval of the engineering Drawings. Easements will need to be created prior to the issue of the subdivision certificate.

2. Where an agreement is reached with adjacent landowners to increase flood levels on their property or otherwise adversely affect their property, a letter signed by all the landowners outlining what they have agreed to and witnessed by an independent person shall be submitted prior to any approval of the engineering Drawings.

D5.24 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet providing the minimum information set out in AR&R is required. ***Hydrology***

2. A copy of a Hydraulic Summary Sheet providing the minimum information set out in AR&R is required. ***Hydraulics***

D5.25 COMPUTER PROGRAM FILES AND PROGRAM OUTPUT

1. Computer program output may be provided as long as summary sheets for Hydrological and Hydraulic calculations in accordance with this Specification are provided with plans submitted for checking and with final Drawings.

2. Copies of final computer data files, for both hydrological and hydraulic models shall be provided for Council's data base of flooding and drainage information in formats previously agreed with Council.

SPECIAL REQUIREMENTS

D5.26 FLOOD STUDIES

The subdivision of flood prone land is to comply with the requirements of Council's DCP relating to development on Flood Prone Land (DCPNo.16) and NSW Government's Floodplain Management Manual 2000

D5.27 FLOOD WAYS AND LOW LEVEL STRUCTURES

(a) GENERAL

In situations where the investment required to provide an all-weather crossing cannot be justified, low or intermediate level waterway crossings, may be approved. Such circumstances may include:

1. where the difference between normal water levels and the design flood level is large;

2. floods being of a relatively short duration;

3. where it is necessary to limit the effects of the crossing on natural flood conditions to an acceptable extent. eg: backwater effects.;

4. limited usage and inconvenience from frequent overtopping would be low;

5. flood free alternative access exists;

6. necessity for submergence during debris - carrying flows.

Waterway structures in this category may include:

1. FORD: A permanent stream and water normally flows across the road, ie, vehicles must ford the stream.

2. FLOODWAY: Intermittent stream flows across the road only after period of rain, ie, stream is normally dry (non-perennial watercourse).

3. CAUSEWAY: A permanent stream and flow is normally taken by a bridge or culvert under the road. Water flows across the road (ie, causeway) only during flood periods exceeding the capacity of the culvert or bridge.

4. LOW-LEVEL BRIDGE: Frequently flooded bridge designed for ARI generally less than 20 years.

5. INTERMEDIATE LEVEL BRIDGE: Rarely flooded bridge designed for ARI typically 20 years to less than 100 years.

The predominant design criteria for low-level structures should be safety and structural stability.

The design of such structures where approved should be carried out with reference to the following guidelines:

- 'Guidelines for the Design of Bridges Subject to Submergence'. RTA, 1990
- 'Bridge Waterways, Hydrology & Design'. NAASRA, 1989 .
- `Bridge Design Code', Austroads, 1992.

(b) FLOW OVER ROADS AND STRUCTURES

If, for the design flood, the flooded area is very wide, it may not be appropriate to force the whole discharge through the drainage structure if this would involve too great a change of the natural conditions. Resulting flow along the road approaches, on the upstream side may also cause significant erosion.

In such cases, where traffic is light, flow across the road, with interruption to traffic only during infrequent floods, may be considered.

It is desirable for floodways and causeways to be designed so that the depth of flow over the road (and where applicable, the structure) is as nearly uniform as possible over the flooded length. This assists in avoiding the situation in which vehicles negotiating the floodway encounter an unexpected increase in the depth of water.

Flow over a road embankment or similar feature which is elevated above the surrounding ground must be analysed to ensure that, during the design flood, the total head (static plus velocity) across the highest point on the road carriageway does not exceed 300 mm.

It is necessary to ensure that the crossing as a whole will function satisfactorily at all stages of flooding including intermediate stages of flooding, at the stage when overtopping commences, during the design flood as well as larger floods.

Road embankments shall be stabilised to prevent scouring. The road surface may also be required to be sealed.

(c) CAUSEWAYS

Causeways across perennial watercourses will require the provision of culverts with sufficient capacity to pass the design flow, allowing overtopping to occur during more significant floods.

(d) FORDS

Ford crossings, where circumstances permit, will generally only be permitted on non-public roads serving single allotments. Construction should be of concrete or stabilised packed rock.

(e) FLOODWAYS

Floodway crossings of non-perennial watercourses will generally only be permitted on minor roads. The surface should be at the same level as the natural bed level of the watercourse and will generally be required to be of concrete construction.

Stabilised, packed rock, may be permitted on non-public roads.

(f) SIGNPOSTING

Signposting of waterway crossings shall comply with the requirements of `Signs & Markings' Manual, DMR.

D5.28 VELOCITIES AND SCOUR PROTECTION

Effective measures must be taken to limit outlet velocities and/or provide sufficient protection and energy dissipaters to prevent scouring of receiving waterways.

Guidelines for design methods, acceptable velocities, scour potential and protective measures are provided in the following publications:

1. 'Bridge Waterways' NAASRA, 1989
2. 'Preparing Soil & Water Management Plans' 1990
3. 'Road Design Guide – Section 8' RTA, 1991
4. 'Roadside Stabilisation' Soil Conservation Service, 1982
5. ' MR Form 371A' RTA, 1976 .

APPENDIX D5

1. **DESIGN RAINFALL INTENSITY DIAGRAMS**
   COOMA, NIMMITABEL, BREDBO, NUMERELLA

2. **RUNOFF COEFFICIENTS**

3. **PRESSURE CHANGE COEFFICIENTS (MISSOURI CHARTS 4 AND 5)**

4. **TRANSITION HEAD LOSS**

5. **ROADWAY CAPACITIES – GUTTER FLOW PROFILE 3% CROSSFALL, 150MM, BARRIER KERB**

6. **DESIGN FORM FOR CULVERT CALCULATIONS**

7. **COUNCIL'S STANDARD DRAWING (PLAN C 40) – STANDARD DRAINAGE INLET PIT.**

CONTENTS