PINE RIVERS SHIRE COUNCIL

DESIGN MANUAL

CIVIL INFRASTRUCTURE DESIGN

PINE RIVERS

DESIGN STANDARDS

Part 1 Design Standards for Roadworks

Part 2 Design Standards for Stormwater Drainage Works

Part 3 Design Standards for Water Supply Works

Part 4 Design Standards for Sewerage Works

PINE RIVERS SHIRE COUNCIL

DESIGN STANDARDS

PART 2
DESIGN STANDARDS FOR STORMWATER DRAINAGE WORKS

PINE RIVERS SHIRE COUNCIL

PART 2 - DESIGN STANDARDS FOR STORMWATER DRAINAGE WORKS

SECTION 4
DESIGN STANDARDS

4.1.0 INTRODUCTION

The design standards have been prepared for the assistance of consulting engineers and design technicians engaged in the design of stormwater drainage works within the Pine Rivers Shire.

These design standards are not intended as a rigid code of practice and the Pine Rivers Shire Council is always prepared to consider, on their merits, alternative or innovative design approaches for unusual circumstances. These design standards, thus, form the probable solutions for stormwater drainage design.

It is hoped that by presenting a comprehensive set of design standards for stormwater drainage design requirements that time, effort and money will be saved on the part of designers, developers and the Pine Rivers Shire Council by reducing, to a minimum, the requirement for amendment and revision of designs.

These design standards should not be presumed to be a "text book" of hydrologic and hydraulic design, but sufficient explanatory matter is included to give the designer some insight into the principles and philosophies on which it is based.

The Queensland Urban Drainage Manual (QUDM) has been adopted as a basis of drainage design by the Pine Rivers Shire Council. However, the Pine Rivers Shire Council adopted design standards take precedence as they contain some QUDM amendments and particular design requirements. The Pine Rivers Shire Council periodically reviews its design standards and accordingly, comment or constructive criticism is invited. Any comments should be made in writing to the Director, Assets and Infrastructure Services Division, Pine Rivers Shire Council.

Finally, designers should note that alternative / innovative designs are welcomed, particularly those which can match the specified drainage performance criteria. These designs however, will be assessed in terms of their environmental sensitivity and their long term maintenance implications for the Pine Rivers Shire Council. Alternative designs should be presented as early as possible in the design process to allow adequate time for review by the Pine Rivers Shire Council prior to detailed design being finalised.

4.2.0 DESIGN DOCUMENTS

Broadly, the hierarchy of technical documents to be used for drainage design is as follows:-

STORMWATER MANAGEMENT ISSUE	REFERENCE
Policy, planning, legal and technical requirements	The Pine Rivers Shire Council Design Manual, Design Standards for Stormwater Drainage
Minor and major drainage design methodologies	Queensland Urban Drainage Manual
Culvert and bridge hydraulics	Austroads Waterway Design Guidelines
Scour protection and drop structures design (chute blocks not permitted)	Queensland Department of Main Roads - Urban Road Design Manual - Volume 2
Sediment & erosion controls, BMPs including sediment retention ponds	Institution of Engineers Australia, (Qld) Soil Erosion and Sediment Control - Engineering Guidelines for Queensland as amended.
Water quality standards	ANZECC Guidelines
Gross pollutant traps	ACT Planning Authority Gross Pollutant Trap Guidelines
Wetlands	Queensland Department of Primary Industries - Interim Guidelines on the Planning, Design and Management of Artificial Wetlands in Queensland
Wetlands (business & industry)	Biological Control of Runoff from Business and Industry Areas. "An Information paper and Guidelines" - Draft, Department of Small Business and Industry.
Best Management Practices including Water Pollution Control Ponds (WPCP)	The Pine Rivers Shire Council Stormwater Management Best Management Practices Document
Runoff routing methods, rainfall analysis, flood frequency analysis etc.	Australian Rainfall & Runoff, 1987 Volumes 1 & 2
Permanent water quality	ACT Planning Authority Water Pollution Control Pond Design Guidelines

Consultants' design reports should clearly state the reference to the specific document (by title, section number and page number) that relates to each design procedure.

4.3.0 DEFINITIONS

4.3.1 ROAD DEFINITIONS

QUDM adopts major / minor terminology for assessing the drainage requirements for roads. Table 4.3.0 should be used to assign major/minor road categories for the Pine River Shire Council road classifications. The concept of major/minor roads should not be confused with major/minor drainage systems.

Table 4.3.0

QUDM	PRSC ROAD CLASSIFICATION
Major	Arterial, Sub-Arterial, Trunk Collector, Collector Road (Industrial)
Minor	Bus Collector Collector Access Street Access Place Collector Road (Rural Residential) Access Road (Rural Residential) Access Road (Industrial)

4.3.2 LAND USE DEFINITIONS

The QUDM defines two broad land use types: urban and rural. Table 4.3.1 indicates to which category each of the Pine Rivers Shire town planning classifications are assigned. Each town planning classification has an associated number. This number is used in later tables to define drainage requirements.

Table 4.3.1

QUDM	Town Planning Zone Ref No.	PRSC Town Planning Classification
Urban	1	Residential A
	2	Residential B
	3A	Special Residential (urban)
	6	Central Business
	7	Commercial
	8	Local Business
	9	Neighbourhood Facilities
	10	Home Industry
	11	Service Industry
	12	General Industry
	15	Future Urban
QUDM	**Town Planning Zone Ref No.**	**PRSC Town Planning Classification**
Rural	3B	Special Residential (non-urban)
	4	Park Residential
	5	Rural Residential
	13	Extractive Industry
	14	Rural
	16	Future Rural Living
	17	Park and Open Space
	18	Sports and Recreation

For the “Special Facilities”, “Special Purposes” and “Special Development” zones, the QUDM classifications shall be determined by the Pine Rivers Shire Council for each particular site.

4.4.0 GENERAL REQUIREMENTS

4.4.1 DEVELOPMENT WORKS

All drainage, whether internal or external to the site, or both as the case may be, relevant or reasonably required in respect of the proposed development, shall be provided at the developer's cost.

In particular, the developer is required to meet the full cost of providing an appropriate drainage system with capacity sufficient to pass through his or her land the design runoff from all upstream catchments when such catchments are fully developed in accordance with the Pine Rivers Shire Council Strategic Plan.

Further, the developer shall pay a catchment headworks or infrastructure charge to the Pine Rivers Shire Council to cater for trunk drainage works resulting from the additional downstream volume of runoff and increased pollution loads generated by the development. This charge is based on the developable area. The charges also vary from catchment to catchment.

Runoff rates and pollutant loads shall not be made worse on downstream properties. Further, calculated pollutant concentrations from the development should not exceed the appropriate ANZECC standards.

This condition requires construction of retention basins and water quality control devices for subdivisional of other developments in excess of 2 ha.

All dry weather runoff and first flush flow catering for the first 15 mm of rainfall from the development shall be treated prior to discharge into the Pine Rivers Shire rivers, creeks or watercourses.

Future maintenance requirements should be considered when specifying the type and location of treatment facilities.

Easements are required for all drainage paths. Roof drainage easements are generally only applicable to urban residential property.

In general, the drainage works as described in the following sections are required to be constructed by the developer.

4.4.2 DRAINAGE IN URBAN AREAS (ZONES 1, 2, 3A, 6, 7, 8, 9, 10, 11, 12 AND 15)

A. Minor System

Kerb and channel is required on both sides of all roads except where swale drains are approved as part of an integrated stormwater management system.

Catchpits at locations such that the flow in the channel does not exceed specified limits.

Field inlet pits at the lowest point of all commercial, industrial and multi-unit residential lots and at the lowest point of Residential A, Residential B and Special Residential lots, where the lot drains one or more upstream properties. An easement over all downstream pipe work is required to the downstream legal point of discharge.

Full piped drainage from all catchpits and other inlets to the boundary of the subdivision, or approved point of discharge, unless otherwise permitted by these design standards or approved by a Pine Rivers Shire Council engineer.

B. Major System

An overland flow system for runoff in excess of the capacity of the pipe system, such that the design flow is carried through the subdivision or development clear of and with required freeboard to allotments.

Overland flow paths will not be permitted within urban allotments.

4.4.3 DRAINAGE IN RURAL RESIDENTIAL AREAS (ZONES 3B, 4 AND 5)

A. Minor System

Open natural water courses within allotments, full piped drainage within road reserves, with:-

- kerb and channel generally is required on both sides of all roads except where swale drains are approved as part of an integrated stormwater management system
- catchpits at locations such that the flow in the channel does not exceed specified limits or alternatively kerb turnouts with approved scour protection at locations such that the flow in the channel does not exceed specified limits
- full piped drainage from all catchpits and other inlets to discharge into defined natural watercourses or approved open channels
- pipe or concrete box culverts structures (including aprons and cut off walls) at road crossings of natural watercourses, extending to the limits of the road reserve unless approved otherwise by a Pine Rivers Shire Council engineer. Services shall generally be carried over the structure within a services corridor of 3.5 m minimum width – refer the Standard Drawings showing service allocations. Cross drainage design shall take into account the possible blockage caused by the debris load from the catchment. The Pine Rivers Shire Council prefers that reinforced concrete box culverts are provided for road crossings in lieu of multiple pipes.

B. Major System

An overland flow system for runoff in excess of the capacity of the pipe system, such that the design flow is carried through the subdivision/development, clear of and with appropriate freeboard to building sites as required by the Pine Rivers Shire Council standards.

4.4.4 DRAINAGE IN RURAL ZONES (ZONES 13, 14 AND 16)

A. Minor System

Open natural watercourses with:-

- pipe or concrete-box culverts, bridges or concrete causeways at road crossings over natural watercourses, to the limits of the road formation. Where services are underground then these services shall be carried over the structure in a services corridor approved by a Pine Rivers Shire Council engineer. Cross drainage design shall take into account the possible blockage caused by the debris load from the catchment and in this regard the provision of reinforced concrete box culverts is preferred to multiple pipe culverts.

- earth table drains and catch drains in road reserves, stone pitched or concrete lined where required for scour protection

- entrance culverts to allotments

B. Major System

An overland flow system for runoff in excess of the capacity of the pipe system, such that the design flow is carried through the subdivision/development, clear of and with appropriate freeboard to building sites as required by the Pine Rivers Shire Council standards .

4.4.5 DRAINAGE IN PARK AREAS (ZONES 17 AND 18)

4.4.5.1 Drain Length < 50 m

A. Minor System

Through small park areas, where the length of drain line is less than 50 m, full underground drainage with capacity as for adjoining development or not less than the five year A.R.I. design storm shall be provided. A Pine Rivers Shire Council engineer may relax this requirement having regard to environmental issues.

B. Major System

Major system flows are contained within the park area.

4.4.5.2 Drain Length > 50 m

A. Minor System

Where the drain line length exceeds approximately 50 m, the preferred solution is to enhance and revegetate the existing watercourse. The revegetation program should ensure that:-

- the watercourse has sufficient base flow and invert/channel grade to obviate objectionable ponding

- a second parallel watercourse is constructed to cater for additional runoff where existing capacity is insufficient. This watercourse should be separated by a levee designed to be overtopped at the two to five year A.R.I level

- the increased duration of flows in the revegetated channel can be sustained without scouring problems

Where enhancement of the existing water course is not possible for environmental and/or social reasons, consideration may be given to the construction of the following possible alternatives:-

- a minor system pipe capacity, equal to the one year design frequency storm, with a shallow grassed floodway to carry excess flow and outlet and inlet structures at the top and bottom of the reduced capacity length

- a grassed channel with a low-flow pipe, minimum 375 mm diameter, with grated field gullies provided at 30 m maximum spacing to drain the channel invert

- where grade limitations prevent use of a low-flow pipe, a concrete invert may be approved in the grassed channel

B. Major System

Major system flows are contained within the park area.

Note: - for the technical design requirements for open channels, see Section 8.00 of QUDM. Minimum pipe velocities / grades are to be in accordance with Section 5.17 of QUDM.

4.4.6 SUMMARY OF MINOR DRAINAGE REQUIREMENTS

A summary of the minor drainage requirements for various land uses is given in Table 4.4.0

Table 4.4.0

PRSC MINOR DRAINAGE REQUIREMENTS

Town Planning Zone Ref. No.	1, 2, 3A, 6, 7, 8, 9, 10, 11, 12, 15	3B, 4, 5	13, 14, 16	17, 18
Minimum Requirements	Pipe drainage to all locations	Pipe drainage road generally in reserves only	Pipe drainage generally not necessary	< 50 m provide pipe drainage in urban zones
	Catchpits in all roads	Catchpits in all roads	Table drains along roads	> 50 m enhance existing watercourse overland flow path or drainage feature
	Field inlets	RCP/RCBC at cross drainage locations	RCP/RCBC at cross drainage locations	Use landscaped crossings (e.g. footbridges, stepping stones etc.)
	Overland flow clear of allotments in urban zones	Entrance culverts to allotments where no kerb and channel is provided	Entrance culverts to allotments	

Note: - See Section 4.3.2 of the Design Standards for Stormwater Drainage

4.5.0 LEGAL AND TOWN PLANNING ASPECTS

The developer shall satisfy a Pine Rivers Shire Council engineer prior to the approval of engineering drawings for drainage that they will adequately drain every street and every allotment or every area of development and that they will carry the drainage to a point at which it may be lawfully discharged without causing nuisance or annoyance to any person.

