TWEED SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

VERSION 1.4

SPECIFICATION D5 – STORMWATER DRAINAGE DESIGN

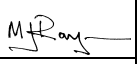
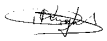
CITATION

This document is named "Tweed Shire Council, Development Design Specification D5 - Stormwater Drainage Design".

ORIGIN OF DOCUMENT, COPYRIGHT

This document was originally based on AUS-SPEC - Development Design Specification D5 - Stormwater Drainage Design, January 2002 (Copyright SWR-TM). Substantial parts of the original AUS-SPEC document have been deleted and replaced in the production of this Tweed Shire Council Development Specification. The parts of the AUS-SPEC document that remain are still subject to the original copyright.

VERSIONS, D5 STORMWATER DRAINAGE DESIGN

VERSION	AMENDMENT DETAILS	CLAUSES AMENDED	DATE ISSUED (The new version takes effect from this date)	Authorised by the Director of Engineering Services
1.1	Original Version		1 July 2003	
1.2	Amendments to referenced standard drawings Amended maximum kerb inlet length to side entry pits	D5.03 D5.10.4	1 June 2004	
1.3	Changes to major system criteria: factor of safety for rainfall intensity; increase freeboard to adjoining development. Interallotment drainage long sections may be required Update references from standard drawings to C221 Update QUDM references	D5.04, D5.12 D5.17 D5.18 Various	18 December 2013	
1.4	Update interallotment drainage specifications. Clarify easement widths. Add shared easement requirements Add reference to UPRCT On-Site Detention Handbook Trenchstops and Bulkheads requirements added	D5.03(e), D5.04, D5.12, D5.17, D5.20, D5.23, D5.26, Table D5.5 D5.16 D5.18	15 September 2015	

DEVELOPMENT DESIGN SPECIFICATION D5

STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

1. This specification is for the design of stormwater drainage systems. Stormwater quality issues are addressed in D7.

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.

   (d) To ensure a development does not drain areas nearby zoned as Wetlands (Environmental Protection).

   (e) To comply with the objectives of Section 1.03 QUDM.

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 Section 7.03 of QUDM and the "major/minor" system concept set out in Chapter 14 of Australian Rainfall & Runoff, 1987 (ARR 1987); that is, the "major" system with an Average Recurrence Interval (ARI) of not less than 100 years 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. Notwithstanding, the recommendations of the above references “minor” drainage design for urban areas in the Tweed Valley shall provide for an ARI of not less than five (5) years.

   (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 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

In cases of conflict or contradiction, unless otherwise specified, the provisions of this Specification will prevail over all reference documents and prevail over all Tweed Shire Council Standard Drawings.

(a) Council Specifications

D7	-	Stormwater Quality
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 - Unplasticised PVC (uPVC) pipes and fittings for stormwater or surface water applications.

AS 2032 - Code of practice for installation of uPVC pipe systems.

AS 3725 - Loads on buried concrete pipes.

AS 4058 - Precast concrete pipes.

AS 4139 - Fibre reinforced concrete pipes and fittings.

(c) State Authorities

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

NSW, Dept of Housing

- Managing Urban Stormwater: Soils and Construction 3rd Edition, August 1998.

(d) Other

AUSTROADS - Bridge Design Code.

- Waterway Design, A Guide to the Hydraulic Design of Bridges, Culverts and Floodways, 1994

Inst. of Eng. - Australian Rainfall and Runoff - A guide to flood estimation. Aug 1987.

Queensland Urban Drainage Manual, Volumes 1 & 2, Second Edition, 2007.

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.
- Hydraulics of precast concrete conduits.

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.

Upper Parramatta River Catchment Trust

- On Site Stormwater Detention Handbook, Third Edition, December 1999.

(e) Tweed Shire Council Standard Drawings that apply to this section

S.D. 101	Stormwater Pollution Removal Pit
S.D. 102	Trash Rack & Sediment Basket Details
S.D. 103	Standard Gully Pit – Roll Top Kerb
S.D. 104	Standard Gully Pit – Barrier Kerb
S.D. 105	Security Grate for Stormwater Outlets
S.D. 106	Manholes, Field Inlet Pits & Grated Inlet / Junction Pit – Details
S.D. 107	Concrete Bedding & Bulkhead Details
S.D. 108	Field Inlet Pit Dome Top Cover
S.D. 109	Step Iron Details
S.D. 110	Inter Allotment Drainage / Sewerage Location
S.D. 276	Trench Drainage Bulkheads & Trench Stops

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

1. Design Intensity-Frequency-Duration (IFD) Rainfall - IFD relationships shall be in accordance with Table D5.1 or D5.3. ***I-F-D Relationships***

2. IFD relationships may be derived in accordance with Chapter 2, Volume 1 of ARR 1987, for the particular catchment under consideration. The nine (9) basic parameters read from Maps 1-9 in Volume 2 of ARR 1987 shall be shown in the calculations submitted to Council, except where the Bureau of Meteorology provides a polynomial relationship for the catchment.

