Designation: AS/NZS 3500.3:~~20XX~~202X

Committee: WS-014, Plumbing and Drainage

Project ID: 107247

Project Manager: Thomas Ascroft

Plumbing and Drainage

Part 3: Stormwater drainage

Stage ~~03: Drafting~~04: Public Commenting

Changes made during this edit incorporating introduction of plain language.

Grades are expressed inconsistently throughout.
I have changed all occurrences of "1 in 5", "1 in 100" for example to "1:5" and "1:100" respectively

Pre-kick off review:

All cross-references to Clauses, Sections and Appendices have been hyperlinked and automatically update. Therefore, do not replace these with manual cross-references but add a comment and publishing services will do so for you~~.~~

Automatic cross-references to Tables and Figures is not possible. These are still manually inserted.

For all figures, do not include cross-references within figures to clauses, tables or other figures as these cross-references are static and do not automatically update. This increases the possibility of error and is not time efficient in developing standards. Existing cross-references in figures should be relocated to notes beneath the figure, between the figure and the figure title. To do so, the DL should create a note beneath each figure containing the wording for the cross-reference. A drawing request will need to be raised to have the redundant cross-references removed~~.~~

Synopsis: AS/NZS 3500.3:202X specifies the requirements for materials, design, installation and testing of roof drainage systems, surface drainage systems and subsoil drainage systems to a point of connection

ICS:

91.140.80: Drainage systems

91.140.01: Installations in buildings in general

91.060.020: Roofs, including related elements (gutters, etc.)

Sector: Water and Waste Services

Pricing ticket raised:

Nominating organisations:

Commented [JR1]: PM: Please review the nom-org list and advise if it is complete and correct.

Commented [JH2R1]: Updated as per list provided by PM

Association of Hydraulic Services Consultants Australia

Association of Hydraulic Services Consultants Australia and New Zealand

Australian Building Codes Board

Australian Industry Group

Australian Stainless Steel Development Association

Australian Steel Institute

Backflow Prevention Association of Australia

Chartered Institution of Building Services Engineers ANZ

Engineers Australia

Hydraulic Consultants Association Australasia

International Copper Association Australia

Master Plumbers Australia and New Zealand

Master Plumbers, Gasfitters and Drainlayers New Zealand

NZ Ministry of Business, Innovation and Employment (MBIE)

Plastics Industry Pipe Association of Australia

Plastics New Zealand

Plumbers, Gasfitters and Drainlayers Board

Plumbing Distributors Association of New Zealand

Plumbing Products Industry Group

The Australian Gas Association

The Institute of Plumbing Australia

Water New Zealand

Water Services Association of Australia

Notes:

New natmeta attached for 107247 18/8/2023

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Preface

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee WS-014, Plumbing and Drainage, to supersede AS/NZS 3500.3:20182021.

The objective of this document is to provide stormwater drainage solutions for compliance with —

(a) the National Construction Code (NCC); and

(b) the New Zealand Building Code (NZBC), Clause E1 Surface Water.

A list of all parts in the AS/NZS 3500 series for plumbing and drainage can be found in the Standards Australia and Standards New Zealand online catalogues.

The major changes in this revision are as follows:

(i) Definitions have been relocatedLeaves and gutter systems, Clause 3.5.

(ii) Devices and appliances connected to AS/NZS 3500.0stormwater drainage systems, Clause 5.3.8.

(iii) Rainwater harvesting systems, Section 11, including solutions for consistency across the seriesinstallation of rainwater harvesting systems; allocation of minimum SN rating for charged rainwater services, and rainwater storage for drinking and non-drinking use.

(ii) Design rainfall intensities are now expressed in terms of the Annual Exceedance Probability (AEP) values to reflect the practice of the Australian Bureau of Meteorology (BOM) and the performance requirements of NZBC Clause E1 Surface Water. There has been no change in the requirements or the calculations, and the original ARI values are shown for comparison.

(iii) The 5 min duration rainfall intensities for representative places in Australia given in Table D.1 have been updated to show the latest values from the BOM.

(iv) The New Zealand rainfall maps have been replaced by Table E.1 showing 10 % AEP (10 years ARI) and 2 % AEP (50 years ARI) rainfall intensities for selected locations.

(v) The range of materials that can be used for wet wells has been expanded to encompass prefabricated wells.

(vi) Changes have been made to the requirements for the marking of pipes in commercial buildings to assist in the better identification of pipework and avoiding cross connections.

(vii) The design rainfall intensities for balcony and terrace drainage systems in New Zealand have been included.

Notes or footnotes to tables or figures that are expressed in mandatory terms are deemed to be requirements of this document.

Notes to clauses in this document are informative only and do not include requirements.

This document includes commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ”C” preceding the clause number, and is printed in italics in a box. The commentary is for information and guidance and does not form part of the document.

The terms “normative” and “informative” are used in documents to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a document, whereas an “informative” appendix is only for information and guidance.

Notes or footnotes to tables or figures that are expressed in mandatory terms are deemed to be requirements of this document.

Notes to clauses in this document are informative only and do not include requirements.

1 Scope and general

1.1 Scope

This document sets out ~~the~~ requirements for —

(a) materials, design, installation and testing of roof drainage systems, surface drainage systems and subsoil drainage systems to a point of connection~~.~~; and

~~Illustrations used in this Standard are diagrammatic only and have been chosen without prejudice.~~

(b) rainwater harvesting systems.

NOTE: Appendix M provides general information to users of the document.

1.2 Application

1.2.1 Australia

This document shall be read in conjunction with the National Construction Code (NCC).

~~Where~~If alternative Australian or New Zealand Standards are referenced ~~(e.g. AS 1345),~~, the Australian Standard shall be used for Australia only.

1.2.2 New Zealand

This document shall be read in conjunction with the New Zealand Building Code (NZBC). ~~This document~~It may be used to demonstrate compliance with the NZBC, Clause E1 Surface Water.

~~Where~~If alternative New Zealand Standards are referenced ~~(e.g. NZS 5807),~~, the New Zealand Standard shall be used for New Zealand only.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE: Documents referenced for informative purposes are listed in the Bibliography.

<std>AS 1074, *Steel tubes and tubulars for ordinary service*</std>

<std>AS 1273, *Unplasticized PVC (UPVC) downpipe and fittings for rainwater*</std>

<std>AS 1289.5.4.1, *Methods of testing soils for engineering purposes, Method 5.4.1: Soil compaction and density tests — Compaction control test — Dry density ratio, moisture variation and moisture ratio*</std>

<std>AS 1289.5.6.1, *Methods of testing soils for engineering purposes, Part 5.6.1: Soil compaction and density tests — Compaction control test — Density index method for a cohesionless material*</std>

<std>AS 1379, *Specification and supply of concrete*</std>

<std>AS 1432, *Copper tubes for plumbing, gasfitting and drainage applications*</std>

<std>AS 1478.1, *Chemical admixtures for concrete, mortar and grout, Part 1: Admixtures for concrete*</std>

<std>AS 1604.1, *Specification for preservative treatment, Part 1: Sawn and round timber*</std>

<std>AS 1628, *Water supply — Metallic gate globe and non-return valves*</std>

<std>AS 1631, *Cast grey and ductile iron non pressure pipes and fittings*</std>

<std>AS 1646, *Elastomeric seals for waterworks purposes*</std>

<std>AS 1657, *Fixed platforms, walkways, stairways and ladders — Design, construction and installation*</std>

<std>AS 1834.1, *Material for soldering, Part 1: Solder alloys*</std>

<std>AS 2050, *Installation of roof tiles*</std>

<std>AS 2200, *Design charts for water supply and sewerage*</std>

<std>AS 2439.1, *Perforated plastics drainage and effluent pipe and fittings, Part 1: Perforated drainage pipe and associated fittings*</std>

<std>AS 2865, *Confined spaces*</std>

<std>AS 3517, *Capillary fittings of copper and copper alloy for non-pressure sanitary plumbing applications*</std>

<std>AS 3571.1, *Plastics piping systems — Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin, Part 1: Pressure and non-pressure drainage and sewerage (ISO 10467:2004, MOD)*</std>

<std>AS 3571.2, *Plastics piping systems — Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin, Part 2: Pressure and non-pressure water supply (ISO 10639:2004, MOD)*</std>

<std>AS 3579, *Cast iron wedge gate valves for general purposes*</std>

<std>AS 3600, *Concrete structures*</std>

<std>AS 3648, *Specification and methods of test for packaged concrete mixes*</std>

<std>AS 3680, *Polyethylene sleeving for ductile iron piping*</std>

<std>AS 3705, *Geotextiles—Identification, marking and general data*</std>

<std>AS 3795, *Copper alloy tubes for plumbing and drainage applications*</std>

<std>AS 3996, *Access covers and grates*</std>

<std>AS 4060, *Loads on buried vitrified clay pipes*</std>

<std>AS 4139, *Fibre-reinforced concrete pipes and fittings*</std>

<std>AS 4198, *Precast concrete access chambers for sewerage applications*</std>

<std>AS/NZS 1167.1, *Welding and brazing — Filler metals, Part 1: Filler metal for brazing and braze welding*</std>

<std>AS/NZS 1234, *Recommendations for coordinated preferred dimensions in building*</std>

<std>AS/NZS 1254, *PVC-U pipes and fittings for storm and surface water applications*</std>

<std>AS/NZS 1260, *PVC-U pipes and fittings for drain, waste and vent applications*</std>

<std>AS/NZS 1477, *PVC pipes and fittings for pressure applications*</std>

<std>AS/NZS 1866, *Aluminium and aluminium alloys — Extruded rod, bar, solid and hollow shapes*</std>

<std>AS/NZS 2032, *Installation of PVC pipe systems*</std>

<std>AS/NZS 2033, *Installation of polyethylene pipe systems*</std>

<std>AS/NZS 2041.1, *Buried corrugated metal structures, Part 1: Design methods*</std>

<std>AS/NZS 2041.2, *Buried corrugated metal structures, Part 2: Installation*</std>

<std>AS/NZS 2041.4, *Buried corrugated metal structures, Part 4: Helically formed sinusoidal pipes*</std>

<std>AS/NZS 2179.1, *Specifications for rainwater goods, accessories and fasteners, Part 1: Metal shape or sheet rainwater goods, and metal accessories and fasteners*</std>

<std>AS/NZS 2280, *Ductile iron pipes and fittings*</std>

<std>AS/NZS 2566.2, *Buried flexible pipelines Part 2: Installation*</std>

<std>AS/NZS 2638.1, *Gate valves for waterworks purposes, Part 1: Metal seated*</std>

<std>AS/NZS 2638.2, *Gate valves for waterworks purposes, Part 2: Resilient seated*</std>

<std>AS/NZS 2648.1, *Underground marking tape, Part 1: Non-detectable tape*</std>

<std>AS/NZS 2878, *Timber — Classification into strength groups*</std>

<std>AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*</std>

<std>AS/NZS 3500.0, *Plumbing and drainage, Part 0: Glossary*</std>

<std>AS/NZS 3500.1, *Plumbing and drainage, Part 1: Water services*</std>

<std>AS/NZS 3725, *Design for installation of buried concrete pipes*</std>

<std>AS/NZS 3879, *Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS ASA pipes and fittings*</std>

<std>AS/NZS 4058, *Precast concrete pipes (pressure and non-pressure)*</std>

<std>AS/NZS 4087, *Metallic flanges for waterworks purposes*</std>

<std>AS/NZS 4129, *Fittings for polyethylene (PE) pipes for pressure applications*</std>

<std>AS/NZS 4130, *Polyethylene (PE) pipes for pressure applications*</std>

<std>AS/NZS 4327, *Metal-banded flexible couplings for low-pressure applications*</std>

<std>AS/NZS 4401, *Plastics piping systems for soil and waste discharge (low and high temperature) inside buildings — Polyethylene (PE)*</std>

<std>AS/NZS 4441, *Oriented PVC (PVC-O) pipes for pressure applications (ISO 16422:2014, MOD)*</std>

<std>AS/NZS 4455.2, *Masonry units, pavers, flags and segmental retaining wall units, Part 2: Pavers and flags*</std>

<std>AS/NZS 4671, *Steel reinforcing materials*</std>

<std>AS/NZS 4680, *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*</std>

<std>AS/NZS 4765, *Modified PVC (PVC-M) pipes for pressure applications*</std>

<std>AS/NZS 5065, *Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications*</std>

<std>NZS 3631, *New Zealand timber grading rules*</std>

<std>NZS 3640, *Chemical preservation of round and sawn timber*</std>

<std>EN 12056-3, *Gravity drainage systems inside buildings, Part 3: Roof drainage, layout and calculation*</std>

~~New Zealand Building Code (NZBC), Acceptable Solution E1/AS1~~

~~New Zealand Building Code (NZBC), Acceptable Solution E2/AS1~~

1.4 Terms and definitions

For the purpose of this document, the terms and definitions in AS/NZS 3500.0 apply.

1.5 Abbreviations

1.5.1 General

The following abbreviations are used in this document.

AHD	Australian Height Datum
AEP	Annual exceedance probability
ARI	Average recurrence interval
BOM	Bureau of Meteorology
FRC	Fibre-reinforced concrete
GMAW	Gas metal-arc welding
GTAW	Gas tungsten-arc welding
HASBM	Hydrometeorological Advisory Services of the Bureau of Meteorology
NIWA	National Institute of Water and Atmospheric Research
OSD	On-site stormwater detention
SW	Stormwater

1.5.2 Plastics abbreviations

The following plastics abbreviations are used in this document.

ABS	Acrylonitrite butadiene styrene
GRP	Glass filament reinforced thermosetting plastic
PB	Polybutylene
PE	Polyethylene
PE-X	Cross-linked polyethylene
PP	Polypropylene
PVC	Polyvinyl chloride
PVC-M	Modified polyvinyl chloride
PVC-O	Oriented polyvinyl chloride
PVC-U	Unplasticized polyvinyl chloride

1.6 Notation

1.6.1 Quantity symbols

~~For the purposes of this document,~~ The following symbols ~~apply~~are used in this document.

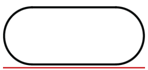
Quantity symbol		Definition	Unit
A	=	cross-sectional area of flow in an open channel	m^2

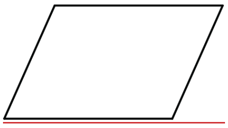
Quantity symbol		Definition	Unit
A_c	=	catchment area of a roof and vertical surface (wall or parapet)	m²
A_{cdp}	=	for a selected eaves gutter, the maximum catchment area of roof per vertical downpipe, see Appendix G	m²
A_{s-c}	=	eaves gutter subcatchment area for a particular downpipe and high point layout	m²
A_e	=	effective cross-sectional area of a gutter	mm²
A_h	=	plan area of a roof including the gutter or parapet which is part of the catchment	m²
A_{hs-c}	=	plan area of subcatchment roof including the gutter or parapet that is part of the catchment	m²
A_i	=	total unroofed impervious (paved) catchment area	m²
A_p	=	total unroofed pervious catchment area	m²
A_r	=	total roofed catchment area	m²
A_v	=	maximum elevation area of a sloping roof, vertical surface, wall or parapet	m²
b_f	=	blockage factor for inlet-to-inlet pit	—
b_n	=	nominal breadth of cross-section of a rectangular or square downpipe	mm
ΣCA	=	equivalent impervious area of all upstream areas on the property	m²
C_i	=	run-off coefficient, for an unroofed impervious (paved) area	—
C_p	=	run-off coefficient for an unroofed pervious area	—
C_r	=	run-off coefficient for a roofed area	—
D	=	diameter of the site stormwater drain	mm
D_e	=	effective equivalent diameter of a rectangular downpipe $2 \times \sqrt{\frac{b_n \times w_n}{\pi}}$, or square downpipe $2 \times \sqrt{\frac{b_n^2}{\pi}}$	mm
D_i	=	internal diameter of a circular downpipe	mm
d_{bg}	=	minimum depth of a box gutter that discharges to a sump/high capacity overflow device (includes h_f)	mm
d_p	=	depth of ponding over an inlet to an inlet pit	m
d_{oc}	=	minimum depth of an overflow channel	mm
F	=	multiplier for increased surface area of roof due to slope	—
h_a	=	minimum depth of a box gutter that discharges to a rainhead (includes h_f)	mm
h_e	=	effective depth	mm
h_f	=	freeboard	mm
h_r	=	total depth of a rainhead	mm

Quantity symbol		Definition	Unit
h_s	=	depth of a sump	mm
h_t	=	minimum height of the top of the box gutter above the crest of the overflow weir or channel	mm
${}^{Y\%}I_t$	=	rainfall intensity for a duration of t and an AEP of Y %	mm/h
k	=	Colebrook–White roughness coefficient	mm
l_{oc}	=	for a sump/side overflow device, the minimum horizontal distance between the sides of an overflow channel and those of the sump	mm
	=	for sump/high capacity overflow device, the height of the overflow weir (crest) above the sole of the gutter	mm
l_r	=	length of a rainhead	mm
m	=	multiplier for rainfall run-off coefficients	—
n	=	Manning roughness coefficient for an open channel	—
${}^{p\%}I_t$	=	rainfall intensity for an AEP of p % and a duration t	mm/h
P	=	wetted perimeter of an open channel	m
	=	perimeter length of the pit excluding any section against a kerb or wall (bars may be disregarded)	m
R	=	hydraulic radius $R = \frac{A}{P}$	m
S	=	gradient of an open channel	—
Q	=	design flow of stormwater	L/s
Q_c	=	discharge capacity for an open channel	L/s
Q_i	=	capacity of an inlet for a sag pit	L/s
T	=	time	min
v	=	full-pipe velocity, in metres square	m^2
w_{bg}	=	sole width of a box gutter	mm
w_e	=	effective width	mm
w_{oc}	=	width of an overflow channel	mm
Y	=	average recurrence interval (ARI)	years

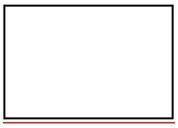
1.6.2 Flow chart symbols

The following flow chart symbols and conventions are used in this document~~ are listed below~~.

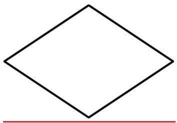
Flow chart symbol		Use
	~~=~~ =	terminator — represents an entry from or an exit to an outside environment (i.e. the start or the finish of a flow chart)



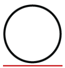
~~=~~ = data input



~~=~~ = process and execute the defined operation or group of operations, resulting in a change in value



~~=~~ = decision or switching — a single entry with more than one exit, only one of which will be activated following the evaluation of the condition



~~=~~ = connector — represents an exit to or an entry from either another part of the same flow chart or from another flow chart and corresponding symbols contain the same unique identification

1.6.3 Gradients

In this document, gradients are expressed in the form of a numerical ratio Y:X, where Y is the vertical dimension and X is the horizontal dimension of a right-angled triangle.

1.7 Identification of piping

Accessible pipework shall be permanently marked so as to be readily identifiable as part of the stormwater drainage system within~~:~~ —

(a) in Australia, all Class 2 to Class 9 buildings (multi-unit, commercial and industrial buildings).

(b) in New Zealand —

(i) Multi-unit dwellings, including apartment buildings but excluding low rise multi-unit dwellings such as an attached dwelling or flat;

(ii) Communal residential buildings, excluding holiday cabins and backcountry huts;

(iii) Communal non-residential buildings;

(iv) Commercial buildings; and

(v) Industrial buildings.

NOTE 1: Refer to the NCC or NZBC ~~as appropriate~~ for information on building use categories and classes.

Identification markings shall be ~~placed~~located —

(i) at spacings not exceeding 6 m;~~ and~~

(ii) adjacent to branches, junctions, valves, service appliances, bulkheads, and wall and floor penetrations~~.~~; and

(iii) at every floor level within vertical ducts and riser cupboards.

NOTE 2: Pipes which are marked as part of the manufacturing process are acceptable.

NOTE 3: Refer to AS 1345 for information on identification tags and labels in Australia.

NOTE 4: Refer to NZS 5807 for information on identification marking in New Zealand.

2 Materials and products

2.1 Scope of section

This section specifies requirements for materials and products ~~for use~~used in a stormwater drainage system.

2.2 Selection and use

2.2.1 General

Materials and products used in a stormwater drainage system shall be fit for their intended purpose for the life of the installation.

NOTE 1: ~~Factors to~~When selecting materials and products, the following factors should be taken into account ~~in the selection include —~~:

(a) The nature of the intended use of the building~~;~~.

(b) The environment (refer to AS/NZS 2312, AS 4312 or the relevant product Standard~~);~~).

(c) The nature of the ground, quality of subsoil water and the possibility of chemical attack therefrom~~;~~.

(d) The physical (e.g. abrasion) and chemical (e.g. corrosion) characteristics of the materials and products~~; and~~.

(e) Components of installations manufactured from more than one material, with either contact between or drainage to them, see Clauses 4.4.1 or ~~.~~4.4.2.

NOTE 2: ~~Where~~If materials are used for the collection of drinking water, the use of materials conforming to AS/NZS 4020 should be considered.

NOTE 3: Consideration should be given to the quality and quantity of the discharge as it may have an impact on the network utility operator's infrastructure or an on-site stormwater management system.

2.2.2 Materials for devices and appliances connected to stormwater drainage

The selection of pipework and fittings shall be based on —

(a) anticipated discharge temperature; and

(b) quality of discharge.

NOTE 1: Temperature limitations of different pipework materials should be considered in relation to continuous and intermitted discharges for continued stability of the pipework and fittings.

NOTE 2: Consideration should be given to the quality of the discharge as it may impact the pipework used in the stormwater system.

2.3 Roof drainage system

2.3.1 Roof drainage system components

Roof drainage system components that are made from aluminium alloys, aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel, copper, copper alloys, zinc-coated steel, stainless steel and zinc shall ~~conform to~~meet the requirements of AS/NZS 2179.1.

2.3.2 Downpipes

Materials and products used for downpipes, other than those specified in Clause ~~, used for downpipes~~2.3.1, shall meet the following requirements:

(a) Aluminium alloy pipes shall ~~conform to~~ be as specified in AS/NZS 1866 and be in straight (i.e. not bent) lengths.

(b) Cast iron pipes and fittings shall ~~conform to~~be as specified in AS 1631.

(c) Copper pipes and fittings shall ~~conform to~~be as specified in AS 1432 and AS 3517, respectively, and ~~satisfy~~meet the following additional ~~criteria~~requirements:

 (i) ~~When~~If Type B pipe is field bent, the offset angle shall be not greater than 10°.

 (ii) Type D pipe shall be in straight (i.e. not bent) lengths.

 (iii) Fabricated bends and junctions at the base of downpipes less than 9 m high shall be, as a minimum, fittings suitable for Type D applications.

(d) Copper alloy pipes and fittings shall be as specified in AS 3795 and AS 3517, respectively ~~with~~, and meet the following ~~limitations on use~~additional requirements:

 (i) Type D shall be in straight (i.e. not bent) lengths.

 (ii) Only junctions shall be field fabricated.

 (iii) Only cast or hot-pressed bends and junctions shall be used at the base of downpipes with heights equal to or greater than 9 m.

(e) Ductile iron pipes and fittings shall be as specified in AS/NZS 2280.

(f) Fibre-reinforced concrete (FRC) pipes and fittings shall be as specified in AS 4139 and be autoclaved.

(g) Galvanized steel pipes and malleable cast iron fittings shall be as specified in AS 1074~~, with the following limitations on use:~~ provided —

 (i) pipes ~~shall be~~are in straight (i.e. not bent) lengths~~.~~; and

 (ii) pipes and fittings ~~shall be~~are installed in accessible locations.

(h) Glass filament reinforced thermosetting plastic (GRP) pipes shall —

 (i) be as specified in AS 3571.1 and AS 3571.2~~. They shall~~ ; and

 (ii) be resistant to ultraviolet light when installed in direct sunlight.

(i) Polyvinyl chloride (PVC) pipes and fittings shall be ~~as specified in AS/NZS 1254, AS/NZS 1260, AS 1273 or AS/NZS 1477. They shall be resistant to ultraviolet light where installed in direct sunlight.~~ —

 (i) be as specified in AS/NZS 1254, AS/NZS 1260, AS 1273 or AS/NZS 1477; and

 (ii) be resistant to ultraviolet light if installed in direct sunlight.

(j) Polyethylene (PE) pipes and fittings shall ~~conform to~~ —

 (i) be as specified in AS/NZS 4129, AS/NZS 4130 or AS/NZS 4401~~. Unless coloured black, pipes and fittings shall~~ ; and

 (ii) not be exposed to direct sunlight without protection as specified in ~~accordance with~~ AS/NZS 2033 unless coloured black.

NOTE 1: Chains should not be used as downpipes.

NOTE 2: Copper pipes manufactured as specified in ~~accordance with~~ NZS 3501 are also suitable for use in New Zealand.

2.3.3 Accessories and fasteners

Accessories and fasteners manufactured from aluminium alloys, aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel, copper, copper alloys, zinc-coated steel, stainless steel and zinc shall ~~conform to~~be as specified in AS/NZS 2179.1.

2.4 Stormwater drains (non-pressure)

Products used for non-pressure stormwater drains shall ~~conform to~~meet the following requirements:

(a) Aluminized or galvanized steel shall be as specified in AS/NZS 2041.4.

(b) Cast iron, copper, copper alloys, ductile iron pipes and fittings shall ~~conform to~~be as specified in Clause 2.3.2 Items (b) to (e~~)~~), respectively.

(c) FRC pipes and fittings shall be as specified in AS 4139 and ~~have~~meet the following ~~limitations on use~~additional requirements:

  (i) Site fittings shall be concrete encased ~~where~~if the resin used to manufacture fittings has not been designed for stormwater drainage.

  (ii) Pipes and fittings shall be autoclaved.

(d) Galvanized steel pipes and malleable cast iron shall ~~conform to~~be as specified in Clause ~~(~~2.3.2(g).

(e) GRP pipes and fittings, minimum Class SN 2500, shall be as specified in AS 3571.1. They shall be resistant to ultraviolet light when installed in direct sunlight.

(f) Precast concrete pipes (steel reinforced) shall be as specified in AS/NZS 4058. ~~Where~~If located under buildings, they shall have no lifting holes.

(g) Circular PVC pipes and fittings shall ~~conform to~~be as specified in Clause ~~(~~2.3.2(i).

(h) Polyvinyl chloride (PVC) pipes and fittings shall be as specified in AS/NZS 1254, AS/NZS 4765, AS/NZS 4441, AS/NZS 1260, AS 1273 or AS/NZS 1477.

(i) Polyethylene (PE) pipes and fittings shall ~~conform to~~be as specified in AS/NZS 4129, AS/NZS 4130, AS/NZS 4401 or AS/NZS 5065. Unless coloured black, pipes and fittings shall not be exposed to direct sunlight without protection as specified in ~~accordance with~~ AS/NZS 2033.

2.5 Rising mains (pressure)

Rising mains shall be constructed from pressure pipes and fittings as specified in AS/NZS 3500.1.

2.6 Subsoil drains

Plastics pipes used in subsoil drains shall ~~conform to~~be as specified in AS 2439.1. Pipes of stiffness SN2 shall be limited to use in single dwellings.

2.7 Joints

2.7.1 Resin adhesives

2.7.1.1 General

Resin adhesives shall have positive adhesion to~~,~~ and compatibility with~~,~~ the materials being jointed.

2.7.1.2 Sealants

Sealants, including caulking compounds and tapes, shall —

(a) be neutral cure;

(b) be resistant to ultraviolet radiation ~~where~~if exposed above ground;

(c) have the range of service temperatures for the location;

(d) have positive adhesion to and compatibility with the materials being jointed; and

(e) retain flexibility throughout ~~the~~their service life~~ where applicable~~.

2.7.1.3 Silver brazing alloy

Silver brazing alloys used for jointing copper and copper alloy pipes and fittings shall ~~conform to AS/NZS 1167.1. They shall have a silver content of not less than 1.8 %.~~—

(a) be as specified in AS/NZS 1167.1; and

(b) have a silver content of not less than 1.8 %.

2.7.1.4 Soft solder

Soft solder shall ~~conform to~~be as specified in AS 1834.1 and —

(a) for roof drainage system components used for the conveyance of drinking water, have a lead content not greater than 0.1 %;

(b) for zinc-coated steel, copper, copper alloy and stainless steel, be 50/50 solder to Grade 50 Sn; and

(c) for zinc, have an antimony content of less than 0.5 %.