The requirements set out in QUDM - Section 3.00 shall apply. Where conflicting requirements occur, the requirements and provisions as set out below shall prevail.

A. Subject to the conditions set out in paragraph B below, if drainage is to be carried through land not owned by the developer, a Pine Rivers Shire Council engineer shall be satisfied by the developer that there is a legal right of:-

- drainage through the land and
- support and access to the pipes

in favour of the Pine Rivers Shire Council and/or the land to be developed, EXCEPT where a Pine Rivers Shire Council engineer approves the construction of a retention basin in a drainage reserve or in a Pine Rivers Shire Council easement in an allotment or, in exceptional circumstances, in public garden or recreation space and, as a condition, the developer constructs the retention basin to the satisfaction of a Pine Rivers Shire Council engineer such that the rate of outflow from the land resulting from the major design storm event is not increased after the land is fully developed and provides calculations confirming such result.

B. Where drainage from any development is taken to a watercourse, as defined in the Water Resources Act 1926-1987, a Pine Rivers Shire Council engineer shall not require the developer to satisfy the Pine Rivers Shire Council that there is a legal right of drainage through the land in which the watercourse if located where:-

- the developer is able to provide calculations to the satisfaction of a Pine Rivers Shire Council engineer that:-
  - the run-off from the major design storm with the land fully developed will not increase downstream flood levels
  - flooding downstream of fully developed allotments and allotments which cannot be further subdivided in the residential A, residential B, neighbourhood facilities, local business, central business, home industry, commercial, service industry and general industry zones will not increase in the run-off from the design major storm with the subject land, fully developed

- the developer is to satisfy a Pine Rivers Shire Council engineer that the watercourse will not be subject to undue silting or downstream erosion problems as a result of the development

- the developer is able to satisfy a Pine Rivers Shire Council engineer that the run-off from the development shall be discharged into the watercourse without causing nuisance or annoyance to any person

The above is subject to change through various local law provision and amendments. The designer should contract the Pine Rivers Shire Council for further advice on these matters.

4.6.0 PLANNING OF THE DRAINAGE SYSTEM

The requirements of QUDM - Section 4.00 shall apply. It should be noted that the Rivers Shire Council has prepared Master Drainage Schemes and Catchment Management Plans for some areas and that prior to commencing design, the designer shall check with the Pine Rivers Shire Council for any such schemes or documents that may exist.

4.7.0 QUDM MODIFICATIONS

The requirements of QUDM - Section 5.00 shall apply except as amended below.

4.7.1 DESIGN ARIS

The following Design ARIs replace Table 5.06.1 of QUDM:-

Table 4.7.0

TABLE OF DESIGN AVERAGE RECURRENCE INTERVALS

MAJOR SYSTEM		
ZONE		**DESIGN ARI (years)**
All		100 (see Notes 1 & 2)
MINOR SYSTEM		
ZONE		**DESIGN ARI (years)**
Central Business, Commercial, Local Business, Neighbourhood Facilities		10
Service Industry, General Industry, Home Industry		5
Residential B		5
Residential A, Special Residential (urban), Future Urban		5
Special Residential (non-urban), Park Residential, Rural Residential, Rural, Future Rural Living		5
Park and Open Space, Sports and Recreation where length of drain is:-		< 50 m - adopt 5 > 50 m enhance open watercourse (see Note 3)
Major Road	Kerb and Channel Flow	50 (see Notes 4 & 6)
	Cross Drainage (culverts)	50 (see Notes 5 & 6)
Minor Road	Kerb and Channel Flow	Refer to relevant development category
	Cross Drainage (culverts)	10 (see Notes 5 & 6)
Bikeway	Cross Drainage	2

Notes:-

1. Where the major system design flow is conveyed to an existing downstream pipe or channel drainage system and sufficient on-site detention to mitigate flows is unachievable, an appropriate major design ARI shall be determined by a Pine Rivers Shire Council engineer (generally not less than 50 years ARI).

2. Where augmentation of an existing undersized drainage system is required and topographic or other features limit the ability to convey the major storm flow, a Pine Rivers Shire Council engineer may review the design major storm ARI.

3. Enhancement of the existing overland flow path, drainage feature or watercourse will require revegetation, and where necessary, the waterway area increased to cater for the additional runoff. To cater for this additional runoff a second high level channel should be constructed. This channel should be grassed and be set apart from the original watercourse. The levee separating the channels should be designed to be over-topped at the two to five year ARI level.

4. The design ARI for the minor drainage system in a major road shall be that indicated for the major road, not that for the development category of the adjacent area.

5. The Pine Rivers Shire Council requires that RCBCs be used for road crossings where a Pine Rivers Shire Council engineer considers that the potential for blockage resulting from the stream debris load will be significant. Culverts under all roads should be designed to accept the full flow for the minor system ARI while maintaining the required freeboard to the carriageway. In addition the designer must ensure that the 100 year ARI backwater does not reduce the required minimum freeboard for properties upstream. If upstream properties do not have the required freeboard, it may be necessary to install culverts of capacity greater than that required for the minor system ARI to ensure that no increase in flooding of upstream properties occurs. In addition, the downstream face of the causeway embankment may need protection where overtopping is likely to occur. Design allowance for debris load and appropriate blockage factors shall be approved by a Pine Rivers Shire Council engineer. In urban areas, the road crossing over the watercourse may need to be depressed to ensure that any flows passing over the road shall be contained to a width similar to the natural flow width.

6. In situations where zones of differing ARIs abut the same road and are likely to share the drainage system, the design ARIs must be satisfied in all possibly affected zones. For existing zones or designs which cannot practicably fulfil the above requirements, the Pine Rivers Shire Council may review the design ARIs.

4.7.2 TIME OF CONCENTRATION

For urban, business, commercial and industrial areas QUDM standard inlet times are to be used. The Kinematic Wave and the Bransby-Williams equations are not to be used. QUDM recommended standard inlet times are reproduced in the table below.

For rural areas, use methods specified by QUDM.

Table 4.7.1

RECOMMENDED STANDARD INLET TIMES

Location	Inlet Time (Minutes)
Road surfaces and paved areas	5
Urban residential areas where average slope of land is greater than 15%	5
Urban residential areas where average slope of land is greater than 10% and up to 15%	8
Urban residential areas where average slope of land is greater than 6% and up to 10%	10
Urban residential areas where average slope is greater than 3% and up to 6%	13
Urban residential areas where average slope is up to 3%	15

Note: - The average slopes referred to are the slopes along the predominant flow paths for the catchment in its developed state

4.7.3 RAINFALL INTENSITIES

Rainfall intensities shall be calculated in accordance with Chapter 2 of the Australian Rainfall and Runoff - 1987 Edition.

For simplicity, the Pine Rivers Shire Council has derived standard rainfall intensities for use in the Pine Rivers Shire and these are provide in Table 4.7.2

Table 4.7.2

RAINFALL INTENSITIES - PINE RIVERS SHIRE

DURATION (MINS)	AVERAGE RECURRENCE INTERVAL						
	1 year mm/hr	2 year mm/hr	5 year mm/hr	10 year mm/hr	20 year mm/hr	50 year mm/hr	100 year mm/hr
5.0	118	150	189	216	245	294	329
5.2	117	149	187	213	243	290	324
5.4	115	147	185	211	240	286	319
5.6	114	146	183	208	238	282	315
5.8	112	144	182	205	235	278	310
6.0	111	143	180	203	233	274	305
6.2	110	141	178	201	231	271	302
6.4	109	140	176	198	228	268	299
6.6	107	138	174	196	226	265	296
6.8	106	136	173	194	223	262	292
7.0	105	135	171	192	221	259	289
7.2	104	133	169	190	219	257	287
7.4	103	132	167	188	217	254	284
7.6	102	131	166	186	215	252	281
7.8	101	129	164	185	212	250	278
8.0	100	128	162	183	210	247	276
8.5	97	125	159	179	206	242	270
9.0	95	122	155	175	201	237	264
9.5	93	120	152	171	197	232	259
10.0	91	117	149	168	193	227	254
10.5	89	115	146	164	189	223	249
11.0	87	112	143	161	186	219	244
11.5	86	110	140	158	183	215	240
12.0	84	108	138	156	179	211	236
12.5	83	106	135	153	176	208	232
13.0	81	105	133	150	173	204	228
13.5	80	103	131	148	171	201	225
14.0	79	101	129	146	168	198	222
14.5	77	100	127	143	166	195	218
15.0	76	98	125	141	163	192	215
15.5	75	97	123	139	161	190	212
16.0	74	95	121	137	159	187	209
16.5	73	94	120	135	157	185	207
17.0	72	93	118	134	154	182	204
17.5	71	91	117	132	152	180	201
18.0	70	90	115	130	150	178	199
18.5	69	89	114	129	149	176	197
19.0	68	88	112	127	147	174	194

DURATION (MINS)	AVERAGE RECURRENCE INTERVAL						
	1 year mm/hr	2 year mm/hr	5 year mm/hr	10 year mm/hr	20 year mm/hr	50 year mm/hr	100 year mm/hr
19.5	67	87	111	126	145	171	192
20.0	66	86	110	124	143	169	190
20.5	66	85	108	123	142	168	188
21.0	65	84	107	121	141	166	186
21.5	64	83	106	120	139	164	184
22.0	64	82	105	119	138	163	182
22.5	63	81	104	118	136	161	180
23.0	62	80	103	116	135	159	179
23.5	61	79	102	115	133	158	177
24.0	61	78	101	114	132	156	175
24.5	60	77	99	113	130	154	173
25.0	59	77	98	111	129	153	171
26.0	58	75	97	110	127	150	168
27.0	57	74	95	108	125	148	165
28.0	56	72	93	106	122	145	163
29.0	55	71	91	104	120	142	160
30.0	54	70	90	102	118	140	157
31.0	53	69	88	100	116	138	155
32.0	53	68	88	100	115	137	153
33.0	52	68	87	99	115	136	152
34.0	52	67	86	98	114	135	151
35.0	50	64	83	94	109	130	145
36.0	49	63	82	93	108	128	144
37.0	48	62	81	92	106	126	142
38.0	48	62	79	90	105	124	140
39.0	47	61	78	89	103	123	138
40.0	46	60	77	88	102	121	136
45.0	43	56	73	83	96	114	128
50.0	41	53	69	78	91	108	121
55.0	39	50	65	74	86	103	115
60.0	37	48	62	71	82	98	110
90.0	28	37	48	54	63	75	85
120.0	24	31	39	45	52	62	70
150.0	21	27	35	40	46	55	61
180.0	18	23	30	34	40	47	53
210.0	16	21	27	31	36	43	48
240.0	15	19	25	28	33	39	44
360.0	11	15	19	22	25	30	33

4.7.4 "C" VALUES VS ZONE

The runoff coefficients (C values) given in the Table 4.7.3 replace QUDM Tables 5.04.1, 5.04.2 and 5.04.3.

Table 4.7.3

RUNOFF COEFFICIENTS

Zone	C1	C2	C5	C10	C20	C50	C100
Central Business	0.72	0.77	0.86	0.90	0.95	1.00	1.00
Commercial, Local Business, Neighbourhood Facilities, Service Industry, General Industry, Home Industry and Residential B	0.70	0.75	0.84	0.88	0.92	1.00	1.00
Significant Paved Areas e.g. Roads and Car parks	0.70	0.75	0.84	0.88	0.92	1.00	1.00
Urban Residential A/Special Residential (urban) (including roads) Average Lot							
>= 600 m^2	0.63	0.67	0.75	0.79	0.83	0.91	0.95
>= 400 m^2 < 600 m^2	0.65	0.69	0.77	0.81	0.85	0.93	0.97
Urban Residential A/Special Residential (urban) (excluding roads) Average Lot							
>= 600 m^2	0.62	0.66	0.74	0.78	0.82	0.90	0.94
>= 400 m^2 < 600 m^2	0.64	0.68	0.76	0.80	0.84	0.92	0.96
Special Residential (non-urban), Park Residential, Rural Residential, Future Rural Living	0.59	0.63	0.70	0.74	0.78	0.85	0.89
Park and Open Space, Sports and Recreation, Rural	0.56	0.60	0.67	0.70	0.74	0.81	0.84

For the "special facilities", "special purposes", "extractive industry" and "special development" zones, the QUDM classifications shall be determined by the Pine Rivers Shire Council for each particular site.

4.7.5 DG VAVE PRODUCT

The d_g V_{ave} product shall be limited to 0.6 m^2/s, except where there is an obvious danger of pedestrians being swept away and drowned. In such circumstances d_g V_{ave} should be limited to 0.4 m^2/s.