3. Design IFD rainfalls may be provided by the Bureau of Meteorology for specific locations and these are to be submitted to Council.

4. Recurrence intervals for “minor” events depend on the zoning of the land being serviced by the drainage system. The “minor” system design ARIs are to be in accordance with QUDM table 7.02.1, except a 5 year ARI applies for Rural Residential, Urban Residential (both Low and High Density) and Industrial developments. ***Average Recurrence Intervals***

5. Deleted

6. Deleted

7. For the design of major systems in Tweed Shire (overland flow paths, open channels, surcharge systems etc), a factor of safety of 1.2 shall be applied to design rainfall intensities, to properly account for blockages, obstructions to flow, deterioration of cross sectional capacity over time, and the potential impacts of climate change. ***Factor of Safety***

   Where major drainage systems are located adjacent to residential development and have horizontal bends in excess of 45 degrees this factor of safety must be increased to 1.5.

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. Catchments external and internal to the site are to be shown on drawing plans (see Design Specification D13 – ENGINEERING DRAWINGS (SUBDIVISIONS)).

Catchment plans required

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 QUDM and the requirements of this Specification.

2. All calculations shall be certified by a qualified person experienced in hydrologic and hydraulic design.

Qualified Person

3. Coefficients of Run-off shall be calculated as per Section 4.05 of QUDM except that Table D5.2 or D5.4 of this Specification shall be used in lieu of QUDM Table 4.05.2. Full details of coefficients utilised are to be shown in the calculations submitted to Council.

Runoff Coefficients

4. Details of percentage impervious are defined in QUDM Table 4.05.1.

5. Times of Concentration - 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. Inlet times for urban catchments are to be in accordance with QUDM Table 4.05.1. For rural catchments and developed catchments with overland flow lengths greater than 50m, QUDM Table 4.06.3 and Figure 4.07 shall be adopted. These can be used in lieu of more detailed calculations.

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.

Overland Flow

7. The maximum time of concentration in urban and residential catchments (including playing fields and park areas) 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.

9. Surface roughness coefficients "n" shall generally be derived from information in Chapter 14 of AR&R 1987. Values applicable to specific zoning types and overland flow path types are given below:

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 recommended by QUDM may be used as long as the requirements of AR&R 1987 are met, summaries of calculations are provided and details are given of all program input and output. ***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 along with the final drawings and drainage calculation sheets for approval by Council. Specific programs are to produce results that are able to be confirmed by simple hand calculations.

HYDRAULICS

D5.08 HYDRAULIC GRADE LINE

1. Hydraulic calculations shall generally be carried out in accordance with QUDM 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 to be shown on the plans and details of all calculations are to be submitted including listings of all programme inputs, outputs and assumptions. ***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 grate or lip 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 obvert of the outlet pipe shall be adopted as the minimum downstream control level, when the water level of the open channel is unknown.

   (d) The downstream control level shall not be less than the obvert of the pipe outlet, where the water level of the open channel is unknown.

   (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 ARI 100 year flood level.

   (f) Where the outlet is tidal, the downstream control shall be not less than the Mean High Water Mark

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 widths in the ARI 5 year storm event is 2.5 metres maximum. Roadway flow widths and capacity shall comply with section 7.04 of QUDM. ***Gutter Flow Widths***

2. Minimum conduit sizes are given below: ***Conduit Sizes***

   (a) The minimum pipe size shall be 375mm diameter.

   (b) The minimum box culvert size shall be 600mm wide x 300mm high.

   (c) All pipes to 600mm diameter are to be RRJ.

   (d) Pipes that are greater than 600mm diameter may be elastic banded except where pipes are subject to internal hydraulic surcharge or have an invert more than 300mm below the water table, in which case shall be rubber ring jointed (RRJ).

3. Velocity of flow in stormwater pipelines shall be maintained within desirable minimums and maximums in accordance with section 7.11 of QUDM. Where outside of these limits documentation shall be provided to demonstrate measures of preventing scour or pipe erosion or in the case of low velocities how cleaning will occur. ***Velocity Limits***

4. Where a pipe network incorporates an "in-line" Pollution Control Device in order to satisfy the requirements of Design Specification D7 – STORMWATER QUALITY, the device must be installed such that the incoming pipe is laid at a grade no greater than 5%.

