Armidale
Regional Council

ENGINEERING CODE
DESIGN SPECIFICATION D5

STORMWATER DRAINAGE DESIGN

(Refer Handbook of Stormwater Drainage Design)

Amendment Record for this Specification Part

This Specification is the Armidale Regional Council version of the AUS-SPEC generic specification D5 and includes Council's primary amendments to the specification.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part D5. 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.	Amendment Code	Author Initials	Amendment Date
1	Major Revision of specifications for adoption by Armidale Regional Council	All	AMO	SPM	25/05/16
2	CCTV inspection requirement added for new infrastructure	D5.22 (9)	A	SPM	16/09/16
3	Class 'D' cast iron pit covers added in new clause	D5.10 (7)	A	MW	30/11/16

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DESIGN SPECIFICATION D5
STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

1. The work included within 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 land use and the characteristics of the catchment.

   (d) The Principles of Water Sensitive Urban Design (WSUD) be incorporated into the design of water quality objectives while minimising Council's maintenance and operations resources.

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). 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

Local Environmental Plan (LEP) - current
Development Control Plan – current
Armidale Dumaresq Council's Stormwater Drainage Strategy
Armidale Dumaresq Council's Flood Study
All Specifications for Design and Construction, including:

C220	-	Stormwater Drainage - General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures
C224	-	Open Drains including Kerb & Gutter

(b) Australian Standards

AS 1254	-	PVC-U pipes and fittings for stormwater and surface water applications.
AS 2032	-	Installation of PVC pipe systems.
AS/NZS 2566.1	-	Buried flexible pipelines - Structural design.
AS 3725	-	Design for installation of buried concrete pipes.
AS 4058	-	Precast concrete pipes (pressure and non-pressure).
AS/NZS 4130	-	Polyethylene (PE) pipes for pressure applications.
AS 4139	-	Fibre reinforced concrete pipes and fittings.
AS/NZS 5065	-	Polyethylene and polypropylene pipes & fittings for drainage and sewerage applications.

(c) State Authorities

RMS, NSW - Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings, 1979.

(d) Other

AUSTROADS - Guide to Road Design - Drainage Set (Refer Parts 5, 5A & 5B).

Inst. of Eng. - Australian Rainfall and Runoff (AR&R) - A guide to flood estimation. Aug 1987. *Engineers Australia is currently revising ARR and once this is finalised, the new ARR shall be used.*

Queensland Urban Drainage Manual (QUDM), Current Version.

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.

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

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

Henderson, FM.Open Channel Flow, 1966.

Chow, Ven Te - Open Channel Hydraulics, 1959.

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

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

NSW OEH - Managing urban stormwater: Soils and Construction.

Australian Runoff Quality (ARQ) 2006 by Engineers Australia – A guide to Water Sensitive Urban Design

Evaluating Options for Water Sensitive Urban Design – A National Guide by Commonwealth Department of the Environment

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

IFD Relationships

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.

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 Armidale Regional Council's current Handbook of Stormwater Drainage Design.

Average Recurrence Intervals

4. Design Average Recurrence Interval (ARI) depend on the zoning of the land being serviced by the drainage system – For design under the "major/minor" concept, the design ARIs to be used are given in Table D5.1 and Table 5.2.

Commercial/Industrial	Residential	Rural Residential	Parks & Reserves
20 years	5 years	5 years	1 year

Table D5.1 - Recurrence intervals for minor systems

Locations/Drainage Types	Minor event
Driveway culvert crossings	ARI 5
Culverts across minor road	ARI $20_{(1)}$
Culverts across major road	ARI 50 to ARI $100_{(1)}$

Table D5.2 - Recurrence intervals for minor events at culvert crossings

(1) Higher ARI of up to ARI 100 may be required if access with the culvert is only access and there are no other flood safe access to service the development.

Major System

5. Recurrence intervals for major system flows for all development types shall be the 100 year ARI.

Easements in Private Property

Blockage Factors

6. In addition, where a development is designed in such a way that the major system flows involve surcharge across private property, 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. Blockage factors as provided for in AR&R should also be accounted for in design. Easements are to be provided in private property over pipe systems and surcharge paths.

D5.05 CATCHMENT AREA

Catchment Definition

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 and possible infill development.

2. Where no detailed survey of the catchment is available, orthophoto maps or other method approved by Council may be used to determine the catchments and to measure areas.

3. Catchment area land-use shall be taken into consideration and shall be based upon current and possible future planning constraints and zonings. The ultimate developed state of each catchment shall be adopted for design.

Future Land Use

4. In urban catchments, it is possible that a greater flow rate may be obtained by applying the Rational Method to the lower part of the catchment with a time of concentration less than the full area travel time. These partial area effects commonly occur when large paved areas are directly connected to the pipe inlet, and the sub-catchment discharge is based on a larger pervious area. Similarly, partial area effects can also occur, where a large open space catchment contributes to an urban catchment, with a time of concentration substantially different to the urban catchment.

Partial Areas

5. In areas where there is a possibility that partial area effects may occur, a partial area check, based on times of concentration of impervious areas directly connected to the pipe system, is necessary. The following situations are known to increase the risk of partial area effects:

- When sub-catchments are not homogeneous in terms of land use;
- When variations of slope or land use occur within a catchment; and
- Catchment shape can sometimes be a cause.

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, acceptable to Council, with experience in hydrologic and hydraulic design.

Qualified Person

3. Coefficients of Run-off shall be calculated as per Volume 1, Chapter 14.5 of AR&R or other Council approved reference. Full details of coefficients used shall be provided.

Runoff Coefficients

4. Details of percentage impervious area and Coefficients of Run-off for specific locations and for individual zonings are given in Council's current Handbook of Stormwater Drainage Design. 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, the flow time of each portion of the flow path shall be calculated separately and then added together to determine the total time of flow.

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. The minimum time of concentration in an urban area shall be 5 minutes.