4.7.6 MINIMUM PIPE AND MATERIAL STANDARDS

The minimum standards for acceptable materials are provided in Table 4.7.4

Table 4.7.4
MATERIALS STANDARDS

Stormwater Pipes	Roof & Allotment Drainage
SRCP Class 2 FRCP Class 2	SRCP Class 2 FRCP Class 2 u/O/M PVC Class SN4 uPVC dual wall

uPVC pipes are not to be used for other than roof water drainage in road reserves and public open space. All flush joint stormwater drainage pipes shall be fitted with “sand bands” or approved equivalent.

The minimum diameter of pipes shall be as follows:-

- urban pipe drainage and culverts - 300 mm
- non-urban pipe drainage and culverts - 375 mm
- roof water drainage - 150 mm
- allotment drainage - 225 mm

4.7.7 PIPELINE, MANHOLE AND CATCHPIT LOCATION (REFER QUDM SECTION 5.12)

Pipelines shall not be located under kerb and channel in roads. Pipe connection from catchpit to catchpit is generally not permitted except for drainage of sag points where catchpit to catchpit connection across the road is acceptable.

Pipelines from sag points shall only be taken through drainage reserves or pathways or parkland to a watercourse.

Pipelines in the road reserves shall generally be located on a 1.5 m alignment measured towards the road centreline from the invert of the kerb and channel. Manhole tops or access points shall generally be located to avoid wheel paths of vehicles. The alignment for larger or multiple pipelines shall be to the satisfaction of a Pine Rivers Shire Council engineer.

Where pipelines are located in allotments easements are to be provided.

Minimum cover to pipelines shall be accordance with QUDM Section 5.15, and Pine Rivers Shire Council standard drawings.

Manholes shall be provided at not greater than 120 m spacing along the pipeline. Refer also to QUDM Section 5.11.

Catchpit to manhole connections shall not exceed 20 m in length.

Catchpits shall be located at all low points in kerb and channel and when required to maintain required roadway unflooded widths.

Catchpits incorporating standard extended back inlets shall not be located on kerb returns of radius 9.0 m or less (cul-de-sacs excepted).

4.7.8 GRATED INLETS AND OUTLETS

Grates or trash racks may be required on stormwater system inlets where considered appropriate by a Pine Rivers Shire Council engineer. Specific design shall take into account possible debris loading from the upstream catchment and the impact of potential system failure should the inlet become blocked.

Proposals incorporating pipe outlets greater than 450 mm diameter (or equivalent box culvert) may be required by a Pine Rivers Shire Council engineer, to provide outlet grates where safety and/or security may be an issue. Outlet grates shall comply with the Pine Rivers Shire Council standard drawing.

4.7.9 DROWNED OUTLETS

Drowned outlets shall not be used without the approval of a Pine Rivers Shire Council engineer.

4.7.10 ROAD DRAINAGE PRACTICAL CAPACITY

The practical roadway flow capacity to be used for design major storm shall be taken as 80% of the theoretical value unless otherwise approved by a Pine Rivers Shire Council engineer. This reduction to theoretical value is required to provide for some loss of capacity due to debris in the channel, parked vehicles, and kerb and channel and pavement irregularities.

4.7.11 FLOODED WIDTHS FOR ROADWAY DRAINAGE

Table 4.7.5 replaces QUDM Table 5.09.1 and will apply using the major / minor road classifications as set out in Section 4.3.1 of the Design Standards for Stormwater Drainage.

Table 4.7.5

ROADWAY FLOW WIDTH AND DEPTH LIMITATIONS (LONGITUDINAL DRAINAGE)

Roadway Flow Width and Depth Limitation	Major Roads	Minor Roads
1. For Minor Storm		
a) Normal situation	Parking lane width (usually 2.5 m) or breakdown lane width. Where No K&C - the minor storm should be contained in Table drain.	(i) For K&C - full pavement width with zero depth at crown; where no K&C - contained within table drain. (ii) Where one way crossfall, to high side of road pavement but not above top of kerb on low side.
b) Where parking lane may be replaced by a through, acceleration, deceleration or turn lane.	1.0 m	Not applicable
c) Where road falls towards median	1.0 m	Not applicable
d) Pedestrian crossing or bus stops	0.45 m	0.45 m
e) At intersection kerb returns (including entrances to shopping centres and other major developments)	1.0 m (3) (4)	1.0 m (3) (4)
2. For Major Storm		
a) Where floor levels of adjacent buildings are above road level	(i) Total flow contained within road reserve (ii) Freeboard > 250 mm to floor level of adjacent buildings, and with maximum flow depth of 200 mm	(i) Total flow contained within road reserve (ii) Freeboard ≥ 250 mm to floor level of adjacent buildings, and with maximum flow depth of 300 mm
b) Where floor levels of adjacent buildings area below or, less that 300 mm above		
(i) Where 100 mm fall on footpath towards kerb;	50 mm above top of kerb	50 mm above top of kerb
(ii) Where less than 100 mm fall on footpath towards kerb.	Top of kerb	Top of kerb
(c) Other	As determined by a Pine Rivers Shire Council engineer	As determined by a Pine Rivers Shire Council engineer
3. Pedestrian Safety (Major and Minor Storms)		
a) No obvious danger	≤ 0.6 m^2/s	≤ 0.6 m^2/s
b) Obvious danger	≤ 0.4 m^2/s	≤ 0.4 m^2/s
4. Vehicle Safety		
Vehicle safety	0.6 m^2/s	0.6 m^2/s

4.7.12 ROOFWATER AND ALLOTMENT DRAINAGE

4.7.12.1 General

The design of roof water and allotment drainage shall be generally in accordance with QUDM Section 5.18

Table 4.7.6 outlines roof and allotment (interallotment) drainage requirements for various town planning zones. Designers should note that Type III drainage level is required for all Residential A properties.

Table 4.7.6

ROOF AND ALLOTMENT DRAINAGE REQUIREMENTS

Zones	QUDM Drainage Level
Special Residential (non-urban), Park Residential, Rural Residential, Extractive Industry, Rural, Future Rural Living	I or II *
Residential A and Special Residential (urban)	III*
Residential B, Commercial, Local Business, Neighbourhood Facilities, Home Industry, Service Industry and Industry zones.	III, IV or V *
Central Business	V *

* Easements over Type II and higher are required at no cost to the Pine Rivers Shire Council.

The requirements for easements are set out in these design standards, the Pine Rivers Shire Council Town Planning Scheme and various local laws.

The following are more detailed additional requirements:-

A. Residential A, Residential B and Special Residential (Urban) Zones (Zones 1, 2 and 3A)

(i) Where a proposed allotment in a subdivision has a gradient greater than 1 in 100 toward the road for the whole of the allotment and where a concrete or other paved footpath is proposed along the frontage of the allotment, the developer shall provide a roof water drainage pipe under the concrete footpath or other paved footpath and an approved connection into the kerb and channel.

(ii) Where a proposed allotment in a subdivision does not have a gradient greater than 1 in 100 toward the road for the whole of the allotment which would allow roof water to be discharged directly to the kerb and channel of the road fronting the allotment, the developer shall provide an underground

stormwater system including field inlet and junction pits for the purpose of intercepting and carrying roof water and overland stormwater runoff from the land. The pipe system shall be designed to carry the run-off resulting from the minor storm event.

An easement to the Pine Rivers Shire Council satisfaction shall be granted to the Pine Rivers Shire Council at no cost to the Pine Rivers Shire Council over the underground drainage.

B. Central Business, Commercial, Local Business, Neighbourhood Facilities, Home Industry, Service Industry and General Industry Zones (Zones 6, 7, 8, 9, 10, 11 and 12)

(i) Where a proposed allotment in a subdivision has a minimum fall of one in 100 towards the road for the whole of the allotment or where the stormwater drainage system proposed in the road shall be sufficient to accommodate the stormwater run-off from the minor storm for the whole of the allotment, the sub divider shall construct such number of catchpits and pipe inlets located in the road in front of the allotment and in a position and at a level capable of commanding the allotment for the purpose of draining roof water and overland stormwater run-off from the allotment. Where a concrete or footpath is also proposed the pipe inlet shall be constructed from the gully pit for a minimum distance of 300 mm past the alignment into the allotment.

(ii) Where the roof water and stormwater run-off from the proposed allotment in a subdivision cannot be accommodated in the manner provided for in the above sub-clause, the sub divider shall provide an underground stormwater system including gully and junction pits for the purpose of intercepting and carrying roof water and overland drainage from the land. The system shall be designed to carry the run-off from the major storm. An easement to the Pine Rivers Shire Council satisfaction shall be granted to the Pine Rivers Shire Council at no cost to the Pine Rivers Shire Council over the underground drainage.

C. Residential A, Residential B, Special Residential (Urban), Central Business, Commercial, Local Business, Neighbourhood Facilities, Home Industry, Service Industry and General Industry Zones (Zones 1, 2, 3A, 6, 7, 8, 9, 10, 11, 12)

Where a proposed allotment in a subdivision has a catchment area at its boundary greater than 2000 square metres, the sub divider shall provide an underground stormwater system including gully and junction pits for the purpose of intercepting and carrying roof water and overland drainage from the land. The system shall be designed to carry the run-off from the major design storm. An easement to the Pine Rivers Shire Council satisfaction shall be granted to the Pine Rivers Shire Council at no cost to the Pine Rivers Shire Council over the underground drainage.

4.7.12.2 Location and Construction

Interallotment drain lines (and or sewers) shall not exist along more than two boundaries of any allotment.

Inter-allotment drain lines shall generally be placed in the allotments which they serve directly (higher allotment) unless otherwise required by a Pine Rivers Shire Council engineer. Where future allotment earthworks are likely to reduce the effectiveness of the drainage system or where bunding is required to ensure capture of surface flows, the drain line and bund should be located in the allotment being protected by the bund (lower allotment).

Interallotment drain lines shall be located centrally in the easement or 1.0 m from the centreline of an adjacent sewer. (Refer also to Section 4.7.3 Minimum Easement Widths).

All interallotment drain lines shall be constructed with a full sand surround extending 100 mm above the crown pipe.

Pits are to be located at each change of direction, change of grade or junction of other interallotment drain lines. The maximum spacing of pits is to be 90 m.

Pits are to be the Pine Rivers Shire Council Standard Roof Water Drain Pit or Standard Field Inlets or other approved pre-cast pits. The designer shall confirm that the Pine Rivers Shire Council has issued product approval for any particular pre-cast pit system. The maximum depth of a roof water pit is 1.2 m.

Interallotment drain lines shall only be constructed from approved pipes (refer to Section 4.7.6 of the Design Standards for Stormwater Drainage).

4.7.12.3 Connection to Kerb and Channel

Roof water connections to kerb and channel shall use approved PVC kerb adaptors. Connections to the kerb shall not be made within 5 m upstream of a catchpit.

Level III interallotment drainage shall generally not be permitted to connect to kerb and channel unless specifically approved by a Pine Rivers Shire Council engineer.

4.7.12.4 “As Constructed” Information

“As constructed” information shall be provided in accordance with the Pine Rivers Shire Council adopted Guidelines for Engineering Drawings and shall be presented in the format indicated in the Pine Rivers Shire Council Sample Roof Water “As Constructed” Plan.

4.7.13 MINIMUM EASEMENT WIDTHS

A. Minimum easement widths for underground and drainage are shown in Table 4.7.7

Table 4.7.7

MINIMUM EASEMENT WIDTHS – UNDERGROUND DRAINAGE

Pipe Diameter	Easement Width *
Stormwater pipe ≤ 825 mm diameter	3.0 m
Stormwater pipe ≤ 825 mm diameter and Sewer pipe ≤ 225 mm diameter	4.0 m
Stormwater pipe ≤ 825 mm diameter	Easement boundary to be 1.0 m clear of outside wall of stormwater pipe

* A Pine Rivers Shire Council engineer may require additional easement width to be provided, in certain circumstances, in order to facilitate maintenance access to the stormwater system.

B. Minimum easement widths for open channels, catch drains etc.

All drainage works must be located within easement boundaries. For the construction of large open channels, consideration should be given for easement access by the Pine Rivers Shire Council maintenance vehicles and equipment. The minimum easement width for open channels are shown in Table 4.7.8

Table 4.7.8

MINIMUM EASEMENT WIDTHS – OPEN CHANNELS

Channel Type	Total Width of Easement
Concrete lined	Channel width + 3 m
Grassed lined	Channel width + 6 m *
Grassed swale batter slopes <1:4H	Swale width + 3 m
Catch drain/bank	3 m minimum (completely contained in easement)

* Refer to Section 8.13 QUDM

4.7.14 DRAINAGE OF SAG POINTS

All new roads shall be designed such that where possible overland flow for stormwater run-off shall be by way of the road system. Overland flow from sag points in the gradeline of the road shall drain through public garden and recreation space or through a drainage reserve.