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:

   (a) To enable access for maintenance.

   (b) At changes in direction, grade, level or class of pipe.

   (c) At junctions.

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

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

4. Maximum kerb inlet lengths to side entry pits is 3.6m. ***Inlet Capacity***

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

   (a) Queensland Urban Drainage Manual

   (b) 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.

(c) Pit relationships given in Chapter 14 of AR&R 1987.

(d) The maximum theoretical capacity of Council's standard gully pits in a sag is not to exceed 170 litres/second.

6. Where not already allowed for blockage factors are to be applied to the figures obtained from pit charts. The percentage of theoretical capacity allowed in relation to type of pit is given below:- ***Allowance for Inlet Blockage***

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%

D5.11 HYDRAULIC LOSSES

1. The pressure change co-efficient "Ke" shall be determined from the appropriate charts given in QUDM. ***Pit Losses***

2. RESERVED

3. Computer program default pressure change co-efficient "Ke" shall not be acceptable unless they are consistent with QUDM. The chart used and relevant coefficients 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.

4. RESERVED

5. Penetration of one service through another is not to occur. ***Service Penetrations***

6. 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 the inside and be grouted into the pit wall. ***Private pipes into system***

7. Construction of a junction without a structure is to be avoided. ***Pipe Junction Losses***

8. The design of larger upstream to smaller downstream conduits is to be done in accordance with QUDM. In going from smaller to larger pipes detailed design of the benching in the pits to enable a smooth flow transition shall be provided. Losses in sudden expansions and contractions are given in 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 and pipe sizes in relation to discharge shall be determined using the Colebrook-White formula with the acceptable roughness coefficients being 0.6mm for concrete pipes and 0.06mm for FRC pipes.

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 as defined below.

Surcharging

   (a) Surcharging of drainage system for storm frequencies greater than the 20 year ARI storm event may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property, and the road is not a high level access road for flood evacuation (refer DCP Section A3).

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

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.

Velocity/ Depth Criteria

3. Freeboard requirements for floor levels and levee bank levels from stormwater flood levels in open channels, roadways and stormwater surcharge paths are given in QUDM and shall not be less than the following:

Freeboard

   Generally:-

   (a) A minimum freeboard of 500mm shall be provided between the 100-year stormwater 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 overtopping level of the footpath. Driveway construction in these instances needs to consider this requirement.

   (c) Cross sections of open channels and stormwater surcharge paths shall provide 0.5m freeboard above the Q100 design storm, before overtopping can occur.

4. Road capacity charts are provided in QUDM. For other road designs, flow capacities of roads should be calculated using Technical Note 4 in Chapter 14 of AR&R 1987 with a value of 0.8 for the flow adjustment factor unless otherwise specified by Council.

Roadway Capacities

5. The design levels shall comply with the levels given in Tweed Shire Council's DCP Section A3 - "Development of Flood Liable Land".

Flood Liable Land

6. Trunk drainage and major system overland flowpaths (other than interallotment drainage) through private property are to be avoided. Where this is not possible the underground system (both pipes and inlets) shall be designed to capture and convey flows up to the "minor" storm event. A surcharge, overland flow path of capacity not less than ARI of 100 years (Q100) shall be provided and cross section defined. The profile of the overland flow path must provide a minimum freeboard of 500mm for a Q100 storm event before the cross section can overtop. Easements are to be provided in accordance with section D5.23.5

Overland Flowpaths in Private Property

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, such a channel shall comply with the requirements of this Specification.

Safety

2. Design of open channels shall be generally in accordance with QUDM and shall be designed with safety requirements as set out in Section 14.10.4 of ARR 1987 and QUDM as a primary criterion. Open channels will be designed to contain the "major" system flow. The effect of a catchment that has different discharge outlets for the "minor" and "major" systems is to be determined.

   In the extremely rare circumstance where a "minor" system discharges into the channel being designed and the "major" system goes elsewhere, assume that there is no blockage at the "minor" system inlets (ref table 7.05.1) during an ARI 100 years (Q100).

3. Friction losses in open channels shall be determined using Mannings "n" values given below:-

Channel Roughness

   Mannings "n" Roughness Coefficients for open channels shall generally be derived from information in Chapter 14 of AR&R 1987. Mannings "n" values applicable to specific channel types are given below:-

Concrete Pipes or Box Sections	0.013
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Asphaltic Concrete	0.015
Bricks or pavers	0.018
Pitchers or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038
Short Grass	0.033
Long Grass	0.043

   Where a grassed channel invert is permitted the roughness coefficient must be representative of the channel condition prior to mowing (i.e. long grass)

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.