2.7.1.5 Solvent cement and priming fluid

Solvent cement and priming fluid used for jointing PVC pipes and fittings shall ~~conform to~~be as specified in AS/NZS 3879.

2.7.2 Types

2.7.2.1 Bolted gland

Bolted gland (BG) joints shall ~~conform to~~be as specified in AS 1631 for cast grey and ductile iron materials with elastomeric seals compatible with the material and dimensions of the pipes or fittings being jointed.

2.7.2.2 Cement mortar

Cement mortar (CM) joints shall ~~conform to~~be as specified in Clause ~~.~~2.9.2.

2.7.2.3 Elastomeric seals

Elastomeric seals (ES) shall ~~conform to~~be as specified in AS 1646.

2.7.2.4 Epoxy resin

Epoxy resin (ER) shall be compatible with the materials being joined.

NOTE: Epoxy resin joints should only be used ~~where~~if the joint is designed for use with epoxy resin.

2.7.2.5 Fusion welded

Fusion welded (FW) joints shall be compatible with the materials being jointed.

2.7.2.6 Mechanical coupling

Mechanical couplings (MC) shall ~~conform to~~be as specified in AS/NZS 2041.4.

2.7.2.7 Metal-banded flexible coupling

Metal-banded flexible couplings (FC) shall ~~conform to~~be as specified in AS/NZS 4327.

2.7.2.8 Silver brazed

Silver-brazed (SB) joints shall be made from silver brazing alloy ~~conforming to~~as specified in Clause ~~.~~2.7.1.3. Joints shall be made ~~by~~ either by —

(a) using fittings; or

(b) fabricating junctions from the pipes.

2.7.2.9 Soft soldered

Soft soldered (SS) joints shall be made from solder ~~conforming to~~as specified in Clause ~~. They shall~~2.7.1.4 and be used only for jointing zinc-coated steel, copper, copper alloy and stainless-steel rainwater goods.

2.7.2.10 Solvent cement

Solvent cement (SC) joints for PVC pipes and fittings shall be ~~made~~as specified in ~~accordance with~~ AS/NZS 2032.

2.8 Valves

2.8.1 Gate and globe

Copper alloy gate and globe valves shall ~~conform to~~be as specified in AS 1628.

2.8.2 Non-return

Cast iron and copper alloy non-return valves shall ~~conform to~~be as specified in AS 1628.

2.8.3 Sluice

Sluice valves shall ~~conform to~~be as specified in AS/NZS 2638.1 or AS/NZS 2638.2.

2.8.4 Wedge gate

Cast iron wedge gate valves shall ~~conform to~~be as specified in AS 3579.

2.9 Concrete and mortar

2.9.1 Concrete

Concrete shall ~~conform to~~be as specified in AS 1379. It shall have a minimum characteristic compressive strength of 15 MPa~~,~~ as ~~defined~~specified in AS 3600.

For minor works, site-mixed concrete shall consist of cement, fine aggregate and coarse aggregate, all measured by volume, and water added to make the mix workable. It shall have a minimum strength compromise of 15 MPa.

NOTE: See Appendix A for typical mixes for minor works.

Packaged concrete mixes shall ~~conform to~~be as specified in AS 3648.

2.9.2 Cement mortar

Cement mortar shall consist of one part cement and three parts fine aggregate, measured by volume, thoroughly mixed with the minimum amount of water necessary to render the mix workable.

Cement mortar that has been mixed and left standing for more than 1 h shall not be used.

2.9.3 Chemical admixtures

Chemical admixtures used in concrete shall conform to AS 1478.1.

2.9.4 Water for concrete and mortar

Water used for mixing concrete and cement mortar shall be free from matter that is harmful to the mixture, the reinforcement or any other items embedded within the concrete or mortar.

2.9.5 Steel reinforcement

Steel reinforcing materials used in concrete structures shall conform to AS/NZS 4671.

2.10 Embedment material

2.10.1 Site stormwater drains

Embedment material for below ground site stormwater drains shall be as specified in Clause ~~.~~6.4.2.1.

2.10.2 Subsoil drains

Embedment for subsoil drains shall be as specified in Clause ~~.~~6.4.2.1.

2.11 Trench fill

Trench fill for site stormwater drains and subsoil drains shall be as specified in Clause ~~.~~6.2.10.

2.12 Miscellaneous

2.12.1 Clay building bricks

Clay building bricks shall ~~conform to~~be as specified in AS/NZS 4455.2.

2.12.2 Concrete masonry units

Concrete masonry units (concrete bricks or concrete blocks) shall ~~conform to~~be as specified in AS/NZS 4455.2.

2.12.3 Cover and sump grates

Metal access cover and sump grates and frames for stormwater and inlet pits and arresters shall ~~conform to~~be as specified in AS 3996.

2.12.4 External protective coating

The external protective coating of metal pipes and fittings shall meet the following requirements:

(a) They shall be impervious to the passage of moisture.

(b) They shall be resistant to —

  (i) the external corrosive environment; and

  (ii) damage by the embedment material.

(c) They shall not contain material that could cause corrosion.

2.12.5 Fibreglass-reinforced plastic tanks

Water collection tanks for re-use water shall ~~conform to~~be as specified in AS/NZS 3500.1.

2.12.6 Geotextiles

Geotextiles shall be marked as specified in ~~accordance with~~ AS 3705 and ~~conform to~~meet the requirements of Clause ~~.~~2.2.

2.12.7 Polyethylene sleeving

Polyethylene sleeving for corrosion protection shall ~~conform to~~be as specified in AS 3680.

2.12.8 Precast or prefabricated pits and arresters

2.12.8.1 Concrete

The dimensions of precast concrete units for pits shall be as specified in Table 7.5.2.1. Precast concrete units for pits shall ~~conform to the dimensions in Table 7.5.2.1 and to the following:~~meet —

(a) in New Zealand, all relevant requirements of AS/NZS 4058~~.~~; and

(b) in Australia, the relevant ~~criteria~~requirements of AS 4198 to —

  (i) support for a minimum of 30 s, without structural failure or significant cracking, the applicable pit lid design loads in accordance with AS 3996 ~~(where~~. If a precast unit has knockout panels, this requirement shall apply with the knockout panels removed~~);~~; and

  (ii) be classified and marked in accordance with the pit lid classification of AS 3996 for which they are designed.

2.12.8.2 Corrugated metal

Prefabricated corrugated metal pits and arresters shall ~~conform to~~ be as specified in AS/NZS 2041.4. They shall support, without structural failure, the ~~applicable~~ pit lid design loads as specified in ~~accordance with~~ AS 3996.

2.12.8.3 Other materials

Precast or prefabricated pits and arresters of materials, other than those specified in Clauses 2.12.8.1 and ~~,~~2.12.8.2, shall support~~, without structural failure,~~ the ~~applicable~~ pit lid design loads specified in AS 3996 without structural failure.

2.12.9 Timber

Timber exposed to the weather shall be of durability Class 2 ~~conforming to~~ as specified in AS/NZS 2878 or NZS 3631 or be treated as specified in ~~accordance with~~ AS 1604.1 or NZS 3640.

2.13 Filters for subsoil drains

2.13.1 Filter material

Filter materials consisting of natural clean washed sands and gravels and screened crushed rock shall be —

(a) well-graded, with a mix of different sizes of sand particles and permeability with —

  (i) natural sand, less than 5 % passing a 75 µm sieve; and

(ii) screened crushed rock, sizes 3 mm to 20 mm;

(b) sufficiently coarse not to wash into the subsoil drain, or through pores in a geotextile cover to such a drain; and

(c) chemically stable and inert to possible actions of soil and groundwater.

2.13.2 Geotextile filters

The permeability of geotextiles used in subsoil drains shall be greater than that of the native soil.

NOTE 1: A desirable permeability for geotextiles is 10 times that of the native soil.

NOTE 2: There is a tendency for geotextiles to clog at some locations, particularly whereif iron salts are present (e.g. scoria). Oxidization and biologically related actions can cause plate-like deposits of ferruginous particles on filter surfaces, rapidly clogging them. In such areas, carefully selected granular filters should be used instead of geotextiles. Advice from a professional engineer with geotechnical expertise should be sought in such situations.

3 Roof drainage systems — Design

3.1 Scope of section

This section specifies methods for the design of roof drainage systems.

3.2 General method

The general method is applicable to —

(a) eaves gutters and associated vertical downpipes with overflow measures, see Clause ;3.5;

(b) valley gutters, see Clause ;3.6; and

(c) box gutters and associated vertical downpipes with overflow devices, see Clause .3.7.

NOTE 1: The general method does not include allowance for any of the following:

(a) Localized variation in rainfall intensities due to wind or adjacent buildings.

(b) Blockages of roof drainage systems (e.g. by snow, hail or debris).

(c) Reduced hydraulic capacity caused by —

(i) reduced gutter gradient due to ground movement; or

(ii) turbulence due to wind.

NOTE 2: See Appendix G for an example of the application of the general method.

NOTE 3: The general method assumes regular inspection and cleaning, see Clause .M.5.

3.3 Meteorological criteria

3.3.1 General

The relationship between AEP and ARI is represented by the following equation:

$$AEP = \frac{\exp\left(\frac{1}{ARI}\right) - 1}{\exp\left(\frac{1}{ARI}\right)} \qquad 3.3.1$$

NOTE 1: ARI is expressed in years.

Equation 3.3.1 was used to produce the conversions of AEP to ARI givenspecified in Table 3.3.1.

Table 3.3.1 — AEP to ARI conversion

AEP %	ARI years
63.21	1
50	1.44
39.35	2
20	4.48
18.13	5
10	9.49
5	19.50
2	49.50
1	100
NOTE 1: These are exact conversions. NOTE 2: Equivalent values have been rounded to the next whole number in this document for convenience.	

Roof drainage systems shall be designed for the averageannual exceedance probability (AEP) (see Clause)3.3.4) for the site in respect tofor potential loss of amenity and injury to personspeople due to overtopping.

NOTE 12: A frequent cause of such overtopping is inadequate inspection and cleaning (see Clause)M.5) and not the intensity of rainfall.

NOTE 23: Although hail can restrict or block roof drainage systems, the present lack of performance data prevents the inclusion of requirements for hail barriers.

3.3.2 Snowfall effects

In regions subject to snowfalls, for roof drainage systems, there shall be no effect on size.

NOTE 1: Roof drainage support systems should be designed to include an allowance for snow load, refer to AS/NZS 1170.3.

NOTE 2: Sometimes eaves gutters are not used in alpine regions because the stormwater from roofs is collected at ground level, generally in site stormwater channels.

3.3.3 Wind effects

For other than flat or permanently projected sloping surfaces (see Clause),3.4), a gradient of 2:1 shall be adopted to allow for the effects of wind or rainfall.

NOTE: As studies in Australia are insufficient to determine the maximum gradient of descent of wind-driven rain at design intensities, European practice has been adopted, refer to EN 12056-3.

3.3.4 Design probabilities

The averageannual exceedance probability (AEP) shall be as givenspecified in Table 3.3.4.

Table 3.3.4 — AverageAnnual exceedance probability

Effect of overtopping	AEP %

		Australia	New Zealand
(a)	Eaves gutters, external, normal flow	≥ 5	≥ 10
(b)	Box gutters and valley gutters, and eaves gutter overflow measures	≥ 1	≥ 2
NOTE 1: For Australia, this table should be used in conjunction with the NCC, which includes requirements to prevent rain and stormwater from roof drainage from entering certain buildings.			
NOTE 2: 1 % AEP is equivalent to 100 years ARI; 2 % AEP is equivalent to 50 years ARI; 5 % AEP is equivalent to 20 years ARI; and 10 % AEP is equivalent to 10 years ARI.			

3.3.5 Rainfall intensity

3.3.5.1 Australia

Five minutesminute duration rainfall intensity (in mm/h) for any place in Australia shall be determined for —

(a) an AEP of 5 % (20 years ARI) and 1 % (100 years ARI),) from ;Appendix D; and

(b) an AEP of 0.2 % (500 years ARI), assumed to be 1.5 times the 1 % AEP (100 years ARI) intensity at the same place.

NOTE 1: Guidelines for the determination of rainfall intensity are given in .Appendix C.

NOTE 2: Intensities for specific locations throughout Australia can be obtained using the Bureau of Meteorology rainfall intensities described in .Appendix D.

3.3.5.2 New Zealand

Ten minutesminute duration rainfall intensity (in mm/h) for any place in New Zealand shall be determined for an AEP of 10 % (10 years ARI) and 2 % (50 years ARI),) from .Appendix E.

NOTE: Guidelines for the determination of rainfall intensity are given in .Appendix C.

3.4 Catchment area

3.4.1 General

The catchment area for a roof, or roof and vertical wall(s), depends upon the gradient of the descent of the rain, see Clause .3.3.3. It shall be the greatest value for any direction of wind-driven rain.

NOTE 1: It may be necessary to trial different directions for the wind-driven rain to determine the catchment area for a particular case.

The components of the largest catchment area for a single dwelling shall be calculated by one of the following methods: —

(a) rational analysis.; or

(b) the application of Clauses 3.4.2 to ,3.4.4, inclusive.

NOTE 2: See Clause G.2 for a worked example.

3.4.2 Three-dimensional representation

A three-dimensional representation of the two components A_h and A_v of the catchment area for a sloping roof with its top edge either horizontal or not horizontal is shown in Figure 3.4.2(A). These components are represented in Figures 3.4.2(B) and 3.4.2(C) by lines in the horizontal and vertical planes.

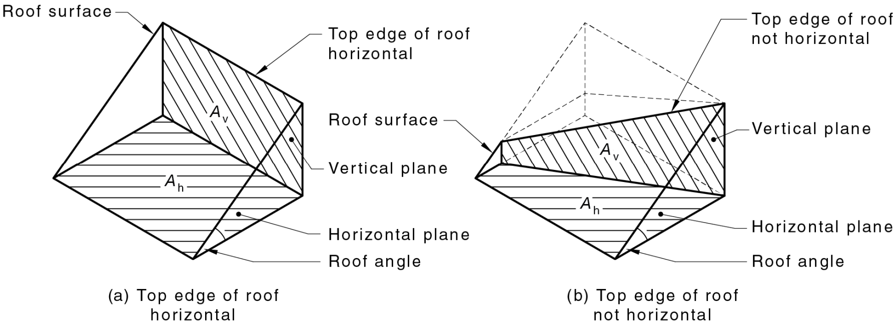


Figure 3.4.2(A) — Components of the catchment area

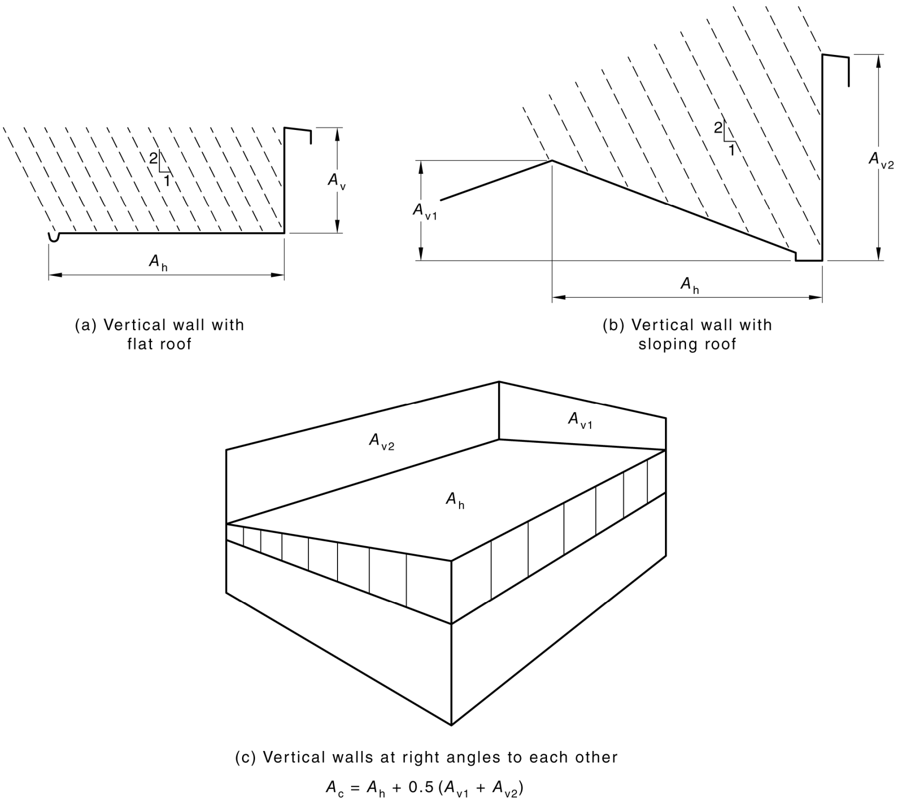


Figure 3.4.2(B) — Catchment area for vertical ~~wall(s)~~walls and roof

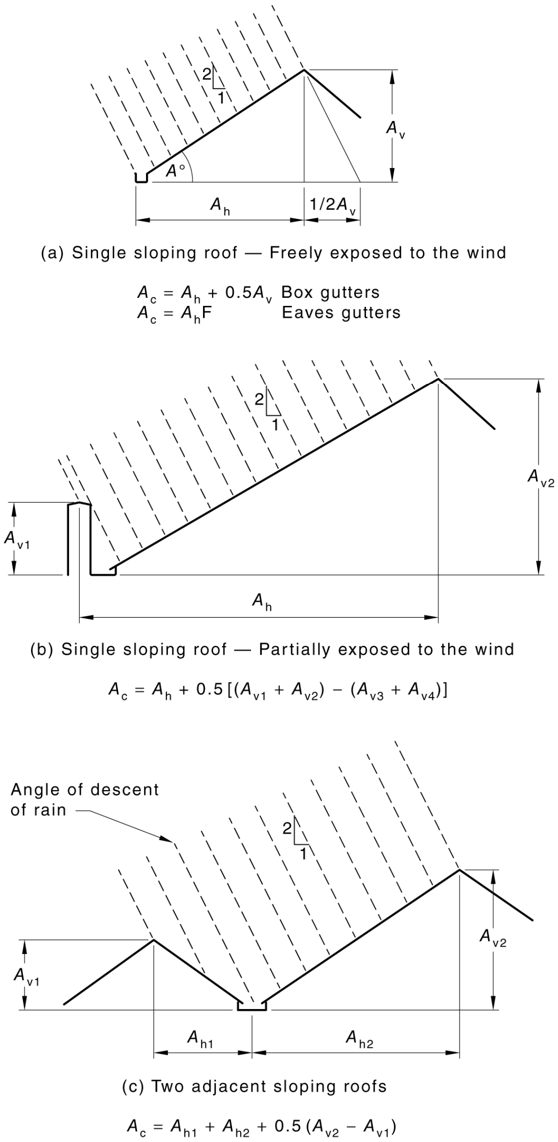


Figure 3.4.2(C) — Catchment area for roofs

3.4.3 Roof

3.4.3.1 Flat roof

The catchment area (in m^2) of a flat roof that is freely exposed to the wind shall be equal to the plan area of the roof and ~~gutter(s).~~any gutters.

3.4.3.2 Single sloping roof

The catchment area (in m²) of a single sloping roof that is —

(a) freely exposed to the wind [see Figure 3.4.2(C) (a)] shall be calculated from —

$$A_c = A_h + 0.5A_v \qquad 3.4.3.2(1)$$

or

$$A_c = A_h F \qquad 3.4.3.2(2)$$

NOTE: For values of F, see Table 3.4.3.2.

(b) partially exposed to the wind [see Figure 3.4.2(C) (b)] shall be calculated from —

$$A_c = A_h + 0.5\left[\left(A_{v1} + A_{v2}\right) - \left(A_{v3} + A_{v4}\right)\right] \qquad 3.4.3.2(3)$$

Table 3.4.3.2 — Catchment area multiplier (*F*) for various roof slopes (eaves gutters only)

Roof slope degrees	Multiplier (*F*)	Roof slope degrees	Multiplier (*F*)	Roof slope degrees	Multiplier (*F*)
0	1.00	22	1.20	44	1.48
1	1.01	23	1.21	45	1.50
2	1.02	24	1.22	46	1.52
3	1.03	25	1.23	47	1.54
4	1.03	26	1.24	48	1.56
5	1.04	27	1.25	49	1.58
6	1.05	28	1.27	50	1.60
7	1.06	29	1.28	51	1.62
8	1.07	30	1.29	52	1.64
9	1.08	31	1.30	53	1.66
10	1.09	32	1.31	54	1.69
11	1.10	33	1.32	55	1.71
12	1.11	34	1.34	56	1.74
13	1.12	35	1.35	57	1.77
14	1.12	36	1.36	58	1.80
15	1.13	37	1.38	59	1.83
16	1.14	38	1.39	60	1.87
17	1.15	39	1.40	61	1.90
18	1.16	40	1.42	62	1.94
19	1.17	41	1.43	63	1.98
20	1.18	42	1.45	64	2.03
21	1.19	43	1.47	65	2.07

3.4.3.3 Two adjacent sloping roofs

The catchment area (in m²) of two adjacent sloping roofs [see Figure 3.4.2(C) (c)] shall be calculated from ~~the following equation:—~~

$$A_c = A_{h1} + A_{h2} + 0.5\left(A_{v2} - A_{v1}\right) \qquad 3.4.3.3$$

NOTE: Equation 3.4.3.2(2) may be applied to the plan area of a roof (A_h) of a dwelling regardless of the wind direction~~,~~ provided there is no vertical surface that contributes to the catchment area, see ~~.~~Appendix G.

3.4.4 Vertical ~~wall(s)~~walls and roof

3.4.4.1 Vertical wall with a flat roof

The catchment area (in m²) for a vertical wall with a flat roof [see Figure 3.4.2(B) (a)] shall be calculated from ~~the following equation~~Equation 3.4.4.1:

$$A_c = A_h + 0.5A_v \qquad 3.4.4.1$$

3.4.4.2 Vertical wall with a sloping roof

The catchment area (in m²) for a sloping roof [see Figure 3.4.2(B) (b)] shall be calculated from ~~the following equation~~Equation 3.4.4.2:

$$A_c = A_h + 0.5\left(A_{v1} + A_{v2}\right) \qquad 3.4.4.2$$

3.4.4.3 Vertical walls at right angles to each other

The catchment area (in m²) for vertical walls at right angles to each other [see Figure 3.4.2(B) (c)] shall be calculated from ~~the following equation~~Equation 3.4.4.3:

$$A_c = A_h + 0.5\left(A_{v1} + A_{v2}\right) \qquad 3.4.4.3$$

NOTE: The catchment area for high vertical walls (e.g. a ~~multistorey~~multi-storey building) may be considerably less than half its surface area. Therefore, for a single wall, 50 % of its total vertical surface area up to a maximum exposed height of 10 m may be used.

3.4.5 Higher catchment area

Stormwater from a higher catchment area shall be discharged directly to a rainhead~~,~~ or the sump shall be sized as specified in ~~accordance with~~ this document. Alternatively, a spreader may be used provided —

~~Alternatively, a spreader may be used subject to the following requirements:~~

(a) for a tiled roof in Australia, the lower section ~~shall be~~is sarked a minimum width of 1 800 mm either side from the point of discharge and extended down to the eaves gutter as specified in ~~accordance with~~ AS 2050~~.~~; and

(b) for a corrugated metal roof in Australia, a minimum width of 1 800 mm on either side of the point of discharge ~~shall be~~is sealed for the full length of side laps.

NOTE 1: In New Zealand, spreaders that meet the requirements of NZBC Acceptable Solution E2/AS1 may be used.

The downpipe and gutter system of the lower catchment shall be sized as specified in ~~accordance with~~ Clause 3.4 to take into account the total flow from both catchments.

NOTE 2: The rainhead or sump may need to be larger than ~~that sized~~specified in ~~accordance with~~ this ~~Standard~~document and may include a device to dissipate energy. Sizing of such a rainhead or sump is beyond the scope of this document and may require hydraulic tests.

NOTE 3: ~~Where~~If spreaders are used, an allowance for an increased overflow provision for the gutter on the lower catchment should be considered.

NOTE 4: For a tiled roof, consideration should be given to sarking the roof below any upper eaves gutters to take into account any overflows.

3.4.6 Green, landscaped or garden roofs

The full run-off rate shall be used for the design of the system.

NOTE: The run-off rates from green, landscaped or garden roofs may be lower than for an impervious roof.

3.5 Eaves gutter systems

3.5.1 General

Eaves gutter systems, including downpipes, shall be designed and installed so that water will not flow back into the building.

3.5.2 Design procedure — normal flow

The design procedure for normal (or downpipe) flow shall follow the general method for design of eaves ~~gutters~~gutter systems~~,~~ as ~~given in the flow chart~~ shown in Figure 3.5.2.

NOTE: See Appendix G for an example of the application of the design procedure.

3.5.3 Design procedure — overflow measures

The design inflow volume *Q** (L/s) for overflow design shall be calculated based on —

(a) all downpipes assumed to be fully blocked; and

(b) an annual exceedance probability (AEP) of 1 % as specified in Table 3.3.4 Item (b).

The design of overflow measures shall be as specified in Appendix F.

The relevant catchment area for overflow design shall be determined as specified in Clause 3.4. The total catchment area shall include both upper and lower catchments if overflow from the upper catchment increases the volume of water to be handled by the lower catchment overflow measures.

Overflow measures are not required if eaves gutters are fixed to a veranda or an eave that is greater than 450 mm in width and —

(i) has no lining; or

(ii) is a raked veranda or a raked eave with a lining sloping away from the building.

NOTE: Consider the potential interactions of all overflow devices with other building elements and services such as roof membranes, leaf excluders and rainwater harvesting systems.

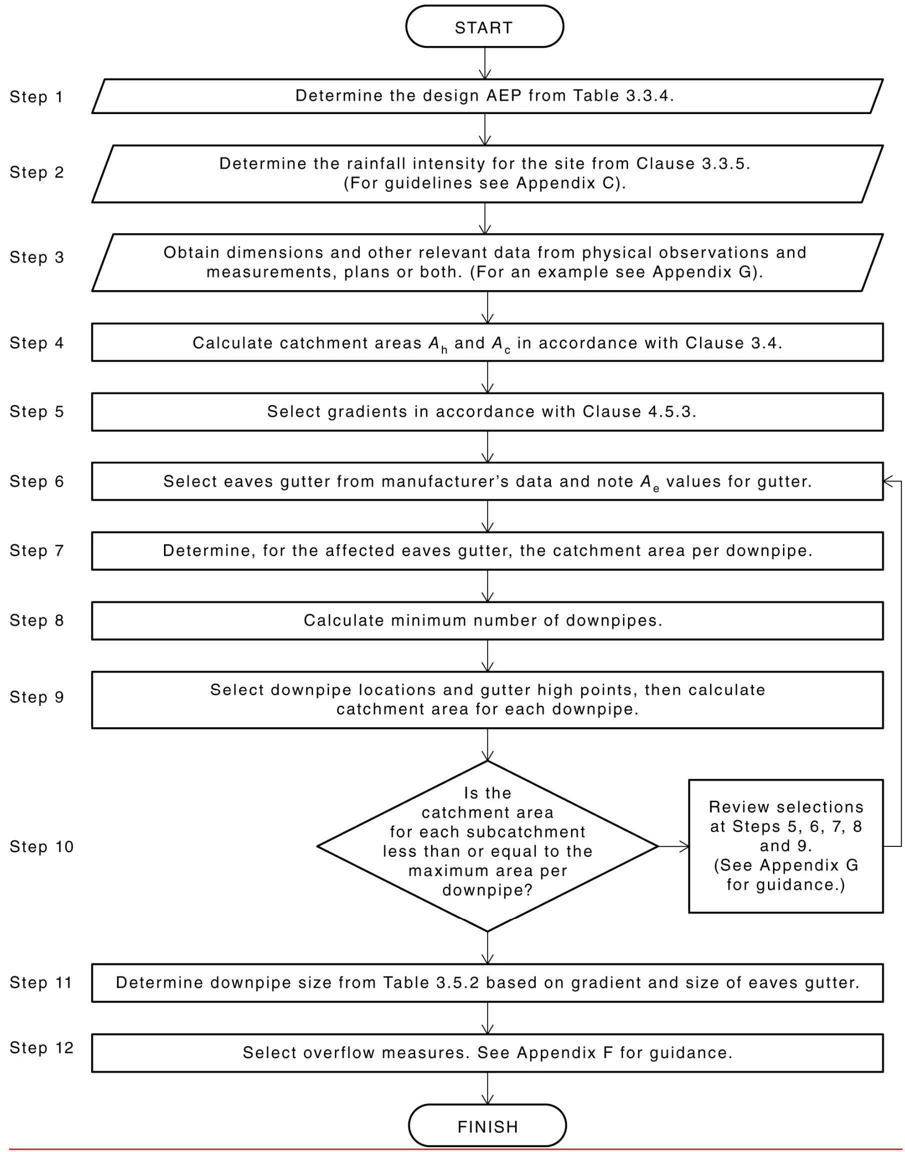


Figure 3.5.2 — Flow chart — General method for design of eaves gutter systems

Commented [JR3]: Post-PC figure number change.