Max/Min t_c

8. Flow paths to pits shall be representative of the fully developed catchment considering such things as fencing and the likely locations of buildings. These 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 coefficients "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 fully considered, summaries of calculations are provided and details are given of all program input and output. A sample of a summary sheet for hydrological calculations is given in Council's current Handbook of Stormwater Drainage Design.

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. Details on the use of specific programs and additional requirements when using these are given in Council's current Handbook of Stormwater Drainage Design. Electronic data files that may be used in Council's current drainage design software are preferred. Advice from Council's Development Engineer regarding current drainage software should be sought.

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 acceptable to Council, with experience 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 shall be included on the plans and details of all calculations given including listings of all programme input and output. A sample of a summary sheet for hydraulic calculations is given in the Council's current Handbook of Stormwater Drainage Design.

Qualified Person

Calculations

2. The "major" system shall provide fail 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.

(d) 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% Annual Exceedance Probability (AEP) flood level.

4. The water surface in drainage pits shall be limited to 0.15m, below the gutter invert for inlet pits and 0.15m below the underside of the lid for junction pits. ***Water Surface Limits***

D5.09 MINOR SYSTEM CRITERIA

1. The acceptable gutter flow widths in the 20% (AEP) event is 2.5m as a maximum flow width. 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.
- or as determined by Council's Senior Design Engineer and/or Development Engineer

3. Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/sec and 6m/sec respectively with a preferable non-scour maximum velocity of 3m/s. ***Velocity Limits***

4. Where flow velocity in stormwater pipe lines is less than 0.6m/s or greater than 6m/s, alternative designs may be accepted provided hydraulic calculations are submitted to support the design assumptions made. Particular attention will need to be given to sediment build up in the low flow velocity situation. In the high flow velocity situation, scour of the pipe barrel and scour at the outlet will be major design issues to be considered. ***Alternative Designs***

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 D5.3 below: ***Pit Spacing***

Pipe Size (mm)	Spacing (m)
All	75

Table D5.3 - Pit Spacing

4. Kerb inlet lengths to side entry pits are to be a preferred maximum of 2.4m (1.8m opening), with an absolute maximum of 3.0m (2.4m opening) where the grade is 10% or more, and an absolute maximum of 3.6m (3.0m opening) where the grade is less than 10%. Inlet widths may be reduced below 2.4m depending upon the location of the inlet and justification by the designer to show that by pass flows and flow widths are not excessive. ***Kerb Inlet Widths***

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

- Council's current Handbook of Stormwater Drainage Design.

- Roads and Maritime Service'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 and/or QUDM.

6. The percentage of theoretical capacity allowed with respect to type of pit is given in Table D5.4. Also refer to AR&R Report No. 11 - Blockage of Hydraulic Structures and QUDM.

Allowance for Inlet Blockage

7. All new stormwater junction pits shall be installed with cast ductile iron covers with concrete surrounds. Lids shall have stormwater marked on the cover. All covers shall be Class D for vehicle trafficable and non vehicle trafficable areas. Class B covers shall not be permitted.

Cast Iron Class 'D' Covers Only

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"	80%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%

Table D5.4 - Allowable Pit Capacities

D5.11 HYDRAULIC LOSSES

1. The pressure change coefficient K_e shall be determined from the appropriate charts referenced in Council's current Handbook of Stormwater Drainage Design but are available in full from Appendix 2 'Structure Pressure Change Coefficient Charts' within the Queensland Urban Drainage Design Manual (QUDM).

Pit Losses, K_e

2. Allowable reduction in K_e due to benching is referenced in Council's current Handbook of Stormwater Drainage Design but are available in full from Appendix 2 'Structure Pressure Change Coefficient Charts' within the Queensland Urban Drainage Design Manual (QUDM).

Benching

3. Computer program default pressure change coefficient K_e shall not be acceptable unless they are consistent with those from the charts referenced in Council's current Handbook of Stormwater Drainage Design. The chart used and relevant coefficients for determining K_e value from that chart shall be noted on the hydraulic summary sheet provided for plan checking and included on the final design drawings.

Default Ke

4. Bends may be permissible in certain circumstances however approval from Council's nominated engineer regarding their use is required prior to detailed design. Appropriate values of pit pressure change co-efficient at bends are referenced in Council's current Handbook of Stormwater Drainage Design but are available in full from Appendix 2 'Structure Pressure Change Coefficient Charts' within the Queensland Urban Drainage Design Manual (QUDM).

Bend Losses

5. Pipeline design shall avoid clashes between services. Services passing through stormwater pipelines is not permitted under any circumstances.

Pipe line Clashes

6. An approval under Section 68 of the NSW Local Government Act is required for connection to a Council drainage system. Requirements for private pipes entering Council's system are given below:- *Section 68 Approval*

(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) For minor system stormwater lines, side lines connecting greater than 150mm diameter will require a junction pit to be installed. *Junction Pit*

(c) For minor system stormwater lines, 100mm and 150mm diameter pipe lines shall be connected to the main pipe using an approved proprietary saddle connection device. If the main pipe being broken into is a RCP, the hole is to be cored or drilled to break out and all cut surfaces sealed with a proprietary epoxy product to prevent corrosion of the steel reinforcement. The side line pipe must not protrude into the barrel of the pipe. *Saddle Connection*

(d) For interallotment drainage lines where connection to a pit is not available, house drainage pipes may be connected to the line via a proprietary connection device manufactured for the pipe product utilised,.

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. Where this is unavoidable the pressure change coefficients K_u, for the upstream pipe and K_l, for the lateral pipe, shall be determined from the charts given in Appendix 2 'Structure Pressure Change Coefficient Charts' within the Queensland Urban Drainage Design Manual (QUDM). *Pipe Junction Losses, K_u & K_l*

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 expansions and contractions are given in Appendix 2 'Structure Pressure Change Coefficient Charts' within the Queensland Urban Drainage Design Manual (QUDM). *Contraction/ Expansion 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 shall be determined in accordance with Manning's 'n'. *Pipe Friction Losses*

D5.12 MAJOR SYSTEM CRITERIA

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

(a) Surcharging of drainage system for storm frequencies greater than 5% (AEP) 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.