Sag points which do not have an overland flow path through public garden and recreation space or through a drainage reserve shall not be approved by the Pine Rivers Shire Council if the following works cannot be provided:-

- a pathway shall be dedicated opposite the low point of the sag which shall be suitable for draining the sag point
- an underground stormwater system shall be provided in the pathway from the sag point to carry not less than the run-off resulting from a one in ten year ARI storm
- a depressed concrete footpath with a minimum width of 1.2 m shall be constructed in the pathway. The gradeline and the depressed cross-sectional area of the pathway shall be sufficient for it to act as an overland flow path from the sag point such that the adjoining allotments will be a minimum of 250 mm above the level of the stormwater flowing in the pathway resulting from the run-off from the design major storm.
- special consideration should be given to the possible position of driveways and building levels on lots adjoining drainage pathways at sag points

4.7.15 CATCHPITS

The following inlet types may be used:-

- standard catchpits as shown on various Pine Rivers Shire Council Standard Drawings
- "drain way" type inlets - it should be noted that pipelines running under kerb and channel are not permitted

Note: - Provision for blockage of all inlets, other than the Pine Rivers Shire Council standard catchpits, shall be as per QUDM Table 5.10.1.

4.7.16 FIELD INLETS (REFER QUDM SECTION 5.10.4)

The following inlet types may be used:-

- Pine Rivers Shire Council standard and side entry field inlets are shown on the various Pine rivers Shire Council Standard Drawings
- approved pre-cast units

The maximum depth of a field inlet or other chamber not constructed as a “manhole” is 1.8 m. Step irons shall be provided in any chamber in excess of 1.5 m deep.

4.7.17 MANHOLES (REFER QUDM SECTION 5.11)

- the Pine Rivers Shire Council standard manholes are shown on various Pine Rivers Shire Council Standard Drawings
- pre-cast manholes are generally not permitted, in stormwater drainage systems
- approved pre-cast access chambers may be used on roof and allotment drainage

4.7.18 FACTORY MANUFACTURED BENDS AND OFFTAKES

Factory manufactured fittings may be used as follows:-

- The use of factory manufactured concrete bends on stormwater lines of 1500 mm diameter or larger may be approved provided that the length of the section of the line in which the bend is placed (measured between manholes) is not greater than 120 m, and further that one bend only is used between manholes.

- The use of factory manufactured concrete off-take pipes on stormwater lines may be approved provided that:-

  - the length of the section offline in which the off-takes are used (measured between manholes) is not greater that 120 m
  - the diameter of the branch line is not greater that 450 mm and the branch line is not a main line

  - the angle between the branch line and the main line is not greater that 600 unless approved by a Pine Rivers Shire Council engineer

  - connections from catchpits to main lines shall be kept to a minimum. Two catchpits may be connected together to provide one connection to the main line. Length of connection from furthermost catchpit to main line shall not be greater than 20 m.

  - the branch line shall be straight from the last catchpit to the main line and shall be at the same angle to the main line as the factory manufactured off-take

  - branch lines shall be no deeper than 2.4 m measured from finished surface to invert of branch line

  - manholes shall be provided at top of main line

4.7.19 CURVED PIPELINES

Curved pipelines using splayed joints are generally not permitted.

4.8.0 DETENTION BASINS

4.8.1 GENERAL

A fundament principle of these design standards is that development should not increase either downstream peak flow rates or pollutant loads on downstream properties. This condition requires construction of detention basins (wet/dry) and/or water quality control devices.

Detention basins are generally employed for two reasons (a) to match an existing (possibly limited) downstream minor drainage system capacity and/or (b) to return runoff rates to pre-development conditions.

Detention basins shall be provided for all development in excess of 2 ha in area or where required by a Pine Rivers Shire Council engineer, to minimise the impact on existing downstream systems.

Where practical, detention basins should be provided with a low flow water quality treatment system to treat the first 15 mm of runoff. The storage time for these flows shall not be less than 24 hours and not greater than 48 hours. This requirement should not be confused with the Hydraulic Residence Time (HRT) required for nutrient/pollutant removal in Water Quality Treatment Devices. Where basins incorporate sporting fields, sufficient area just upstream of the outlet will be required to be reserved for water quality treatment facilities.

4.8.2 DEVELOPMENT OF CONCEPT PLANS

A preliminary concept plan should be prepared and submitted to a Pine Rivers Shire Council engineer for approval prior to detailed plans being prepared. The concept plan shall include the following details:-

- existing vegetation on the site
- a plan outlining the proposed basin
- the design volume between the invert of the outlet pipe and the spillway level
- the design flow capacity at spillway/crest level
- the inundation area of the basin for the major design storm event
- existing and future developments adjacent to the basin
- the capacity of the downstream minor drainage system

A detailed hydrologic model should also accompany the concept plan. The model should extend to downstream catchments to determine limiting peak flow rates from the proposed basin. The extent of downstream analysis applicable shall be to the satisfaction of a Pine Rivers Shire Council engineer.

4.8.3 LOCATION OF BASINS

It is preferred that basins are located in natural depressions requiring a minimum disturbance to the existing vegetation and minimum excavation. On flat sites or where extensive works are required, basins shall be designed so that they appear to be a natural land form. This will generally require a curved or serpentine form with side slopes having a variable gradient to provide contour relief.

Landform, geology and soils at the proposed site must be suitable for the development of the basin. If significant quantities of sediment are estimated to enter the storage area, there must be scope for periodic de-silting. Areas showing evidence of land instability or with a high water table should be avoided.

The basin shall ultimately be located in a drainage reserve unless otherwise approved by the Pine Rivers Shire Council. The drainage reserve will preferably be located to parkland to facilitate future maintenance.

Where possible, basins should be integrated into public open space (subject to safety requirements) and form part of the overall landscape plan for the development.

4.8.4 SAFETY OF BASINS

The consultant shall submit a separate safety report for the basin. This report will consider any standards or other requirement for warning signs, fencing, refuge mounds, depth indicators, safety rails and grates around outlet structures.

The basins structural behaviour under a PF flood should also be considered. A catastrophic failure should not occur under these conditions.

4.8.5 DESIGN OF OUTLET STRUCTURES

The design of the low level outlet structure shall include orifice plates, single or multiple level outlet pipes and/or other structures necessary to achieve the required flow attenuation. The intake to outlet pipes shall be protected with trash racks, bar screens, fencing or other devices to prevent blockage and to reduce hazard to persons trapped in the basins. Pillar-box type structures fitted with grates and screens are acceptable provided other design criteria and safety requirements are met.

4.8.6 DETAILED DESIGN

The design shall follow the guidelines set out in the QUDM and the following criteria shall be observed:-

- the piped outflows from the basin should match the capacity of the downstream drainage system. Where the nearest adjacent downstream drainage system is not immediately downstream, then the piped outflow should be scaled back to allow for the development of the intermediate catchment area. The capacity of the basin should ensure no overtopping for the major design storm.

- the depth of water in the basin should not exceed 1.2 m for the five year ARI event, 1.5 m for a 20 year ARI event and 2 m for a 100 year ARI event

- any tail water controls should be considered when assessing the hydraulic performance of the basin outlet
- a check should be made to confirm that the basin is not a "referable dam" which requires the approval from the Department of Natural Resources
- the high level outlet should be checked for adequate hydraulic performance during the PF event
- the side slopes of the basin should be 1 in 4 or flatter to allow for easy egress (refer also to Section 4.8.3 of the Design Standards for Stormwater Drainage)
- the downstream embankment of the spillway should have slopes of 1 in 6 or flatter for grass lining
- the top width of the spillway embankment should be 3 m minimum
- the effects of hydrography modification on total catchment performance may need to be assessed. Retardation basins, as well as decreasing urbanised hydrography peak flows, change the timing and shape of flood waves. Although local flows are reduced, the lagged wave may combine with another tributary downstream to produce an increase in flow. Catchments with several basins on different tributaries may combine to substantially increase flow.

The following additional criteria shall be observed for large dry detention basins proposed for playing fields or recreation uses:-

- base crossfall shall generally be 1(V) in 70(H) with a maximum slope length of 70 m. The absolute minimum crossfall shall be 1(V) in 100(H)
- single playing fields should generally be crowned along the longest centreline with drains provided around the perimeter of the base
- single playing fields with one way crossfall may be approved where the length of overland flow (rainfall runoff) does not exceed 70 m and crossfall is not less than 1(V) in 70(H)
- central drainage in the base is not permitted

4.8.7 SUMMARY OF REQUIREMENTS

A summary of detention basin design requirements are shown in Table 4.8.0

Table 4.8.0

DETENTION BASIN DESIGN REQUIREMENTS

A. SINGLE USE BASINS (RUNOFF RATE REDUCTION)

Design Parameter	Criteria
Depth/ARI	1.2 m for 5 year event 1.5 m for 20 year event 2.0 m for 100 year event
ARIs to be investigated for analysis	1, 5, 20, and 100 for critical durations
Structural stability of outlet	Check under PF conditions
Basin batter slopes	1V:4H max
Spillway embankment slopes	1V:6H max
Minimum spillway width	3 m
Pipe outflows	Match downstream pipe/culvert capacity
Safety report	Safety report to be provided by competent engineer

B. MULTI USE DETENTION BASINS (PLAYING FIELDS, PARKS, ETC)

Design Parameter	Criteria
Minimum crossfall	1:100
Desired crossfall	1:70
Maximum crossfall length	70 m

C. MULTI USE DETENTION BASINS (WITH SINGLE PLAYING FIELDS)

All of the above criteria apply including the following:-

Design Parameter	Criteria
Drainage location	Sited along perimeter
Crown location	Along longest centreline

4.9.0 OPEN CHANNEL DESIGN AND ANALYSIS

4.9.1 MANNING'S "N" VALUES

In the analysis of channels, three roughness co-efficient shall be used representing the well maintained, normal condition and poorly maintained or revegetated state to check velocity, capacity and freeboard requirements respectively.

The Manning's "n" values to be used for each category for each surface type are given in the following tables (based on US Army Corp of Engineers (HEC) and documented in their HEC-RAS Manual (Version 1, 1995)). Freeboard and flood development levels should be based on maximum values.

Table 4.9.0.A

NATURAL STREAMS

Type of Channel and Description	Manning's "n" Values		
	Minimum	Normal	Maximum
	Velocity Check	Capacity Design	Flood Level Check
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, lower stages, more ineffective slopes and sections	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or flood ways with heavy stands of timber and brush	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated Areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees	0.040	0.060	0.080
3. Medium brush	0.045	0.070	0.110
4. Dense brush	0.070	0.100	0.150
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.150
5. Dense trees with good undergrowth	0.120	0.150	0.200

Table 4.9.0.B

LINED OR BUILT-UP CHANNELS

Type of Channel and Description	Manning's "n" Values		
	Minimum	Normal	Maximum
	Velocity Check	Capacity Design	Flood Level Check
1. Concrete			
a. Trowel finish	0.011	0.013	0.015
b. Float finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	0.023
h. On irregular excavated rock	0.022	0.027	0.030
2. Concrete bottom float finished with sides of:-			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. Gravel bottom with sides of:-			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. Brick			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. Metal			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. Asphalt			
a. Smooth	0.013	0.013	0.015
b. Rough	0.016	0.016	0.020
c. Bitumen seal	0.015	0.015	0.020
7. Vegetal lining	0.030	0.040	0.050
8. Reno mattress/gabion	0.025	0.030	0.035
9. Concrete grout filled mattresses	0.022	0.025	0.028

Table 4.9.0.C

EXCAVATED OR DREDGED CHANNELS

Type of Channel and Description	Manning's "n" Values		
	Minimum	Normal	Maximum
	Velocity Check	Capacity Design	Flood Level Check
1. Earth, straight and uniform			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and weedy sides	0.030	0.040	0.050
3. Dragline-excavated or dredged			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. Rock cuts			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. Channels not maintained, weeds and brush			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.110	0.150

4.9.2 COMPOSITE CHANNELS

The treatment of composite channels shall be in accordance with Section 8 of QUDM. Velocity checks should be made at stages where each sub-section of the composite channel reaches capacity.

4.10.0 DEVELOPMENT RELATED ISSUES

4.10.1 DEVELOPMENT LEVELS

Development levels define the minimum fill level for a given development. They are based on a calculated Q100 (ult) flood level. Where a site is subject to many sources of flooding e.g. storm surge, river, creek or overland flows, the highest development level as calculated for each flooding mechanism shall be adopted. These levels may be available from the Pine Rivers Shire Council through previous flood studies.

Where this information is not available, the determination of the Q100 flood level is based on ultimate catchment and channel conditions. Ultimate catchment conditions are determined from the Pine Rivers Shire Council Strategic Plan and Development Control Plans. Ultimate channel conditions are based on maximum Manning's "n" values (see Section 4.9.1) and any proposed revegetation schemes outlined in the relevant catchment management plans (where available).

Information contained in the strategic plan will require modifications to the hydrologic model to account for planned land use e.g. by adjusting the fraction impervious/ urbanisation index for each sub-catchment.