Notes to Figure 3.5.2

Commented [JR4]: Post-PC figure number change.

NOTE 1: Each step designation refers to the corresponding step in the example, see Clause ~~.~~G.2.1.

NOTE 2: Appendix C provides guidelines for the determination of rainfall intensities.

NOTE 3: A_e to be in the range for gradients of ~~—~~(a) 1:500 and steeper, 3 ~~000~~500 mm² to ~~18~~20 000 mm²; or (b) flatter than 1:500, 4 ~~000~~700 mm² to ~~24 200~~26 800 mm².

NOTE 4: Consideration should be given to the criteria for thermal variation, see Clause ~~.~~4.3.

NOTE 5: For eaves gutters of domestic buildings with hipped or gable roofs of constant slope with no flat roofs or walls contributing to the catchment area, the catchment area calculations may be based entirely on Equation 3.4.3.2(2) using *F* determined by the roof slope and A_h determined from a plan. If Equation 3.4.3.2(2) is used, it is not necessary to take ~~account of~~ wind direction~~.~~ into account. Examples of ~~the use of~~ this method are shown in ~~.~~Appendix G.

NOTE 6: The vertical downpipe and any horizontal bends in an eaves gutter may be located at any point along the length of the catchment. ~~Where~~If this occurs, the whole catchment to that downpipe should be used with Figure 3.5.~~4~~5(A) or ~~Figure~~ 3.5.~~4~~5(B) (gutters less than 1:500) to size the eaves gutter~~, so as~~ to ~~ensure~~confirm that the vertical downpipe size is sufficient.

NOTE 7: As there are no high points for flat eaves gutters to define the catchment areas for each downpipe and downpipe section, halve the total catchment area between the adjacent downpipes.

NOTE 8: For aesthetic and practical considerations, the size of eaves gutters and associated vertical downpipes for the largest catchment area of the building are usually adopted for ~~each of~~ the other catchments.

~~**Figure 3.5.2 — Flow chart — General method for design of eaves gutter systems**~~

Table 3.5.2 — Eaves gutter — Required size of vertical downpipe

Commented [JR5]: Post-PC table number change.

Effective cross-sectional area of an eaves gutter (A_e)[a,b]		Internal size of vertical downpipe, mm	
Gradient		Cross-section	
1:500 and steeper	Flatter than 1:500	Circular	Rectangle or square
3 500	4 700	65	65 × 50
4 200	5 600	75	65 × 50
4 600	6 200	75	75 × 50
4 800	6 400	80	75 × 50
5 200	7 000	80	100 × 50
5 900	7 900	85	100 × 50
6 400	8 600	90	100 × 50
6 600	8 900	90	75 × 70
6 700	9 000	100	75 × 70
8 200	11 000	100	100 × 75
9 600	12 900	125	100 × 75
12 800	17 100	125	100 × 100
12 800	17 200	150	100 × 100
16 000	21 500	150	125 × 100
18 400	24 700	150	150 × 100
19 200	25 800	—	150 × 100

Effective cross-sectional area of an eaves gutter (A_e)[a,b]		Internal size of vertical downpipe, mm	
Gradient		Cross-section	
1:500 and steeper	Flatter than 1:500	Circular	Rectangle or square
20 000	26 800	—	125 × 125

[a] The effective cross-sectional area shall be obtained from Figures 3.5.4(A) and 3.5.4(B)]]) to the nearest 100 mm².

[b] Refer to AS/NZS 2179.1.

3.5.33.5.4 Vertical downpipes

Gutter outlets shall be fitted vertically to the sole of eaves gutters.

3.5.43.5.5 Effective cross-sectional area of eaves gutters

The effective cross-sectional area of an eaves gutter (to the nearest 100 mm²) for each nominal size of eaves gutter shall be as follows:—

(a) for an eaves gutter with external brackets—, the cross-sectional area beneath a line not less than 10 mm below the overflow (e.g. front bead, gutter back or bottom of overflow slots).); and

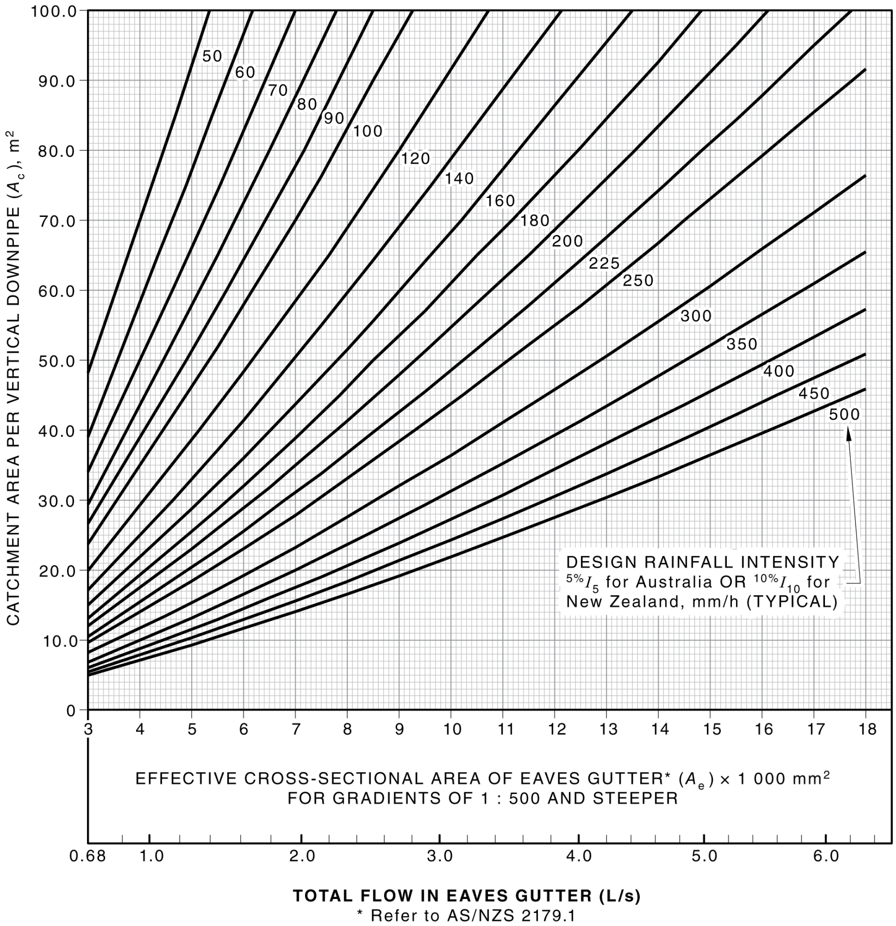
(b) for an eaves gutter with internal brackets—, as givenshown in FiguresFigure 3.5.4(A) or 3.5.4(B), less the allowance for the effects of the brackets.

NOTE 1: For the cross-sectional area of the eaves gutter and the effect of internal brackets, the manufacturer's specifications should be consulted.

NOTE 2: The method specified in this document for the sizing of eaves gutters is based on research using eaves gutters with external brackets.

NOTE 3: Internal brackets increase the potential for debris collection.

NOTE 4: WhereIf the manufacturer does not provide data on the effect of the internal bracket, the projected gross area of the edge of the internal bracket, including stiffening rib facing the direction of flow, may be deducted, provided the area so deducted is not greater than 15 % of the original cross-sectional area of the gutter.



NOTE 1: This graph assumes ~~—~~ —

(a) an effective width~~:~~ to depth ratio of about 2:1;

(b) a gradient in the direction of flow, 1:500 or steeper;

(c) the least favourable positioning of the downpipe and bends within the gutter length;

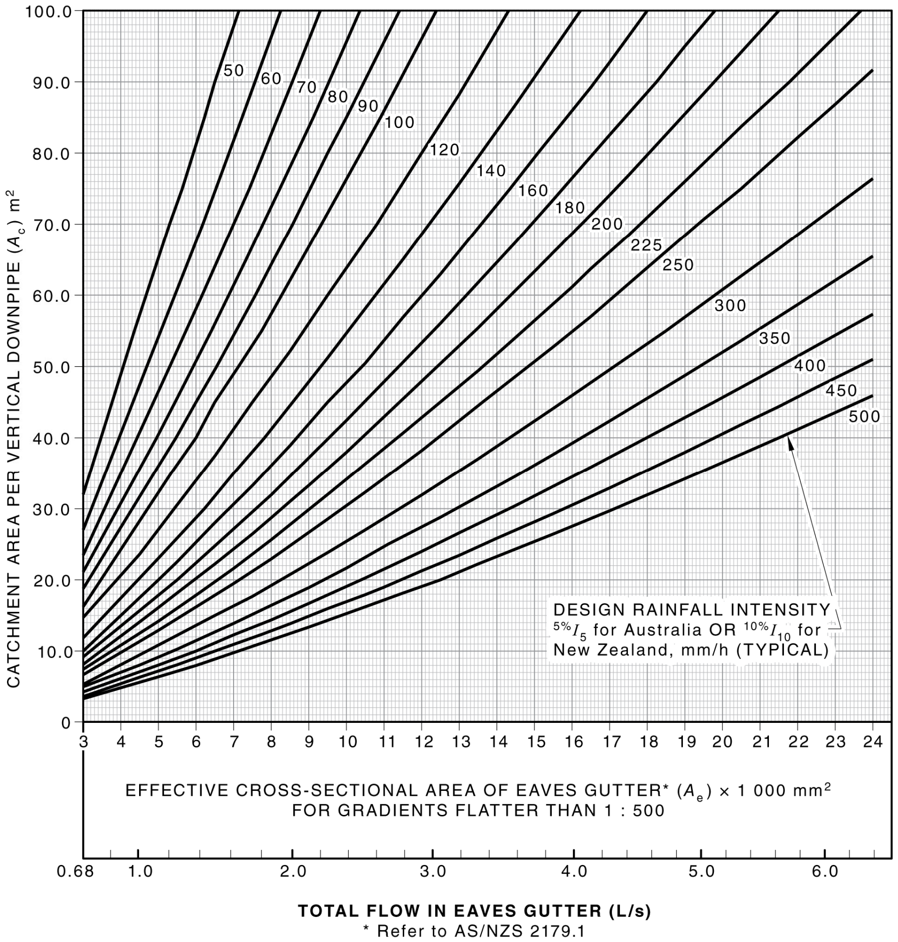
(d) a cross-section or half round, quad, ogee or square; and

(e) the outlet to a vertical downpipe is located centrally in the sole of the eaves gutter.

NOTE 2: The eaves gutter discharge areas do not allow for loss of waterway due to internal brackets.

Figure 3.5.~~4~~5(A) — Size of eaves gutters for gradients 1:500 and steeper

Commented [JR6]: Post-PC change to "* Refer to AS/NZS 2179.1" in figure -- move to figure note.



NOTE 1: This graph assumes —

(a) an effective width to depth ratio of about 2:1;

(b) a gradient in the direction of flow flatter than 1:500;

(c) the least favourable positioning of the downpipe and bends within the gutter length;

(d) a cross-section or half round, quad, ogee or square; and

(e) the outlet to a vertical downpipe is located centrally in the sole of the eaves gutter.

NOTE 2: The eaves gutter discharge areas do not allow for loss of waterway due to internal brackets.

Figure 3.5.5(B) — Size of eaves gutters for gradients flatter than 1:500

3.6 Valley gutters

3.6.1 Limitations

Commented [JR7]: Post-PC -- See previous comment.

The following limitations of the general method apply for valley gutters:

(a) Roof slopes shall be not less than 1:4.5 (12.5°).

(b) The nominal valley gutter side angle shall be 1:3.4 (16.5°).

NOTE 1: See Figure 3.6.1 for a profile of a valley gutter.

(c) The catchment area shall not exceed ~~20 m²~~the limits shown in Figure 3.6.2.

NOTE 2: See Clause 3.6.3 for the effect of obstructions on the effective width of the valley gutter.

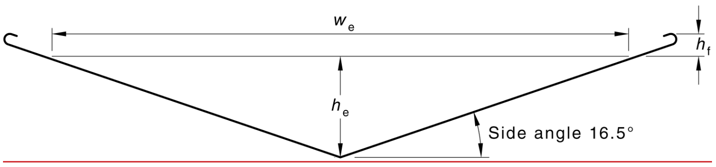


Figure 3.6.1 — Profile of a valley gutter

3.6.2 Design procedure

The design rainfall intensity for a 5 min duration in Australia and a 10 min duration in New Zealand (~~in~~ mm/h) shall be determined as specified in ~~accordance with~~ Clause ~~,~~3.3.5, Appendix D and ~~,~~Appendix E.

~~NOTE 1: See for guidelines on determining rainfall intensities.~~

The effective width of the valley gutter shall be determined using either Table 3.6.2 for catchments not more than 20 m² or Figure 3.6.2 for all other catchments.

NOTE 1: Computational Fluid Dynamics (CFD) may also be used, see Clause F.4.5.

NOTE 2: Dimensions of valley gutters with a catchment area not more than 20 m² are given in Table 3.6.2.

NOTE 3: Figure 3.6.2 compares design rainfall intensity (DRI) with catchment area for various valley gutter effective widths.

Table 3.6.2 — Valley gutters — Dimensions

Design rainfall intensity mm/h		Minimum, mm Sheet width	Effective depth (h_e)	Effective width (w_e)
	≤ 200	355	32	215
> 200	≤ 250	375	35	234
> 250	≤ 300	395	38	254
> 300	≤ 350	415	40	273
> 350	≤ 400	435	43	292

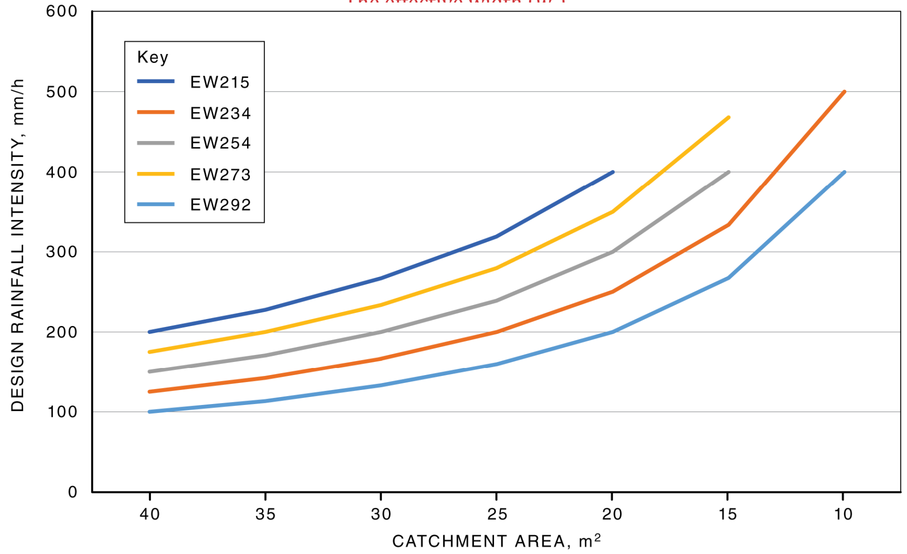
NOTE 1: This table is derived from Martin and Tilley and is based on a 23.5° roof angle.

NOTE 2: Maximum catchment area 20 m².

NOTE ~~2~~3: Freeboard (h_f), 15 mm.

NOTE ~~3~~4: The sheet width from which the valley is ~~to be~~ formed has been calculated based on ~~the basis of~~ h_f = 15 mm and an allowance for side rolls or bends of 25 mm.

~~### 3.6.3 Effective width~~



Key

EW = Effective width, in mm

NOTE: See Clause 3.6.3 for the effect of ~~a~~obstructions on the effective width of the valley gutter~~ shall .~~. The width may need to be ~~such that~~ increased if obstructions are expected.

Figure 3.6.2 — DRI vs catchment area for various valley gutter sizes

3.6.3 Effective width

The effective cross-sectional area of valley gutters, below the effective width ~~(as~~ shown in Figure 3.6.1~~), is~~, shall not be obstructed by bedding, anti-vermin strips or overhangs of roof cladding.

NOTE: Refer to Martin and Tilley for further information on protrusion of roof covering into the valley.

3.7 Box gutter systems

3.7.1 General

Box gutter systems shall incorporate overflow devices as specified in ~~accordance with~~ Clause ~~.~~3.7.7.

3.7.2 Freeboard

The freeboard (h_f) for box gutters shall be 30 mm~~ in accordance with~~, see Figure I.5.

3.7.3 Limitations

The following limitations of the general method apply to box gutter systems:

(a) Gradients shall be in the range 1:40 to 1:200.

NOTE 1: Figures H.6 and H.8 assume that box gutters slope in the range 1:40 to 1:200.

(b) For rainheads —

(i) design flows shall not exceed 16 L/s; and

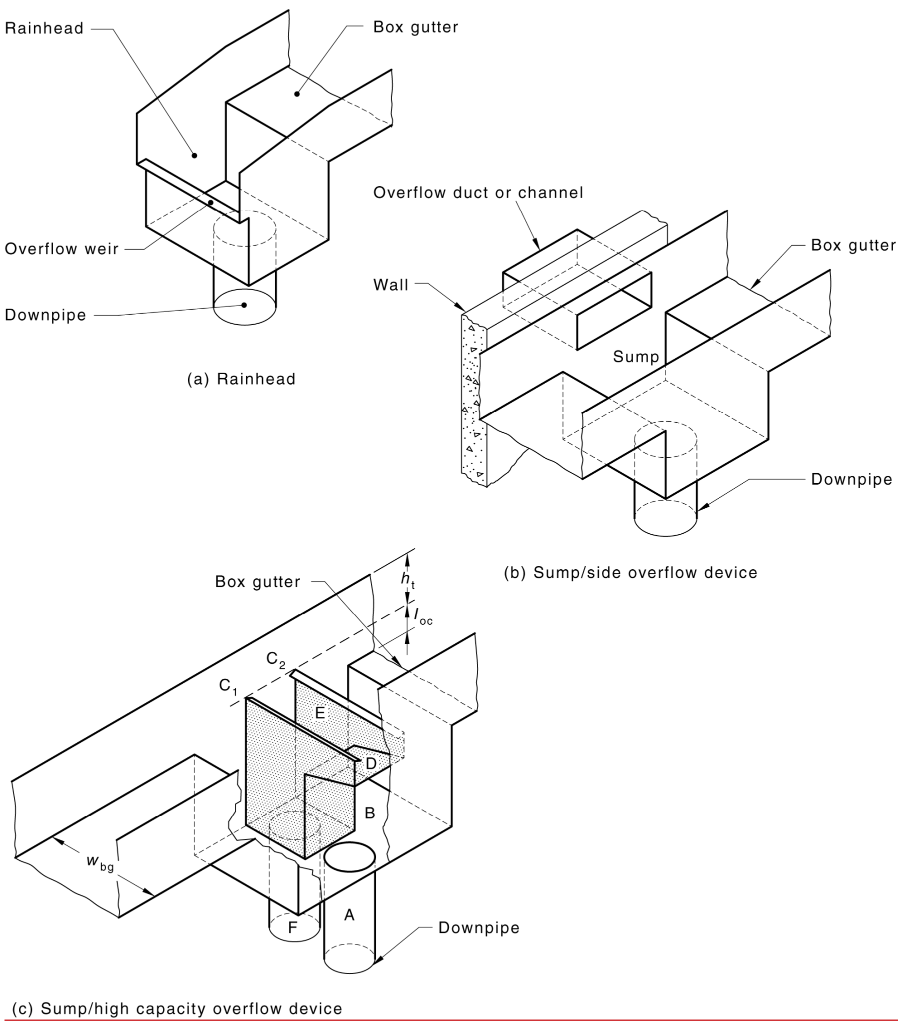
(ii) the size range of vertical downpipes shall be ~~according to~~as shown in Figure H.3.

(c) The limitation of solution for sumps with overflow devices shall be the size range of vertical downpipes ~~according to~~as shown in Figure H.4.

NOTE 2: ~~Criteria~~Requirements for box gutter overflow devices are ~~given~~specified in Clause 3.7.7 and illustrated in Figure 3.7.3.

NOTE 3: The minimum width of box gutters used for commercial construction is 300 mm. In Australia, box gutters 200 mm wide may be used for domestic construction~~,~~ but ~~they~~ are more prone to blockages. Additional height is recommended ~~where~~if possible.

NOTE 4: See Appendix I for examples of the application of the general method.



NOTE 1: Layout of sump/side overflow device may have to be varied due to constraints, see Figure 3.7.3(b).

NOTE 2: WhereIf desired, the sides of the sump/high capacity overflow device may be perforated to flush the downpipe *F,* see Figure 3.7.3(c).

NOTE 3: The normal outlet may be moved longitudinally to enable better inspection and maintenance access, see Figure 3.7.3(c) and Clause (3.7.6(f).

NOTE 4: For criteriarequirements for overflow devices, see Clause .3.7.7.

NOTE 5: For sump/high capacity overflow devices, see Clause 3.7.4(c).

Figure 3.7.3 — Overflow devices — Box gutters

3.7.4 Design procedure

Box gutter systems shall be designed in accordance withto meet the requirements of the general method —

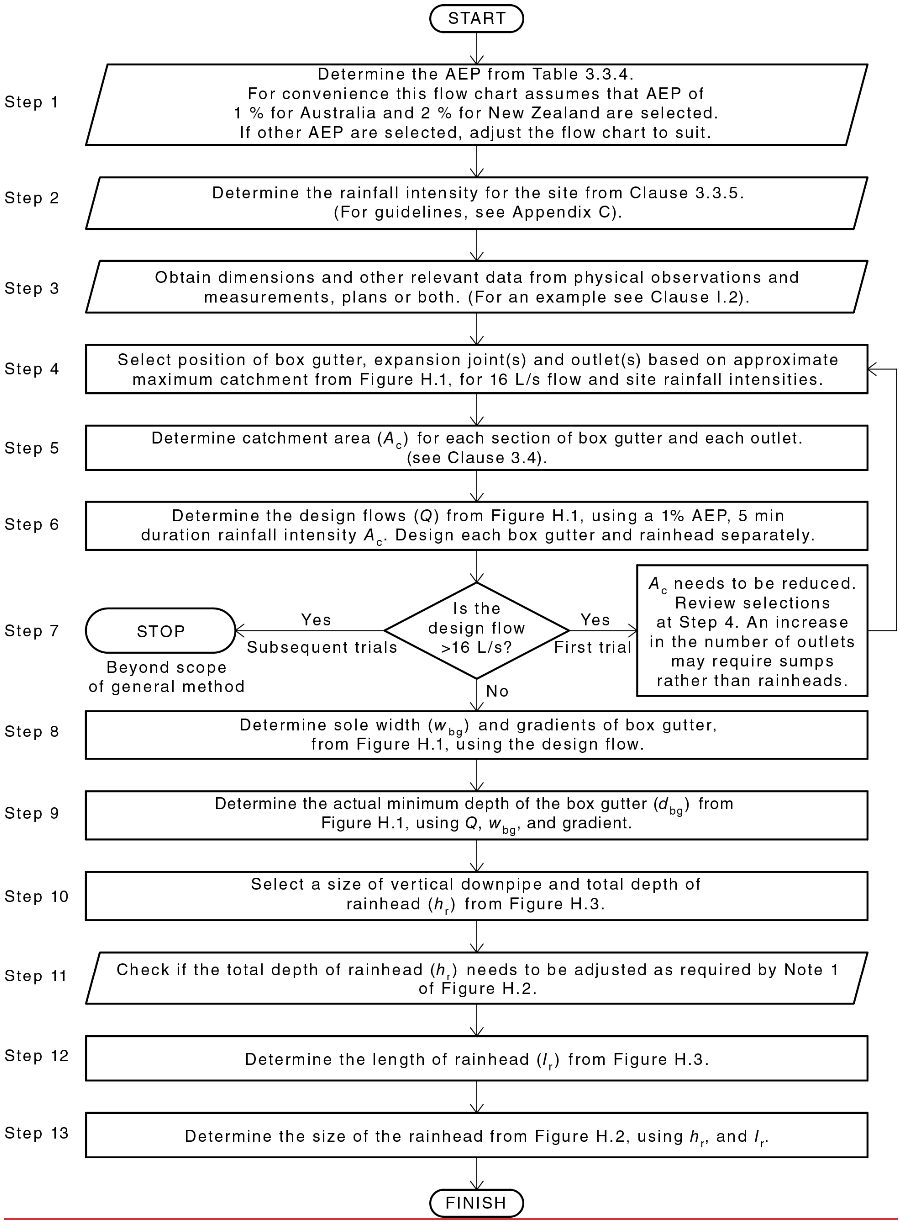
(a) for box gutters, rainheads and downpipes, as given insee Figure 3.7.4(A);

(b) for box gutters, sump/side overflow devices and downpipes, as given insee Figure 3.7.4(B); and

(c) for box gutters, sump/high capacity overflow devices and downpipes, as given insee Figure 3.7.4(C).

NOTE 1: For flow chart symbols and conventions used in this document are given in, see Clause .1.6.2.

NOTE 2: It should be ensured that The hydraulic capacities of downpipes systems or surface water drain (upstream) of a surcharge outlet as definedspecified in Clause are5.4.12.1 should be sufficient to carry 1 % AEP (100 years ARI) box gutter flows.



NOTE 1: Selected positions of box ~~gutter~~gutters, expansion ~~joint(s),~~joints, rainheads, downpipes and overflow devices shall be compatible with the layout of buildings and site stormwater drains and the ~~criteria~~requirements for thermal variation~~, see~~ specified in Clause ~~.~~4.3.

NOTE 2: Figure H.3 is for a box gutter with a gradient of 1:200. For steeper gradients, determine from Figure H.1 for the design flow, the equivalent total depth of box gutter with a gradient of 1:200. Determine from Figure H.3 for the equivalent total depth, the increased I_r.