(c) Surcharge flooding across footpaths and within roadways will only be permitted in situations where floodwaters can drain away readily and do not cause long term inundation of the roadway or footpath areas. In general this should only be for the duration of the rainfall event or as an absolute maximum up to one hour after rainfall has ceased. *Inundation Limit*

2. The velocity x depth product of flow across the footpath and within the road reserve shall be such that the safety of children and vehicles is ensured. The maximum allowable depth of water is 0.2m and the maximum velocity x depth product of 0.4m^2/s is *Velocity/ Depth Criteria*

permitted. Where only the safety of vehicles may 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 alternatively the design shall address the requirements for safety in relation to children by providing safe egress points from the channel.

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

Generally:-

(a) Minimum freeboard of 500mm, unless directed otherwise by Council policy and/or by Council's delegated engineer, shall be provided between the 100 year flood level and floor levels on habitable 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, an 80mm freeboard shall be provided between the ponding level of water in the road and the high point in the footpath. Driveway construction needs to consider this requirement in these instances.

4. Road capacity charts are provided in the Council's current Handbook of Stormwater Drainage Design 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 1987. ***Roadway Capacities***

D5.13 OPEN CHANNELS

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, the channel shall comply with the requirements of this Specification. ***Safety***

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 plus minimum 150mm freeboard.

3. Friction losses in open channels shall be determined using Manning's 'n' values given below: ***Channel Roughness***

Manning's 'n' Roughness Coefficients for open channels shall generally be derived from information in Chapter 14 of AR&R. Manning's 'n' values applicable to specific channel types are as follows:

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.

V x d > 0.4m²/s

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

Side Slopes

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 a concrete lined channel section shall be the width of the drain invert or at least of sufficient width to accommodate the full width of a tractor.

Low Flows

Channel Width

7. Transition in channel slopes to be designed to avoid or to accommodate any hydraulic jumps due to the nature of the transition. If a hydraulic jump can not be avoided, its location shall be determined and anti scour beaching shall be provided in the area of high turbulence.

Hydraulic Jumps

D5.14 MAJOR STRUCTURES

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.

Afflux

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.

Freeboard at Structures

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 Specification D3 ‘Structures Bridge Design’ and Austroads Design Guidelines.

4. Culverts (either pipe or box section) shall be designed in accordance with charts provided and/or referenced in Council's current Handbook of Stormwater Drainage Design, with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

Culverts

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 a 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. Referral to the NSW Dam Safety Committee also may be required.

High Level Outlet

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

6. Wherever practical and in areas known to be affected by high water tables and/or salinity of groundwater, retarding basins shall be designed to be water retentive so that surface drainage water does not leak to the subsurface, recharging groundwater. ***Salinity Prevention***

7. 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. Other services and/or conduits will not be permitted through or across the footprint of the basin wall. Geotechnical engineering assessment and approval will be required for any proposed adjacent underground services. ***Low Flow Provision*** ***Minimise Seepage***

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

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

10. Public Safety Issues - Basin design is to consider the following aspects relating to public safety (refer Handbook of Stormwater Drainage Design): ***Safety Issues***

- 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 a hazard.
- Basins shall be designed so that no ponding of water occurs over 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 their submission.

STORMWATER DETENTION

D5.16 STORMWATER DETENTION (refer Handbook of Stormwater Drainage Design)

1. Installation of Stormwater Detention is required on redevelopment sites within the region where under capacity drainage systems exist. A redevelopment site is defined as a site which previously had or was originally zoned to have a lower density development than currently proposed. ***Re-development***

2. Location of basins for stormwater detention, stormwater treatment or sediment control purposes shall avoid areas that are known to be permanent or seasonal groundwater discharge areas. This action reduces the likelihood of recharge into the groundwater. ***Salinity Prevention***

3. The requirements for Stormwater Detention Design are outlined in the Council's current Handbook of Stormwater Drainage Design.

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

Allotment Drainage

1. Interallotment Drainage shall be provided for every allotment which does not drain directly to its frontage street or to existing piped infrastructure of adequate capacity to accept additional flow, or to a natural watercourse. Where possible, interallotment drainage shall drain to the underground stormwater pipe system and not directly to the street.

Easements

2. The alignment of a common inter-allotment drainage pipeline is to be at least 1m from an allotment boundary line and contained within a 2m (minimum) wide easement. Where water from a public road/reserve is to be discharged through the system, these dimensions are to be increased to 1.5m and 3m (minimum) respectively. A wider easement may be required to contain overland flow or for larger or deep pipelines. Consideration will be given to reduce the width of the easement in constrained sites to not less than 1.5m for pipe sizes 225mm and smaller. Combined easements with sewers shall be a minimum of 3m wide but may require widening for deep sewers.

3. Interallotment drainage (overland flow path and underground pipe) is to be contained within an easement, provided in favour of the upstream allotments, with Council as the Authority empowered to vary, modify or release the easement and Section 88b instrument.

Surcharge Flows

4. 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. (Refer Section D5.04, Table D5.1and Section D5.09). Drainage lines shall be designed with an ARI of 5 years over the entire lot area assuming full development of the catchment. Provision should also be made for the escape of surcharge runoff from ARIs above the minor flow regime up to the major storm event i.e. the 100 year ARI. This can be achieved through the use of driveways to the roadway system or through open swales within the drainage easement that discharge to main overland drainage systems.

Plans to Show OFP

5. All stormwater designs are to accommodate the major flows in excess of the piped drainage system capacity, up to 1 % AEP event. The design plans are to indicate the location and extent of all overland flow paths (OFP) required for such flows.

Impervious Area

6. In lieu of more detailed analysis, the following minimum areas of impervious surface are assumed to contribute runoff to the interallotment drain:

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

Grated Inlet Pits

7. Each lot served by an inter-allotment drainage line shall be provided with at least one grated inlet pit to permit the inlet of surface water. From the wall of the pit a 150mm junction is to be left for the connection of roof water. The connection by the plumber of roof water to this point is to be supervised by Council's Building Inspector. Pipes shall be designed to flow full at the design discharge without surcharging of inspection pits.