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.

Side Slopes

6. Low flow provisions in open channels (man-made or altered channels) will require flows for ARI of 1 year to be contained within a pipe system (preferred) 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. ***Low Flows***

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

8. Lining of channels is required by a material approved by the Director of Engineering where the flow velocity during an ARI 20 year storm event exceeds the velocities in table 9.05.3 of QUDM. ***Channel Lining***

9. Concrete inverts that extend 300mm above the hydraulic grade line for ARI 2 year flows are required under the following conditions:-

   (a) Channel slope is less than or equal to 0.5%.

   (b) Channel slope is greater than or equal to 5.0%.

D5.14 MAJOR STRUCTURES

1. All "major" structures shall be designed for the 100-year ARI storm event without afflux in urban areas. 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***

3. All bridges in urban areas shall be designed for flood intensity in accordance with Table D1.14 of Design Specification D1 Road Design. ***Bridges***

4. 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 AUSTROADS Bridge Design Code.

5. All culverts in urban areas shall be designed for flood intensity in accordance with Table D1.14 of Design Specification D1 Road Design. ***Culverts***

6. Culverts (either pipe or box section) shall be designed in accordance with charts provided in QUDM or design publications or programmes approved by the Director Engineering Services, with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

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 temporal patterns shall be those given in Gold Coast City Council's "Land Development Guidelines – 2003". 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 by the designer for the storms examined.

3. Flood Routing should be modelled by methods outlined in AR&R 1987. ***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 Australian National Conference on Large Dams ANCOLD (1986). ***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 design low flow (minimum 2 year ARI storm event) 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 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***

   (a) 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.

   (b) The depth indicators should be provided indicating maximum depth in the basin.

   (c) Protection of the low flow intake pipe shall be undertaken to reduce hazards for people trapped in the basin.

   (d) Signage of the spillway is necessary to indicate the additional hazard.

   (e) Basins shall be designed so that no ponding of water occurs on to private property or roads.

   (f) No planting of trees in basin walls is allowed.

   (g) No basin spillway is to be located directly upstream of urban areas.

   (h) Submission of design plans to the New South Wales 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 where under capacity downstream drainage systems exist. ***Re-development***

2. The requirements for Stormwater Detention Design are outlined in the Upper Parramatta River Catchment Trust On-Site Detention Handbook and section 5.00 of QUDM.

3. The development shall limit the maximum discharge rate to 200 l/s/ha for all storm events up to and including the ARI 100 storm event, unless the following is demonstrated:

   (a) The downstream ("minor" or "major") drainage systems have unutilised or uncommitted capacity greater than the increased peak stormwater discharge from the subject site and

   (b) The drainage capacity planned for, or committed to other sites will not be consumed or

   (c) Written satisfactory arrangements with Tweed Shire Council have been made to augment the downstream drainage systems.

4. Where the downstream drainage system capacity is unable to accept an increased stormwater discharge without resulting in the following:

   (a) Flooding, or

   (b) Increased risk of danger, damage or nuisance to other persons or property, or

   (c) Exceeding downstream roadway flow width and depth limits.

   Then a permissible site discharge lower than 200 l/s/ha will be required.

5. Combined sedimentation and detention ponds must be designed in accordance with Design Specification D7 – "Stormwater Quality" so that remobilisation of the sediment is minimised.

Sediment Retention Basins

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

1. Unless directed otherwise in conditions of development consent, Interallotment Drainage (IAD), shall be provided for every allotment which does not drain directly to its street frontage or a legal point of discharge. In areas with high soil infiltration capacity, conditions of development consent may require runoff from roofs and/or hardstand areas to be disposed of on site by infiltration and may specifically prohibit such runoff from being piped to the street gutter, IAD system, or any other public drainage system.

Warrant

2. Interallotment drainage shall be contained within an easement of width not less than that specified in D5.23

Easement

3. Where the subdivider only has ownership or control over the title to the lower land below the rear boundaries of the lots requiring interallotment drainage, then an IAD system satisfying the requirements of this Specification, as well as a grass swale profiled to convey stormwater up to the Q100 ARI storm event (unless otherwise approved by Council), shall be provided within an easement located in the lower land property..

IAD In Downstream Property

4. Where the subdivider has no interest in the lower land (i.e. properties below the rear boundaries of the lots requiring interallotment drainage), then an IAD system satisfying the requirements of this Specification, as well as a grass swale profiled to convey stormwater up to the Q100 ARI storm event (unless otherwise approved by Council), shall be provided within an easement, located in the subdivider's land.