Figure 3.7.4(A) — ~~Flow chart —~~ General method for design of box gutters, rainheads and downpipes

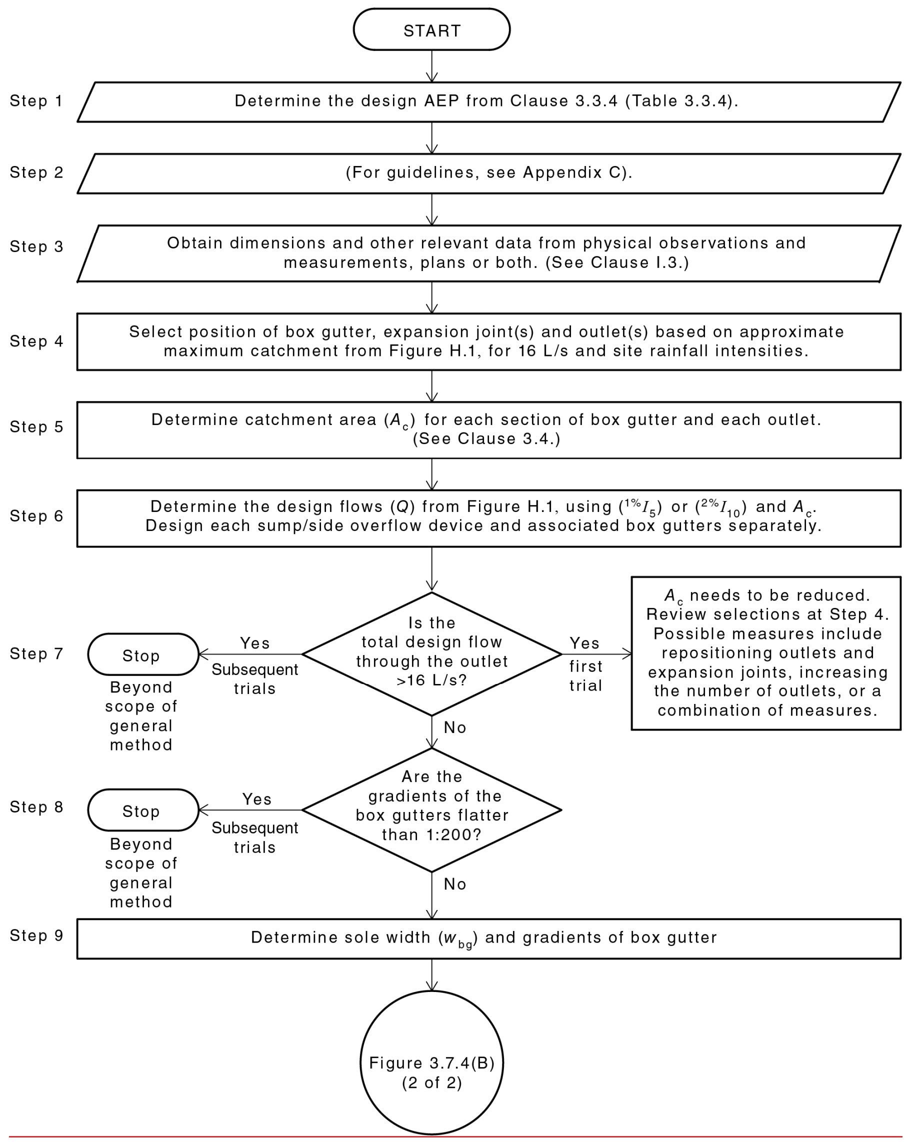
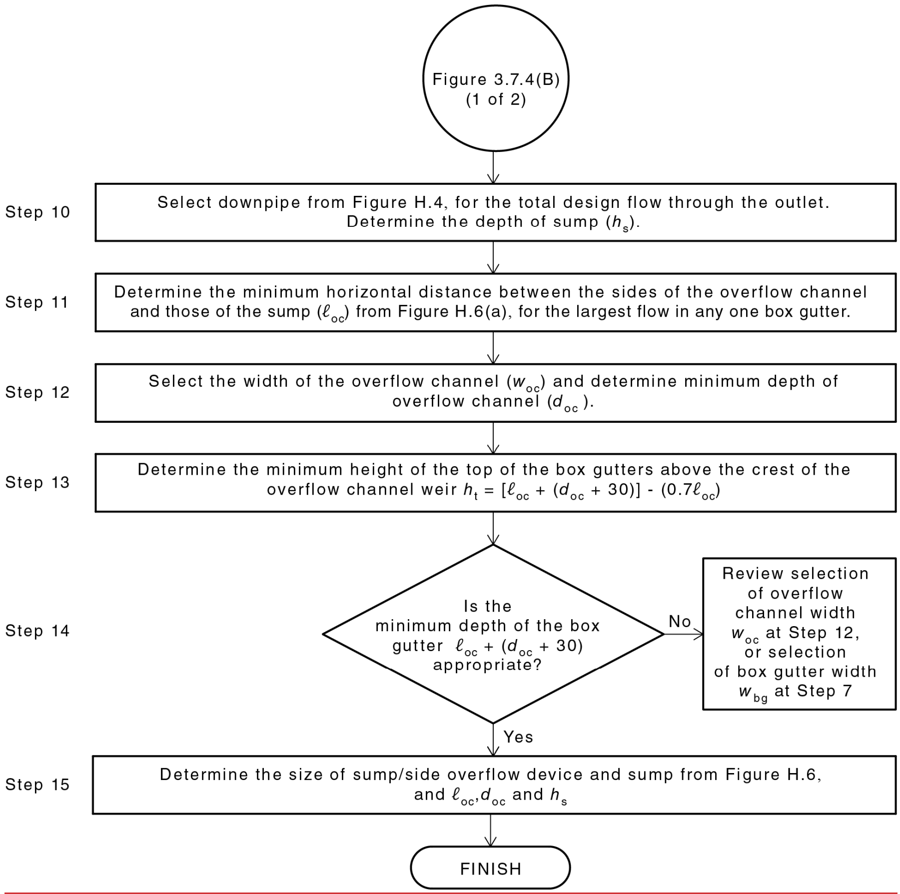


Figure 3.7.4(B) (1 of 2) — ~~Flow chart —~~ General method for design of box gutters, sump/side overflow devices and downpipes



NOTE 1: Selected positions of box ~~gutter~~gutters, expansion ~~joint(s),~~joints, sumps, downpipes and overflow devices shall be compatible with the layout of buildings and site stormwater drains and the ~~criteria~~requirements for thermal variation~~, see~~ specified in Clause ~~.~~4.3.

NOTE 2: The total design flow is the summation of the design flow for each box gutter and the section of roofing discharged directly into the sump.

Figure 3.7.4(B) (2 of 2) — ~~Flow chart —~~ General method for design of box gutters, sump/side overflow devices and downpipes

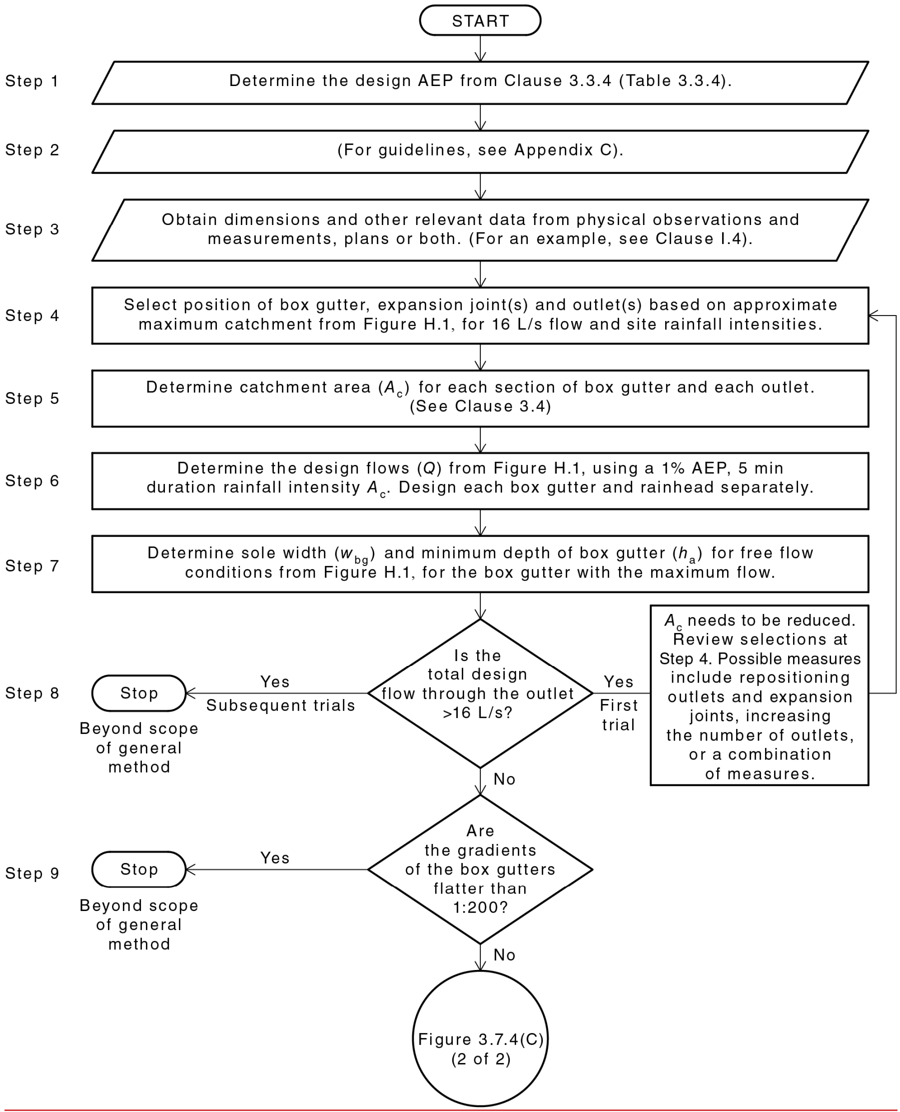
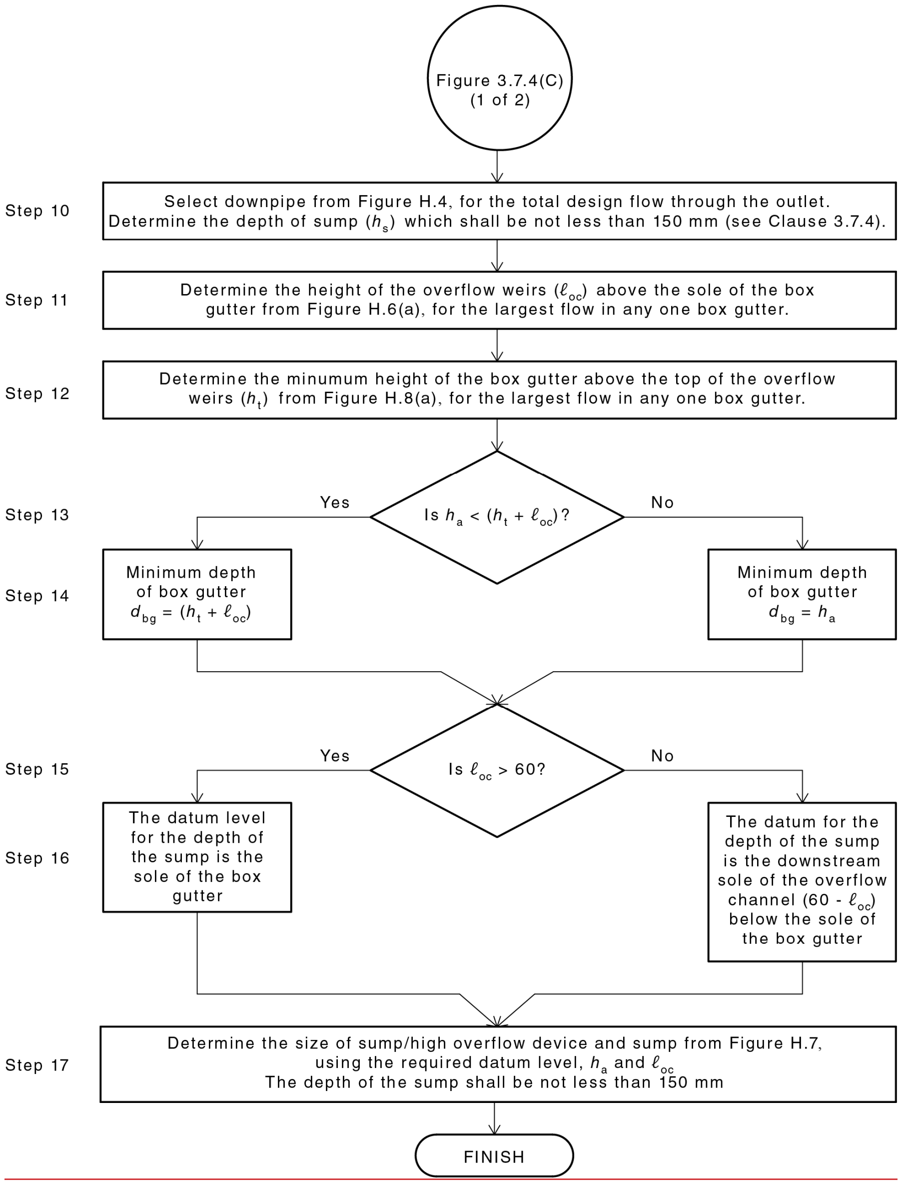


Figure 3.7.4(C) (1 of 2) — ~~Flow chart —~~General method for design of box gutters, sump/high capacity overflow devices and downpipes



NOTE 1: Selected positions of box ~~gutter~~gutters, expansion ~~joint(s),~~joints, sumps, downpipes and overflow devices shall be compatible with the layout of buildings and site stormwater drains and the ~~criteria~~requirements for thermal variation~~, see~~ as specified in Clause ~~-~~4.3.

NOTE 2: The total design flow is the summation of the design flow for each box gutter and the section of roofing discharged directly into the sump.

Figure 3.7.4(C) (2 of 2) — Flow chart—General method for design of box gutters, sump/high capacity overflow devices and downpipes

3.7.5 Hydraulic capacity

The hydraulic capacity (e.g. maximum design flow) of a box gutter is based on the sole width and gutter depth, the gradient [see Clause (a)], and whether the discharge is to a rainhead, a sump/side overflow device or a sump/high capacity overflow device.—

(a) the sole width and gutter depth;

(b) the gradient, see Clause 4.5.4(a); and

(c) if the discharge is to a rainhead, a sump/side overflow device or a sump/high capacity overflow device.

NOTE 1: The hydraulic capacity of an associated rainhead or sump is dependent on the selected size of the vertical downpipe and the depth of the rainhead or sump, see Figures 3.7.4(A), 3.7.4(B) and 3.7.4(C).

NOTE 2: For the same design flow, the required depth of a rainhead or sump increases if the cross-sectional area of the vertical downpipe decreases.

3.7.6 Layout

The following apply to The layout of box gutter systems shall meet the following requirements:

(a) The location and size of the box gutter shall be taken into consideration.

(b) The size of the support system (see Clause)4.9) shall be taken into consideration.

(c) Provision for the effects of thermal variation (see Clause)4.3) on the box gutter and support system shall be taken into consideration.

(d) Consideration shall be given to the location of associated vertical downpipes with rainheads or sumps in relation to —

(i) features within the building and usage;

(ii) surface water drainage system external to the building;

(iii) the space within or external to the building; and

(iv) provision for flow from each overflow device (see Clause)3.7.5) to be discharged, without danger, indirectly to the surface water drainage system.

(e) For the sump/high capacity overflow device, the depth of the sump (h_s) shall be not less than 150 mm regardless of the position of the normal outlet. Changes to the depth of the sump are not required, provided the sump/side overflow device is used.

(f) The normal outlet shall not be moved laterally to cross the longitudinal centre-line of the overflow device. However, it may be moved longitudinally to clear the overflow channel to enable better inspection and maintenance access. The outlet shall not be moved laterally to cross the longitudinal centre-line of the overflow device.

NOTE: If the normal outlet is moved, it should preferably be moved towards the box gutter with the greater flow.

(g) Box gutters shall —

(i) be straight (without change in direction);

(ii) have a horizontal constant width base (sole) with vertical sides in a cross-section;

(iii) have a constant longitudinal slope between 1:200 and 1:40;

(iv) discharge at the downstream end without change of direction (i.e. not to the side); and

(v) be sealed to the rainheads and sumps.

3.7.7 Overflow devices

3.7.7.1 Hydraulic capacity

The hydraulic capacity of an overflow device shall be not less than the design flow for the associated gutter outlet. Overflow devices shall discharge to the atmosphere.

NOTE: In New Zealand, overflow outlets should be located to give an early, conspicuous warning to the building occupier that maintenance is required. Overflow outlets should discharge outside the building, clear of doors, windows or other opening, and within the property boundary.

3.7.7.2 Operation

There shall be an increase in the depth of flow in the box gutter for overflow devices that discharge from sumps. The overflow devices shall ~~be~~ either be —

(a) side overflow, see Figure 3.7.3 (b); or

(b) high capacity overflow [see Figure 3.7.3 (c~~)], where~~)] if, in the event of a blockage in the normal vertical downpipe *A*, the water level in the primary sump *B* will rise to and overtop the overflow weirs C_1 and C_2 ~~(each weir length equal to the width of the adjacent box gutter)~~ to flow either directly or indirectly by the overflow channel *D*~~,~~ to the secondary sump *E* and then to the overflow vertical downpipe *F*.

~~NOTE 1~~NOTE 1: Each weir length is equal to the width of the adjacent box gutter.

NOTE 2: Overflow devices that discharge from rainheads do not require an increase in the depth of flow in the box gutter, see Figure 3.7.3 (a).

NOTE ~~2~~3: Vertical piped overflow outlets, covered overflow devices and other type overflow provisions not specifically ~~presented~~shown in Figure 3.7.3 are not covered by this document.

NOTE ~~3: Where~~4: If water flowing directly into the overflow is a problem, a deflector or cap may be installed to divert the water.

3.7.8 Downpipes

Downpipes shall be at least 90 mm in diameter or 100 mm × 50 mm rectangular downpipe~~,~~ shall be fitted vertically to the base of a rainhead or sump, and discharge to —

(a) a rainhead or sump of a lower gutter; or

NOTE: See Clause 3.4.5 for higher catchment area.

(b) a surface water drainage system with the capacity to convey run-off from a storm event as specified in ~~accordance with~~ Table 3.3.4.

3.8 Balcony and terrace areas

Systems for draining balconies and terraces shall be designed for —

(a) in Australia —

(i) 5 % AEP (20 years ARI) rainfall intensity; and

(ii) 1 % AEP (100 years ARI) rainfall intensity for overflow.

(b) in New Zealand —

(i) 10 % AEP (10 years ARI) rainfall intensity; and

(ii) 2 % AEP (50 years ARI) rainfall intensity for overflow.

4 Roof drainage systems — Installation

4.1 Scope of section

This section specifies installation requirements for roof drainage systems.

4.2 Installation

Strippable polymer coatings shall be removed from components during installation.

4.3 Thermal variation

4.3.1 General

~~Where~~If thermal variation of roof drainage system components and/or support systems ~~or both would otherwise~~may have a ~~deleterious~~harmful effect, provision shall be made to accommodate such variation. ~~Where~~If thermal variation is to be controlled, the restraint shall be limited to one fixed point per section and ~~due~~ allowance made for the forces imposed by the restraint.

4.3.2 Expansion joints

Expansion joints shall ~~conform to~~meet the following requirements:

(a) *Box gutters* — For box gutters and support systems, the maximum lengths between expansion joints and minimum expansion space shall be as ~~given~~specified in Table 4.3.2. The gaps between the stop ends shall be bridged by a suitable saddle flashing. The maximum lengths between expansion joints in Table 4.3.2 shall apply from the fixed point to the free ~~end(s). Where~~ends. If the gutter is fixed between two fixed points that are more than 6 m apart, such as ~~in~~ between two sump outlets or similar, an expansion joint of 25 mm shall be provided ~~where the distance between the fixed points exceeds 6 m~~.

(b) *Eaves gutters* — Eaves gutters shall have support systems that permit longitudinal thermal expansion without detriment to the gutter or accessories.

(c) *Downpipes* — Downpipes shall have support systems that permit thermal expansion without detriment to the downpipe or accessories.

NOTE: The temperature variation experienced by products depends upon geographical location, extent of shading and absorptivity and surface colour. During summer, in most parts of Australia and New Zealand, the temperature of products exposed to direct sunlight may exceed 80 °C.

Table 4.3.2 — Box gutters and support systems — Maximum length between expansion joints and minimum expansion space

Materials	Coefficient of thermal expansion per °C	Base metal thickness mm	Maximum length between expansion joints, m		Minimum expansion space mm
			One end fixed and one end free to move	Both ends free to move	
Aluminium	24×10^{-6}	0.90	12	24	50
		1.00	12	24	
Copper	17×10^{-6}	0.60	9	18	50
		0.80	15	30	
		1.00	26	52	

Materials	Coefficient of thermal expansion per °C	Base metal thickness mm	Maximum length between expansion joints, m		Minimum expansion space mm
			One end fixed and one end free to move	Both ends free to move	
Steel	12×10^{-6}	0.55	20	40	50
		0.75	25	50	
Stainless steel	17×10^{-6}	0.55	20	40	50
PVC	70×10^{-6}	—	10	20	30
Zinc	26×10^{-6}	0.80	10	20	50

4.4 Corrosion

4.4.1 Corrosion due to direct contact

Metal roof drainage system components, including accessories~~ and~~, fasteners and~~, where used,~~ metal cladding, shall be designed with either —

(a) compatible metals in direct contact as ~~given~~specified in Table 4.4.1; or

(b) ~~where~~if unavoidable, incompatible metals separated by an impervious non-conducting material.

NOTE 1: The combinations of metals~~ given~~ in Table 4.4.1 are based on current knowledge and the premise that the area of rainwater goods or metal cladding is relatively large in comparison to that of accessories or fasteners.

NOTE 2: The resistance of roof drainage system components of certain metals to corrosive agents is partly dependent on the beneficial washing action of rain and no permanent ponding.

NOTE 3: The service life of most metals in severe marine atmospheres and industrial areas with atmospheres contaminated by acid-bearing agents may be extended by the use of special painting procedures, refer to AS/NZS 2312.

4.4.2 Corrosion due to drainage

Metal roof drainage system components shall be designed and installed to prevent corrosion~~,~~ and/or erosion~~, or both,~~ due to drainage from metal and non-metal roof drainage system components and, ~~where~~if used, cladding.

NOTE: See Table 4.4.2 for guidance on combinations for materials to prevent corrosion, erosion, or both, due to drainage.

Table 4.4.1 — Compatibility of direct contact between metals

Roof drainage system components and any cladding material	Accessory or fastener material												Fastener material
	Aluminium alloys		Copper and copper ~~alloys[a]~~alloys		Stainless steel (300 series)		Zinc-coated steel and zinc		Aluminium/zinc and aluminium/zinc/ magnesium alloy-coated steel		Lead		Ceramic or organic coated
	Atmospheric classification												
	SI and VS	Mild	SI and VS	Mild	SI and VS	Mild	SI and VS	Mild	SI and VS	Mild	SI and VS	Mild	SI, VS and Mild
Aluminium alloys	Yes	Yes	No	No	[b]	Yes	[c]	[c]	Yes	Yes	No	No	Yes
Copper and copper alloys	No	No	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes
Stainless steel (300 series)	No	No	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes
Zinc-coated steel and zinc	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel	Yes	Yes	No	No	No	Yes	[c]	[c]	Yes	Yes	No	No	Yes
~~Lead[d]~~Lead [d]	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes

~~Key~~

SI, VS, Mild = Severe industrial, very severe and mild classifications, refer to AS/NZS 2312.

Yes = Acceptable — as a result of bimetallic contact, either no additional corrosion of rainwater goods takes place or, at the worst, only very slight additional corrosion. It also implies that the degree of corrosion would not shorten the service life.

No = Not acceptable — moderate to severe corrosion of rainwater goods will occur, a condition which may result in a significant reduction in the service life.

NOTE: Unless separation can be ensured, pre-painted rainwater goods should be considered in terms of the base metal or coated metal product.

Commented [JR8]: Post-PC. No footnote references at end of table.

Table 4.4.2 — Compatibility of drainage from an upper surface to a lower metal surface

Lower roof drainage system material	Upper cladding or roof drainage system material										
	Aluminium alloys	Copper and copper alloys	Stainless steel (300 series)	Zinc-coated steel and zinc	Aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel	Lead	Pre-painted metal	Roof tiles		Plastic	Glass
								Glazed	Unglazed		
Aluminium alloys	Yes	No	[a]	Yes	Yes	[a]	Yes	Yes	Yes	Yes	Yes
Copper and copper alloys	[a]	Yes	[a]	[a]	[a]	Yes	[a]	Yes	Yes	Yes	Yes
Stainless steel (300 series)	[a]	[a]	Yes	[a]	[a]	Yes	[a]	Yes	Yes	Yes	Yes
Zinc-coated steel and zinc	No	No	No	Yes	No	[a]	No	No	Yes	No	No
Aluminium/zinc and aluminium/zinc/ magnesium alloy-coated steel	Yes	No	[a]	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Lead	[a]	[a]	[a]	[a]	[a]	Yes	[a]	Yes	Yes	Yes	Yes

~~Key~~

Yes = acceptable

No = not acceptable

[a] Although drainage between the materials shown would be acceptable, direct material contact should be avoided, see Table 4.4.1.

NOTE: "Acceptable" and "not acceptable" imply similar performances to those noted in Table 4.4.1.

4.4.3 Corrosion due to crevices

Metal roof drainage systems and support systems shall be designed and installed to achieve complete drainage or drying. Shielded areas capable of causing permanent ponding shall be avoided to prevent the possibility of intense localized corrosion known as crevice corrosion.

NOTE: This type of attack results from contact of metal with moisture and salts under oxygen-deficient conditions in which trapped moisture cannot readily evaporate. It can be caused by lap joints, absorbent gaskets, holes, crevices under bolt or rivet heads, or surface deposits, including non-metallic materials such as elastomeric materials, plastics, fabrics, lifted paint films or accumulated solids.

4.4.4 Corrosion due to chemical incompatibility

Bedding materials used in conjunction with roof drainage systems shall be chemically compatible. Cement-based bedding may be used between tiles and valley gutters other than those of exposed aluminium/zinc or aluminium/zinc/magnesium alloy-coated steel.

4.5 Installation and testing

4.5.1 Installation

Installation of each new or altered section of the roof drainage system shall ~~conform to~~meet the following requirements:

(a) There shall be no restrictions to the free flow of stormwater due to —

(i) protrusions or other obstructions; or

(ii) debris (e.g. cement, mortar, clippings and similar debris).

(b) All accessories shall be effectively fixed and securely anchored.

4.5.2 Testing

Downpipes within buildings shall be tested as specified in ~~accordance with~~ Section ~~.~~9.

4.5.3 Eaves gutters

The installation of eaves gutters shall ~~be installed as follows~~meet the following requirements:

(a) *Gradients* — Deviations from nominal gradients shall be smooth and not cause permanent ponding.

NOTE 1: ~~Where~~If a building is likely to move due to reactive soils, gradients should not be flatter than —

(a) 1:250 to achieve an effective gradient not flatter than 1:500; or

(b) 1:500 to achieve an effective gradient with no permanent ponding.

NOTE 2: Light condensation does not generally cause permanent ponding, whereas heavy condensation, particularly in conjunction with retained silt, can reduce the design lifetime of the product.

(b) *Lap joints* — For metal gutters with laps between 20 mm to 25 mm, the lap shall be fully sealed. Wider laps shall be sealed and fastened at each end of the lap rather than filling the total area.

(c) *Support systems* — Support systems shall be as specified in ~~accordance with~~ Clause ~~.~~4.9.

4.5.4 Box gutters

The installation of box gutters shall ~~be installed as follows~~meet the following requirements:

(a) Gradients shall be not flatter than 1:200 for sole widths equal to or less than 600 mm wide. Deviations from these gradients shall be smooth and not cause permanent ponding.

(b) Lap joints shall be as specified in ~~accordance with~~ Clause ~~(~~4.5.3(b).

(c) Support systems shall be as specified in ~~accordance with~~ Clause ~~.~~4.9.

(d) Outlets shall discharge through either a rainhead or a sump.

(e) ~~Where~~If necessary, expansion joints shall be provided (see Clause ~~).~~4.3.2). All fixings shall be in the form of cleats and clips to allow freedom of movement.

NOTE: The sides of a box gutter should have structural strength so that water pressure does not cause deformation that can affect water surface levels and hence the hydraulic capacity of a box gutter.

4.5.5 Valley gutters

The installation of valley gutters shall ~~conform to~~meet the following requirements:

(a) Lap joints shall be as specified in ~~accordance with~~ Clause ~~(~~4.5.3(b) and ~~be~~ a minimum of 150 mm for an unsealed joint.

(b) Support systems shall be as specified in ~~accordance with~~ Clause ~~.~~4.9.

(c) Edges shall be rolled or returned to prevent splashing.

4.5.6 Downpipes

~~The following applies to~~ The installation of downpipes shall meet the following requirements:

(a) *Locations* — Downpipes shall be located —

(i) so that they do not interfere with the normal operation of any door, window, access opening or occupancy of a building;

(ii) where they do not cause a nuisance or lead to injury of a person;

(iii) as close as practicable to the supporting structure;

(iv) so that they are protected from mechanical damage;

(v) at least 100 mm clear of any electrical cable or gas pipe; and

(vi) at least 50 mm from any other pipework or service.

(b) *Concealment or limited access* — Downpipes in buildings may be concealed or have limited access~~,~~ provided ~~they conform to the following:~~—

(i) the inspection openings [see Item (d) below] are accessible~~.~~;

NOTE: To facilitate maintenance, inspection openings should be extended to the face of a wall or slab.