Pits & Lids

8. 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. Pre-cast pits require the approval of Council's delegated engineer. Pits shall be with a 100mm concrete lid finished flush with the surface of works. Depressed grated inlets are acceptable.

Grade

9. Pipes - Minimum Grade - The interallotment drainage shall have a minimum longitudinal gradient of 1.0%.

Pipe Type

10. 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, PE pipe, or UPVC pipe which shall conform to the requirements of the relevant Australian Standard. In public road and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only, shall be used. Half pipes shall not be permitted for interallotment drainage.

Half Pipes

Sewer

11. Interallotment Drainage Pipe - Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other the interallotment drainage pipe shall be located closest to the boundary of the lot.

12. Where there is a disparity in level between inverts the spacing is to be submitted for approval. A minimum clearance of 200mm between the outside surfaces of the conduits is required and bridging designs may be requested by Council's engineer.

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

Pipe Size

14. The minimum pipe size for the provision of interallotment drainage shall be 150mm diameter with a maximum of 2 lots connected where there is no further potential for subdivision/development. Thereafter the minimum size pipe is to be 225mm diameter.

Marked Sewers

15. Approved marker tape is to be laid above all sewer mains laid adjacent to interallotment stormwater drainage lines.

Maintenance Responsibility

16. Inter-allotment drainage systems are intended to collect both roof water and surface water and shall be maintained by the property owners benefiting from the system, not by Council.

Registered Surveyor

17. Prior to the issue of an Occupation/ Subdivision Certificate, the developer shall submit certification from a registered surveyor stating that all pipes, pits and associated structures are constructed wholly within their respective easements.

Building Near Drainage Lines

18. Council will not approve the construction of any permanent structure or the placing of filling over a piped drainage system or easement that may prevent or hamper constructing or maintaining pipelines or easement infrastructure. Permanent structures include habitable dwellings, eaves & balconies, garages, sheds, swimming pools and retaining walls. Consideration may be given to overhang a piped drainage system or easement subject to the provision of an overland flow path with a minimum clearance of 3m across the natural ground surface. Footings of structures outside the easement or piped drainage system but within the zone of influence shall be extended to transfer load to outside or below the zone on influence (refer to Fig 5.1).

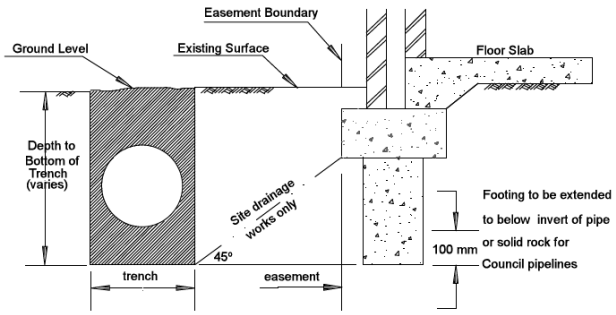


Fig D5.1 – Building near drainage lines

DETAILED DESIGN

D5.18 PIPES AND CULVERTS

1. Pipes and culverts and materials shall be in accordance with the following requirements: ***Materials***

- Steel reinforced concrete pipe shall have been manufactured and tested for quality AS4058:2007 Precast concrete pipes (pressure and non-pressure). They shall have spigot and socket joint with rubber ring. Flush or butt joints shall not be used. ***RCP***

- Polypropylene Pipe with ribbed profile such as StormPRO and BlackMAX may be used where vehicular loading is not likely and shall have minimum cover of 600mm. Polypropylene Pipe shall not be used within road reserves. ***Poly Pipe***

- Fibre reinforced concrete pipe shall comply with AS 4139. They shall have spigot and socket (or collar) double V-ring joints. Butt joints or single V-ring joints shall not be used ***FRC Pipe***

- Minimum pipe sizes shall be in accordance with clause 5.09(2).

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 and PE pipes, the requirements shall be to the relevant Australian Standard. ***Bedding and Cover***

3. Pipe and culvert jointing shall be in accordance with the relevant Australian Standard and Council's Specifications. ***Jointing***

4. Drainage lines in road reserves shall generally be located behind the kerb line and parallel to the kerb or as approved by Council's delegated engineer. Drainage lines in easements shall generally be centrally located centrally within the easements. ***Location***

5. The minimum grade of any pipe shall be 1 %, unless otherwise approved by Council ***Pipe Grade***

6. Pipelines crossing roads shall generally be at 90 degrees to the centreline except where such an arrangement will have a substantive impact on the hydraulic grade line of the main pipeline. Pipelines within road reserves shall generally be under and parallel to the kerb have a minimum cover of 900mm to allow other services over the pipe. ***In Road Reserves***

7. Pipe culverts design shall be in accordance with the procedures contained in Section 3 of the Concrete Pipe Association of Australia's publication: "Hydraulics of Precast Concrete Conduits Hydraulic Design Manual". ***Pipe Design Procedures***

8. The minimum grade of any pipe shall be 1 %, unless otherwise approved by Council

9. Pipe lines across the splay corner at an intersection shall be avoided. Incorporating junction pits at an intersection for changes of direction is the preferred layout method as illustrated in Fig D5.2. ***Pit Layout***

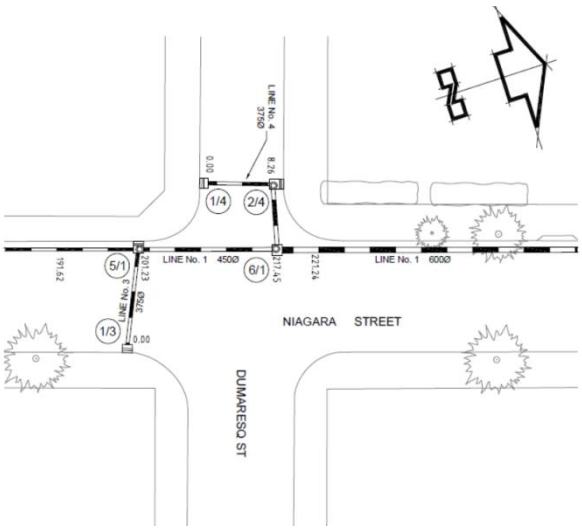


Fig D5.2 – Typical pit layout at cross intersection

D5.19 PIT DESIGN

1. Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding. Typical pit designs and other pit design requirements are included in Council's current Handbook of Stormwater Drainage 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. Lists of the Standards or Codes relevant to pit designs are included in Council's current Handbook for Drainage Design and can be referenced in Council Standard drawings.