IAD In Upstream Property

5. Where the subdivider's land is supported by a batter or retaining structure, then an IAD system satisfying the requirements of this Specification, as well as a grass swale profiled to convey stormwater up to the Q100 ARI storm event (unless otherwise approved by Council), shall be provided within an easement, located in the subdivider's land. ***IAD Near Retaining Walls***

6. Easements shall be protected with a Section 88B Restriction as to User, preventing rigid paving or alteration of the ground level by more than 0.3 metres. ***Section 88B Restriction***

7. IAD must be discharged to a legal point of discharge and may require easements through private property to achieve this. ***IAD Discharge***

8. Designers should be alert to the occasional possibility of underground utilities being on three sides of a newly created lot and consider enlarging the parcel or revising the engineering detail as appropriate to ensure a house pad envelope is containable within the site.

9. For Pipe Capacity - refer to Section 7.13 QUDM. If deemed necessary Council may request long sections to confirm that lines can hydraulically convey Q5 flow (piped) and Q100 overland.

10. The pipe alignment shall be generally 1.5m from the rear boundary. Where the easement is shared, the minimum offset to the rear boundary shall be 1m in accordance with the requirements of SD110. Where the underground infrastructure is to be located on land supported by a batter or retaining structure, the alignment of the pipeline shall be in accordance with Clause D6.06.6 of Design Specification D6 – SITE REGRADING. ***Alignment***

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

12. Interallotment drainage pits shall be located at the lowest point of each lot and all changes of direction, pipe size or pipe gradient. Pits shall be constructed of concrete and may be either cast-in-situ or prefabricated. Cast-in-situ pits shall conform with the requirements of SD106 and SD110. Prefabricated pits are subject to acceptance by Council and are still to meet the general requirements of SD106 and SD110. Depressed grated inlets for hardstand areas are acceptable. ***Pits***

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

14. 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 (or equivalent) of minimum diameter 375mm, shall be used. ***Pipe Type***

15. Interallotment Drainage Pipe - Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are also to comply with Development Design Specification D12 - Sewerage System and Standard Drawing S.D.110 ***Sewer***

16. Where there is a disparity in level between inverts of interallotment drainage pipe and sewer mains, the spacing is to be submitted for approval.

DETAILED DESIGN

D5.18 PIPES AND CONDUITS

1. Conduit and Material Standards - Conduits and materials shall be in accordance with the standards detailed in Development Construction Specification C221 – Pipe Drainage.

2. Pipe Class, Bedding and Cover - Pipe Class, Bedding and Cover Requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association "Concrete Pipe Selection and Installation" or AS 3725. Compaction densities shall comply with Development Construction Specification C221 – Pipe Drainage. For UPVC pipes, the requirements shall be to AS 2032. Design pipe loadings shall allow for the heaviest construction equipment likely to be used on the site.

Pipe Class, Bedding and Cover

3. Conduit Jointing - Conduit Jointing shall be in accordance with Development Construction Specification C221 – Pipe Drainage.

4. Conduit Location - Drainage lines in road reserves shall generally be located in accordance with Table D1.8 of Design Specification D1 – ROAD DESIGN.

5. Where pipes are to be laid at a grade of 5 per cent to <15 per cent, the design shall specify trench stops. Refer standard drawing S.D.276.

Trench Stops

The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}, \text{ whereby}$$

D = Distance between stops in m,

G = Grade of pipe expressed in percentum.

Bulkheads may be used in lieu of trench stops.

6. Stormwater drainage infrastructure shall be designed with respect to the pipe grade limits specified in QUDM section 7.12. Approval from the Director of Engineering is required for any pipes laid at grades outside these limits. Where pipes laid at grades >15% are permitted the design shall specify concrete bulkheads in accordance with Development Design Specification D12 - Sewerage System and Standard Drawing S.D.276

Bulkheads

D5.19 PIT DESIGN

1. Pits shall be designed for safe access with benching to improve hydraulic efficiency and reduce water ponding. Typical pit designs and relevant Standards or Codes are included in Council's series 100 standard drawings: 'Stormwater Standards'.

D5.20 STORMWATER DISCHARGE

1. Scour protection at culvert or pipe system outlets shall be constructed in accordance with guidelines set down in QUDM unless outlet conditions dictate the use of more substantial energy dissipation arrangements.

Scour

From any outlet scour protection shall be provided for the length upon which turbulence is sufficiently dissipated. In the absence of hydraulic modelling the length shall not be less than 10 x (Vo - Vi) in metres.

Where

Vo = the maximum design outlet velocity in metres per second at the end of the pipe or box culvert.

Vi = the average velocity in the open channel prior to any development.