(ii) the seams and joints are watertight~~.~~; and

(iii) they are ~~—~~either —

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(A) clear of any structural member (e.g. beam, column or party wall); or

(B) not concealed in any wall construction in a manner that could interfere with the structural integrity of the wall.

(c) *Connections within buildings* — ~~Where~~If a downpipe is connected to a site stormwater drain located below a slab-on-ground, the connection shall be located above the level of the floor.

(d) *Inspection openings* — ~~Where~~If provided for testing and maintenance purposes, inspection openings shall have a nominal size of not less than the nominal diameter of the downpipe.

(e) *Support systems* — The support systems shall ~~conform to~~be as specified in Clause ~~.~~4.9.

4.6 Overflow devices

Overflow devices for box gutters shall ~~conform to~~be as specified in Clause ~~.~~3.7.7.

NOTE: See Appendix F for examples of overflow measures for eaves gutters.

4.7 Joints for metal components

4.7.1 General

Compatibility of materials shall be as specified in ~~accordance with the requirements of~~ Table 4.4.1. Gutters shall not be jointed along the length to increase gutter depth.

NOTE: See Table 4.4.2 ~~gives guidance on~~ for combinations ~~for~~of materials to prevent corrosion, erosion, or both~~,~~ due to drainage.

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~~4.7.2 Type of joints~~

4.7.2 Joint types

4.7.2.1 Soldered

Soldered joints shall be clean and free from grease. Soldered joints shall be flush and lapped in the direction of the outlets, as specified, and completely sweated with solder to form a secure joint that does not cause permanent ponding. Immediately after cleaning, the surfaces to be jointed shall be painted with the ~~appropriate~~relevant flux specified in Table 4.7.2.1.

NOTE 1: 60/40 or 80/20 tin/lead solder enhances the surface finish of stainless steel.

NOTE 2: Because of the risk to health and safety, care should be exercised during the preparation and handling of fluxes.

Laps shall be as ~~per~~specified in Clause ~~.~~4.7.2.3.

Table 4.7.2.1 — Fluxes

Material to be joined	Type of flux
Zinc-coated steel	Diluted hydrochloric ~~acid[a]~~acid [a]
Copper and copper alloy	Zinc chloride (killed spirits)
Stainless steel	Phosphoric acid-based flux for ~~soldering[b]~~soldering [b]
Zinc	Zinc chloride (killed spirits)

[a] Muriatic acid, 1:3 dilution of hydrochloric acid.

[b] Chloride-based fluxes are not used.

4.7.2.2 Sealant

Sealant joints shall be used in conjunction with mechanical connections or fasteners as specified in AS/NZS 2179.1 and spaced at not more than 40 mm centres. The sealant shall be sandwiched between clean surfaces of the components of the joint to ensure a positive seal and to protect the sealant from exposure to ultraviolet radiation.

Laps shall be as ~~per~~specified in Clause ~~.~~4.7.2.3.

4.7.2.3 Laps

The laps for eaves gutters shall be not less than 25 mm. The laps for box gutter fasteners shall be spaced at not more than 40 mm centres and not less than 10 mm from the edges of the joint.

4.7.3 Aluminium alloys

Aluminium alloy components, including accessories, shall be jointed with one of the following:

(a) *Brazed joints* — Brazed joints shall have a minimum lap and be brazed with aluminium/silicon alloys containing 11.5 ± 1.5 % silicon. Lower melting point aluminium/silicon alloys shall not be used. Flux-affected areas shall be thoroughly washed with water to prevent subsequent corrosion.

(b) *Welded joints* — Welded joints shall be shop-fabricated and be either the gas metal-arc welding (GMAW) or gas tungsten-arc welding (GTAW) type.

NOTE 1: Refer to AS/NZS 1665 for welding of joints.

(c) *Soldered joints* — Soldered joints shall not be used with aluminium alloys due, in the presence of moisture, to galvanic action.

NOTE 2: Field fabrication should be limited to joints that are fully protected from air movement and moisture.

NOTE 3: GMAW and GTAW types are also known as MIG and TIG welding types, respectively.

4.7.4 Aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel

Aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel components, including accessories, shall be jointed with sealant joints and fasteners as specified in Clause 4.7.2.2.

4.7.5 Stainless steel

Stainless steel components, including accessories, shall be jointed with one of the following:

(a) *Sealant joints* — Sealant joints shall be as specified in Clause 4.7.2.2.

(b) *Soldered joints* — Soldered joints shall be as specified in Clause 4.7.2.1.

(c) *Welded joints* — Welded joints shall be either —

(i) spot welds at normal rivet centres (i.e. about 40 mm), and sealed with either solder by sweating from the inside or sealant; or

(ii) continuous weld.

~~Where~~NOTE: If material thickness allows, GMAW or GTAW may be used.

4.7.6 Zinc and zinc-coated steel

Zinc and zinc-coated steel components, including accessories, shall be jointed with one of the following:

(a) *Sealant joints* — Sealant joints shall be as specified in Clause 4.7.2.2.

(b) *Soldered joints* — Soldered joints shall be as specified in Clause 4.7.2.1.

4.8 Joints for other components

Joints for other components of similar and dissimilar metals and non-metals shall be as ~~given~~specified in Table 4.8(A).

Table 4.8(A) — Joints for other components of similar or dissimilar materials

To material 2	From material 1							
	Aluminium alloy	**Cast iron and ductile iron**	**Copper and copper alloy**	**Galvanized steel**	**FRC[a]**	**GRP**	**PVC**	**PE**
Aluminium alloys	BG MC	BG		BG			BG	
	ES WD[b]	ES	—	ES	—	—	ES	—
	ER			ER			SC/ER	
Cast iron and ductile iron	BG	BG	BG	BG	BG	BG	BG	—
	ES	ES	SB/ER	ER	ES	ES	ES	
		ER			ER	ER	SC/ER	
Copper and copper alloy	—	BG	SB	BG	BG	BG	SC/TH/SB	BF/TH
		ER/SB	ES	TH/SB	ER	ES	SC/TH	TH/TH
			SS	ER/SB			SC/ER	TH/SS
Galvanized steel	BG	BG	SB/TH	TH BG	ER	BG	SC/TH	—
	ES	ER	SB/TH	MC		ER	SC/ER	
FRC	—	BG ER	BG	ER	BG ER	—	ES	—
		ES	ER		ES		ER	
GRP	—	—	—	—	BG ER	BG	—	—
					ES	ER		
						ES		
PVC	BG	BG	SB/TH/SC	TH/SC	BG ER		SC	SC/TH
	ES	ES	SB/ER/SC	ER/SC	ES		ES	
		ER/SC	ES				FC	
PE	BG	—	TH/BF	—	—	—	TH/SC	BF TH
	ES		TH/TH					EF ES
			SS/TH					MC FL

Key

BF = Butt fusion
BG = Bolted gland
EF = Electrofusion
ER = Epoxy resin
ES = Elastomeric seal
FC = Metal-banded flexible coupling
FL = Flanged
MC = Mechanical coupling
SB = Silver brazed
SC = Solvent cement
SS = Soft solder
TH = Threaded
WD = GMAW or GTAW

[a] Under buildings limited to ES.

[b] Limited to shop GTAW for thicknesses equal to or greater than 0.7 mm.

NOTE 1: The direction of flow shall be from material 1 to material 2.

NOTE 2: If joint types are separated by one or more slashes, the joint between pipe materials shall use an appropriate transition fitting or adaptor.

NOTE 3: Joints of dissimilar materials shall conform to Clause 4.4.

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The joint types~~ listed~~ in Table 4.8(A) shall meet the requirements of the Standards or clauses specified in Table 4.8(B).

Table 4.8(B) — Joints for other components of similar or dissimilar materials — Conformance requirements

Joint type	Standard or Clause
Butt fusion	
Bolted gland	Clause 2.7.2.1
Electrofusion	
Epoxy resin	Clause 2.7.2.4
Elastomeric seal	Clause 2.7.2.3
Metal-banded flexible coupling	Clause 2.7.2.7
Flanged	AS/NZS 4087
Mechanical coupling	AS/NZS 2041.4
Silver brazed	Clause 2.7.2.8
Solvent cement	Clause 2.7.2.10
Soft solder	
Threaded	AS 1646
GMAW or GTAW	AS/NZS 2041.4

4.9 Support systems

4.9.1 Types

~~The types of ~~Support systems are either non-trafficable or trafficable and may be discontinuous or continuous.

NOTE: Refer to AS/NZS 2179.1 for vertical load test.

~~4.9.2 Criteria~~

4.9.2 General

Support systems shall ~~conform to the following:~~ —

(a) ~~They shall ~~be fabricated from materials that —

(i) are compatible with the supported roof drainage system; and

(ii) ~~where~~if exposed to direct sunlight, are resistant to ultraviolet light~~.~~;

NOTE: Incompatible materials may be used~~,~~ provided the contact surfaces are lined with a non-abrasive, impervious, non-conducting material.

(b) ~~They shall ~~be securely attached to the building structure~~.~~;

(c) ~~They shall ~~have no other service attached to them or be attached to any other service~~.~~;

(d) ~~They shall ~~be protected against corrosion ~~where~~if exposed to a corrosive environment~~.~~; and

(e) ~~They shall ~~be securely attached to prevent longitudinal movement, unless designed to allow for thermal effect.

4.9.3 Support systems for eaves gutters

Support systems for eaves gutters that are manufactured from metals shall conform tobe as specified in AS/NZS 2179.1. All eaves gutters and their support systems shall be non-trafficable.

4.9.4 Support systems for box gutters

Support systems for box gutters that are manufactured from metals shall conform tobe as specified in AS/NZS 2179.1.

Such support systems shall be either —

(a) continuous, whereif the support extends across the sole width for the full length of the gutter and provides a direct evenly distributed contact to not less than 25 % of the sole width; or

(b) discontinuous, whereif the support brackets extend across the sole width of the gutter and are located at stop ends, both ends of sumps, rainheads and intervals not greater than 750 mm.

NOTE 1: Continuous support systems should be used for sole widths greater than 450 mm.

NOTE 2: Refer to AS/NZS 1170.1 for the design loads for support systems.

4.9.5 Support systems for valley gutters

Support systems for valley gutters that are manufactured from metals shall conform tobe as specified in AS/NZS 2179.1.

NOTE: Refer to AS/NZS 1170.1 for the design loads for support systems.

4.9.6 Support systems for downpipes

4.9.6.1 Vertical

Support systems for vertical downpipes that are manufactured from metals shall conform tobe as specified in AS/NZS 2179.1.

4.9.6.2 Graded

Support systems for graded downpipes of metals shall conform tobe as specified in AS/NZS 2179.1.

Jointed pipes and fittings shall have support spacing —

(a) for aluminium alloys, not exceeding 2 000 mm;

(b) for cast iron, ductile cast iron, copper, copper alloys, galvanized steel and stainless steel, not exceeding 3 000 mm;

(c) for FRC and GRP, not exceeding 4 000 mm;

(d) for PVC, as specified for pressure pipe systems in AS/NZS 2032; and

(e) for PE, as specified for pressure pipes above ground in AS/NZS 2033.

5 Surface water drainage systems — Design

5.1 Scope of section

This section specifies methods for the design of surface water drainage systems.

5.2 Design

5.2.1 Methods

This section provides two design methods~~, as follows~~:

(a) The general method, see Clause ~~.~~5.4.

(b) The nominal method, see Clause ~~.~~5.5.

5.2.2 General~~ criteria~~

Piped systems shall meet the minimum requirements of this document for pipe diameter, cover and gradient~~ criteria specified in this document. Such~~. These systems shall be arranged ~~so that~~to prevent any overflows ~~will not pond~~from ponding against or ~~enter~~entering into buildings.

5.2.3 Design rainfall intensity

Elements shall be designed to contain minor storm flows of the ~~appropriate~~relevant annual exceedance probability (AEP) or average recurrence interval (ARI) specified in Table 5.4.3 within surface water drains, gutters or formed flow paths.

In Australia, ~~where~~if a box gutter system is directly connected to downpipe systems or surface water drains (upstream of a surcharge outlet as specified in Clause ~~),~~5.4.12.1), these conduits shall be sized for a 1 % AEP (100 years ARI) storm event. Pipes downstream of the designated surcharge point shall be designed for AEPs set out in Table 5.4.3.

NOTE: Surface water drainage systems should be designed to ensure overflows, in storm events with an AEP of 1 % (ARI of 100 years) in Australia or an AEP of 2 % (ARI of 50 years) in New Zealand, do not present a hazard to people or cause damage to property.

5.3 Layout~~ — General criteria~~

5.3.1 Roof areas

Stormwater from roof areas shall be collected and conveyed in gutters and downpipes (see Section ~~)~~3) and, during periods of high rainfall intensity or blockage of the roof drainage system, be discharged through overflow devices to —

(a) site stormwater drains or channels;

(b) paved areas;

(c) impinge onto concrete or stone splash blocks and then infiltrate into pervious areas; or

(d) discharge to subsoil drains or soakaways, either directly (i.e. by pipe) or indirectly (i.e. by infiltration).

NOTE: ~~Such~~These systems may be desirable in areas with permeable soils as a ~~means~~way of reducing the discharge of stormwater or increasing the water table~~;~~. However, in areas with impervious soils, ~~such systems~~they may cause waterlogging of land and dampness in buildings. ~~Where~~If soils are expansive, damage may occur to footings.

5.3.2 Other than roof areas

Stormwater from other than roof areas shall be collected and conveyed via site stormwater channels and inlets to site stormwater drains.

5.3.3 Ponding

Except for on-site stormwater detention (OSD) systems, ponding of stormwater shall only occur temporarily at sag pits ~~conforming to~~that meet the requirements of Clause ~~.~~5.4.10.1.

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NOTE 1: ~~Where~~If the ground floor of a building is lower than the adjacent land, except at access ramps, the latter should be graded so that there is a reverse slope away from the building to allow the discharge of stormwater to a site stormwater drain or channel.

NOTE 2: The ground beneath timber floors and landscaping around and under buildings should be graded to prevent ponding and allow drainage to the outside of buildings.

5.3.4 Entry into buildings

Stormwater shall be prevented from entering doorways and other openings in buildings. ~~Where~~If these are lower than adjacent ground surfaces, grated drains shall be designed and placed across ramps or entrances to intercept any flow~~,~~ which would otherwise drain into the building.

5.3.5 Containment of harmful substances

Separate surface water drainage systems or special arresters (see Clause ~~)~~7.5) shall be provided for any parts of the property where materials that ~~could~~can pollute or block ~~such drainage~~these systems are stored or used.

NOTE: These drainage systems should ~~conform to~~meet the ~~criteria~~requirements of the network utility operator ~~regarding~~in relation to containment of polluting substances.

5.3.6 Inlet and pit locations

Inlet pits shall be located to intercept surface flows, while also fitting neatly into the layout of the site stormwater drains.

On-grade pits situated on sloping surfaces or in channels or gutters shall be sized to intercept a large proportion of the flow. They shall be located so that any bypass flows under minor storm event conditions will not cause a nuisance and that widths of concentrated flow are negotiable by pedestrians.

Inlet pits in locations subject to dengue fever ~~borne~~spread by mosquitoes shall be without a sump and be self-draining.

NOTE 1: Care should be taken in locating and specifying details of grated pits in areas subject to pedestrian or vehicular traffic to avoid possible damage to pits and danger to pedestrians and cyclists.

NOTE 2: Site stormwater drains should be laid in straight lines to —

(a) avoid conflict with other services; and

(b) minimize overall length and number of changes in direction.

5.3.7 Sanitary drainage system

Surface water drainage systems shall be completely separate to any sanitary drainage system.

5.3.8 Devices or appliances connected to stormwater drainage system

5.3.8.1 Stormwater connection

If a device or appliance discharges to a stormwater drainage system —

(a) the discharge to the stormwater system shall be external to the building via a tundish or pit; and

(b) the point of discharge from each drain line shall be located so that the release of steam or heated water does not cause a nuisance, is readily discernible, and causes no risk of damage to the building or injury to people.

If a tundish or pit is installed, the point of discharge shall —

(i) be in an accessible location;

(ii) be securely fixed to prevent movement;

(iii) allow any discharge to be visible to building occupants; and

(iv) maintain a minimum 25 mm air gap.

5.3.8.2 Stormwater system design

The stormwater system shall be sized to allow for the maximum discharge.

NOTE 1: Refer to manufacturer's specifications for information relating to anticipated discharge volumes.

NOTE 2: See Clause 2.2.2 for information relating to materials.

NOTE 3: Consideration should be given to the quality of the discharge and approval requirements of relevant local authorities.

5.4 General method

5.4.1 General

The design of surface water drainage systems shall ~~be designed to~~ provide protection against potential losses caused by any overflows, including damage to buildings and their contents~~,~~ and injury and nuisance to ~~persons~~people.

NOTE 1: The general method for design of surface water drainage systems uses the Rational Formula (see Equation 5.4.8) to calculate design flows from rainfalls of a given design probability (AEP or ARI) and hydraulic charts to determine characteristics of the pipes necessary to convey such ~~flow~~flows. As consequences of failure may vary at different locations on a property, the design probability may be varied to reflect this.

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NOTE 2: The less frequent the design probability selected for design, the greater the design rainfall intensity and flow, the larger the system and, subject to regular inspection and cleaning (see Clause ~~),~~M.5), the lower the probability of overflow.

NOTE 3: See Figure I.5 for examples that illustrate the application of the general methods.

5.4.2 Overland flood path

Allowance shall be made for flows onto the site from adjacent properties. The system shall convey flows without serious consequences, such as entry of water into openings in buildings. However, if this does occur, remedial action shall be taken~~, such as one or more of the following:~~. Such remedial action includes —

(a) enlargement or extension of the surface water drainage system~~.~~;

(b) alteration of surfaces and flow paths by regrading and redirection, or provision of landscaping, bunds and other barriers~~.~~; and/or

(c) raising the level of the lowest floor.

5.4.3 ~~Average~~Annual exceedance probability

The values of ~~average~~annual exceedance probability (AEP) for design vary according to the importance of the property, consequences of failure and local practice.

The AEP shall be as ~~given~~specified in Table 5.4.3.

Table 5.4.3 — ~~Average~~Annual exceedance probability

Effect of surcharge — Overland flow	~~AEP[a]~~ AEP [a], %	
	Australia	New Zealand

Small impact, in low density areas	≥ 63	≥ 63
Normal impacts	≥ 50	≥ 50
Ponding in flat topography; or flooding of parking lots to depths greater than 150 mm	≥ 10	≥ 10
Impeded access to commercial and industrial buildings	≥ 10	≥ 10
Ponding against adjoining buildings; or impeded access to institutional or important buildings (e.g. hospitals, town halls and school entrances)	≥ 5	≥ 10

a a higher AEP should be used whereif there is only limited access for maintenance.

NOTE 1: For Australia, this table should be used in conjunction with the NCC, which has requirements to prevent rain and stormwater from entering certain buildings.

NOTE 2: For Australia, AEP of 63 % is equivalent to 1 year ARI; AEP of 50 % is equivalent to 2 years ARI; AEP of 10 % is equivalent to 10 years ARI; and AEP of 5 % is equivalent to 20 years ARI.

NOTE 3: For New Zealand, AEP of 63 % is equivalent to 1 year ARI; AEP of 50 % is equivalent to 2 years ARI; and AEP of 10 % is equivalent to 10 years ARI.

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5.4.4 Time of concentration

The time of concentration used in the general method for design of surface water drainage systems shall be as follows:—

(a) in Australia — 5 min.

(b) in New Zealand — 10 min.

5.4.5 Rainfall intensity

The rainfall intensity used in Equation 5.4.8 shall be determined for a duration equal to the time of concentration and the selected AEP, using design information available from the following:

(a) In Australia, the Bureau of Meteorology's Intensity-Frequency-Duration (IFD) procedure.

NOTE 1: Appendix C covers the Bureau of Meteorology's IFD procedure.

(b) In New Zealand —

(i) the local territorial authoritiesauthority's design aids showing rainfall intensities for various durations and AEPs; or

(ii) ,Appendix E, which shows rainfall intensities for 10 min duration and AEPs of 10 % (10 years ARI) and 2 % (50 years ARI).

NOTE 2: Design aids are usually in the form of rainfall intensity/frequency/duration plots and tables supplied in New Zealand by the National Institute of Water and Atmospheric Research (NIWA), see .Appendix C.

5.4.6 Run-off coefficients

The run-off coefficients used in Equation 5.4.8 shall be as followsmeet the following requirements:

(a) In Australia, they shall have the following values:

(i) For a roofed area, C_r equal to 1.0.

(ii) For an unroofed impervious (paved) area, C_i equal to 0.9.

(iii) For an unroofed pervious area, as calculated from the following equationEquation 5.4.6:

$$C_p = m\left(0.0133\,{}^{10\%}I_{60} - 0.233\right) \qquad 5.4.6$$

where

where

C_p	=	run-off coefficient for an unroofed pervious area
m	=	multiplier for run-off coefficient [see Table 5.4.6(A)]
${}^{10}I_{60}$	=	rainfall intensity for a 60 min (1 h) duration and AEP of 10 % (ARI of 10 years), in millimetres per hour but if —

(a) less than 25, adopt 25; or

(b) greater than 70, adopt 70.

for —

(A) clay soils, increase C_p by 0.1; and

(B) sandy soils, decrease C_p by 0.1, provided the final value of C_p is not less than 0.1.

For —

(A) clay soils, increase C_p by 0.1; and

(B) sandy soils, decrease C_p by 0.1 provided the final value of C_p is not less than 0.1.

(b) In New Zealand, they shall have the following values:

(i) For a roofed area, C_r for the following:

(A) Steel and non-absorbent surfaces equal to 0.9.

(B) Near flat and slightly absorbent, equal to 0.8.

(ii) For an unroofed impervious (paved) area, C_i for ground slopes of 1:20 to 1:10 with the following:

(A) Asphalt and concrete surfaces, equal to 0.85.

(B) Stone, brick and precast paving panels and —

(1) sealed joints, equal to 0.8; and

(2) open joints, equal to 0.60.

(iii) For an unroofed pervious area, C_p for ground slopes of 1:20 to 1:10, as given in Table 5.4.6(B).

For ground slopes other than 1:20 to 1:10, the values given in Clause 5.4.6(b) Items (ii) and (iii) shall be varied as specified in accordance with Table 5.4.6(C).

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Table 5.4.6(A) — Multipliers for run-off coefficients (m)

AEP % (ARI years)	m
63 (1)	0.8
39 (2)	0.85
34 (3)	0.95
10 (10)	1.0
5 (20)	1.05

2 (50)	1.15
1 (100)	1.2
> 1 (<100)	1.25
SOURCE: Australian Rainfall and Runoff: A guide to flood estimation.	

Table 5.4.6(B) — Run-off coefficients for unroofed pervious area (C_p) — New Zealand

Description of surface	Value for C_p	Description of surface	Value for C_p
Natural surface types:	0.70	Developed surface types:	0.50
Bare impermeable clay with no interception channels or run-off control		Unsealed roads	
Bare uncultivated soil of medium soakage	0.60	Railway and unsealed yards and similar surfaces	0.35
Heavy clay soil types: — pasture and grass cover — bush and scrub cover — cultivated	 0.40 0.35 0.30	Land use types: Fully roofed or sealed developments	 0.90
Medium soakage soil types: — pasture and scrub cover — bush and scrub cover — cultivated	 0.30 0.25 0.20	Industrial, commercial, shopping areas and town house developments	0.65
High soakage gravel, sandy and volcanic soil types: — pasture and grass cover — bush and scrub cover — cultivated	 0.20 0.15 0.10	Residential areas in which impervious area exceeds 35 % of gross area (this includes most modern subdivisions)	0.45
Parks, playgrounds and reserves: —mainly grassed —predominantly bush	 0.30 0.25		
Garden and lawns	0.25		

Table 5.4.6(C) — Adjustment for ground slope — New Zealand

Ground slope	Adjustment to values of C_i and C_p
Flatter than 1:20	−0.05
1:20 to 1:10	Nil
1:10 to 1:5	+0.05
Steeper than 1	+0.10

5.4.7 Catchment area

The catchment area used in Equation 5.4.8 for the components of surface water drainage systems shall be the plan area of the catchment, including buildings, draining to a particular component.

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For minor storm events, the catchment area shall be limited to the extent of the property.

NOTE: For major storm events the catchment area may extend beyond the property, see Clause .5.4.2.

5.4.8 Determination of design flows

The general method for the determination of design flows shall be as follows:

(a) Select from Table 5.4.3 the AEP for the particular application from Table 5.4.3.

(b) Determine from Clause 5.4.5 for the particular location the rainfall intensity, in mm/h, for the selected AEP and the following:

(i) 5 min duration in Australia.

(ii) 10 min duration in New Zealand.

(c) Determine byfrom physical observations and dimensions or from the building plans, or both, the following: —

(i) the layout for —

(A) the downpipes [see Clause (3.7.4(d)]; and

(B) the site stormwater drains, including the available gradients and appurtenances, see Section .7;

(ii) the limits of the subcatchments for the components of the surface water drainage systems.;

(iii) for each subcatchment —

(A) the run-off coefficients based on the extent and type of surface, see Clause ;5.4.6; and

(B) the plan areas of roofed, impervious and pervious surfaces, in m².; and

(d) determine the design flow of stormwater (Q) for the subcatchments of the surface water drainage system from the following equation:

$$Q = \frac{\left(C_{\mathrm{r}}\ A_{\mathrm{r}} + C_{\mathrm{i}}\ A_{\mathrm{i}} + C_{\mathrm{p}}\ A_{\mathrm{p}}\right)\ {}^{\mathrm{Y\%}}I_{\mathrm{t}}}{3\,600} \text{ or } \frac{\Sigma CA\ {}^{\mathrm{Y\%}}I_{\mathrm{t}}}{3\,600} \qquad 5.4.8$$

where

where

-	Q	=	design flow of stormwater, in litres per second
-	C_{r}	=	run-off coefficient for a roofed area
-	A_{r}	=	total roofed catchment area, in metres square
-	C_{i}	=	run-off coefficient for an unroofed impervious (paved) area
-	A_{i}	=	total unroofed impervious (paved) catchment area, in metres square
-	C_{p}	=	run-off coefficient for an unroofed pervious area
-	A_{p}	=	total unroofed pervious catchment area, in metres square
-	${}^{\mathrm{Y\%}}I_{\mathrm{t}}$	=	rainfall intensity for a duration of t and an AEP of Y %, in millimetres per hour
-	ΣCA	=	equivalent impervious area of all upstream areas on the property, in metres square

NOTE: No allowance is included for flow from subsoil drains.

5.4.9 Design of open channels

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The general method for designing an open channel for a site stormwater drain shall be as follows:

(a) Determine the design flow as specified in accordance with Clause .5.4.8.

(b) Determine byfrom physical observation and dimensions or from the building plans, or both, the gradient of the open channel.

(c) Select a surface type and Manning roughness coefficient, as given in Table 5.4.9, and dimensions for the open channel, then calculate its hydraulic capacity from the following equation (the Manning formula):

$$Q_c = 1000 \frac{A}{n} R^{2/3} S^{1/2} \quad 5.4.9$$

where

where

Q_c	=	discharge capacity of open channel, in litres per second
A	=	cross-sectional area of flow in open channel, in metres square
R	=	hydraulic radius, in metres
S	=	gradient of open channel
n	=	Manning roughness coefficient for an open channel

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(d) If the discharge capacity [see Step (c)] is less than the design flow [see Step (a)], assume a new set of dimensions for the open channel and repeat Step (c) until the discharge capacity exceeds the design flow.

(e) Check that the depth of flow in the channel is at least 300 mm below the floor level or damp course of any adjacent building. If the water level is higher than this limit, the channel shall be enlarged or its bed lowered to meet this requirement.