The catchment management plans determine the long term channel conditions of the waterway. These conditions will affect the parameters entered into the hydraulic model e.g. a 20 m vegetated strip each side of the water will require higher roughness values.

Prior to modelling, however, the designer should first seek advice from a Pine Rivers Shire Council engineer regarding ultimate catchment and channel conditions.

Table 4.10.0 outlines the development levels for each land use category.

Table 4.10.0

DEVELOPMENT LEVELS

Zone	Minimum Area Within Allotment	Minimum Development Levels
General Industry, Service Industry	4000 m^2 (see Note 1)	Q100* + freeboard (see Note 2)
Residential A, Residential B, Special Residential, Future Urban, Neighbourhood Facilities, Local Business, Central Business, Home Industry, Commercial,	2000 m^2 (see Note 1)	Q100* + freeboard (see Note 2)
Park Residential, Rural Residential, Rural, Future Rural Living	1500 m^2	Q100* + freeboard (see Note 2)

Note:-

1. Where the allotment is less than the minimum area given then the whole of the allotment shall be at the minimum development level.
2. The Q100 calculation should be based on ultimate development of the catchment, and on the planned long term waterway condition as determined by a Pine Rivers Shire Council engineer.
3. The floor level should be set above the development level in accordance with the requirements of the Building Act, the Pine Rivers Shire Council local laws and relevant Pine Rivers Shire Council resolutions.

4.10.2 MINIMUM FREEBOARD

The freeboard is added to the calculated Q100 (ult) level to determine the development level. It varies from location to location as per Table 4.10.1

Table 4.10.1

MINIMUM FREEBOARD

Location	Minimum Freeboard
Existing natural watercourse	Greater of:- ▪ 750 mm; or ▪ the highest recorded flood level + 750 mm - calculated Q100 flood level
Engineered channels	Greater of:- ▪ 500 mm; or ▪ flood level in unmaintained channel + 250 mm flood level of maintained channel
Urban road drainage	Greater of :- ▪ 250 mm; or ▪ 150 mm + difference in level due to blocked catchpits or inlets.
Overland flowpaths	Greater of:- ▪ 250 mm; or ▪ flood level in unmaintained flow path + 150 mm - flood level of maintained flow path
Road drainage	▪ flow widths and depth limitations in accordance with Section 4.7.10 and 4.7.11 of the Design Standards for Stormwater Drainage

Note: - see Section 4.9.1 of the Design Standards for Stormwater Drainage for values of unmaintained channel roughness coefficients (Manning's “n” values).

4.10.3 DEVELOPMENT ADJACENT TO WATERCOURSES, CREEKS AND RIVERS

The following are the general requirements for development close to watercourses, creeks and rivers.

Table 4.10.2

Development Requirement	Criteria
Filling	Only permitted on land above the maximum of:- ▪ Q50 (ult) flood contour for creeks and watercourse ▪ Q100 (ult) flood contour for rivers ▪ highest recorded flood level
Park	Excludes land below the maximum of:- ▪ Q20 (ult) flood contour ▪ 20 m from low bank of waterway

In addition the following guidelines should be applied:-

- Channelling of creeks and watercourses for the purpose of maximising development area is not permitted by the Pine Rivers Shire Council.

- Any works that will have an effect on a defined watercourse shall also be approved by the Department of Natural Resources and/or any other controlling stakeholder. These works may include stormwater outlets, scour protection, diversions, widening or enhancements. This approval, including any license and conditions, shall be submitted with the application for approval of engineering drawings and specifications.

- The long term aim of the Pine Rivers Shire Council is to revegetate all of its major creek and river corridors. Accordingly all hydraulic calculations shall assume a dense vegetated buffer each side of the waterway, whether or not these buffers exist at present. A vegetated buffer of width 20 m and Manning's “n” of 0.15 each side of the waterway should be applied.

- Where additional revegetation is proposed beyond the normal 20 m wide buffer area e.g. nature reserves, an appropriate allowance for the additional vegetation shall be made.

- All watercourses, as defined under the Water Resources Act, will be required to be revegetated. The minimum density of native trees/bushes is 1 per 8 square metres. The plan will require a tree canopy to be established along the length of the watercourse. The revegetation plan is to be approved by a Pine Rivers Shire Council engineer prior to proceeding with the development.

- Existing watercourse erosion problems shall be repaired to the satisfaction of a Pine Rivers Shire Council engineer. Placement of gabions, reno mattresses, and/or rip rap will be the normal requirement, followed by re-establishment of appropriate vegetation.

- A bikeway/walkway may be located in the drainage reserve between Q2 (ult) and Q20 (ult) flood levels, but generally not closer than 20 m to low bank of the waterway. Refer also to the Pine Rivers Shire Council Bikeway Plan.

- All outlet treatment devices (GPTs, trash traps etc.) are to be located above the Q20 (ult) contour or the 20 m buffer distance from the low bank of the nearby waterway whichever is greater. Revegetation of receiving creeks, watercourses or drainage features will be required to minimise gully erosion. All proposed creek, watercourse or drainage feature vegetation plans should be submitted to the Pine Rivers Shire Council for approval.

- The developer will be required to place at least one sign (preferably at a waterway crossing associated with the development) indicating the creek name, its catchment area or source location, the name of the next major waterway downstream and the distance to this waterway. These signs shall be to the Pine Rivers Shire Council standard.

4.10.4 WATERWAY BANK STABILITY REQUIREMENTS

Where the Pine Rivers Shire Council considers bank stability may be a problem, the Pine Rivers Shire Council will require as a special condition of development, applicants with land adjacent to waterways to investigate the stability of the banks and propose development designs or construction works to ensure their long term stability, and to ensure that no allotments will be subject to erosion or landslip. The following guidelines detail general requirements necessary for investigations to satisfy the Pine Rivers Shire Council subdivision permit condition.

Investigation of stream bank stability shall be undertaken by registered professional engineering companies with expertise in the geotechnical and hydraulic engineering fields.

A. Site Investigation

The subsurface materials in the bank and stream bed shall be determined from surface and subsurface investigation. The extent of subsurface investigation shall be adequate to establish the geotechnical profile of the bank material throughout the site and accurately map the extent of erodible materials allowing prediction of the boundary of erosion potential and limit of future instability.

The investigation shall perform the following tasks:-

- locate the depth of recently deposited alluvial materials overlaying the site

- locate the depth to erosion resistance materials underlying the site

- obtain sample of representative materials for classifications, in accordance with the unified soil classification system, strength and emersion dispersion test assessment

- accurately locate by subsurface excavation the boundary between erodible and non-erodible materials

- identify areas of past instability on the site

- identify areas of filling

Any testing shall be carried out by a NATA registered laboratory.

B. Site Geology

The investigation shall review all information available on the geology of the area. This shall include maps prepared by the Geological Survey of Queensland and any other geological reports prepared for the land in the vicinity of the development.

The investigation shall include the stream channel and opposite bank so that a course evaluation of the stability of the opposite bank may be made.

All information shall be date collated to allow bank and stream bed movement mapping.

C. Stream Hydraulics

The investigation shall determine the velocity of flow for a range of design events up to the major design storm including the "bank full" event stream velocity shall be determined from lower bound roughness coefficients (see Section 4.9.0 of the Design Standards for Stormwater Drainage). Localised channel effects should be considered.

An assessment shall be made on the erosive potential of flood flows and any remedial action which may be required to redress the situation. This assessment should utilise, where available, previous studies and aerial photography.

D. Creek Morphology

An investigation shall be undertaken of the regime aspects of the waterway e.g. calculation of dominant flows, widths, depths, pool distance, riffles etc. Evidence of any aggradations and degradation of the low flow channel should be documented.

The investigation shall also assess the potential for movement of the watercourse within the floodplain and the effect of possible changes in stream sediment supply and/or movement rates.

E. Bank Stability

Analysis should be undertaken to establish the stability of the bank slopes. This assessment should be based on engineering geotectonical principles and soil parameters determined from laboratory analysis or past experience with similar materials. The conclusions with regard to stability shall account for long term degradation of the bank materials by environmental conditions, with particular emphasis to the action of water on the soil or rock composition.

Development of land with freehold title shall only be permitted for areas which are considered stable and where provision is made for an appropriate buffer zone which shall incorporate land suitable for access to the bank by maintenance vehicles.

The preferred solution for natural waterways is to retain the existing native vegetation on the stream banks. A buffer shall be provided for this vegetation to ensure the long term viability of this environment.

F. Remedial Works

Details shall be provided showing the extent and type of work proposed. The existing environment should be enhanced by the proposed works. Provision of a vegetation buffer and bio-engineering techniques are the preferred treatment and shall be used wherever possible.

Structural works shall be founded on non-erodible material or below the movement zone expected in extreme flooding events.

The report shall include recommendations on treatment required for local catchment stormwater drainage outlets. The discharge from outlets shall be directed to erosion resistant surfaces or contained in protected channel treatments.

G. Report

A report which details all aspects of the investigation and analysis shall be prepared. The report shall include a detailed plan of the subject land. The plan shall show:-

- cadastral boundaries on the site
- proposed RP boundaries
- site contours
- the location of both banks of the waterway
- existing erosion problems
- geological boundaries
- geological features

H. Ground Survey

Prior to the approval of engineering drawings, a ground survey is to be carried out where necessary to identify the limits of the Q50 (ult) (creeks) or Q100 (ult) (rivers) and the 20 year ARI event. The top of the banks of the creek and the area for practical access along the creek should also be identified.

Where the bank/floodplain is suitable for inclusion as park, the extent of the Q20 (ult) should be used to determine the extent of the park provided. Filling is not permitted in the area below the Q50 (ult) flood level adjacent to creeks or (Q100 (ult) flood level adjacent to rivers).

I. Defined Watercourses

After approval of the report and where remedial works are required in a watercourse as defined in the Water Resources Act 1989, the applicant shall obtain an approval of and appropriate licenses from the Queensland Department of Natural Resources. These approvals or licenses shall be forwarded to the Pine Rivers Shire Council to obtain approval to proceed with the remedial works.

On completion of the works, written evidence that the works have been completed to the satisfaction of the Department of Natural Resources shall be provided prior to sealing of plans of survey.

4.11.0 ENVIRONMENTAL REQUIREMENTS

4.11.1 BEST MANAGEMENT PRACTICES

Designers are advised to refer to the Pine Rivers Shire Council Stormwater Drainage Best Management Practices section of the Design Manual for relevant water quality design parameters. The following are broad guidelines.

4.11.2 WATER QUALITY TREATMENT

- Receiving water quality standards shall be in accordance with the ANZECC standards.
- Oil/grit separators are to be provided for car parks or handstand areas of commercial or industrial developments where other catchment based water quality treatment devices are not available.
- The Pine Rivers Shire Council standard weir type sediment and trash traps are to be provided on all outlets of stormwater drainage pipes serving catchments greater than 2 ha.
- GPTs designed for the collection and easy removal of sediment and trash are to be provided on the outlets of stormwater drainage systems serving catchments greater than 5 ha.
- All detention basins are to include a low flow water quality treatment facility. The minimum storage time is 24 hours and the maximum storage time is 48 hours.
- Water quality control ponds, lakes and or artificial wetlands are to be provided where a natural drainage feature traverses the development. Generally, these facilities will be applicable to subdivisional developments which are in excess of 5 ha or where a Pine Rivers Shire Council engineer determines that the development will have a detrimental effect on the quality of the receiving waters.
- Existing watercourses or drainage features shall be re-vegetated with native species in accordance with an approved landscaping plan.

4.11.3 PROPOSED RECREATION/ORNAMENTAL LAKES

A Lake Water Quality Management Plan is required for proposed lakes within developments, be they natural or created. This report will include an assessment of the long term maintenance of lake water quality. Water treatment facilities such as buffer zones, sedimentation basins, GPTs, trash traps, wetlands, water pollution control ponds, etc. shall also be documented.

Prior to commencing this report, the developer must submit to the Pine Rivers Shire Council for agreement,

- the terms of reference and
- the company and names of the persons proposed to undertake this report.

4.11.4 CONTROLS DURING THE CONSTRUCTION STAGE

A sediment and runoff control management plan called a "Silt Management Plan" is required to be submitted to the Pine Rivers Shire Council prior to commencement of any construction or clearing for approval by a Pine Rivers Shire Council engineer.

All approved sediment and runoff management works shall be constructed as far as practical to the satisfaction of a Pine Rivers Shire Council engineer, prior to commencement of site clearing works.

A. Design Criteria for Runoff Control Works

The basis of design of runoff control works is the Institution of Engineers (Qld.) Soil Erosion and Sediment Control - Engineering Guidelines for Queensland as amended.

For multi stage developments the plan is also required showing temporary drainage/diversion works to ensure that runoff from future stages does not adversely affect residential lots already created. These works shall be capable of diverting the runoff resulting from the ten year ARI storm.