2. Easement width is to be no less than that specified in D5.23 ***Easements***

3. Where the drainage is to discharge to an area under the control of another statutory authority (e.g., Gold Coast City Council) the design requirements of that Statutory Authority are also to be met.

4. 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 subdivider 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. ***Downstream Discharge onto Adjoining Property***

5. Discharge to Recreation Reserves - Piped stormwater drainage discharging to recreation reserves is to be taken to a natural watercourse and discharged in an approved outlet structure or alternatively taken to the nearest trunk stormwater line.

6. For the future connection of roof water conduit every allotment that drains directly to the street frontage shall be provided with an approved kerb adaptor and end cap.

   The approved kerb adaptor is to be located at the lowest point within the street frontage and installed during the construction of the kerb and channel.

D5.21 MISCELLANEOUS

1. Subsoil Drainage in Pipe Trenches - Subsoil Drainage shall be provided in pipe trenches as outlined below.

2. In cases where pipe trenches are backfilled with sand or other pervious material, a 3m length of subsoil drain shall be installed along 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. ***Subsoil Drain at Pits***

3. 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.

4. Termination of Kerb and Gutter and Associated Scour Protection - Kerb and Gutter shall be extended to drainage pit or natural point of discharge. 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. ***Kerb & Gutter Termination***

DOCUMENTATION

D5.22 PLANS

1. See Development Design Specification D13 – ENGINEERING DRAWINGS (SUBDIVISIONS) for plan requirements. ***D13***

2. Open Channel Cross Sections shall be drawn at a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. ***Open Channels***

3. Special Details including non-standard pits, pit benching, open channel designs and transitions shall be provided on the design drawings at scales appropriate to the type and complexity of the detail being shown.

4. "Work-as-executed" drawings are required in accordance with Development Design Specification D13 – ENGINEERING DRAWINGS (SUBDIVISIONS)".

Work-as-Executed Plans

5. Erosion and sediment control is to be in accordance with the requirements of Development Design Specification D7 – STORMWATER QUALITY.

Erosion and sediment control

6. Drainage design is to comply with the Tweed Urban Stormwater Quality Management Plan and Development Design Specification D7 - STORMWATER QUALITY.

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 plans. Easements will need to be created prior to issue of the Subdivision Certificate.

2. Lawful point of discharge, discharge off site

Lawful point of discharge

Stormwater runoff and drainage may only be discharged from a development site at a "lawful point of discharge". This must be on or immediately adjacent to the development site and may be:

(a) A natural watercourse or waterway to which the development site naturally drains.

(b) A "lawful point of discharge" agreed to by Council (a kerb entry, pipe or open drain in a road, reserve or easement).

Such points of discharge will only be acceptable if there is legal continuity and capacity in the drainage path from the "lawful point of discharge" to the final discharge point in a natural watercourse or waterway. If there is uncertainty regarding the capacity and continuity of the drainage path, the developer will be required to carry out all necessary survey and hydraulic analysis to prove its adequacy to Council.

Where no acceptable point of discharge presently exists, Council may conditionally approve a "lawful point of discharge" with conditions that require the proponent to

(a) Acquire and dedicate to Council, reserves or easements that provide legal continuity between the "legal point of discharge" and the final discharge point in a natural watercourse or waterway.

(b) Design/construct/enlarge/improve drains to enable adequate transport of stormwater from the "lawful point of discharge" to the final discharge point (in such cases, Council will determine the appropriate width of easements and drainage standards).

Progressive subdivision of a site will need to create a lawful point of discharge at each stage of title creation, despite the discharge being into the applicant's own (for the time being) land.

3. Easements for single interallotment drainage lines (with no other services installed) and/or overland flow paths shall be the greater of:

Easement Size

(a) 3.0m wide minimum.

(b) The conduit width plus twice the depth from surface level to conduit invert.

(c) The width of the grass swale profiled to convey stormwater up to the Q100 ARI storm event (unless otherwise approved by Council).

4. Shared easements (containing two different services where approved by Council e.g. sewer and interallotment stormwater) shall be:, ***Shared Easements***

(a) 4.0m wide minimum for services up to and including 300mm diameter each. Refer to S.D.110 for details of service allocation and separation distances within this minimum shared easement width.

(b) If either service exceeds 300mm diameter, the width of the easement may be required to exceed the minimum 4.0m width, subject to considerations including (but not limited to): pipe depth and diameter, zone of influence, minimum pipe separation requirements in accordance with WSA 02-2014, Part 1, Section 5.4, and/or geotechnical and groundwater conditions.

5. Easements for trunk drainage and major system overland flowpaths (other than interallotment drainage) through private property shall be the greater of: ***Easements for Trunk Drainage***

(a) That specified in D5.23.3 above.