2. The following design criterion shall be adopted in the positioning of drainage pits:

- Pit spacing shall be in accordance with Clause 5.10(3)

- The location of gully pits on curves is to be avoided and they are not to be placed in line with the normal passage of pedestrians. Where curves can not be avoided, the pit lintel shall be formed to match the curve and the kerb shall follow the true alignment of the curve radius.

Pits on curves

- Pits which are located on curves shall be designed to have a lintel length not exceeding 1.8m (1.2m preferred).

- Changes in diameter should be graded obvert to obvert.

- Where the depth of the pit exceeds 1.2 metres, standard galvanised or other approved step-irons are to be provided as per the standard drawing.

Step Irons

- All inlet pits shall be constructed using welded steel "Weldlok" type or equivalent grates with appropriate skirts. Grates in pathways shall be "bicycle safe" to avoid tyres entering grate, to the manufacturer's recommendations. Class B type grates may be utilised in parks and reserves. Class D type grate shall be utilised in roads.

Grates

Avoid flat Crossfalls

- Ensure inlet pits at the road intersections are located such that the road cross fall will ensure gutter flows are directed to the inlet pit. Flattening road crossfalls at intersections can cause high gutter flows to flatten and spread causing the inlet pit to be bypassed.

D5.20 STORMWATER DISCHARGE

Salinity Prevention

1. Deleted as no known salinity areas within Armidale Regional Council.

Scour Protection

2. Scour protection at culvert or pipe system outlets shall be constructed in accordance with RMS, Austroads Design Guidelines, NSW 'Managing Urban Stormwater: Soils 7 Construction Guidelines' or as required by Council's delegated engineer.

Kerb & Gutter Termination

3. Kerb and gutter shall be extended to drainage pit or natural point of outlet. Where outlet velocity is greater than 2.0m/s or where the kerb and gutter discharge causes scour, protection shall be provided to prevent scour and dissipate the flow.

Easements, Adjoining Owners

4. At points of discharge of gutters or stormwater drainage lines or at any concentration of stormwater from one property 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). The Deed shall grant permission for 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

5. Where drainage is to discharge to an area under the control of a Federal Government, State Government or Statutory Authority e.g., RMS, the design requirements of that Authority are also to be met.

Council Easement

6. The minimum drainage easement width shall be 3.0m for drainage systems to be taken over by Council. The overall width of the easement in Council's favour must consider the underground drainage system location, size and depth and must contain the full width of overland flow and/or open channel flow in the major system design event. Maintenance access and adjacent infrastructure and structures (including fencing) must be considered.

Recreation Reserves

7. 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.

D5.21 TRENCH SUBSOIL DRAINAGE

1. Subsoil Drainage shall be provided in pipe trenches 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

Pipe Type

2. The subsoil drain shall consist of 100mm diameter slotted PVC pipe and geotextile sock. 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

Catchment Area Plans

1. Catchment Area Plans shall be drawn to approved by scales of 1:500, 1:4000 or 1:25000, unless alternative scales are specifically approved by Council's delegated engineer. The plans 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.

Drainage System Layout

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. For small catchments plans may be drawn to scales of 1:100, 1:200 or 1:250.

3. The plans shall also show all drainage easements, reserves and natural water courses. The plans may be combined with the road layout plan provided the plans do not appear crowded and detail is readily identified.

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, pipe capacity and velocity of flow in accordance with the relevant Australian Standard, 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, HGL

5. Open Channel Cross Sections shall be drawn to a natural scale of 1:100 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.

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. A structural engineer's certification may be required, as determined by Council's delegated engineer.

Details

7. Work as executed drawings (WAE drawings) shall be submitted to Council upon completion of the drainage construction and prior to the issue of the Subdivision Certificate or Occupation Certificate, as determined by Council's delegated engineer. The detailed Drawings may form the basis of this information however, any changes must be noted on these Drawings. WAE drawings shall be presented with mark ups in red where deviations from the approved plans have been made and shall also be presented as clean copies with the amendments incorporated in the final WAE plans. The requirements for Work-As-Executed Drawings are provided in Sections D1.06 and C101.11 of this specification and shall be provided in electronic digital format and hard copy drawings until 1 March 2017. After this date only electronic format in the form stipulated by Council will be accepted by Council for compliance with this clause

Work-as-Executed Drawings

8. Longitudinal sections of drainage lines shall identify all existing services and all proposed services and possible conflicts. The services shall be clearly identified but shall be in a lighter line type than the drainage longitudinal section details. Care shall be exercised not to crowd the drawing to ensure that the main subject of the drawing can be clearly identified.

Services Identified

9. CCTV inspection, including the provision of a detailed certified report and DVD by an appropriately qualified and experienced person, is required on newly constructed stormwater lines at the developers cost.

CCTV Inspection

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 operational Development Consent being issued. Easements will need to be created prior to the issue of the Development Consent. A deferred commencement Development Consent may be issued with the provision that any easements and/or agreements are finalise before the consent can become operational. Also see clause D5.17(16)

Refer D5.17(16)

Deferred Commence-ment

2. Where an agreement is reached with adjacent landowners to increase flood levels over 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 Council's current Handbook of Stormwater Drainage Design is required. Electronic data files for Council's current drainage software are required.