Table 5.4.9 — Manning roughness coefficient (*n*)

Surface type	Typical values for *n*
Polyethylene (PE)	0.009 to 0.010
Polyvinylchloride (PVC)	0.009 to 0.010
Smooth concrete	0.011 to 0.012
Trowelled concrete	0.012 to 0.015
Asphalt paving	0.013 to 0.015
Brickwork	0.014 to 0.016
Roughly jointed bricks or pitchers	0.016 to 0.020
Sprayed concrete (gunite)	0.016 to 0.020
Earth-lined channels	0.018 to 0.025
Corrugated metal	0.012 to 0.015
Rock lining or rip-rap	0.025 to 0.030
Rock cut	0.035 to 0.040
Grassed or vegetated channels	0.025 to 0.075 [a]

[a] Depending on vegetation growth

5.4.10 Design of inlets

5.4.10.1 Sag pits

The general method for designing an inlet for a sag pit shall be as follows:

(a) Determine the design flow as specified in ~~accordance with~~ Clause 5.4.8.

(b) Determine ~~by~~from observations or the building plans the maximum depth of ponding, noting where water may pond against or enter a building. The maximum level shall be not less than 300 mm below the floor or damp course of the building.

(c) If the depth of ponding is equal to or less than 0.12 m, calculate the capacity of an inlet from the following equation:

$$Q_i = b_f \; 1600 \; P \; d_p^{1.5} \qquad 5.4.10.1$$

where

~~where~~

Q_i	=	capacity of an inlet for a sag pit, in litres per second
b_f	=	blockage factor for inlets to stormwater pits
P	=	perimeter length of the pit excluding any section against a kerb or wall (bars may be disregarded), in metres
d_p	=	depth of ponding over inlet to an inlet pit, in metres

NOTE: A common value for b_f is 0.5.

5.4.10.2 On-grade pits

Inlet capacities of on-grade pits vary considerably with the shape and size of the pit. Blockage factors are variable, but a value of 0.8 (reducing capacities to 80 % of values given by design aids) shall be used for on-grade pits.

NOTE: ~~Reference should be made~~Refer to both street drainage design manuals and manufacturer's literature and recommendations.

5.4.11 Design of pipe drains

5.4.11.1 General

Pipe drains of site stormwater drains shall —

(a) be laid with even gradients and straight runs and with a minimum number of changes of direction or change of cross-section;

(b) be laid with any change of direction or cross-section occurring at either a fitting or at a pit;

(c) be constructed of materials and products as specified in Clause ~~;~~2.4;

(d) have pits and arresters~~,~~ as specified in Clause ~~;~~7.5;

(e) have surcharge outlets~~,~~ as specified in Clause ~~;~~5.4.12; and

(f) have jump-ups~~,~~ as specified in Clause 7.8.

5.4.11.2 Design procedure

The general method for designing a pipe drain for a site stormwater drain shall be as follows:

(a) Determine the design flow in accordance with Clause 5.4.8.

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(b) Determine ~~by~~from physical observation and dimensions or from the building plans, or both, a suitable gradient for the pipe drain.

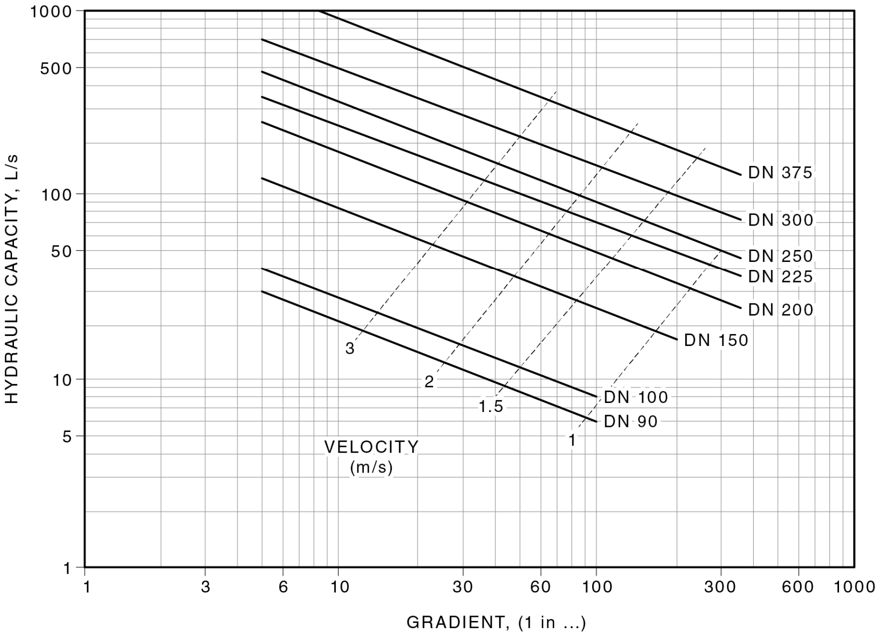
(c) Select the pipe material and the Colebrook–White roughness coefficient from AS 2200, or see Table 5.4.11.2 for normal conditions, and determine from Figure 5.4.11.2 the hydraulic capacity of the pipe drain for the selected DN.

(d) If the pipe hydraulic capacity is less than the design flow, assume a new DN for the pipe drain and repeat Step (c) until the hydraulic capacity exceeds the design flow. The full-pipe velocity shall not exceed 2.0 m/s.

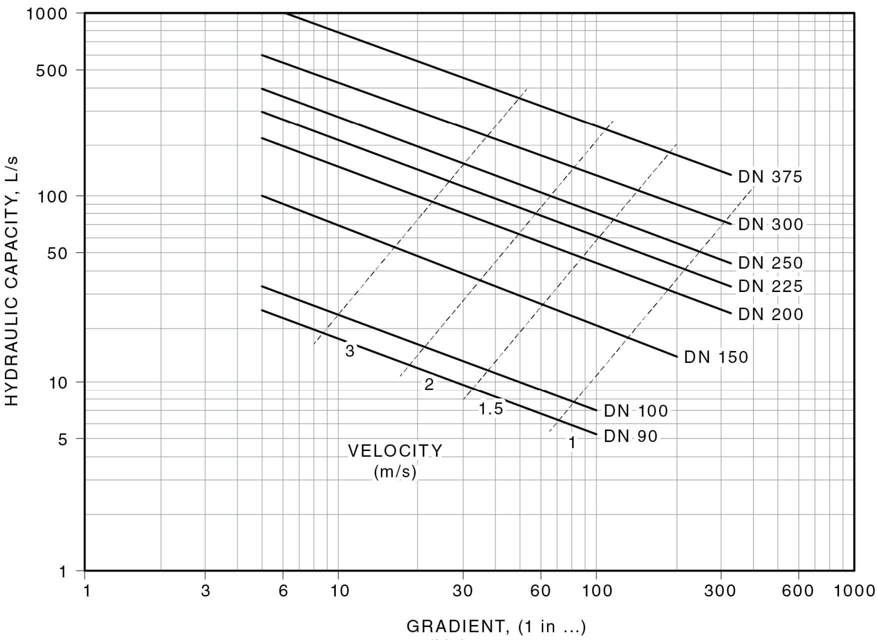
NOTE: To reduce the possibility of overflow from stormwater pits due to increased energy losses, the full-pipe velocity in the outlet pipe should not exceed 1.5 m/s.

Table 5.4.11.2 — Colebrook–White roughness coefficient (*k*)

Pipe material	**Typical values for *k*, mm**
Copper, copper alloys, stainless steel	0.015
All plastics pipelines having a smooth (non-profiled) internal bore	0.015
Fibre-reinforced concrete (FRC)	0.15
Cast iron, ductile iron, galvanized steel and malleable cast iron	0.6
Vitrified clay, precast concrete	0.6
Corrugated aluminium and steel	3.0



(a) k = 0.015 mm



(b) k = 0.15 mm

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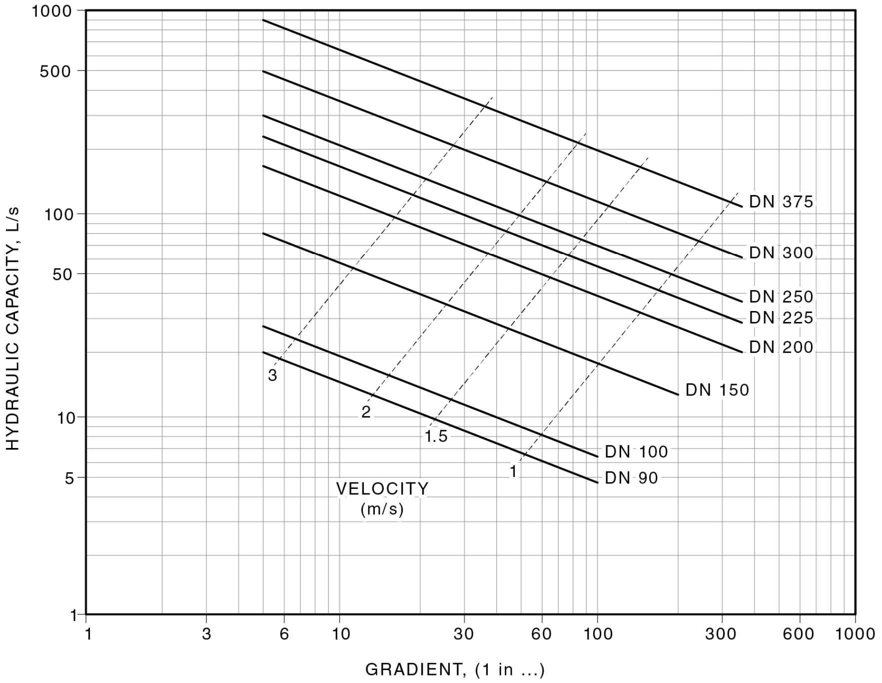
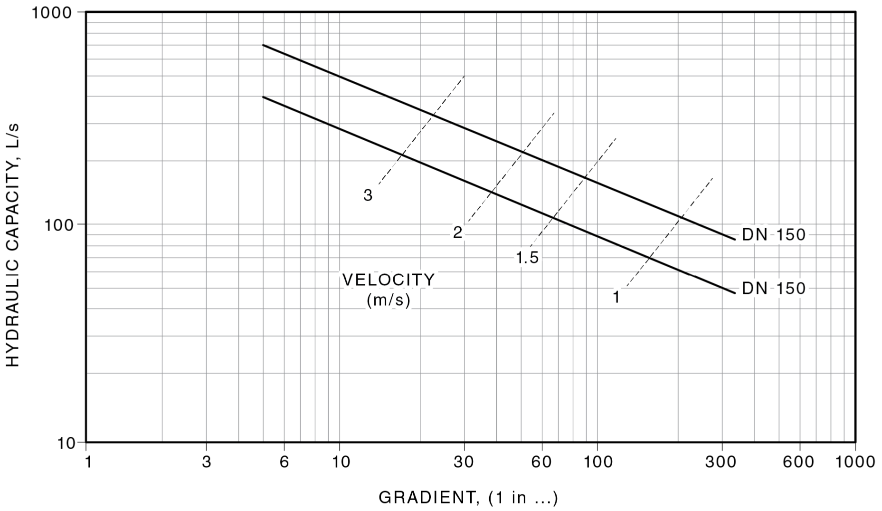
Figure 5.4.11.2 (1 of 2) — Hydraulic design charts — Water at 20 °C



(c) *k* = 0.6 mm



(d) *k* = 3.0 mm

Figure 5.4.11.2 (2 of 2)— Hydraulic design charts — Water at 20 °C

5.4.12 Design of surcharge outlets (Australia only)

5.4.12.1 General

~~Where the connection of any downpipes to the surface water drainage system is not open to the atmosphere and where a surcharge outlet will not affect the normal operation of the system,~~ At least one surcharge outlet shall be located along the site stormwater drain leading to a point of connection~~.~~ provided —

(a) the connection of any downpipes to the surface water drainage system is not open to the atmosphere; and

(b) a surcharge outlet will not affect the normal operation of the system.

NOTE: This surcharge outlet may also operate as an inlet pit or a grated drain.

Surcharge outlets are also required where discharges designed for a greater AEP (such as box gutters) are connected to a drainage system. ~~The~~Any drainage network~~(s)~~ upstream of a surcharge pit or surcharge outlet shall be sized ~~in a manner to ensure~~so that the hydraulic capacity of the upstream systems ~~are~~ is not reduced. ~~Where~~If box gutters are connected to surcharge pits or surcharge outlets, drainage networks upstream of the surcharge outlet shall have a hydraulic capacity of 1 % AEP and accommodate the flow from all associated upstream catchment surfaces.

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Surcharge outlets shall be located ~~as follows:~~—

(~~a~~i) with the grate level —

(~~i~~A) not less than 300 mm below the lowest floor level; and

(~~ii~~B) not less than 75 mm above an unpaved surface or level with a paved finished surface~~.~~;

(~~b~~ii) wholly within the property~~.~~;

(~~c~~iii) clear of any buildings~~.~~;

(~~d~~iv) so that any discharge is noticeable~~.~~; and

(~~e~~v) with an overflow path, so that overflows do not cause damage to buildings (including contents) or danger to ~~persons~~people.

5.4.12.2 Design procedure

The procedure of the general method for design of a surcharge outlet shall be as follows:

(a) Determine the minimum area of the grated opening from the following equation:

$$A = \frac{Q}{150} \qquad 5.4.12.2$$

where

~~where~~

A = cross-sectional area of flow in an open channel, in metres square

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Q = design flow of stormwater (assuming full blockage), in litres per second

(b) Determine the exit velocity from the grated outlet and, if greater than 0.15 m/s, increase the area of the grate to achieve the determined exit velocity.

5.5 Nominal method

In Australia, the ~~"~~nominal method~~"~~ may be used for single dwellings in non-urban areas and single dwellings on urban allotments ~~with~~ less than 1 000 m² in area. ~~Where~~If the nominal method is used, pipe design shall be determined according to local practice and experience (without specific design calculations~~),~~) and ~~according~~ to meet the minimum diameter (see Clause ~~),~~6.3.3), cover (see Clause ~~),~~6.2.5), gradient (see Clause ~~)~~6.3.4) and other relevant ~~criteria~~requirements of this document.

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The layout shall ~~conform to~~ be as specified in Clause ~~.~~5.3.

NOTE 1: An example ~~illustrating~~of the application of the nominal method is given in ~~.~~Appendix K.

NOTE 2: The nominal method is suitable for two dwellings, one above the other.

6 Surface and subsoil drainage systems — Installation

6.1 Scope of section

This section specifies installation requirements for site stormwater drains for the conveyance of stormwater from roof, surface and subsoil drainage systems.

NOTE: In New Zealand, the mandatory provisions for surface water in building work are contained in ~~the~~ NZBC~~,~~ Clause E1 Surface water.

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6.2 General requirements

6.2.1 Products and joints

Products and joints for site stormwater drains and subsoil drains shall ~~conform to~~be as specified in Section 2 and in Clause ~~.~~4.8.

6.2.2 Terminology

Trench terminology for flexible and rigid pipes is ~~shown~~given in Figure 6.2.2.

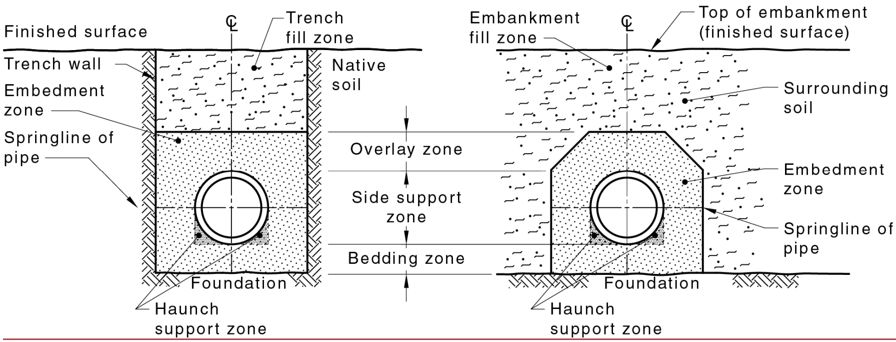


Figure 6.2.2 — Trench terminology

6.2.3 Trench width

Trench widths measured at the top of the pipes, between the faces of either the unsupported trench walls or the inside face of the sheeting of the trench support system, shall be not less than the widths specified in —

(a) AS/NZS 2041.1 and AS/NZS 2041.2 for corrugated metal pipes;

(b) AS/NZS 2566.2 for flexible pipes and fittings;

(c) AS/NZS 3725 for FRC and reinforced concrete pipes; and

(d) AS 4060 for vitrified clay and ceramic pipes and fittings.

6.2.4 Over-excavation

~~Where~~If a trench has been excavated deeper than necessary, the excess depth shall be filled either with bedding material compacted to achieve a density as near to the original soil density as possible or with concrete.

6.2.5 Cover

Except as specified in Clause ~~,~~6.3.6, the cover shall ~~be~~ either be not less than that given in Table 6.2.5 or as specified in ~~accordance with~~ —

(a) AS/NZS 2041.1 and AS/NZS 2041.2 for corrugated metal pipes;

(b) AS/NZS 2032 for PVC pipes;

(c) AS/NZS 2566.2 for flexible pipes and fittings;

(d) AS/NZS 3725 for reinforced concrete and FRC pipes;

(e) AS 4060 for vitrified clay and ceramic pipes and fittings; and

(f) AS/NZS 2033 for polyethylene pipes.

Table 6.2.5 — Minimum pipe cover — Finished surface to top of pipe

Location			Ductile iron, galvanized steel	Plastics
			Minimum cover, mm	
1	Not subject to vehicular loading:			
	(a)	Without pavement in Australia —		
		(i) for single dwellings; or	100	100
		(ii) for other than single dwellings.	100	300
	(b)	Without pavement in New Zealand.	100	300
	(c)	With pavement of brick or unreinforced concrete.	100[a]	100
2	Subject to vehicular loading:			
	(a)	Other than roads:		
		(i) Without pavement.	300	450
		(ii) With pavement of —		
		(A) reinforced concrete for heavy vehicular loading; or	Nil [a]	100[a]
		(B) brick or unreinforced concrete for light vehicular loading.	Nil [a]	75[a]
	(b)	Roads —		
		(i) sealed; or	600	600

	(ii) unsealed.	600	750
3	Subject to construction equipment loading or in embankment conditions.	600	750
4	Land zone for agricultural use.	600	600
[a] Below the underside of the pavement.			

6.2.6 Proximity to other services

NOTE 1: The proximity to other services will vary, depending on the type and size of the services affected.

The installation of above-ground and below-ground site stormwater drains shall ~~be installed as follows~~meet the following requirements:

(a) No potential safety hazard shall be created when in close proximity to other services.

(b) Access for maintenance and potential branch insertions shall not be impaired by other services.

(c) Sites shall not be located where physical damage to the drain is likely to occur~~,~~ unless protection is provided.

(d) Separation of at least 25 mm shall be maintained between any above-ground ~~storm water~~stormwater drains and any of the following services:

(i) Electrical or telecommunications conduits.

(ii) Electrical or telecommunications wires or cables.

(iii) Consumer gas pipes.

(iv) Sanitary plumbing and drainage.

(v) Other ~~storm water~~stormwater drainage.

(vi) Above-ground water services.

(vii) Any other services.

~~Where~~If a pipe is insulated, the measurement shall be from the outer edge of any insulation or wrapped material applied to the pipework.

(e) Stormwater drains shall not be installed in below-ground situations ~~where~~if electrical supply cables, consumer gas piping, water service or communication cables are intended to be installed below ground in the area above the drain.

(f) The separation between ~~any~~ underground stormwater ~~drain~~drains and ~~an~~ electrical supply ~~cable~~cables shall be —

(i) 100 mm minimum provided the electrical supply cable is indicated along its length with orange marker tape ~~conforming to~~as specified in AS/NZS 2648.1 and is mechanically protected; or

(ii) 600 mm minimum ~~where~~if the electrical supply cable is neither indicated nor mechanically protected.

NOTE 2: Mechanical protection is provided by concrete slabs, continuous concrete pour, or bricks designed for protecting electrical supply cables.

(g) The separation between ~~any~~ underground stormwater ~~drain~~drains and consumer gas pipes shall be —

(i) 100 mm minimum provided the consumer gas pipe is indicated along its length with marker tape ~~conforming to~~as specified in AS/NZS 2648.1 and laid 150 mm above the installed pipe; or

(ii) 600 mm minimum ~~where~~if the consumer gas pipe is ~~neither~~not indicated ~~nor~~or mechanically protected.

NOTE 3: Mechanical protection is provided by concrete slabs, continuous concrete pour, or bricks designed for protecting electrical supply cables.

(h) For an electrical supply not exceeding 1 000 V, the separation between any underground stormwater drain and an electrical earthing electrode shall be 600 mm minimum.

(i) The separation between ~~any~~ underground ~~drain~~drains and ~~a~~ communication ~~cable~~cables shall be at least 100 mm.

(j) The separation between ~~any~~ underground stormwater ~~drain~~drains and any ~~other~~ service other than consumer gas piping and electrical or communication ~~service~~services shall be —

(i) a minimum of 100 mm ~~min.~~ from a drain not exceeding DN 100 and ~~is~~ serving the same property; and

(ii) a minimum of 300 mm ~~min.~~ for any other service exceeding DN 100.

(k) ~~Any~~ Underground stormwater ~~drain crossing~~ drains that cross another service shall —

(i) cross at an angle of not less than 45~~°,~~° as shown in Figure 6.2.6;

(ii) have a vertical separation of not less than 100 mm; and

(iii) be marked along its length for 1 m either side of the centre-line of the service with marker tape ~~conforming to~~as specified in AS/NZS 2648.1, laid 150 mm above the installed service.

(l) Stormwater drains shall be installed with a minimum 300 mm clearance to any underground obstruction to protect the drain from physical damage and to permit repairs.

NOTE 4: See Clause 6.2.8 for drains in close proximity to footings or foundations.

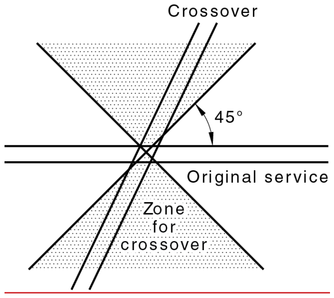


Figure 6.2.6 — Crossover zone for electrical cables and gas pipes

6.2.7 Shoring and underpinning buildings

~~Where~~If the bottom of the trench is adjacent to or below the footing and walls of any adjoining building or structure, the footing shall be supported while the trench is open.

NOTE: Criteria for the footing support and backfilling of the trench should be determined by a professional engineer.

6.2.8 Installation near and under buildings

The following apply to drains in close proximity to footings or foundations:

(a) WhereIf a drain passes under a strip footing, its angle of intersection with the footing in the horizontal plane shall be not less than 45°. The minimum clearance between the top of the drain to the underside of the footing shall be 25 mm.

(b) If a drain is laid through footings or walls, other than below-ground external walls, it shall be installed with an annular space of not less than 25 mm filled with a liner of flexible material.

(c) A drain may be laid through below-ground external walls, provided —

(i) two flexible joints are provided externally within 800 mm of the external face of the wall, and such joints are not less than 600 mm apart; and

(ii) the penetration of the wall is made watertight.

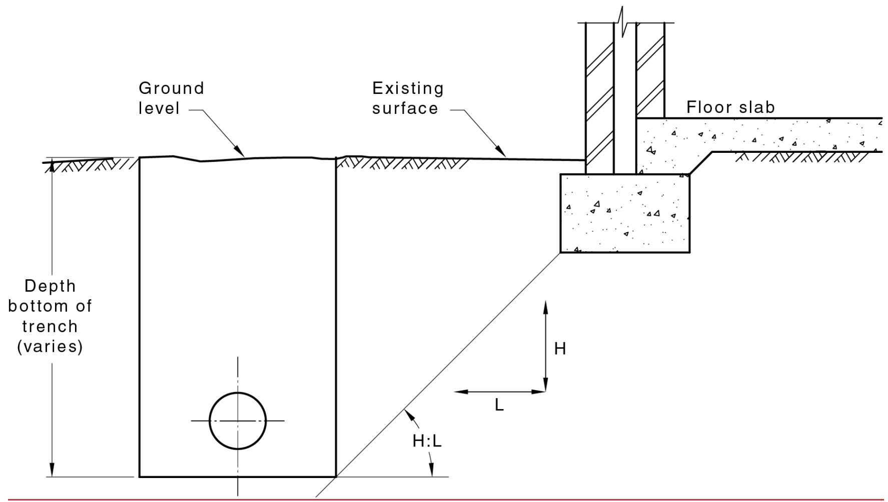
(d) WhereIf a drain is to be laid parallel to a footing, the trench shall be located as follows:

(i) In Australia, drains shall be laid as shown in accordance with Figure 6.2.8 for single dwellings.

NOTE 1: The requirements for laying drains are specified in the NCC Volume Two.

(ii) In New Zealand, in accordance with NZBC Acceptable Solution E1/AS1 for light timber framed and concrete masonry buildings.

NOTE 2: For all other buildings or whereif the requirements of Item (d) ()(ii) cannot be achievedmet, an engineered design should be used.



Soil type	Slope H:L	
	Compacted fill	Undisturbed ground
Stable rock[a]rock [a]	2:3	8:1
Sand[a]Sand [a]	1:2	1:2
Silt[b]Silt [b]	1:4	1:4
Firm clay	1:2	1:1

Soft clay	Not suitable	2:3
Soft ~~soils[b]~~soils [b]	Not suitable	Not suitable

[a] Most sand and rock sites with little or no ground movement from moisture changes.

[b] Sites include soft soils, such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils, soils subject to erosion, reactive sites subject to abnormal moisture conditions, or sites that cannot be classified otherwise.

Figure 6.2.8 — Excavation near footings

6.2.9 Water-charged ground

Excavation in water-charged ground shall ~~be in accordance with~~meet the following requirements:

(a) The water level shall be lowered below the bottom of the proposed trench and maintained at that level during construction, including the placing of trench fill.

(b) Dewatering shall be carried out by pumps and spearheads or similar devices. The removed water shall discharge to a location where it ~~shall~~does not cause a nuisance or damage. In no case shall it discharge either directly or indirectly into any sanitary sewer.

NOTE: ~~Where~~If water-charged ground is encountered, ~~consideration should be given to the~~its effect on adjacent buildings and other services should be considered.

6.2.10 Trench fill

Trench fill shall be either —

(a) ~~be~~ material excavated from the trench or imported~~,~~ provided the material placed within 300 mm of the top of pipes is free from builders' waste, bricks, pieces of concrete, rocks or similar material that would be retained on a 75 mm sieve; or

(b) ~~be~~ embedment material~~.~~, see Clause ~~.~~6.3.5.

6.2.11 Backfilling

Trench fill shall be placed in loose layers not more than 200 mm thick and compacted to not less than 90 % ~~or~~to 95 % under pavements of the standard maximum dry density specified in AS 1289.5.4.1 or AS 1289.5.6.1~~ in such a way that the pipes are neither dislodged nor damaged~~. Trench fill shall not dislodge or damage pipes.

The finished surface (top of trench fill) and the trench surround shall be restored~~,~~ as near as practicable~~,~~ to the level and condition of the existing surface before commencement of the excavation, see Figure 6.2.2.

6.2.12 Excavation near point of connection

Excavation by a machine shall not be carried out within 600 mm of a point of connection to an external stormwater drainage network.

6.2.13 Corrosive areas

Buried metal pipes and fittings in corrosive areas shall be externally protected by —

(a) an external protective coating, see Clause ~~;~~2.12.4;

(b) sealed polyethylene sleeving, see Clause ~~;~~2.12.7; or

(c) continuous wrapping with petrolatum taping material.

NOTE: Corrosive areas contain compounds consisting of magnesium oxychloride (magnesite) or its equivalent, coal wash, sodium chloride (salt), ammonia or materials that may be detrimental to the installation.

6.3 Site stormwater drains

6.3.1 General

6.3.1.1 Site stormwater drains

Site stormwater drains shall be laid —

(a) with no lipped joints or internal projections;

(b) ~~so as~~ to prevent the ingress of embedment and trench fill or embankment fill;

(c) with protection to prevent damage during installation and service; and

(d) using sweep junctions.

6.3.1.2 Site stormwater pipes

Pipes for site stormwater drains shall —

(a) have joints ~~that conform to~~as specified in Clauses 2.7 and ~~;~~4.8;

(b) ~~where~~be continuously supported by embedment (see Clause 6.3.5) if installed below ground~~,~~ for other than cast iron, ductile iron and galvanized steel~~, be continuously supported by embedment, see Clause ;~~; and

(c) be cleaned internally ~~prior to~~before installation and commissioning.