B. Design Criteria for Sedimentation Basins

Permanent and temporary sedimentation basins are required at the downstream end of all proposed developments whose total drainage area is in excess of 2 ha or where in the opinion of a Pine Rivers Shire Council engineer, there is potential for substantial sediment generation from the site. The basis of design of sedimentation basins is the Institution of Engineers (Qld.) Soil Erosion and Sediment Control - Engineering Guidelines for Queensland as amended.

Table 4.11.0 highlights the minimum design parameters.

Table 4.11.0

Design Parameter	Criteria
Design storm	10 year, 6 hour storm
Minimum basin volume	200 cubic metres per disturbed hectare
Spillway design	10 year ARI
Structural adequacy	100 year ARI

For multistage developments, sedimentation basins shall be designed to accommodate all stages contained in the contributing catchment.

Temporary "trash racks" shall be provided at either individual drainage outlets or a single rack at the sedimentation basin itself.

The hydraulic and structural adequacy of the embankment of the basin shall be checked for the major design storm event to avoid damage caused by the ensuing flood wave should the embankment fail.

4.11.5 EXISTING WATER BODIES

Where existing water bodies i.e. dams and lakes are to be retained and incorporated into a development the developer shall provide a water quality report including recommendations for any works required to achieve water quality criteria appropriate to its intended use. The following issues shall be addressed in the report:-

- The provision of water quality criteria:-
  - quantification of acceptable pollutant loads
  - the need for artificial mechanisms to prevent stratification
  - the need for water quality control devices
  - maintenance requirements
  - ongoing monitoring requirements

The works shall generally include gross pollutant traps, sediment controls and nutrient reduction mechanisms. The works shall be designed for ease of maintenance. High maintenance designs shall not be approved.

All works shall be designed to the following requirements:-

- design for easy access and maintenance by the Pine Rivers Shire Council machinery
- design for appropriate maintenance intervals
- design for safety including appropriate fencing as applicable
- all works to be included in drainage reserve

Subject to the Pine Rivers Shire Council approval, existing water bodies may be converted to wet retention basins in accordance with QUDM Section 9.03.8.

4.11.6 STORMWATER QUALITY IMPROVEMENT (PERMANENT WORKS)

Where stormwater drainage discharges to a river, creek, watercourse, channel or gully appropriate permanent stormwater quality improvement works shall be provided. These works shall generally include gross pollutant traps, trash racks, sedimentation traps or basins and may also include nutrient reduction mechanisms.

All works shall be designed to the following requirements:-

- design for easy access and maintenance by the Pine Rivers Shire Council machinery
- design for an appropriate maintenance interval to the satisfaction of a Pine Rivers Shire Council engineer
- design for safety including appropriate fencing as applicable
- all works to be included in drainage reserve

4.11.7 GROSS POLLUTANT TRAPS

Gross pollutant traps shall be installed on all trunk drainage systems which drain areas greater than 5 ha. The methodology to be adopted for design is the ACT Planning Authority Gross Pollutant Trap Guidelines. The following are key design criteria. These criteria supersede those documented in the ACT Planning Authority Gross Pollutant Trap Guidelines.

- Construction of major GPTs (> 20 ha) should be avoided where possible because of poor aesthetics. Minor GPTs should instead be constructed on upstream pipe systems.

- Where open or major GPTs are proposed, the developer will be required to demonstrate that no other alternative is available. This may require re-consideration of alternate subdivision layout designs to facilitate installation of one or more minor/underground GPTs.

- The outlet pipe for internal GPTs should be designed for the same capacity (average recurrence interval) as the inlet pipe. The trap however should be designed for a Q1 flow i.e. sediment contained flows in excess of Q1 will not be trapped. Finally a hydraulic gradeline calculation should be carried out through each GPT. Each component hydraulic loss should be individually assessed.

The following design parameters shall apply to enclosed minor GPTs:-

Design

- Degree of urbanisation (U) = 100% for urban areas with up to 15% open space

- Average annual retention (P) = 70% of grain sizes ≥ 0.04 mm for discharge to waterways *

  * This figure may not be appropriate for discharge to water bodies such as lakes and dams.

- Minimum trap area = 8 m^2

- Maximum trap area = 24 m^2

- Trap width = 2 m

- Maximum trap length = 12 m

- Trap length = multiple (integer) × 2 m

- Sediment density (ρ_s) = 2.65t/m^3

- Sediment porosity (λ') = 0.42

- Average frequency of cleaning = twice per year (when GPT is half full)

- Minimum depth of trap below trash rack = 0.5 m

- Maximum peak average velocity during the one year ARI storm event = 0.3 m/s

- Check velocity for trap half full of sediment and trash rack 50% blocked is < 0.3 m/s
- Maximum inlet pipe approach velocity to trap the one year ARI storm event = 1 m/s
- Maximum total depth of GPT = 3.5 m
- Minimum trash rack height = 500 mm
- Maximum trash rack height = 1200 mm
- Check trash rack is not overtopped the one year ARI storm event with the rack 50% blocked
- Check impact of fully blocked trash rack with trap 50% full of sediment on the minor and major flow designs

Locating the GPT

- minimum setback from the edge of the geomorphic stream channel edge = 10 m*

  * Setback may be increased where bank stability or erosion potential is considered by a Pine Rivers Shire Council engineer to warrant additional distance.

- minimum clearance to residential allotments = 10 m where significant screen planting is provided
- access for maintenance must be flood free in the 20 year ARI storm event

Landscaping is required to all GPTs to improve the aesthetic quality of the installation

4.11.8 WATER POLLUTION CONTROL PONDS

Water pollution control ponds are permanent water areas used for the removal of sediment and nutrients. They are essentially sedimentation systems and differ from wetlands in that they do not have formal macrophyte areas contributing to the removal of sediment and nutrient. Accordingly, their removal efficiencies are less than those for wetlands.

They should be used for development areas in excess of 5 ha and, where possible, flood detention storage should be incorporated into their design.

Their design should be based on the ACT Planning Authority - Water Pollution Control Pond Design Guidelines. The designer is also referred to the Pine Rivers Shire Council Design Standards for Stormwater Drainage Works - Best Management Practices.

As a guide, the pond volume should be 300 cubic metres per contributing hectare. This approximates to a volumetric runoff coefficient of 0.6 and an average residence time of approximately two weeks. The area of the pond should be at least 2% of the contributing catchment area. This limits the average depth of the pond to 1.5 m.

The submission to the Pine Rivers Shire Council should show how the proposed basin will return nutrient and suspended sediment loads to acceptable levels to the satisfaction of a Pine Rivers Shire Council engineer.

A development shall not increase pollutant loads on downstream properties. Further, calculated pollutant concentrations from the development should not exceed the appropriate ANZECC standards.

The basis for assumed nutrient and suspended solids reduction curves should be provided in the submission. Finally, a safety report should accompany the submission to the Pine Rivers Shire Council.

The consultants' attention is drawn to the requirements of Section 4.11.3 and Section 4.11.5 of the Design Standards for Stormwater Drainage

4.11.9 ARTIFICAL WETLANDS

Artificial wetlands are to be constructed for the following situations:-

- for urban development in excess of 5 ha located in any of the Pine Rivers Shire water supply catchments
- for urban development in excess of 5 ha which discharges to any of the Pine Rivers Shire Council conservation areas
- for any development in excess of 5 ha which discharges directly to any of the Pine Rivers Shire waterways or estuary areas
- as a stormwater quality treatment facility to achieve appropriate ANZECC water quality standards

The design of wetlands is necessarily a multi-disciplinary process. Accordingly only consultants of known competence in this area should be engaged to undertake the design.

The submission to the Pine Rivers Shire Council should show how the proposed wetland will return nutrient and suspended sediment loads to acceptable levels to the satisfaction of a Pine Rivers Shire Council engineer.

A development shall not increase pollutant loads on downstream properties. Further, calculated pollutant concentrations from the development should not exceed the appropriate ANZECC standards.

The basis for assumed nutrient and suspended solids reduction curves should be provided in the submission. Finally, a safety report should accompany the submission to the Pine Rivers Shire Council.

The methodology set out in the Queensland Department of Primary Industries - Interim Guidelines on the Planning, Design and Management of Artificial Wetlands in Queensland is to be used in the design of wetlands. The designer should also refer to Section 3 of Design Standards for Stormwater Drainage.

The following are broad design guidelines:-

- the minimum wetland area should be 3% of the contributing catchment area
- flow routing through macrophyte areas should be maximised

- a minimum 30% macrophyte area should be provided
- sediment deposition areas should be stabilised from wind, wave or current resuspension through:-
  - sufficient water depth (sediment basins only)
  - physical barriers (energy dissipaters, protective berms etc.)
  - sufficient density of nearby macrophyte plantings
- minimise potential for deoxygenation of surface sediments through:-
  - minimise areas deeper than 3 m
  - regularly maintain sedimentation areas
  - the following options should be considered:-
    - installation in-situ aeration devices
    - recirculation of water
    - chemical treatment
- a detention capacity of not less than three days and not more than seven days should be provided to discharge the one year ARI Design flood event
- ensure integrity of all structures and bank areas to withstand a Q100 design flood without structural damage or significant loss of vegetation
- wetland shape and landscaping should be integrated with surrounding topography and parkland through:-
  - wall structure contoured and planted with compatible tree, shrubs and ground covers
  - where practicable inclusion of rock cascade feature to improve oxygenation
  - varied sub-surface topography and shape to encourage some diversity in macrophyte species and variation in vegetation height
  - use soft edges with aquatic and semi aquatic vegetation above and below the shoreline
- plant native plant species of South East Queensland
- incorporate plantings of sub-aquatic species in ephemerally wet areas (generally within 1.5 m above the normal operating level)

- provide ease of maintenance facilities which allows for:-
  - access for sediment dredging equipment
  - access for weed removal and macrophyte harvesting
  - litter and gross sediment trapping
- minimise mosquito potential
  - eliminate potentially stagnant areas
  - provide for fish movement across structure (where appropriate)
  - prevent build up of sediments which may create isolated pools
- artificial habitats for fish refuge and breeding should be provided

4.11.10 DESIGN CRITERIA FOR WATER QUALITY TREATMENT FACILITIES

The assessment for water treatment facilities (such as wetlands and water quality control ponds) should be cross-checked with the following “deemed-to-comply” parameters.

A. Average Annual Rainfall

The average annual rainfall (AAR) to be adopted for use in Pine Rivers Shire shall be as follows:-

- average annual rainfall = 1240 mm

B. Runoff Coefficients and Pollutant Export Rates

The following annual volumetric runoff coefficients and pollutant export rates shall apply:-

Table 4.11.1

Town Plan Zone	AVRC	Loading Rate (kg/ha)		
		TP	TN	SS
Residential A	0.50	1.6	10.3	950
Residential B	0.65	2.0	10.5	1050
Special Residential (urban)	0.50	1.6	10.3	950
Central Business	0.70	2.3	10.7	1150
Commercial	0.65	2.1	10.6	1100
Local Business	0.65	2.1	10.6	1100
Neighbourhood Facilities	0.60	2.0	10.5	1050
Home Industry	0.50	1.6	10.3	950
Service Industry	0.65	2.1	10.6	1100
General Industry	0.70	2.3	10.7	1150
Future Urban	0.30	0.7	7.4	290
Special Residential (non-urban)	0.35	1.1	9	570
Park Residential	0.35	1.1	9	570
Rural Residential	0.30	0.9	8	400
Extractive Industry [1]				
Rural	0.30	0.7	7.4	290
Future Rural Living	0.30	0.7	7.4	290
Park and Open Space	0.35	0.8	7.8	380
Sports and Recreation	0.35	0.9	8.5	750
Forest	0.15	0.08	1.0	50

AVRC = Annual Volumetric Runoff Coefficient
TP = Total Phosphorus
TN = Total Nitrogen
SS = Suspended Solids

[1] AVRC and Pollutant Export Rate from Extractive Industry to be approved by the Pine Rivers Shire Council

C. Water Quality Guidelines

In order to rationalise the calculation process in terms of the stormwater quality system performance on an annual basis, rather that on specific events i.e. EMCs, pollutant concentrations need to be expressed in terms of Annual Mean Concentrations (AMCs). The following table lists AMCs which are considered to be appropriate to the design of stormwater drainage systems which are in keeping with maintaining ANZECC Water Quality standards for receiving water bodies.

Table 4.11.2

ANNUAL MEAN CONCENTRATION (AMC) (MG/L)

TP		TN		SS
Limiting	Non Limiting	Limiting	Non Limiting	Design
0.05	0.08	0.5	0.7	50

The compliance criteria are governed by the limiting nutrient. In freshwater system, streams and lakes, the limiting nutrient is phosphorus and the controlling AMC is 0.05 mg/L. The corresponding permissible total nitrogen AMCs 0.8 mg/L. In the case of an estuarine (nitrogen limited) system the controlling nitrogen AMC is 0.5 mg/L and the permissible phosphorus AMC is 0.08 mg/L.