Hydrology

Hydraulics

2. A copy of a Hydraulic Summary Sheet providing the minimum information set out in Council's current Handbook of Stormwater Drainage Design is required. Electronic data files for Council's current drainage software is required

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 agreed with Council.

SPECIAL REQUIREMENTS

D5.26 PERMIT TO ENTER TO DISCHARGE STORMWATER/CONSTRUCT

Permit Required

1. Where it is proposed to divert, direct or intensify the flow of stormwater into adjoining property, a 'Permit to Discharge Stormwater' shall be sought and shall be submitted to Council prior to the approval of the Development Consent. The above shall apply unless otherwise specified by Council. A permit shall also be sought to carry out construction work on adjoining property and shall be presented to Council prior to the issue of a Construction Certificate for the works.

D5.27 CONCRETE BULKHEADS

Bulkheads

1. Bulkheads shall be designed on drainage lines where the pipe gradient exceeds 15 %. The design details shall address the size, and position in the trench as well as spacing along the line. (Refer to Table D5.5)

Trench Stops

2. Pipes laid on grades between 7.5% and 15% shall require the provision of trench stops. (Refer to Table D5.5)

Concrete Bulkheads

3. Concrete bulkheads shall be constructed on stormwater lines with a grade steeper than 15% at 7.5m intervals. Reinforced concrete pipes of 2.44 metre length and laid steeper than 15% shall have bulkheads placed at every third joint (i.e. 7.32m intervals).

Drainage Through Bulkheads

4. The axis of the bulkhead shall be vertical with a minimum top width of 150mm. The top of the bulkhead shall extend to within 300mm of finished surface level or to the subgrade level where the pipeline is within a road pavement. On each side of the pipe at the level of the trench invert, 100mm diameter pipes shall pass through the bulkhead to allow free draining of the trench. Such pipes shall be filled with fibreglass wool or other approved filter material or a capped 1.5m length of sub-soil drainage line.

Grade (%)	Requirements	Spacing S (m)
7.5 to 14	Trench stop	S = 100/Grade (%)
15 to 29	Concrete bulkhead	S = L/Grade % where L = 80 x Pipe length$_{(1)}$ (450 m max). Where L>100m use intermediate trench stops at spacing <100/Grade %
30 to 50	Concrete encasement (continuous) & concrete bulkheads	S = 100/Grade (%)
Over 50	Special Design is required	

Note: (1) Pipe length is the standard pipe length installed.

Table D5.5 - Requirements for Bulkheads and Trench stops

D5.28 WATER QUALITY OUTCOMES

'MUSIC' Software

1. Water Quality Outcomes can be sourced from Queensland 'Healthy Waterways Water-By-Design' documentation and the 'Water Sensitive Urban Design Technical Design Guidelines for South East Queensland'. The use of 'MUSIC' software and the adoption of NSW EPA water quality targets can provide valuable guidance in achieving environmentally sensitive stormwater management designs. Care must be exercised in the assessment of MUSIC as the results can be manipulated to desired outcomes for certain development works.

D5.29 BURIED FLEXIBLE DRAINAGE PIPES

1. Particular situations may be identified during the design of a development for the use of buried flexible pipes instead of the pipes specified in Council's Handbook or Specification C221 PIPE DRAINAGE.

2. In such cases, the 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 to Council as a variation to the development consent, for approval by Council's Senior Design Engineer. If use is approved, then the supply and construction specification clauses shall be inserted in the Special Requirements section of Specification C221 PIPE DRAINAGE.

D5.30 FLOOD ROUTING

1. Information and advice dealing with flooding from natural watercourses including Dumaresq Creek, Martin's Gully, Black Gully and Yoogoonda Gully, is available in Council's Policy 038 – Armidale Floodplain Management Policy, Clause 6.2 of Council's LEP and NSW Floodplain Development Manual (April 2005) which was prepared for the management of flood liable land in accordance with Section 733 of the Local Government Act 1993.

Major Drainage System

2. A major drainage system shall be a permanently unobstructed and failsafe, above ground floodway for the drainage of roads and interallotment drainage. Interallotment drainage systems do not always require a defined above ground floodway, however a flow path should be identified and protected by an easement. A major system overland flow path catering for more than five (5) properties shall generally be contained within road reserves, pathways, parks and other reserves. If this is not practical or possible, the overland flow path shall be shaped to contain stormwater for up to 1% AEP with a suitable freeboard (300mm) and measures to protect the flow path for its designed operation shall be provided with the design documents.

3. Development in the downstream catchment shall not obstruct flows from the upstream catchment. Sheet flow from undeveloped/unimproved parts of the upstream properties shall be permitted to flow through downstream properties. However, proposed drainage systems must not cause nuisance to neighbouring properties or downstream land.

4. Both major and minor systems shall discharge to a Council approved (natural or engineered) receiving drainage system. If the receiving drainage system does not have adequate capacity to cater for additional development generated stormwater flows, some form of retarding or detention system must be provided to limit discharge flow rates to pre-development flow rates.

5. The parameters and techniques for flow estimation in urban catchments, as set out in this code, generally refer to the Rational Method. However, depending on catchment size and characteristics, it may be more appropriate to use a Unit Hydrograph

or Nonlinear Run-Off Routing Model for flow estimation. The advantages and disadvantages of Unit Hydrographs are explained in detail in Australian Rainfall and Runoff (AR&R). It is the responsibility of the Design Engineer to determine the most appropriate methodology for each application. Various drainage tools, proprietary software and construction methods are available to the Design Engineer to achieve a best practice design. Regardless of the technique or method used, detailed documentation shall be submitted to Council for assessment and approval.

D5.31 ROOF AND PROPERTY DRAINAGE

AS3500.3

1. Roof and property drainage shall be designed and constructed in accordance with AS3500.3. Any household stormwater pipe required to cross a footpath must be a minimum pressure Class 12, 100mm diameter pipe with kerb adaptor in the case of single or dual occupancy development.

No Pump Out

2. Pump- out systems are not acceptable in any urban location.

3. The preferred means of stormwater drainage from development sites areas is through a gravity system directing stormwater to an approved receiving system (e.g. natural watercourse, Council drain, road reserve or inter-allotment drainage).