(b) The width of the Q100 capacity overland flow swale (including 500mm freeboard) plus 2 metres.

D5.24 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet providing the information necessary for Council to assess the development is required (see Development Design Specification D13 – ENGINEERING DRAWINGS (SUBDIVISIONS)). ***Hydrology***

2. A copy of a Hydraulic Summary Sheet shall provide the input, calculations, and output of the proposed hydraulic system and shall be submitted to Council for approval. ***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 database of flooding and drainage information in formats previously agreed with Council.

SPECIAL REQUIREMENTS

D5.26 ALLOTMENT AND INTERALLOTMENT DRAINAGE

1. The minimum level of interallotment drainage required shall be generally in accordance with QUDM section 7.13 with specific attention to section 7.13.5, Table 7.13.3 (excluding all references to components (a), (b), (c) and (d)), and table D5.5 of this specification. Notwithstanding QUDM requirements and Council's standard drawings the minimum interallotment drainage pipe standard in urban residential areas shall be 300mm RRJ RCP.

2. For a level IV or level V interallotment drainage system, connection is to be provided with RRJ RCP to the gully pit inlet or trunk drainage system in the street

Where the only connection possible is to the kerb and channel in the street supporting documentation shall be submitted for approval to the Director Engineering.

3. No connection of private stormwater drainage to the public stormwater system (including any interallotment drainage) will be permitted without written approval of Council under section 68 of the Local Government Act 1993.

D5.27 MINOR SYSTEM JUNCTIONS

1. The design shall avoid the occurrence of concrete pipe headwalls facing each other especially at the junction of a development with adjoining properties. Continuity of the "minor" system pipe work is to be maintained. ***Continue pipe work***

2. Cut off drains, inlets and junctions are to be installed on the upstream side of developments to capture the water from contributing catchments. These shall be designed to cater for any differences to the ARI capacity of existing upstream pipework. Surcharge devices are to be installed as required. The inlets design is to allow the free movement of stormwater into (or out of) the inlet pits for the flows outlined in table D5.6 of this specification. ***Cut off drains***

3. At the legal point of discharge, allowance for future development is to be made. Where discharging into an existing development is proposed, provision for the outlet to cater for a design flow capacity in accordance with table D5.7 must be allowed for. ***Outlets***

4. Allowing for blockage, the capacity of a stormwater surcharge outlet, consisting of a grated inlet shall not exceed a maximum of 80% of its theoretical or tested capacity. The designer shall submit to Council for approval, the design of any surcharge device proposed and provide supporting documentation on the capacity of such a device. ***Blockage to Surcharge Devices***

DURATION OF STORM													
ARI years	5 minutes	6 minutes	10 minutes	20 minutes	30 minutes	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours	48 hours	72 hours
1	130	122	100	73	60	40.9	26.0	19.8	12.4	7.8	5.3	3.5	2.67
2	164	154	126	93	76	51.9	33.1	25.3	16.0	10.1	6.8	4.5	3.49
5	198	186	154	113	93	64.4	41.6	32.0	20.4	13.0	9.0	6.0	4.67
10	217	204	169	125	103	71.4	46.4	35.8	23.0	14.8	10.2	6.9	5.38
20	243	229	190	141	116	81.0	52.9	41.0	26.4	17.1	11.9	8.1	6.31
50	277	261	216	161	133	93.4	61.3	47.7	30.9	20.1	14.1	9.6	7.54
100	301	284	236	177	146	102.7	67.7	52.7	34.3	22.4	15.7	10.8	8.50

Table D5.1
RAINFALL INTENSITY
(millimetres / hour)
for coastal areas

ARI (years)	Frequency Factor Fy
1	0.67
2	0.81
5	0.92
10	1.00
20	1.07
50	1.17
100	1.28

Table D5.2
Frequency Factor
for coastal areas below 500 m AHD

DURATION													
ARI years	5 minutes	6 minutes	10 minutes	20 minutes	30 minutes	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours	48 hours	72 hours
1	127	119	98	71	58	39.6	25.7	19.9	12.8	8.2	5.5	3.6	2.78
2	161	151	124	91	74	50.8	33.4	26.0	16.8	11.0	7.4	4.8	3.69
5	198	186	154	114	93	64.8	43.7	34.5	23.0	15.3	10.3	6.7	5.13
10	219	206	171	127	104	72.9	49.8	39.6	26.8	18.1	12.1	7.9	6.04
20	248	233	194	145	119	83.7	57.9	46.4	31.7	21.7	14.5	9.5	7.21
50	285	268	224	168	139	98.0	68.6	55.4	38.4	26.6	17.8	11.6	8.81
100	313	295	246	185	154	108.8	76.8	62.4	43.6	30.5	20.4	13.3	10.08