6.3.2 Connections to pits and arresters

~~Where~~If a site stormwater drain passes through the wall of a pit or arrester that is more than 1 m deep, two flexible joints shall be located on ~~such~~that drain within 800 mm of the outer face of the structure~~,~~ and not more than 600 mm apart.

6.3.3 Minimum diameter

Minimum diameters shall ~~conform to~~meet the following requirements:

(a) For single dwellings in rural areas and residential buildings on urban allotments with areas less than 1 000 m^2, minimum diameters shall be DN 90.

(b) For other properties that are downstream of a stormwater or inlet pit, minimum diameters shall be the greater of —

(i) the diameter of the largest pipe entering the pit;~~ or~~

(ii) DN 150 in Australia; or

(iii) DN 100 in New Zealand.

An exception to the above is at footpath crossings [see Clause ~~(~~7.5.1.2(b)] where multiple pipes of DN 100 or less are used.

6.3.4 Gradients

The minimum gradient of a site stormwater drain shall be as ~~given~~specified in Table 6.3.4.

NOTE: No maximum gradient is specified, but ~~designers~~designs should ~~be aware of~~take into account the possibility of scour of pipes by rapid flows, particularly by sediment-laden water.

Table 6.3.4 — Minimum gradient of site stormwater drains

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Nominal size	Minimum gradient		Nominal size	Minimum gradient	
DN	**Australia**	**NZ**	**DN**	**Australia**	**NZ**
90	1:100	1:90	225	1:200	1:350
100	1:100	1:120	300	1:250	1:350
150	1:100	1:200	375	1:300	1:350

6.3.5 Embedment

6.3.5.1 Materials

Embedment material shall ~~conform to~~meet the following requirements:

(a) Pipes shall be as specified in the following Standards:

(i) AS/NZS 2041.1 and AS/NZS 2041.2 — corrugated metal pipes.

(ii) AS/NZS 2032 — PVC pipes.

(iii) AS/NZS 2033 — polyethylene pipes.

(iv) AS/NZS 2566.2 — flexible pipes and fittings.

(v) AS/NZS 3725 — FRC and reinforced concrete pipes.

(vi) AS 4060 — vitrified clay and ceramic pipes and fittings.

(b) All other pipe materials shall ~~be as follows~~meet the following requirements:

(i) Bedding material shall be —

(A) suitable sand, free from rock or other hard or sharp objects that would be retained on a 13.2 mm sieve;

(B) crushed rock or gravel up to a maximum size of 14 mm;

(C) excavated material, provided it is free from rock or hard matter~~,~~ and ~~is~~ broken up so that it contains no soil lumps having any dimension greater than 75 mm; or

(D) cement mortar containing one part of Portland cement and four parts of sand by volume thoroughly mixed with clean water to a workable consistency.

(ii) Side support and overlay material shall ~~conform to~~be as specified in Item (b)(i)(A), (b)(i)(B), or (b)(i)(C).

6.3.5.2 Installation

Installation of embedment shall ~~be installed so that~~not dislodge or damage a site stormwater drain ~~is neither dislodged nor damaged and is in accordance with~~. The installation shall meet the ~~following:~~requirements of —

(a) AS/NZS 2041.1 and AS/NZS 2041.2 for corrugated metal pipes~~.~~;

(b) AS/NZS 2032 for PVC pipes~~.~~;

(c) AS/NZS 2566.2 for flexible pipes and fittings~~.~~;

(d) AS/NZS 3725 for FRC and reinforced concrete pipes~~.~~; and

(e) AS 4060 for vitrified clay and ceramic pipes and fittings.

~~(f)~~ All other materials shall ~~be as follows~~meet the following requirements:

(i) The pipe class shall ~~conform to~~be as specified in Section ~~.~~2.

(ii) The foundation shall be consistent and excavated to the gradient and, where over-excavated, ~~conform to~~be as specified in Clause ~~.~~6.2.4.

(iii) The bedding material shall be one of the following:

(A) Cement mortar~~,~~ as specified in Clause ~~(~~6.3.5.1(b)(i)(D~~), where~~) if the trench foundation is rock or shale and the gradient is steeper than 1:5 ~~and~~ shall —

(1) be a minimum depth of 50 mm measured below the bottom of the pipe;

(2) be not less than 75 mm wide;

(3) be kept clear of flexible joints; and

(4) have pipes supported at distances not greater than 1.5 m from the centres of support, ~~prior to~~before placing the mortar bedding.

(B) Earth foundations shall be not less than 75 mm thick.

(C) Rock foundations shall be not less than 100 mm thick with the haunch support not less than 75 mm thick, see Figure 6.2.2.

NOTE: Cast iron and ductile iron pipes may be unsupported for up to 600 mm either side of each pipe joint.

(iv) Chases shall be excavated in the bedding and, if necessary, in the foundation to prevent sockets bearing on either. Pipe lengths shall be fully supported within 600 mm of each socket.

(v) The embedment material specified in AS/NZS 1234 and in Clause ~~(~~6.3.5.1(b)(i) Items (A) to (C) of this document shall be placed in loose layers not more than 200 mm thick and compacted to 90 % of the standard maximum dry density ~~as~~ specified in AS 1289.5.4.1 or AS 1289.5.6.1.

6.3.6 Cover under buildings

For site stormwater drains under buildings —

(a) the thickness of overlay between the top of the pipe and the underside of a reinforced concrete slab shall be not less than 25 mm; and

(b) there shall be protection from mechanical damage.

6.3.7 In easements and public places

The installation of a site stormwater drain located in a road, easement, public place, right of way, or the like, in an open-cut trench~~,~~ shall ~~be installed in accordance with~~meet the following requirements:

(a) ~~Where~~If the full depth at the point of connection is not required to drain the property, a jump-up (see Clause ~~)~~7.8) shall be installed either at the point of connection~~,~~ or within the property boundary.

(b) ~~Where~~If the presence of any conduit or pit prevents the site stormwater drain from being laid at an even grade with the required cover, the drain shall pass beneath the conduit or pit at an even grade with a jump-up only at the point of connection. If this is not possible —

(i) an inclined section of pipe may be installed adjacent to the conduit or pit, in the form of a graded jump-up with changes of direction not greater than 60° in the vertical plane; and

(ii) there shall be a minimum clearance of 25 mm between the conduit or pit and the drain.

(c) The site stormwater drain shall have a minimum cover as specified in Clause ~~.~~6.2.5.

(d) A site stormwater drain that is located in a public road or right of way shall have no fitting that is part of a stormwater drainage system installed above the level of a finished surface.

6.3.8 Disconnection

WhereIf a disused site stormwater drain is to be disconnected, the following requirements shall applybe met:

(a) WhereIf the disconnection is in water-charged ground, dewatering shall be carried out as specified in accordance with Clause .6.2.9.

(b) Disconnection shall be made at either the point of connection to the external stormwater drainage network or the connection to the works remaining.

(c) Extraneous water, soil, sand, rock or other substances shall not enter the site stormwater drain or external stormwater drainage network downstream of the disconnected section.

(d) Site stormwater drains shall be made watertight using a cap or plug, and sealed.

6.3.9 Testing

Site stormwater drains, drains within and under buildings, and main internal drains shall conform tobe as specified in Section .9.

6.4 Subsoil drains

6.4.1 General

Subsoil drains shall be laid —

(a) so any pipe or geocomposite drain employed can be flushed out;

(b) with protection to prevent damage; and

(c) with clean-out points for pipes or geocomposite drains —

- (i) located at their topmost ends (or heads);
- (ii) located at each change of direction greater than 70°;
- (iii) that intersect the drain at an angle not greater than 45°;
- (iv) that extend vertically to the top of paved surfaces or within 300 mm of an unpaved finished surface; and
- (v) that terminate with a screw cap legibly marked “SW”.

Any pipes and fittings in suchthese subsoil drains shall be —

(i) cleaned internally prior tobefore installation and commissioning;

(ii) continuously supported by embedment, see Clause ;6.3.5; and

(iii) jointed using fittings whereif applicable.

NOTE 1: Installation of subsoil drains may include wrapping of the pipes or geocomposite drains with geotextile material prior tobefore placement of the embedment or wrapping of all or part of the embedment with geotextile material.

NOTE 2: Joint overlaps for geotextile material should be not less than 300 mm.

NOTE 3: Permeable geotextile wrap may be used in sandy soil to prevent sand or mobile fines in the ground invading and silting the subsoil pipe.

6.4.2 Embedment

6.4.2.1 Materials

The material for bedding, haunch support, side support and overlay is determined by —

(a) the characteristics of the ground in which the subsoil drain is located; and

(b) the type of geotextile material used (if applicable).

~~Where~~If the conduit consists of a pipe, the embedment material shall be crushed hard rock or natural gravel with not less than 90 % by mass retained on a 9.5 mm sieve.

NOTE 1: ~~Where~~If the conduit is a geocomposite drain, the material may be coarse washed sand.

~~Criteria for~~ Sizing and determining arrangements of filter material ~~are as follows~~shall meet the following requirements:

(i) For proper performance, the filter material (or backfill) shall surround the drain, under as well as over.

If a drain penetrates a water-bearing layer and is socketed into an impervious zone below, the filter material shall, as a minimum, be placed in contact with the pervious soil.

If a drain only partially penetrates a pervious layer such that water would be expected to flow into a drain over its entire depth, the filter material shall surround the pipe and also act as the pipe bedding material.

(ii) ~~Where~~If pipe bedding is a different material to the filter material, it shall be coarser grained than the filter material. The pipe bedding particles shall be greater in size than the perforations in the pipe unless a geotextile wrapping is provided.

NOTE 2: Common practice is to choose a free-draining, stable and inert material with a larger grain size than the filter, such as good quality, screened, crushed rock.

NOTE 3: Ideally, the grain size distribution of the bedding material should be chosen so that it itself acts as a filter to the filter zone.

NOTE 4: A suitable pipe bedding material may surround the pipe.

(iii) The coarse sand acts as the primary filter and the geotextile wrap on the drain as a secondary filter.

NOTE 5: A coarse washed sand should be used as a backfill ~~when~~if geocomposite subsurface drains are used.

6.4.2.2 Installation

Subsoil drains shall be laid —

(a) with embedment installed so that a subsoil drain is ~~neither~~not dislodged ~~nor~~or damaged; and

(b) so as to prevent the ingress of embedment and trench fill.

6.4.2.3 Disconnection

The disconnection of disused subsoil drains shall ~~be disconnected in accordance with~~meet the following requirements:

(a) A subsoil drain shall only be disconnected if it has been established that it is not in use or that it is no longer required to serve its intended purpose.

NOTE: ~~Where~~If there is any doubt as to its purpose or the effects of disconnection, expert geotechnical advice should be sought.

(b) A disconnection shall be made at a pit or other connection to a site stormwater drain.

(c) Extraneous water, soil, sand, rock or other substances shall not enter the site stormwater drain or external stormwater drainage system downstream of the disconnected section.

7 Surface water and subsoil drainage systems — Ancillaries

7.1 Scope of section

This section specifies requirements for ancillaries of surface water and subsoil drainage systems.

7.2 Paved surfaces

Gradients for paved surfaces with areas exceeding 200 m^2~~, which~~ that form part of a catchment area for a surface water drainage system specified in ~~accordance with~~ Clause ~~(~~5.2.1(a) or (b~~),~~) are given in Table 7.2.

Table 7.2 — Gradient limits for paved areas

Drained area	Gradient		
	Access roads	**Paved areas**	**Footpaths**
Longitudinal gradient or fall	1:10 max. [a]	—	—
Road crossfall or average camber	1:40 normal	1:60 min.	1:30 max.
			1:40 min.
Kerb channels:			
without concrete gutter	1:150 min.	1:150 min.	—
with concrete gutter or high-class surfacing	1:200 min.	1:200 min.	—
Super-elevation for road curves not exceeding 100 m radius	1:25 max.	—	—

[a] The first 10 m of an access road from its junction with a major road or public highway should have a gradient not greater than 1:30.

NOTE: Except for a longitudinal gradient or fall, the typical gradient limits are in accordance with EN 12056-3.

7.3 Reflux valves

7.3.1 Purpose

Reflux or non-return valves allow flow in one direction only, permitting stormwater to flow from a property but preventing backflows due to surcharging of the downstream stormwater drainage network.

7.3.2 Location

Reflux valves and reflux valve chambers shall be located ~~as follows:~~ —

(a) wholly within the property~~.~~; and

(b) in a stormwater pit unless ~~such~~the valve is —

(i) above the finished surface level and is ~~capable of being~~able to be maintained from this level; or

(ii) within a building and accessible with sufficient clear space above ~~so that~~to enable it ~~is capable of being~~to be maintained.

Split Cells

7.3.3 Criteria

A reflux valve shall be installed ~~as follows:~~ —

(a) where the network utility operator has determined a surcharge level at a gravitational point of connection that is above —

(i) any floor or basement level; or

(ii) any paved or unpaved area~~.~~; and

(b) ~~Where~~if the surcharge outlet is omitted.

7.4 Inspection openings

7.4.1 Location

~~For~~ Other than for single dwellings, inspection openings for the maintenance of site stormwater drains shall be extended to~~,~~ and capped at~~,~~ the finished surface level ~~and~~. These openings shall be installed at —

(a) each point of connection;

(b) even spacings not more than 30 m apart;

(c) each end of any inclined jump-up that exceeds 6 m in length;

(d) each connection to an existing site stormwater drain; and

(e) at any change of direction greater than 45°.

NOTE: Inspection openings may be replaced by an inlet or stormwater pit.

7.4.2 Size

The nominal size of inspection openings for site stormwater drains shall be —

(a) for nominal pipe sizes less than or equal to DN 150, the same size as the site stormwater drain; and

(b) for nominal pipe sizes greater than DN 150, not less than DN 150.

7.4.3 Access

Access to below-ground inspection openings shall be either by —

(a) a stormwater pit; or

(b) a sealed riser terminated at ground level or floor level in an accessible position.

7.4.4 Plugs or caps

Inspection openings and unused sockets shall be sealed with airtight removable plugs or caps fitted with an elastomeric seal and securely held in position by a clip, strap or threaded connection. Each plug or cap shall be legibly marked “SW”.

When a plug or cap with an elastomeric seal is removed, a new seal shall be fitted before it is replaced.

7.5 Stormwater pits, inlet pits and arresters

7.5.1 Purpose

7.5.1.1 Stormwater pits

Stormwater pits shall be installed —

(a) to provide access to and maintenance of —

(i) junctions, changes of gradient and changes of direction of site stormwater drains;

(ii) inspection openings within buildings;

(iii) reflux valves; or

(iv) flap valves fitted at the downstream ends of subsoil drains; and

(b) where used, to operate as an inlet pit, if used.

7.5.1.2 Inlet pits

Inlet pits shall be installed —

(a) to allow the collection and ingress of stormwater to a site stormwater drain;

(b) where necessary, to operate as a surcharge outlet, if necessary, see Clause ;5.4.12; or

(c) when the point of connection is a street kerb and gutter and the diameter of the site stormwater drain is larger than DN 100.

NOTE: A sump and screen similar to that shown in Figure 7.5.1.2 should be provided adjacent to the property boundary to provide transition to smaller pipes or conduits passing under the footpath.

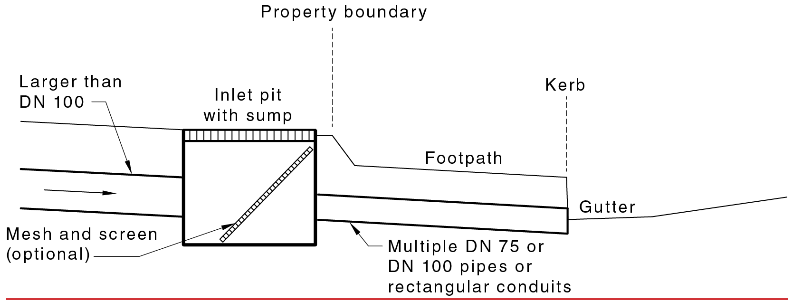


Figure 7.5.1.2 — Typical arrangement of inlet pit and footpath crossing

7.5.1.3 Arresters

Arresters shall be installed to remove contamination, generally silt or oil, or both, from stormwater prior tobefore discharge to the stormwater drainage network.

7.5.2 Size

7.5.2.1 Stormwater and inlet pits

Minimum internal dimensions for stormwater and inlet pits shall be givenas specified in Table 7.5.2.1.

Table 7.5.2.1 — Minimum internal dimensions for stormwater and inlet pits

Depth to invert of outlet	Minimum internal dimensions, mm		
	Rectangular		Circular
	Width	Length	Diameter

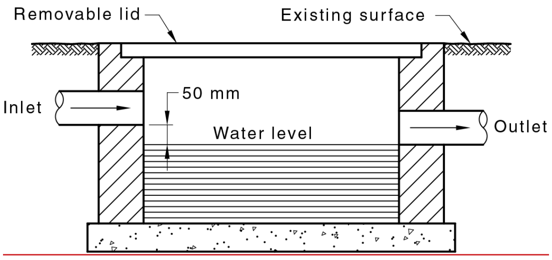
≤ 450	350	350	—
≤ 600	450	450	600
> 600 ≤ 900	600	600	900
> 900 ≤ 1 200	600	900	1 000
> 1 200	900	900	1 000

7.5.2.2 Arresters

The minimum internal dimensions and spacings for baffles and weirs for —

(a) silt arresters shall be as shown in Figure 7.5.2.2(A); and

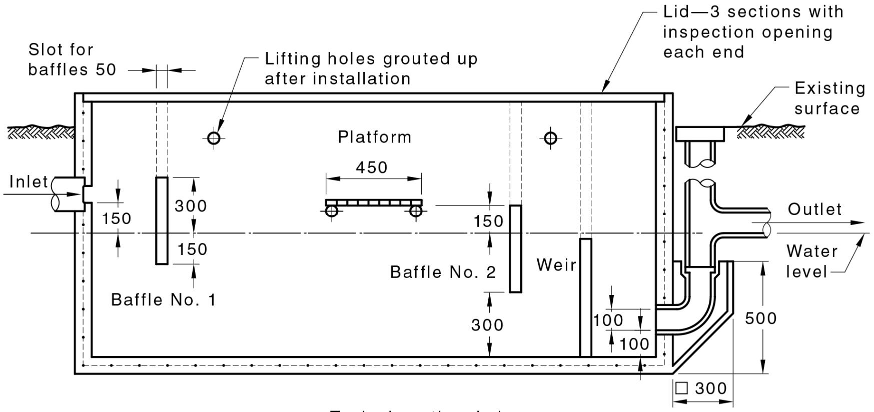
(b) general purpose (oil or silt, or both) arresters shall be as shown in Figure 7.5.2.2(B).



Nominal size of outlet, DN	Minimum internal dimensions, mm			
	Rectangular		Circular	Depth below invert of outlet
	Width	Length	Diameter	
≤ 150	600	1 000	1 000	450
225	700	1 000	1 000	450
300	800	1 000	1 000	450
375	1 000	1 200	1 200	550

Figure 7.5.2.2(A) — Minimum internal dimensions for silt arresters

Dimensions in millimetres



Typical sectional view

Maximum hourly discharge, L	Minimum internal dimensions, mm			Minimum spacing of baffles and weir, mm			
	Width	Length	Depth below crest of weir	Inlet to Baffle No. 1	Baffle No. 1 to Baffle No. 2	Baffle No. 2 to weir	Weir to outlet
500	600	1 870	70	200	1 200	150	200
750	600	1 870	1 000	200	1 200	150	200
1 000	700	2 660	600	300	1 640	300	300
1 500	700	3 020	600	300	2 000	300	300
2 000	1 000	3 020	780	300	2 000	300	300
3 000	1 250	3 820	1 050	300	2 500	300	600
4 000	1 350	4 020	1 150	300	2 700	300	600
5 000	1 450	4 020	1 250	300	2 900	300	600

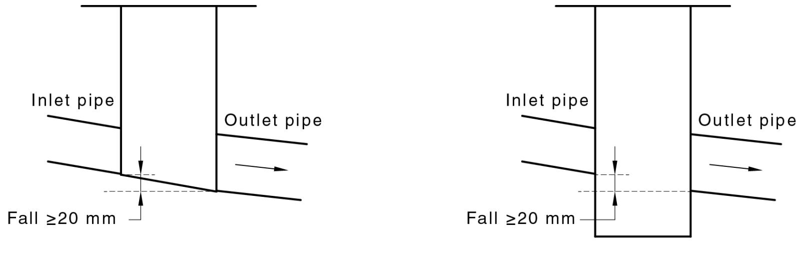
Figure 7.5.2.2(B) — Minimum dimensions for general purpose (oil and/or silt ~~or both~~) arresters

7.5.3 Falls across pits

The ~~positions~~locations of inlet and outlet pipes for pits in site stormwater drains shall be selected to minimize head losses and facilitate the flushing of sediment from pits. The following shall apply:

(a) ~~Where~~If practicable, inlet pipes shall be pointed directly at the pit outlet to assist the passage of flow and reduce turbulence.

(b) Pits without a sump~~,~~ as shown in Figure 7.5.3 (a~~),~~) shall have the floor graded to fall at least 20 mm between the inverts of the inlet and outlet pipes. Sump pits shall have a flat floor but a fall of at least 20 mm between pipe inverts~~,~~ as shown in Figure 7.5.3 (b).



(a) Pit without sump (b) Sump pit

Figure 7.5.3 — Pit arrangements

7.5.4 Inlets

Gratings or slotted kerb inlets shall be provided as specified in Clause ~~. Where pits~~5.4.10. Pits that act as surcharge outlets~~,~~ shall meet the ~~provisions~~requirements of Clause ~~shall apply~~5.4.12.

Gratings shall be set 5 mm below the levels of surrounding paved areas to allow for settlement after construction.

Frames of gratings or inspection covers on pits in areas subject to vehicular traffic shall be bedded using good quality mortar with low-water content on well-built masonry or concrete walls. Time shall be allowed for the bedding to develop its strength before a grating or cover is subjected to traffic.

NOTE: For concrete paved areas, care should be taken that construction or expansion joints do not coincide with the lines of collecting channels and do not cross areas in which ponding occurs at sag inlets.

7.5.5 Materials and construction

7.5.5.1 Rectangular or square pits and arresters

Rectangular or square stormwater pits and inlet pits and all arresters shall ~~be~~ either ~~one of the following:~~be —

(a) constructed *in situ* on 150 mm min. thick concrete bed with at least the same external dimensions as the pit or arrester and with walls of the following:

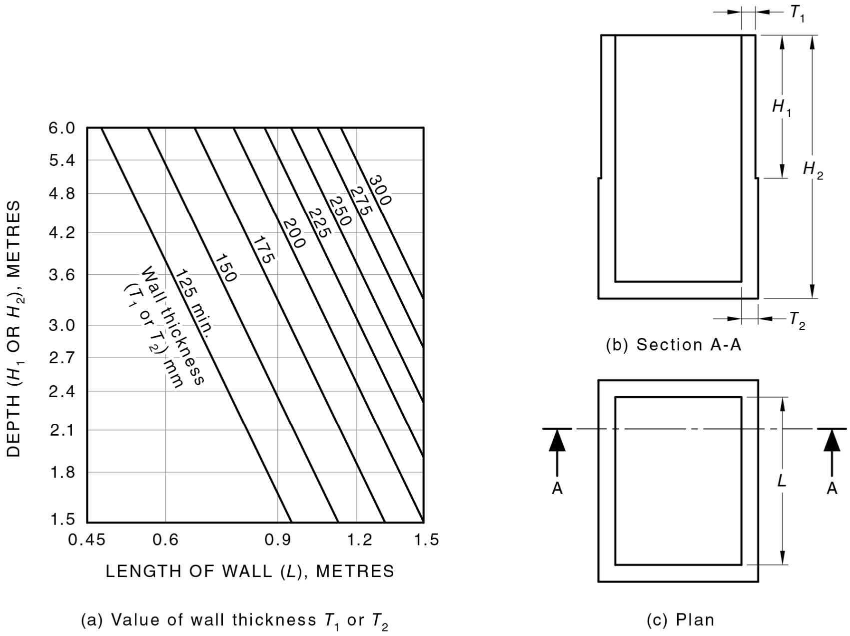
(i) Brickwork for wall depths, measured from the existing surface to the invert of the outlet, that —

(A) do not exceed 600 mm, 110 mm min. thick; or

(B) exceed 600 mm but not 1 500 mm, 230 mm min. thick.

(ii) Non-reinforced concrete with thickness not less than that determined from Figure 7.5.5.1~~.~~; or

(b) precast or prefabricated as specified in ~~accordance with~~ Clause ~~.~~2.12.8.



NOTE 1: T_2 ~~obtained from the graph~~ applies to the thickness of the bottom section~~,~~ and T_1 to the thickness of the top section.

NOTE 2: Example ~~—~~for a non-reinforced concrete wall of length (L) = 1.2 m and maximum ~~depths~~depth of 1.8 m (H).

Figure 7.5.5.1 — Minimum thickness of non-reinforced concrete walls for pits and silt arresters

7.5.5.2 Circular pits

Circular stormwater pits and inlet pits shall be precast or prefabricated as specified in ~~accordance with~~ Clause ~~.~~2.12.8.

7.5.5.3 Conduits and channels

The construction of conduits and channels in pits shall ~~be constructed in accordance with~~meet the following requirements:

(a) The fall from the invert of each inlet to the invert of the outlet shall be not less than the values ~~given~~ in Figure 7.5.3.

(b) For pits located inside buildings, flows shall be conveyed through the pit by —

  (i) a fully enclosed conduit with sealed inspection openings; or

  (ii) a graded floor~~,~~ with the pit fitted with an airtight cover.

(c) For pits located outside buildings, flows shall be conveyed through the pit —

  (i) as specified for Item (b)(i); or

  (ii) by a graded floor or sump.

Inlet pits~~,~~ in locations subject to dengue fever borne by mosquitoes~~,~~ shall be without a sump and be self-draining.

7.5.5.4 Ladders

Rung and individual rung ladders installed in pits and arresters shall ~~conform to~~be as specified in AS 4198 and AS 1657, respectively.

Following manufacture, steel ladders shall be hot dip zinc galvanized as specified in AS/NZS 4680.

7.5.5.5 Cement rendering

Brick walls and floors of pits and arresters shall be rendered with a coat of cement mortar at least 10 mm thick~~,~~ and trowelled to a smooth finish.

7.5.5.6 Upper walls of stormwater pits

The upper walls of stormwater pits shall be either ~~one of the following:~~ —

(a) vertical~~.~~; or

(b) tapered upwards to the access shaft from a point not less than —

  (i) 1 500 mm above the invert of the outlet pipe; and

  (ii) 100 mm above the top of the highest inlet pipe.

The diameter of the access shaft shall be not less than 600 mm~~,~~ and its length not greater than 350 mm.

7.5.5.7 Access openings

For stormwater pits that are not intended to act as inlets for stormwater or arresters, circular or rectangular access openings shall be fitted at finished surfaces with removable covers with a clear opening of not less than 500 mm.

7.5.5.8 Construction joints

Construction joints shall ~~be made in accordance with~~meet the following requirements:

(a) Not more than 24 h shall elapse between successive pours of concrete.

(b) The keying surface shall be scabbled and cleaned.

(c) A thick cement slurry shall be applied immediately ~~prior to~~before pouring concrete.

7.5.5.9 Inserts

Holes broken in or formed in walls of pits and arresters for insertion of pipes or fittings shall be made watertight by —

(a) keying and preparing as for construction joints and caulking the annular space between the concrete and pipe or fitting with a stiff mortar, see Clause ~~;~~2.9; or

(b) sealing with an epoxy-based sealant.

7.5.5.10 Connections

Connections to pits and arresters shall ~~conform to~~ be as specified in Clause ~~.~~6.3.2.

7.6 Surcharge outlets

Surcharge outlets shall ~~conform to~~be as specified in Clause ~~.~~5.4.12.

7.7 Junctions

7.7.1 General

Junctions in site stormwater drains shall be made by means of using —

(a) an oblique junction or sweep junction at an upstream angle not greater than 60°, as shown in Figure 7.7.1(A), and preferably less than 45°;

(b) an opening cut into a site stormwater drain as shown in accordance with Figure 7.7.1(B) for nominal pipe sizes equal to or greater than DN 375; or

(c) a pit.