Alternative Disposal

4. Alternative disposal systems such as on-site absorption and charged line systems are not encouraged but may be permitted in exceptional circumstances in accordance with sections D5.32 and D5.33 of this specification.

D5.32 ON-SITE ABSORPTION SYSTEMS

<50m^2 Increase in Impervious Area

1. On-site absorption systems are generally not supported for stormwater disposal and will only be considered for Class 10a buildings under the Building Code of Australia or minor extension of existing dwellings or commercial or industrial development where the total increase in impervious area is less than 50m^2.

2. On-site absorption systems will only be considered where it can be unequivocally demonstrated that an interallotment drainage easement cannot be provided.

Rural Zones

3. For development in rural zones (e.g. R5 Large Residential, RU1 Primary Production, RU4 Primary Production Small Lots) or environment protection (E3 Environmental manage and E4 Environmental Living) where size of the lots are larger than 1 hectare, on site absorption may be considered.

Geotechnical Information and Design

4. A design and supporting calculations, prepared by a suitably qualified and experienced engineer, of a stormwater management system that will handle runoff from any storm up to the 1% ARI event must be supplied by the applicant with the development application. This shall include any geotechnical information in support of the design, an assessment of the infiltration of the soil profile, consideration of antecedent moisture conditions and performance over a variety of rainfall events. The design shall be accompanied by a geotechnical report attesting to the absorption capacity of the system and which demonstrates that the proposal will have no adverse impact on adjoining and/or downstream properties.

5m Buffer

5. Any on-site absorption structures shall be located as far as possible from the downstream property boundaries and buildings but shall be a minimum of 5.0m.

D5.33 CHARGED LINE SYSTEMS

Inverted Siphon

1. A Charged Line System (Inverted Syphon) is a sealed pipe system which conveys stormwater from roof guttering under gravity pressure head, where the outlet to an approved drainage system is above the level of the site. Charged line systems will only be considered under exceptional circumstances where no other option is available for stormwater disposal.

2. Charged line systems will only be considered for a single residential dwelling and associated Class 10a buildings under the Building Code of Australia, or alterations and additions to existing small commercial/industrial buildings.

3. Charged line systems will only be considered where it can be unequivocally demonstrated that an interallotment drainage easement cannot be provided.

4. A charged line systems must be completely watertight from the roof gutter inlet to the outlet at street level, with a capped inspection/cleaning opening (IO) at the lowest point of the stormwater system.

Must be Watertight

5. All gutters and pipes in the system shall be designed for a 1 % ARI storm event.

6. The minimum difference in height between the roof gutter and the street gutter shall be 1.5 metres.

1.5m Minimum Head

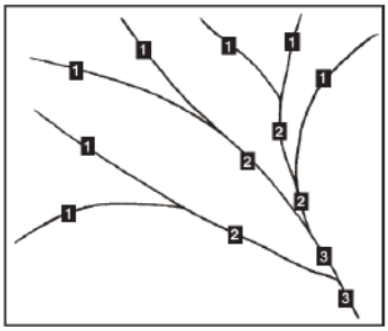
7. Gutter guards must be installed on all gutters to minimise debris entering the system.

8. Full details of the system must be submitted with the Development Application.

D5.34 STORMWATER SYSTEMS NEAR NATURAL WATERCOURSES

1. Any works undertaken near or in a natural watercourse, for which the works are considered a 'Controlled Activity', as defined under the Water Management Act and Regulation, must make application to the NSW Office of Water to undertake the work. The Office of Water recommends a Vegetated Riparian Zone (VRZ) width based on watercourse order as classified under the Strahler System of ordering watercourses (see Fig 5.2) and using current 1:25 000 topographic maps. The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.

Controlled Activity



Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Strahler System for Stream Ordering

Fig D5.2 – Strahler System of ordering watercourses and VRC widths

2. Any existing native vegetation along a natural watercourse shall be retained within the riparian zone during the development of a site and should be considered in the initial design stages.

3. Riparian vegetation shall be protected by fencing to avoid damage from machines during development. Any noxious weeds should be removed.

4. Where little or no riparian vegetation remain, it should be re-established within the riparian zone.

5. Sufficient on-going weed management at the site will be required until indigenous vegetation is re-established. This is usually required for a minimum of 3 years. Maintenance must be included in the overall costs of the project and be detailed in a plan of the proposed works that must be approved by Council prior to commencement of works.

3 Year Maintenance Period

D5.35 ON SITE DETENTION SYSTEMS

1. On-site stormwater detention is used to capture and temporarily store and slowly release stormwater to an approved point of discharge at the pre-development flows from the site.

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

3. On-site detention system should not be installed in flood- prone areas and areas under Probable Maximum Flood as defined in Council's Flood Study. ***Not in Flood Areas***

4. The ongoing maintenance and operation of a site OSD System is the responsibility of the land owner, and shall be subject to Positive Covenants and restrictions on Land Title(s) to ensure compliance. Prior approval from Council is required if on-site detention systems are proposed in land to be maintained by Council, whether existing or proposed. ***Covenants***

5. In single and dual occupancy development stormwater detention systems are required where the proposed impervious area on the site exceeds 50% of the total site area and where the capacity of the existing downstream stormwater drainage system will be exceeded (to surcharge conditions) by the addition of any flows from the proposed development. ***Small Residential***

6. Multi-unit, Commercial and Industrial Development stormwater detention systems are required where the proposed impervious area on the site exceeds 35% of the total site area and where the capacity of the existing downstream stormwater drainage system will be exceeded (to surcharge conditions) by the addition of any flows from the proposed development. ***Multi Unit Residential, Commercial, Industrial***

7. On-Site Detention systems shall be designed to restrict the flows to pre-development flows for all storm durations and frequencies in the range from the 5 year ARI up to and including the 20 year ARI events. An overflow weir shall be designed into the stormwater detention system to allow flows in excess of the 20 year ARI to be released safely to a legal point of discharge. ***Restriction of Flows***