D. Pollutant Retention Times

The required pollutant retention criteria for a water quality control device can be calculated from the catchment export rate and the required pollutant concentration. The necessary retention time for the pollution control device is determined from Table 4.11.3.

Table 4.11.3

HYDRAULIC RESIDENCE TIME
REQUIRED FOR POLLUTANT RETENTION (DAYS)

Pollutant Retention %	Sedimentation System			Wetland		
	TP	TN	SS	TP	TN	SS
10	0.9	1.2	0.3	0.3	0.7	0.17
15	1.3	2.2	0.5	0.7	1.3	0.26
20	2.0	3.9	0.6	1.0	2.2	0.34
25	2.9	6.9	0.9	1.7	3.0	0.6
30	4.4	12	1.3	2.1	3.7	0.8
35	6.5	21	1.8	2.8	4.4	1.2
40	10	38	2.5	3.4	5.4	1.5
45	14	67	3.5	4.3	6.9	1.8
50	21	119	4.8	4.9	9	2.3
55	32	210	6.8	5.7	12	2.9
60	48		10	6.9	19	3.3
65	71		13	8.0	37	4.2
70	106		19	10	57	6
75	158		26	12		8
80	235		37	16		11
85			51	25		18
90			72	50		29
95			101			48

E. Water Pollution Control Pond or Wetland Volume

After determining an appropriate water quality treatment system, it is essential to provide adequate storage volume to ensure that the required hydraulic residence time is achieved. Such storage volume is measured below the system outlet invert level.

The required minimum storage volume can be determined from the following formula:-

$$\textit{Storage Volume} = \frac{HRT}{365} \; ARV$$

Where ARV is the mean annual runoff volume and HRT is the hydraulic residence time. The HRT is calculated as (pond volume/mean annual flow) and can be thought of as the time required for complete interchange of pond volume under average flow conditions.

Combinations of water quality control devices may be needed to meet the water quality guidelines at the receiving water body.

F. Sediment Forebay

A sediment forebay shall be provided at the inlet to wetlands and water quality control ponds to facilitate the removal of coarse sediment. The "deemed-to-comply" criteria for sediment forebay volume is 5% of the total pond volume for a fully developed catchment. The forebay should be designed for ease of access and sediment removal. The design maintenance cycle should be five years.

G. Weir Level

The downstream weir should be set to the Q1 flood storage level i.e. spilling, occurring for events greater the Q1 magnitude.

H. Flood Storage Volume

Wetlands and extended detention ponds are required to have sufficient flood storage such that the pond will drain back to normal water level from weir level in 72 hours. The necessary flood storage volume should be determined using a runoff routing model.

I. Summary

Table 4.11.4 provides a summary of the compliance criteria for a water quality control pond and artificial wetlands:-

Table 4.11.4

Design Parameter	Criteria
Average annual rainfall	1240 mm
Annual volumetric runoff coefficient	As for relevant zone
Pollutant export rates	As for relevant zone
Design AMC	As for limiting nutrient
Maximum depth	3 m
Depth of reed bed zone	0.2 - 0.5 m
Spillway crest level	Q1
Length of width ratio	>3:1 and <10:1
Flood storage depth	1 m
Flood storage release time	72 hours
Sediment forebay size	5% of pond volume

J. Worked Example

The following example demonstrates the metrology used in determining an appropriate size for an artificial wetland:-

Situation

A wetland is required to treat runoff from a 5 ha site consisting of:-

- 4 ha residential A
- 0.5 ha residential B
- 0.3 ha park land
- 0.2 ha forest

The catchment outlet discharges into a natural creek.

Solution

Step 1: Determine the limiting nutrient, creek system - > phosphorus limited

Step 2: Average rainfall, mm = 1240

Step 3: Calculate pollutant loads and annual average runoff

Landuse	Area(ha)	AVRC	ARV(ML)	TP		TN		SS	
				Load Rate kg/ha	Load kg	Load Rate kg/ha	Load kg	Load Rate kg/ha	Load kg
Res A	4	0.50	24.8	1.6	6.4	10.3	41.2	950	3800
Res B	0.5	0.65	4.03	2.0	1.0	10.5	5.3	1050	525
Park	0.3	0.35	1.30	0.8	0.2	7.8	2.3	380	114
Forest	0.2	0.15	0.30	0.08	0.0	1.0	0.2	50	2
Total:	5		30.4		7.6		49.0		4441

Step 4: Calculate pollutant concentration, required retention and wetland size

Pollutant	Runoff Concentration (mg/l)	Target Concentration (mg/l)	Required Retention (%)	Required HRT (days)	Required Volume (ML)
TP	0.25	0.05	80	16.0	1.3
TN	1.61	0.8	50	9.0	
SS	146	50	66	4.6	

Step 5: Calculate final pollutant concentrations based on design wetland volume

Pollutant	HRT (days)	Actual Retention (%)	Outflow Concentration (mg/l)
TP	16	80	0.05
TN	16	50	0.63
SS	16	84	20.9

Step 6: Calculate the minimum size of the sedimentation forebay

Wetland Volume (ML)	Forebay Size % Wetland	Forebay Volume (ML)
1.3	5	0.1

4.11.11 DISCHARGE TO WATERWAYS

A. General

The methodologies set out in QUDM Section 7 shall apply in the determination of appropriate levels and location of stormwater outlets to waterways.

B. Discharge to Tidal Areas

Stormwater runoff from urban areas discharging to tidal waters should, as minimum, be treated using a GPT and vegetated overland flow path. Discharge from the GPT should be sized for a one year ARI design storm. Surcharge from the GPT should be directed overland through a designated vegetated area. An easement will be required to be transferred free of cost to the Pine Rivers Shire Council over this overland flow path. (Refer to Section 4.7.13 - of the Design Standards for Stormwater Drainage for Minimum Easement Widths.)

Tidal waters should be prevented from entering the GPT. In certain circumstances this may require construction of tidal flap valves. However, the Developer will be required to demonstrate that no other reasonable alternatives are available.

Developers shall also contact relevant government departments to ascertain what approvals are necessary e.g. approvals under Section 86 of the Harbours Act. These approvals shall be included in the developer's submission to the Pine Rivers Shire Council.

C. Discharge to Freshwater Water Bodies

Piped stormwater runoff from urban development areas shall be treated prior to discharge to freshwater water bodies e.g. lakes, dams, ponds. As a minimum requirement a GPT should be used as the treatment facility. Preference shall be given to the use of underground or minor GPTs. The outlet pipe shall be designed for a one year ARI design storm and be submerged, with the pipe obvert, below the ambient water level. Flows in excess of the one year ARI design storm shall be directed along a designated vegetated overland flow path. An easement will be required to be transferred free of cost to the Pine Rivers Shire Council over this overland flow path.

Ponded waters should be prevented from entering the GPT. In certain circumstances this may require construction of flap valves. However, the developer will be required to demonstrate that no other reasonable alternatives are available.

4.12.0 MISCELLANEOUS DESIGN REQUIREMENTS

4.12.1 OVERLAND FLOWPATH AND SWALE DRAIN DESIGN

Overland flow paths or swales usually consist of a shallow depth of water, which gives rise to a higher value of Manning's "n" than used for deeper grassed channels. The classification of various vegetal types is provided in Table 4.12.0

Table 4.12.0

Average Length of Vegetation	Degree of Retardance	Example
150 to 250 mm	C	Long grass. Most grasses can be kept to this length with periodic slashing
50 to 150 mm	D	Well maintained grass, e.g. Townhouse Developments
0 to 50 mm	E	Lawn cut short, burned grass or bare earth

Charts 1, 2 and 3 in the "Summary Document", Section 5 of the Design Standards for Stormwater Drainage give the Manning's "n" calculation for the vegetal types C, D, and E respectively. They are sourced from charts presented in the Queensland Department of Main Roads Design Manual, Volume 2.

Overland flow paths should be designed as follows:-

Table 4.12.1

Criteria	Vegetal Type
Flooding check	C
Channel dimensions	D
Velocity check	E

The minimum longitudinal grade of overland flow paths shall be 0.4% unless otherwise approved by a Pine Rivers Shire Council engineer.

Calculation Methodology for the Design of Grassed Overland Flow Paths

1. Determine required flow (Q0L) to be carried by overland flow path e.g. Q100-Q5.

2. Estimate size of channel for preliminary sizing assumes velocity of 1 m/s.

3. Calculate hydraulic radius (area/wetted perimeter).

4. Calculate longitudinal slope i.e. average slope over entire length.

5. Calculate Manning's "n" from for Charts 1, 2 and 3 for vegetal types C, D and E respectively.

6. Check for adequate capacity using Manning's "n" value for vegetal type D using Manning's equation (Chart 2).

7. Perform velocity check, using Manning's "n" derived from Chart 3 (vegetal type E). Velocity should be less than 2 m/s. If greater than 2 m/s increase cross-sectional area or introduce drops structures along flow path.

8. Perform flooding check using Manning's "n" derived from Chart 1 (vegetal type C). Use this value to calculate (V_c). The increase in height can then be approximated by (Q_{ol} - V_c *A) / (V_c *W), where W is the width of the overland flow path, and A is the flow area derived from Step 6 (vegetal type D). The increase in flood levels should not flood adjacent properties.

9. Iterate Steps 6, 7 and 8 until all conditions are satisfied.

4.12.2 HYDRAULIC DESIGN OF CULVERTS

Hydraulic design of culverts, bridges and flood ways shall conform with the latest edition of Austroads Waterway Design, "A guide to the Hydraulic Design of Bridges, Culverts and Floodways" except as amended by the Pine River Shire Council Design Manual.

4.12.2.1 Road Cross Drainage (Culverts)

Road cross drainage (culverts) must be provided to all road crossings of any watercourse, waterway, gully or drainage feature. The impact of backwater upstream of culverts must be checked with particular attention being paid to maintaining the required minimum freeboards for the 100 year ARI for properties. Design allowance for debris land and appropriate blockage factors shall be approved by a Pine Rivers Shire Council engineer. Box culverts shall be used when a Pine Rivers Shire Council engineer considers that stream debris load will be significant.

A. Urban Areas

Minor Streets

Culverts must be designed to accept not less than the full flow for the minor system ARI. In some circumstances it may be necessary to provide culverts of greater capacity to ensure that the 100 year ARI backwater does not reduce the required minimum freeboards for upstream properties. For the major system ARI the flow passing over the road shall be limited as follows:-

- the maximum flow depth at any point on the roadway shall be 200 mm
- the road crossing shall be depressed to ensure that the flow width over the road is similar to the natural flow width
- the product of the flow depth and flow velocity ($d_g V_{ave}$) shall not exceed 0.4 m^2/s

Major Roads

Culverts must be designed to accept not less than the full flow for the major system ARI. In some circumstances it may be necessary to provide culverts of greater capacity to ensure that the 100 year ARI backwater does not reduce the required minimum freeboards for upstream properties.

B. Rural Areas

Minor Roads

Culverts shall generally be designed to accept not less than the full flow for the minor system ARI. In exceptional circumstances a Pine Rivers Shire Council engineer may accept culverts of lower capacity where the road provides access to less than 15 allotments and, in the opinion of a Pine Rivers Shire Council engineer, the construction of a culvert to normal standards is not reasonably required.

The absolute minimum design flow for any road culvert shall be the two year ARI storm.

For the major system design the following design parameters apply:-

Table 4.12.2

Road Classification	Maximum Duration of Inundation	Maximum Flow Depth Over Road
Access road (<15 lots)	6 hours	(see Note 1)
Access road (>15 lots)	6 hours	200 mm (see Notes 2, 3 & 4)
Collector road	4 hours	200 mm (see Notes 2, 3 & 4)

Note:-

1. Road closure - design as a floodway and provide signage and depth markers.
2. The maximum flow depth at any point on the roadway shall be 200 mm.
3. The road crossing shall be depressed to ensure that the flow width over the road is similar to the natural flow width.
4. The product of the flow depth and flow velocity ($d_g V_{ave}$) shall not exceed 0.4 m^2/s.

Major Roads

Culverts must be designed to accept not less that the full flow for the major system ARI. In some circumstances it may be necessary to provide culverts of greater capacity to ensure that the 100 year ARI backwater does not reduce the required minimum freeboards for upstream properties or building areas.

In exceptional circumstances a Pine Rivers Shire Council engineer may accept culverts of lower capacity provided that:-

- the culvert capacity is not less that the full flow for the minor system ARI
- the 100 year ARI backwater does not reduce the required freeboard for upstream properties or building areas
- the maximum flow depth at any point on the roadway shall be 200 mm
- the product of the flow depth and flow velocity ($d_g V_{ave}$) shall not exceed 0.4 m^2/s

4.12.3 SCOUR PROTECTION OF OUTLETS

The discharge of stormwater from outlets on to rural residential and park residential allotments or park, open space reserves and road reserves shall consider the dissipation of energy and scour protection. The following are minimum requirements.