Table D5.3
RAINFALL INTENSITY
(millimetres / hour)
for areas more than 10 km away from the ocean shore line

ARI (years)	Frequency Factor Fy
1	0.67
2	0.81
5	0.92
10	1.00
20	1.07
50	1.01
100	1.02

Table D5.4
Frequency Factor
for non-coastal areas <500m AHD

Zoning	Zone Name	Interallotment Drainage Level required (QUDM 7.13)*
RU1	Primary Production	Nil
RU2	Rural Landscape	Nil
RU5	Village	III
R1	General Residential	III
R2	Low Density Residential	III
R3	Medium Density Residential	IV
R5	Large Lot Residential	III
B1	Neighbourhood Centre	IV
B2	Local Centre	IV
B3	Commercial Core	IV
B4	Mixed Use	IV
B5	Business Development	IV
B7	Business Park	IV
IN1	General Industrial	IV
IN4	Working Waterfront	IV
SP1	Special Activities	as appropriate
SP2	Infrastructure	as appropriate
SP3	Tourist	as appropriate
RE1	Public Recreation	Nil
RE2	Private Recreation	II
E1	National Parks and Nature Reserves	Nil

Table D5.5
REQUIREMENTS FOR INTERALLOTMENT DRAINAGE

* Unless otherwise approved or specified by Council

Proposed system ARI (years)	Existing Upstream System ARI (years)					
	1	2	5	10	50	100
1		surcharge of Q2 u/s - Q1	Surcharge of Q5 u/s - Q1	surcharge of Q10 u/s - Q1	surcharge of Q50 u/s - Q1	surcharge of Q100 u/s - Q1
2	inlet capacity Q2-Q1u/s		Surcharge of Q5 u/s - Q2	surcharge of Q10 u/s - Q2	surcharge of Q50 u/s - Q2	surcharge of Q100 u/s - Q2
5	inlet capacity Q5 - Q1 u/s	inlet capacity Q5 - Q2 u/s		surcharge of Q10 u/s - Q5	surcharge of Q50 u/s- Q5	surcharge of Q100 u/s - Q5
10	inlet capacity Q10 - Q1u/s	inlet capacity Q10 - Q2 u/s	inlet capacity Q10 – Q5 u/s		surcharge of Q50 u/s-Q10	surcharge of Q100 u/s- Q10
50	inlet capacity Q50 - Q1u/s	inlet capacity Q50 - Q2 u/s	inlet capacity Q50 – Q5 u/s	inlet capacity Q50 - Q10u/s		surcharge of Q100 u/s- Q50
100	inlet capacity Q100- Q1u/s	inlet capacity Q100 - Q2u/s	inlet capacity Q100- Q5 u/s	inlet capacity Q100 -Q10u/s	inlet capacity Q100 -50u/s	

Table 5.6

Connecting to Upstream Stormwater

In addition to a standard manhole junction, provision is to be made for flows (Q) given hereunder

Future or Existing Downstream system ARI (years)	Proposed System ARI (years)					
	1	2	5	10	50	100
1		surcharge of Q2 u/s -Q1	surcharge of Q5 u/s- Q1	surcharge of Q10 u/s -Q1	surcharge of Q50 u/s -Q1	surcharge of Q100 u/s -Q1
2	inlet capacity Q2-Q1u/s		surcharge of Q5 u/s - Q2	surcharge of Q10 u/s -Q2	surcharge of Q50 u/s -Q2	surcharge of Q100 u/s -Q2
5	inlet capacity Q5-Q1 u/s	inlet capacity Q5-Q2 l/s		surcharge of Q10 u/s-Q5	surcharge of Q50 u/s - Q5	surcharge of Q100 u/s - Q5
10	inlet capacity Q10-Q1u/s	inlet capacity Q10-Q2u/s	inlet capacity Q10 - Q5 u/s		surcharge of Q50 u/s -Q10	surcharge of Q100 u/s -Q10
50	inlet capacity Q50-Q1u/s	inlet capacity Q50-Q2u/s	inlet capacity Q50 - Q5 u/s	inlet capacity Q50-Q10u/s		surcharge of Q100 u/s -Q50
100	inlet capacity Q100-Q1u/s	inlet capacity Q100-Q2u/s	inlet capacity Q100-Q5 u/s	inlet capacity Q100-Q10u/s	inlet capacity Q100-Q50u/s	

Table 5.7

Stormwater Outlet Connection

In addition to a standard manhole junction, provision is to be made for flows (Q) given hereunder