8. The maximum depth/volume or location of detention systems shall be such that they are not required to meet the requirements described by the Australian National Committee on Large Dams (ANCOLD). ***No Large Dams***

D5.36 DEVELOPMENT CONTROLS ON FLOOD PRONE LAND

1. This clause applies to all development on flood prone land within Armidale Regional Council and shall be read in conjunction with the NSW Government Floodplain Development Manual (2005), the NSW Government Guideline on development controls on low risk areas—Floodplain Development Manual (2007), Clause 6.2 of Council's Local Environment Plan (LEP) and Council's Policy 038 – Armidale Floodplain Management Policy. ***Reference Documents***

2. The NSW Floodplain manual defines flood prone land as land susceptible to flooding by the Probable Maximum Flood (PMF) event. Council's current LEP adopts the 1% AEP (100 years ARI) flood levels plus 0.5 m as the Flood Planning Level (FPL) for Armidale. Council's current flood studies define the extent of FPL for four major creeks Dumaresq Creek, Martins Gully, Black Gully and Yoogoonda Gully within the urban area. If development is proposed near any water course for which Council has not undertaken flood study for, hydrology and hydraulic assessment of the water course may be required to satisfy that the proposed development is above FPL. ***Four Major Creeks***

3. Residential development is not subject to flood related development control in the area of flood prone land above the FPL (also know as low risk areas). However, Council may restrict certain types of development vulnerable to emergency response, e.g. aged care in low risk areas. It may also restrict development of critical emergency response and recovery facilities and infrastructure e.g. evacuation centres and routes, hospitals and major utility facilities in low risk areas.

Restriction to Development Types

D5.37 STORMWATER POLLUTION CONTROL

1. Armidale Regional Council is committed to the principles of improving the quality of stormwater discharge into natural water courses from development within the catchment, through education and the installation of devices to remove pollutants from stormwater.

2. Stormwater pollution typically is composed of:

Typical Pollutants

- Litter, cigarette butts, cans, paper and plastic bags;
- Chemical pollution including detergents, oils and fertilizers;
- Natural pollution including as leaves, garden clippings and animal droppings;
- Sediment pollution including soil erosion silt and runoff from building sites and unsealed roads.

3. The quantity and severity of stormwater pollution is affected by:

Pollution Severity

- The last rain and the intensity of the rainfall
- Building density and other land uses in the catchment area
- Level of vegetation cover
- The cleanliness of the streets
- Local practices, including street sweeping, pet control, garden watering and chemical use

4. Council's stormwater management policy states that all stormwater outlets to natural gullies and water courses in the urban area, shall have a Gross Pollutant Trap (GPT), installed at or near the outlet of the stormwater pipe system. All new urban subdivision shall comply with the policy.

Provision of GPTs

5. Where a new urban subdivision connects to the existing Council stormwater reticulation system, a device will not be required unless there are specific site conditions which warrant provision.

6. GPT's are not required in large lot rural subdivisions as pollution generation is considered low due to the low density of housing.

GPTs not on Rural Subdivisions

7. GPTs are also required for any commercial, industrial or institutional development which requires more than 25 parking spaces. All other development will not require GPT unless particular use or location warrants provision. It is the responsibility of the owner to maintain GPTs when installed on private property. A GPT maintenance plan shall be included in the overall management plan of the facilities

GPTs Required for >25 Car Spaces

8. GPT devices are to be designed as part of the stormwater pipe system. The nominated device will be assessed by Council to determine its suitability for the site, its effectiveness and ease of maintenance.

9. Devices shall typically take the form of a pit device that can be maintained by the removal of a basket or cleaned by educter truck.

10. In the absence of other design criteria from other regulatory authorities, GPT devices shall be designed to:

GPT Design Criteria

- Be designed for the 1 in 1 year first flush from the catchment;
- Capture 75% of sediments 0.04mm and larger;
- Adopt a velocity criterion with a peak average velocity of 0.3m/s during the 1 in 1 year storm. Velocity through the GPT should be minimised to inhibit the re-suspension of deposited particles;
- Have a minimum capacity to accommodate 3 months pollutant discharge from the catchment;
- Consider the impact on the hydraulic performance of the pipe line at its design flow;
- Be designed such that the GPT can be readily accessed by a large rigid truck for maintenance;
- Preference is for the installation of devices with removable baskets to minimise maintenance costs. Alternate device styles may be considered on merit;
- At sites where it is impractical to install a GPT to meet Council requirements, the installation of a trash rack on the outlet may be a suitable alternative.

11. Trash racks shall be designed In accordance with the following requirements:

Trash Rack Design Criteria

- The outlet pipe can discharge at its full design capacity even if the trash rack is fully blocked;
- The rack acts as a critical flow control and should be designed accordingly;
- The trash rack height should be double the expected maximum critical flow depth through an unblocked trash rack during a 1 in 1 year storm. This depth provides capacity for efficient operation during partial blockage but is not so high that it will cause excessive impoundment of stormwater, which compounds the risk of flooding;
- A generous clear depth is also recommended above the rack to ensure the trap discharges flow efficiently, even if the rack is completely blocked, avoiding surcharges at pits upstream of the rack;
- A 50mm to 65mm spacing between bars will ensure that drink cans and larger objects are collected, although small objects can become entangled in the accumulated litter;
- The trap should be capable of gravity drainage to a dry condition for cleaning and maintenance; and
- All exposed metal components are to be hot dip galvanised.

12. For all GPT or trash rack devices, calculations associated with the design shall be submitted to Council for assessment for approval.

13. All building and civil construction works shall have an Erosion and Sediment Control Plan (E&SCP) prepared specifically for the works to be undertaken on the site. The E&SCP shall be designed in accordance specification D6 EROSION CONTROL AND STORMWATER MANAGEMENT and shall form part of the design plans for the development.

E&SC Plans

14. The E&SCP shall include control of rubbish on the site, dealing with minor and major stormwater events during construction, devices to be employed and maintenance schedules.

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