A. Length of Stub Easements

The length of stub easements within rural, rural residential and park residential allotments will depend on the location of adjacent open channels, watercourse and stormwater inlets. For outlets within 60 m of an open channel, watercourse or stormwater inlet, stub easements shall extend from the road reserve boundary to the centre of the open channel, watercourse or stormwater inlet. If the open channel, watercourse or stormwater inlet is bounded by an existing easement or drainage reserve, then the easement shall extend from the road reserve boundary to the existing easement or drainage reserve boundary. Discharge into a "defined watercourse" under the meaning of the Water Resources Act will require consent from the Department of Natural Resources.

For outlets more than 60 m from an open channel, watercourse or stormwater inlet, the minimum length of stub easements shall be 10 m or, where required by a Pine Rivers Shire Council engineer, shall be extended to convey discharge beyond any adjacent nominated building area.

B. Width of Stub Easements

The minimum width of stub easements shall be 3.0 m. However all drainage works must be located within easement boundaries. For the construction of large open channels, consideration should be given for easement access by the Pine Rivers Shire Council maintenance vehicles and equipment.

The minimum easement width for open channels shall be as follows:-

Table 4.12.3

Channel Type	Total Width of Easement
Concrete lined	Channel width + 3 m
Grassed lined	Channel width + 6 m *
Grassed swale batter slopes <1:4H	Swale width + 3 m

* Refer to Section 8.13 QUDM

C. Energy Dissipation

Energy dissipation works should consider the following criteria:-

Table 4.12.4

Outlet Characteristics	Recommended Outlets Treatment
Outlet Q < 2 m^3 /s and/or Outlet V < 3 m/s and/or Outlet slope < 3%	Culvert headwall plus Concrete apron plus 600 mm deep apron cut-off wall
Outlet Q > 2 m^3 /s and/or Outlet V > 3 m/s and/or Outlet slope > 3%	Culvert headwall plus Concrete apron plus 1200 mm deep apron cut-off wall plus an approved energy dissipation device

There are several types of energy dissipation devices ranging from rock lined channels, plunge pools, extended aprons, ramps that induce hydraulic jumps etc. Chute blocks are however not permitted as an energy dissipation device. The design of suitable energy dissipation structures are detailed in the Queensland Department of Main Roads Urban Road Drainage Design Manual Volume 2. This manual should be first point of reference for the designer.

Design methodologies for outlet channels and scour basins are outlined in the following sections.

(i) Outlet Channel

Outlet channels are a suitable method of dissipating energy from culvert outlets provided that their design ensures steady uniform flow. "Deemed-to-comply" criteria for energy dissipation in outlet channels are as follows:-

- slope between 0.3% and 0.6%:-
  - minimum length of outlet channel 10 m long
  - outlet channel velocity to conform to Table 8.03 QUDM, for the applicable soil type
  - outlet channel to discharge to a quiescent water body or spread out evenly over flat well grassed ground with a slope no steeper than 3%

(ii) Detailed Hydraulic Calculations

Detailed hydraulic calculations are required for outlet channel proposal that do not satisfy the above criteria.

(iii) Scour Basins

Scour basins provide a suitable method of dissipating energy at culvert outlets. Basins may be constructed from natural or artificial scour resistant materials e.g. concrete or rocks. The minimum dimensions of the scour basin can be calculated from the following formula:-

Scour Basin Geometry = $\alpha (Y_e)^{\gamma} (Q / Y_e^{2.5})^{\beta} t_c^{\theta}$

where: - α, β, θ, γ are coefficients from the following table
t_c is the time of concentration (min)
Q is the design discharge (m^3/s)
$Y_e = (A / 2)^{0.5}$
A is the area of flow in the culvert (m^2)

Table 4.12.5

SCOUR BASIN DESIGN PARAMETERS

Maximum Scour Hole Dimension	Coefficient			
	α	β	θ	γ
DEPTH				
TW < 0.5D	1.02	0.375	0.10	1.0
TW > 0.5D	0.95	0.375	0.10	1.0
WIDTH				
TW < 0.5D	0.94	0.915	0.15	1.0
TW > 0.5D	0.67	0.915	0.15	1.0
LENGTH				
TW < 0.5D	2.55	0.71	0.125	1.0
TW > 0.5D	2.34	0.71	0.125	1.0

For further details refer to "Drainage Design and Outlet Protection" by A. Chiu and W. Rahmann June 1980 in Queensland Transport Road Design References 2nd Edition December 1991.

(iv) Methodology

1. Determine the time of concentration (tc), design discharge (Q), waterway area of outlet culvert (A) and velocity (Q/A).

2. Check that the time of concentration does not exceed 24 hours.

3. Check that the maximum outlet velocity does not exceed 6 m/s.

4. Calculate $Y_e = \left[\frac{A}{2}\right]^{0.5}$

5. Determine tail water height.

6. Read off values for α, γ, β and θ from the above Scour Basin Design Parameter Table.

7. Calculate depth, width and length of scour basin using the formula for "Scour Basin Geometry".

8. Determine type of outlet materials and apply the appropriate dimensional reduction factor.

9. Dimensional reduction factors.

The scour basin geometry equation given in Section 4.12.3 (c) iii of the Design Standards for Stormwater Drainage Is conservative as it relates to the natural scour of sand in channels. The construction of concrete scour basins is not recommended unless space requirements dictate. For outlet materials other than sand, the following reduction factors apply.

Table 4.12.6

Material	Factor
Sand	1.0
Silty clay	0.5
Clay	0.33
Concrete	0.25

The above factors are not based on any detailed research. The designer may choose to adopt more appropriate values. Justification of different values will however be required. Consideration for the localised drainage of scour basins is also required to reduce the possibility of mosquito breeding.

Typical details of scour basin arrangements are shown on the Pine Rivers Shire Council standard drawings.

(v) Alternative Energy Dissipation Devices

Other types of stormwater drainage energy dissipation devices may be accepted provided that they are:-

- environmentally sensitive
- cost efficient
- minimise nuisance to adjacent property owners
- aesthetically pleasing
- require low maintenance
- are not unsafe

D. Piping or Channel Lining

Where required by a Pine Rivers Shire Council engineer, outlets from the drainage system may have to be piped or conveyed to an approved point of discharge via lined channels in order to minimise risk of damage to property.

4.12.4 CONTROL OF FLOWS FROM EXTERNAL CATCHMENTS

Overland flow, whether in concentrated or broad sheet form is to be controlled where it would otherwise enter residential allotments. The following are a list of possible solutions.

A. Diversion Drains

Table 4.12.7

Size	Type
Allotments $\leq$ 2000 m^2 each	Concrete lined but preferably grass lines swale diversion drain for Q100 capacity.
Allotments > 2000 m^2 each	Natural lined diversion drain for Q100 capacity. Design in accordance with Section 8 QUDM.

Note: - The minimum freeboard for diversion drains shall be 150 mm

B. Bunding

Bunding is not recommended unless the specific area containing the bunding is covered by a suitable easement. Bunding should be graded to avoid ponding of water. Minimum freeboard for bunding shall be 150 mm. The bund shall be located in the downstream allotments.

C. Field Inlets and Pipe Systems

Field inlets and pipe systems should be designed to incorporate any future upstream development. Consideration should be given to the blockage of inlets by natural debris and the impact of overland flow on adjacent residential properties. A minimum blockage factor of 50% shall be applied in all cases.

The following design parameters should be used: -

Table 4.12.8

Pit Size (mm)	Min Depth (mm)	Min Pipe Size (mm)	Flow Depth (mm)	Capacity (l/sec)
600 x 600	750	150	50	22
	750	225	75	41
	900	300	100	62
	900	300	125	87
600 x 900	825	225	50	28
	900	300	75	51
	900	300	100	78
	1000	375	125	109

Table 4.12.8 is based on a maximum 125 mm flow depth, 50% blockage factor and a minimum 1% pipe slope from the inlet.

Field inlets with design elements in excess in these are to be designed in accordance with the Queensland Department of Main Roads Urban Road Design Manual - Volume 2 Section 10-1430 as amended. This methodology requires assessment of either orifice or weir flow depending on the flow height above the inlet.

D. Property Fencing

Property fencing may form part of the wetted perimeter of an overland flow path only if it is of a permanent nature and constructed of masonry brick or similar materials to a height 600 mm above ground level in the flow path. The maximum height of the calculated water surface elevation above the ground level shall be no more than 300 mm. Consideration should be given to reducing the permeability of fencing to avoid adjacent property damage. Any fencing used to contain overland flow is to be constructed as part of the development works.

E. Swale Drains

Grass lined swale drains are a recommended method of conveying stormwater from urban and rural residential areas. Whether a sub-soil drain is required depends on local soil conditions.

(i) Soil Types

Table 4.12.9

Soil Type	Sub-Soil Drain Required
Sandy / loamy soil	No
Clay / impermeable soil	Yes

Clean out points are required every 60 m.

(ii) Grassed Lined Swale Drains

The maximum side slope of grass lined swale drains is 1V:4H. The minimum base width is 2.5 m (except for roadside swales).

(iii) Freeboard

Consideration should be given to the effect of bend losses on the freeboard. For further information refer to QUDM, Section 8, Equation 8.06.

(iv) Slope of Swale Drain

The minimum slope for grass lined swale drains is 0.4%. For maximum slopes refer to QUDM Table 8.03.

4.13.0 COMMERCIAL AND INDUSTRIAL DEVELOPMENTS

4.13.1 DESIGN GUIDELINES

Detailed design standards and requirements for commercial and industrial developments are contained in other parts of the Pine Rivers Shire Council Planning Scheme, Codes and Planning Scheme Policy. What follows is a discussion of On-Site-Detention (OSD) calculations only.

4.13.2 ON SITE DETENTION

Commercial and industrial development shall install On-Site-Detention (OSD) unless alternative treatments are approved by a Pine Rivers Shire Council engineer. Site specific design or proprietary systems may be used provided they incorporate high early discharge devices. The minimum discharge orifice diameter is 100 mm. A Q10 event is required to be partially captured and temporarily stored underground. For Q100 events, suitably sized overland flow paths with lawful points of discharge shall be designed to allow for the full Q100 peak discharge. A check should be made that blockage of inlets does not result in above floor flooding. All OSD systems are to include a water quality treatment system e.g. oil/grit separators and or sediment trap. The minimum requirement is that this system shall capture and treat the first 150 m^3/ha of development runoff.

Methodology

1. Determine capacity of existing downstream connecting minor drainage system, Q_{cap}
2. Determine design catchment discharge to the connecting downstream minor drainage system, Q_{des}
3. Calculate reduction ratio, $r = \dfrac{(Q_{des} - Q_{cap})}{Q_{des}}$ *for* $r \geq 0$
4. Calculate minor drainage site discharge, Q_{site}
5. Calculate permissible site discharge (PSD), $Q_{perm} = Q_{site}(1-r)$
6. Determine orifice pipe diameter using Q_{perm}
7. Ensure calculated orifice pipe diameter ≥ 100 mm
8. Calculate underground site storage requirement, $SSR = 800r^2\ Q_{site}$ m^3/ha
9. Ensure underground site storage requirement, SSR exceeds 150 m^3/ha

4.14.0 DESIGN CHARTS AND TABLES

4.14.1 INTRODUCTION

Design Charts and tables have been produced to assist designers and these are included in the “Summary Document” to the Design Standards for Stormwater Drainage.

4.14.2 CATCHPIT CAPACITY CHARTS

Charts 4 to 7 give the capture rates based on tests commissioned by the Brisbane City Council for their Type A gully. These tests were undertaken at the University of South Australia by Prof. J. Argue. The calculated capacities given in Charts 5 to 7 assume a 10% blockage factor. They represent minimum capacity standards. Alternative catchpit designs may be accepted subject to the Pine Rivers Shire Council approval of the design and associated capacity charts. Preference will be given to systems that incorporate grates that comply with AS 3996.

4.14.3 RAINFALL INTENSITY TABLES

The rainfall intensity tables, provided in the Design Standards for Stormwater Drainage, are derived using the ARR 1987 Volume 2. They are applicable for the whole of the Pine Rivers Shire. Area reduction factors (ARFs) are not to be applied to these values. The Tables are given in Chart 8.

4.14.4 HYDRAULIC DESIGN CALCULATION SHEET

Charts 9 and 10 detail the standard format for hydraulic gradeline calculations to be submitted to the Pine Rivers Shire Council.

Alternative formats are subject to approval by a Pine Rivers Shire Council engineer. An “AutoCAD” drawing of the Pine Rivers Shire Council Standard Hydraulic Design Calculation Sheet, from Pine Rivers Shire Council.

4.14.5 ROADWAY FLOW CAPACITY CHARTS

Charts 11 to 35 detail the capacity charts for the various types of roads used throughout the Pine Rivers Shire. The capacities are based on Izzard's equation as given in Section 5 of the QUDM.

4.15.0 PLAN PRESENTATION

Plans shall conform to the requirements of the various Pine Rivers Shire Council Design Standards, Design Guidelines and Standard Drawings, and Standard Specifications.