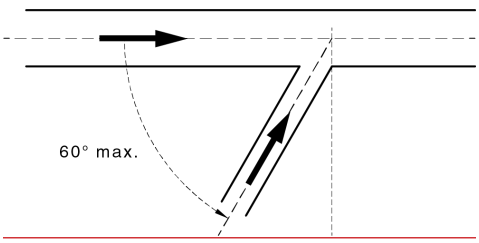
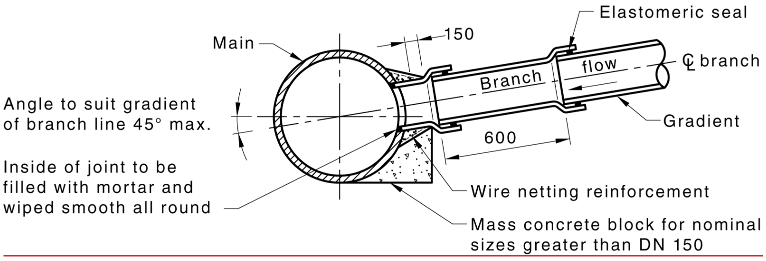


Figure 7.7.1(A) — Oblique or sweep junction connection

Dimensions in millimetres



NOTE 1: The centre-line of each branch shall intersect the centre-line of the main line.

NOTE 2: The change of direction of flow at a cut-in shall be between 45° and 90° as shown in Figure 7.7.1(C).

NOTE 3: For information on gradients, see Clause 6.3.4.

Figure 7.7.1(B) — Cut-in connection for site stormwater drains equal to or greater than DN 375

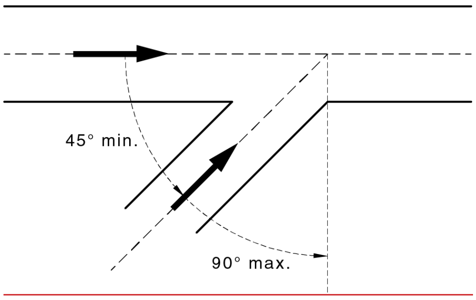


Figure 7.7.1(C) — Change of direction of flow at a branch connection or cut-in

7.7.2 Square junctions

For site stormwater drains, square junctions shall only be used —

(a) at the top of a jump-up at a point of connection;

(b) as an inspection opening; or

(c) at the top of a jump-up in the site stormwater drain in lieu of a bend and inspection opening.

7.8 Jump-ups

The construction of jump-ups in site stormwater drains shall ~~be constructed in accordance with~~meet the following requirements:

(a) The bend at the base of the jump-up shall be supported on a concrete footing of a thickness not less than 100 mm and extending upwards not less than 100 mm.

(b) Either a bend incorporating a full-size inspection opening or a junction fitting shall be used at the top of the jump-up, as shown in Figure 7.8.

(c) Branch site stormwater drains shall connect to the shaft of a jump-up using junction fittings as shown in Figure 7.8 and be fully supported.

(d) The jump-up shall be protected and supported during installation and placement of trench fill.

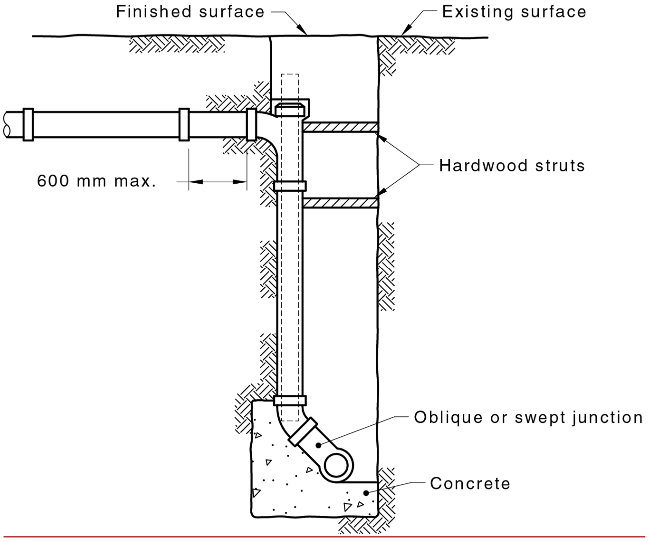


Figure 7.8 — Vertical jump-up to branch site stormwater drain

7.9 Anchor blocks

~~Where~~If the gradient of a site stormwater drain exceeds 1:5, anchor blocks shall be installed —

(a) at the bend or junction at the top and bottom of the inclined site stormwater drain, as shown in Figure 7.9; and

(b) at intervals not exceeding 3 m.

Anchor blocks for ~~such~~these drains shall be of reinforced concrete ~~conforming to~~and meet the following requirements:

Commented [JR24]: fixed

(i) Thickness shall be not less than 150 mm.

(ii) Steel reinforcement for such drains shall be of nominal size DN 100 or DN 150, two bars of not less than 10 mm diameter bent to a radius of about 200 mm or 250 mm, respectively, and ~~placed~~located as shown in Figure 7.9.

NOTE: Nominal sizes greater than DN 150 are not covered by this document.

(iii) The anchor blocks shall extend —

(A) across the full width and be firmly keyed into the sides of the trench;

(B) above the top of ~~such~~the drain by not less than 150 mm; and

(C) below the foundation of the trench by not less than 150 mm.

(iv) The anchor blocks shall not cover any flexible joint.

Dimensions in millimetres

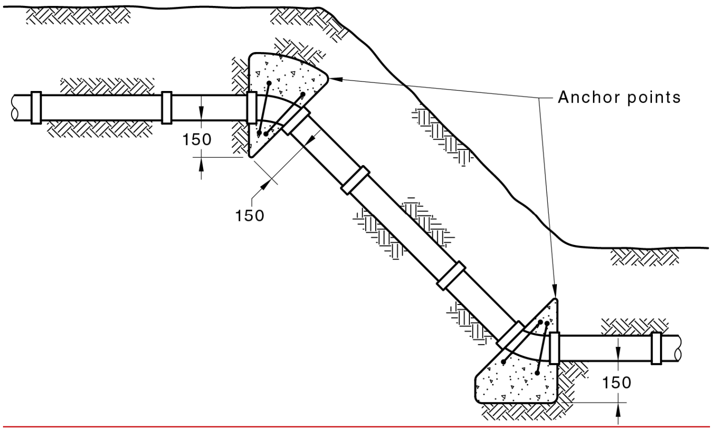


Figure 7.9 — Anchoring of site stormwater drains

7.10 On-site stormwater detention systems

7.10.1 General ~~criteria~~

On-site stormwater detention (OSD) systems shall ~~conform to~~meet the following requirements:

(a) Provision shall be made for the harmless escape of overflows in the event that an outlet ~~gets~~becomes blocked and the storage is completely filled. Any ponding of water resulting from a blockage shall occur at a visible location, so that the fault can be noticed and corrected.

(b) Ponding and overflow levels shall be not less than 300 mm below any adjacent habitable floor levels of buildings and not less than 150 mm below non-habitable floor levels.

7.10.2 Below-ground systems

OSD systems located in underground tanks shall ~~conform to~~meet the following requirements:

(a) The hydraulic control for the storage (usually an orifice plate on an outlet pipe) shall be firmly fixed in place to prevent removal or tampering. A plate of 3 mm to 5 mm thick stainless steel with a circular hole shall be used, provided —

(i) it is machined to 0.5 mm accuracy;

(ii) it retains a sharp edge; and

(iii) the orifice diameter is not less than 25 mm.

(b) For tanks with open storage zones, allowance shall be made for the accumulation of debris and sediment in the storage, as follows:

(i) Tank floors shall be graded at a minimum slope of 1:140 towards the outlet, to minimize ponding and depositing of debris.

(ii) An inspection/access opening shall be provided above the location of the outlet with dimensions at least 600 mm × 600 mm or 600 mm diameter for storages up to 800 mm deep and 600 mm × 900 mm for deeper storages. There shall be no impediments to the removal of debris through this opening. Inspection shall be possible without residents or owners having to remove heavy access covers.

(iii) ~~Where~~If storages are not deep enough to work in (i.e. less than 1.5 m deep), access shall be provided at intervals of approximately 10 m to allow the system to be flushed to the storage outlet. Access shall be provided at the outlet.

(iv) A sump (with a base level set below that of the main storage) shall be provided at the outlet point, set below the level of the main storage to collect debris. ~~Where~~If a discharge control pit is included in the storage, ~~this~~it shall contain a sump set a minimum of 1.5 times the diameter of the orifice of the outlet below the centre of the orifice. Sumps shall ~~be provided with~~have weepholes to drain out to the surrounding soil. They shall be founded on a compacted granular base.

(c) ~~Where~~If the depth of the tank exceeds 1.2 m, a ladder as specified in ~~accordance with~~ Clause 7.5.5.4 shall be installed.

(d) Below-ground OSD systems shall ~~conform to~~be as specified in AS 2865.

NOTE: Underground tanks should ~~conform to~~meet the following requirements:

(a) Screens with the following characteristics should be provided to cover each orifice outlet:

(i) For orifices up to 150 mm diameter, a fine aperture-expanded metal mesh screen with a minimum area of 50 times the area of the orifice. For larger diameter orifices, a coarser grid mesh with a minimum area of 20 times the orifice area may be used ~~as an alternative~~.

(ii) Steel screens should be stainless steel or hot-dip galvanized.

(iii) ~~Where~~If aperture-expanded mesh screens are employed, they should be positioned so that the oval-shaped holes are horizontal, with the protruding lip angled upwards and facing downstream. A handle may be fitted ~~to ensure~~for correct orientation and easy removal for maintenance.

(iv) The location of screens should be ~~located so that they are~~ at least 1.5 times the orifice diameter or 200 mm from the orifice plate, whichever is the greater.

(v) Screens should be placed no flatter than 45° to the horizontal in shallow storages up to 600 mm deep. In deeper or more remote locations, the minimum angle should be 60° to the horizontal.

(b) If the storage is sealed, a vent should be provided to expel any noxious gases.

(c) The storage should be designed to fill without causing overflows in upstream conduits due to backwater effects.

A system may provide a cellular storage volume rather than an open void, and some may allow infiltration to the surrounding soil.

7.10.3 Materials

Storages shall be constructed of concrete, masonry, aluminium/zinc and aluminium/zinc/magnesium alloy-coated steel, zinc-coated steel, galvanized iron or plastics.

8 Pumped systems

8.1 Scope of section

This section specifies requirements for pumped systems.

Pumped systems are for areas normally less than 2 000 m^2 where it is not practicable for the stormwater to be discharged by gravity through the available gravitational point of connection.

8.2 General requirements

The pumping equipment shall —

(a) include a wet well, pumps and motors, pipework and electrical equipment; and

(b) be located to facilitate easy connection to either the surface water system or the pumped point of connection.

NOTE: An illustration of the application of this section is given in ~~.~~Appendix L.

8.3 Wet wells

8.3.1 General

Wet wells~~,~~ for submersible or non-submersible type pumps~~,~~ shall be installed in accessible locations.

8.3.2 Construction and materials

The structure shall be precast or cast *in situ*. It shall be sound and constructed of materials that are capable of resisting corrosion from groundwater and aggressive soils.

NOTE 1: Suitable materials include precast or cast *in situ* reinforced concrete, brickwork, corrosion-resistant metals, glass-reinforced plastics, or suitable plastics such as PE or PP.

NOTE 2: When using plastics and particularly PE, care should be taken in the design and installation to address durability and to avoid problems with buckling and long-term PE creep. WSA 137 provides further information on the design and performance requirements for maintenance shafts, maintenance chambers and maintenance holes, and WSA 129 provides information on plastics collections tanks.

8.3.3 Base

The base shall —

(a) be constructed of materials compatible with the walls~~. It shall~~ ;

(b) maintain a self-cleansing gradient towards the pump inlet~~. The base shall~~ ; and

(c) be supported on stable ground.

8.3.4 Cover

The cover shall be constructed of similar materials to that of the wet well and have removable access openings sized for maintenance purposes. If the access opening is airtight, a breather pipe with a non-corrodible screen shall be installed.

8.3.5 Ladders

~~Where~~If a wet well exceeds a depth of 1.2 m, a ladder as specified in ~~accordance with~~ Clause 7.5.5.4 shall be installed.

8.3.6 Combined effective storage

The capacity of the pumped system shall be achieved by a combination of pump capacity and wet well storage between the high and low working levels of the wet well. The combined effective storage comprising the volume able to be pumped in 30 min plus the wet well storage shall be not less than the volume of the run-off from the storm of 10 % AEP (10 years ARI) and duration of 120 min. The maximum pump capacity shall be as ~~detailed~~specified in Clause ~~(~~8.4(a). The minimum wet well storage between the high and low working levels, expressed in cubic metres, shall be 1 % of the catchment area in m^2 and not less than 3 m^3.

8.3.7 Alarm

High-level and low-level alarms shall be installed in each wet well and located clear of the discharge from the inlet pipe ~~so that~~to prevent false alarms~~ are prevented.~~. The high-level alarm shall be set not higher than 100 mm above the invert of the inlet pipe~~,~~ provided flooding of habitable or storage areas and vehicle garages is avoided. ~~Where~~If flooding ~~could occur~~is possible, the overflow and high-level alarm shall be lowered accordingly to prevent flooding.

8.3.8 Inlet

The invert of the inlet pipe to the wet well shall be located at least 100 mm above the level of the design top water level.

NOTE: An overflow pipe may also be installed ~~where~~if practicable.

8.3.9 Sealing

~~All~~ Pipes or apparatus passing through a wall or cover of a wet well shall be sealed with a compatible material.

8.4 Pumps

~~The~~ Pumps shall be suitable for unscreened stormwater and installed as follows:

(a) Pumps shall be in duplicate. The maximum capacity of each pump shall be selected so that the capacity of the system receiving the discharge is not exceeded. The pump controls shall be set up to enable alternate pump operation at each start. ~~In the event that~~If a pump fails to operate when the water level in the wet well reaches the pump start, the other pump shall be activated~~,~~ and a visible alarm initiated. In the event that both pumps fail to operate, an audible alarm shall be initiated.

(b) Pumping equipment shall be securely fixed to the wet well using corrosion-resistant fixings.

(c) Pumps shall be fitted with a gate valve and a non-return valve on the delivery side of each pump.

NOTE: Valves should be accessible without having to enter the well.

(d) Pumps shall have flanges or unions installed to facilitate removal.

(e) Pumps shall be controlled so as to limit the number of starts per hour to within the capacity of the electrical motors and equipment. Pumps shall, as far as practicable, empty the contents of the wet well at each operation.

(f) The pump flow rate shall be calculated based on an assessment of the expected inflow and, ~~where~~if appropriate, the allowable discharge rate.

8.5 Rising mains

Rising mains shall ~~conform to~~meet the requirements of this document and the relevant sections of AS/NZS 3500.1~~ and to this document~~. They shall connect —

(a) to a stormwater or inlet pit; or

(b) directly to a stormwater drain.

8.6 Electrical connection

All electrical motors and equipment shall be installed as specified in~~ accordance with~~ AS/NZS 3000.

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9 Site testing

9.1 Scope of section

This section sets out a method for testing downpipes within buildings, site stormwater drains and main internal drains under buildings and all rising mains.

9.2 Downpipes, site stormwater drains and drains within or under buildings

Downpipes, site stormwater drains and drains within or under buildings shall be tested as specified in ~~accordance with~~ Clause ~~.~~9.3.

9.3 Test criteria

9.3.1 Downpipes within buildings

Downpipes within buildings shall be free of leaks when subjected to either —

(a) a water test at a pressure of a head of water equal to the lesser of 10 m or the length of the downpipe for a period of not less than 10 min; or

(b) an air test at a pressure of not less than 30 kPa for a period of not less than 3 min.

NOTE: 1 kPa = 100 mm head of water.

9.3.2 Site stormwater drains, drains within and under buildings, and main internal drains

Site stormwater drains, drains within and under buildings, and main internal drains shall be free of leaks when subjected to either ~~of the following:~~ —

(a) *a water test*— Leakage rate not exceeding the relevant value in Table 9.3.2(A) for a pressure within the range 1.5 m to 3.0 m head of water maintained for a period of not less than —

(i) 10 min for FRC, precast concrete (steel reinforced) and vitrified clay (ceramic) products; or

(ii) 5 min for all other products~~.~~; or

NOTE 1: See Clause~~.~~ 9.4.1.

(b) *an air test*— Application of a pressure test of not less than 30 kPa for a period of not less than 3 min then, after disconnection of the pressure source, the period for a pressure drop from 25 kPa to 20 kPa to exceed the relevant value ~~given~~ in Table 9.3.2(B).

NOTE 2: See Clause~~.~~ 9.4.2.

Table 9.3.2(A) — Maximum leakage rate

Material	Maximum leakage rate per 30 m length L/min
FRC, precast concrete (steel reinforced) and vitrified clay (ceramic)	$\frac{DN}{100}$
All other products	Nil

Table 9.3.2(B) — Minimum period for pressure drop

Nominal size DN	Minimum period for pressure drop from 25 kPa to 20 kPa s
100 to 225	90
300 to 450	180

9.3.3 Rising mains

Rising mains shall be free of leaks when subjected to a pressure test at a pressure of not less than twice the shut-off head of the pump connected to the rising main for a period of not less than 10 min.

9.4 Procedure

9.4.1 Water test

The head of water on any section of drain shall not exceed 3 m.

The procedure for the water test shall be as follows:

(a) Seal all openings except the top of the section of the below-ground drain to be tested.

(b) Fill the below-ground drain with water to the highest level in that section.

(c) Maintain the water at this level for a period of —

  (i) 10 min for vitrified clay drains; or

  (ii) 5 min for drains of any other material.

The drain shall be deemed to have passed the test if no make-up water is used.

NOTE: For vitrified clay drains, the quantities of make-up water should be maintained by the addition of measured quantities of make-up water of —

  (a) up to 1 L per 30 m length of DN 100; or

  (b) up to 1.5 L per 30 m length of DN 150.

9.4.2 Air test

The procedure for the air test shall be as follows:

(a) Apply a pressure of 30 kPa to the drain and hold this pressure for 3 min to allow the air temperature to stabilize.

(b) Shut off the air supply and measure the time taken for the pressure in the pipe to drop from 25 kPa to 20 kPa.

The drain shall be deemed to have passed the test if the time taken for the pressure to drop is greater than 90 s for pipes ~~of size~~sized DN 225 or smaller or 180 s for pipes ~~of sizes~~sized DN 300 and DN 375.

10 Siphonic drainage systems

10.1 Scope of section

This section specifies design, materials and installation requirements for siphonic roof drainage systems as shown in Figure 10.1.

NOTE 1: See Appendix N for information on the operation of a siphonic system.

NOTE 2: The gutter sizing and overflow methods presented in this document are not suitable for siphonic systems. Gutter and overflow for siphonic systems need to incorporate prime (fill) times and other variables associated with water profiles in the gutter. Detailed calculation and estimation of these water profiles are outside the scope of this document.

NOTE 3: The methods in this document for sizing downpipes and sumps ~~presented in this document~~ are not suitable for siphonic systems.

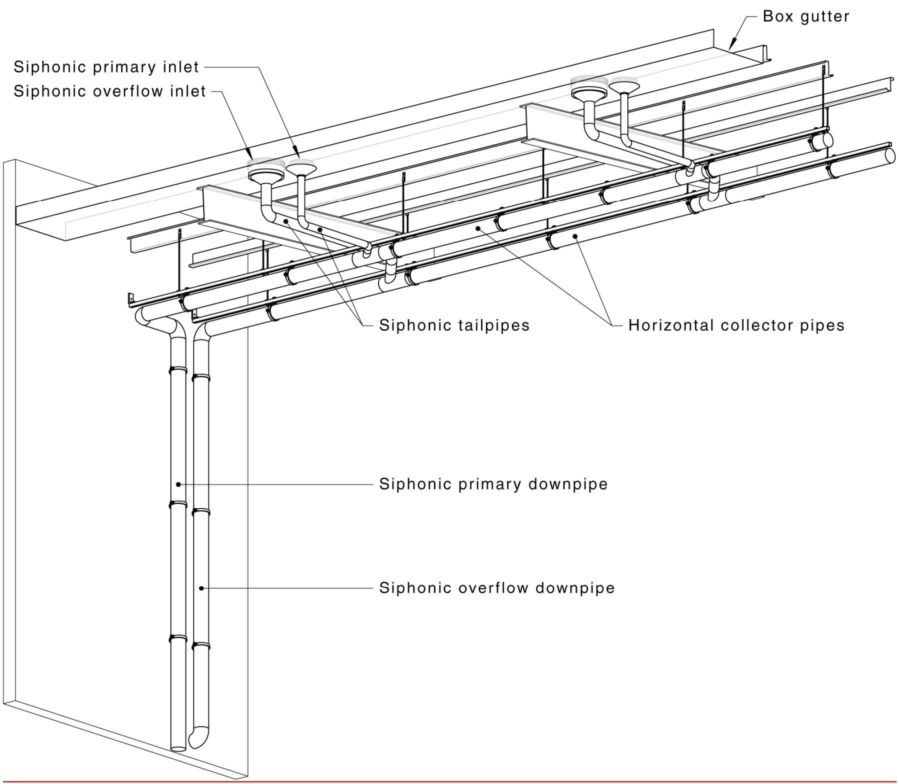

Figure 10.1 — Siphonic roof drainage and overflow system

10.2 Design probabilities

Siphonic drainage systems and associated siphonic or conventional overflows shall be designed to the same AEP (ARI) as ~~per~~specified in Clauses 3.3.4 and ~~.~~3.3.5.

10.3 Design methods

The design of siphonic roof drainage systems shall ~~meet the requirements~~be as specified in Clause ~~.~~10.5.

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NOTE: The design of siphonic roof drainage systems involves the use of specialized software for siphonic hydraulic calculations. Expertise in the use of the software is desirable. Sizing of gutters and overflow provisions should be certified by a suitably qualified person or recognized testing laboratory. See note to

Clause N.1 on the operation of a siphonic system and Clause N.2 for a general approach on siphonic roof drainage systems.

10.4 Materials

All materials used in the construction of siphonic drainage systems shall ~~conform to the requirements of~~be as specified in Section~~.~~ 2. Pipes and fittings shall withstand the maximum positive and negative pressures encountered under design conditions.

NOTE: Additional considerations for material selection (e.g. negative and positive pressures, temperature effects on plastics, formation of airtight joints) should be undertaken.

10.5 Requirements

10.5.1 Freeboard

The freeboard (h_f) for box gutters shall be 30 mm, see Clause ~~.~~3.7.2.

NOTE: See Table F.1 for information on eaves gutters.

10.5.2 Balancing

The overall imbalance in a siphonic system, which is the difference between the maximum and minimum residual pressure between inlets connected to a common siphonic downpipe, shall be designed for 0.5 m but not exceed 1.0 m.

NOTE: The effects of shadowing, wind-driven rain and separate overflow catchment areas should be considered when balancing systems.

10.5.3 Available head

The head available for calculations of siphonic systems shall be the difference in elevation between the inlet lip of the siphonic inlet ~~to~~and the point of discharge at ground level or the level of a siphon break.

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~~Where~~If the outlet of a siphonic system is in a pit or other component, the point of discharge shall be taken as the maximum potential water level for overland flow.

10.5.4 Calculation of flows at inlets

The design flow calculation of the amount of water to each inlet shall be a minimum of 1.7 L/s as specified in ~~accordance with~~ Clause ~~.~~3.4.

10.5.5 Minimum pressure in pipes

The minimum design pressure for a system shall be −8 m (−78 kPa) to avoid cavitation of the water in the pipework.

10.5.6 Minimum velocity

The minimum velocity under full-flow conditions shall be not less than 1.0 m/s to assist in clearing debris entering the piping system.

NOTE: Maximum velocities in siphonic systems are higher than in conventional systems. Therefore, the applied forces should be considered ~~to ensure~~so that the system is supported and restrained to minimize deflections during all flow conditions.

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10.5.7 Overflow capacity

The overflow system shall be not less than the design flow for the associated primary siphonic system. Overflow systems shall be independent toof the primary system and discharge to atmosphere. Overflow systems shall be siphonic or conventional.

NOTE: For overflows for each catchment area to have their own independent system, it is recommended flat expansion joints are utilized for any siphonic overflow system.

10.5.8 Minimum pipe size

The minimum internal diameter for any pipe in a siphonic roof drainage system shall be 44 mm.

NOTE 1: Pipes smaller than 90 mm should be kept to a maximum length of 2 m and contain not more than three 45° bends.

NOTE 2: Leaf guards (debris screens) should be fitted to the siphonic outlets with the inlet hole sizes at a minimum of 10 mm.

NOTE 3: Siphonic systems should utilize 45° junctions.

11 Rainwater harvesting systems

11.1 Scope of section

This section specifies design and installation requirements for rainwater harvesting systems. For this section, rainwater shall mean stormwater discharged from above-ground roof catchment areas which are inaccessible to vehicular and pedestrian traffic.

NOTE 1: For gravity rainwater harvesting system requirements, see Section 2 for materials, Section 3 for design, and Section 4 for installation.

This section shall be read in conjunction with the requirements for rainwater storage tanks and rainwater services in AS/NZS 3500.1.

NOTE 2: Consideration should be given to local environment factors and potential airborne contaminants entering the stored rainwater. Contaminants may come from agriculture, urban air pollution, organics or salt in coastal areas. Consideration should also be given to the system materials and the use of filters and first flush diverters.

11.2 Rainwater storage tank overflows

11.2.1 Overflow

Rainwater storage tanks shall be installed with an overflow pipe that discharges excess rainwater via flow by gravity to the site stormwater drainage system or to an approved outfall or disposal system.

To prevent damage or nuisance, the rainwater tank overflow shall discharge to either —

(a) a stormwater system;

(b) a kerb and channel; or

(c) an inter-allotment stormwater pit.

However, if no stormwater system exists and the lot falls away from the street, the tank overflow may have to be drained to an on-site stormwater dispersion system.

A physical air break or non-return valve on the outlet of the tank overflow shall be provided before connecting to the stormwater drainage system.

NOTE 1: Water from the overflow is considered to be stormwater and should meet the relevant requirements of AS/NZS 3500.3.

For buried rainwater storage tank overflow, the overflow pipe shall be fitted with a non-return device.

NOTE 2: Examples of non-return devices include reflux valves and flap valves.

11.2.2 Overflow sizing

The overflow pipe shall be —

(a) of the same or greater diameter than the tank inlet pipe;

(b) not smaller than DN 90; and

(c) greater than or equal to the rate of ingress.

NOTE: Refer to AS/NZS 3500.1 for requirements relating to rainwater before it is discharged from a rainwater storage tank.

11.3 Debris screens

11.3.1 General

Rainwater harvesting systems shall be installed with debris screens to prevent entry of mosquitoes, vermin and debris into the rainwater storage tank.

11.3.2 Screens

Debris screens shall —

(a) be corrosion resistant; and

(b) incorporate openings no larger than 1 mm.

11.3.3 Location

All rainwater shall pass through a debris screen before entering the rainwater storage tank. Debris screens shall be provided in the rainwater harvesting system at —

(a) downpipes;

(b) gutters and rain heads; or

(c) inlets to a tank, for gravity systems only.

11.3.4 Downpipes

Downpipes shall discharge not less than 50 mm above any screen.

11.3.5 Access for maintenance

All debris screens shall be accessible and removable for cleaning and maintenance.

11.4 Charged rainwater harvesting systems

11.4.1 General

Charged rainwater harvesting systems shall be designed and installed to convey roof-captured rainwater via a rainwater harvesting system.

NOTE 1: These systems are designed to hold water when not in use.

Stormwater services shall not be charged unless intended for rainwater harvesting purposes.

NOTE 2: A charged rainwater harvesting system is created when a roof captured rainwater downpipe drain is directed below the level of a rainwater storage tank inlet. The charged system remains full of rainwater up to the invert level of the rainwater storage tank inlet.

11.4.2 Materials

Materials and products used in charged rainwater harvesting systems shall be as specified in Section 2.

NOTE: Consideration should be given to the materials used for a charged rainwater harvesting system which should be suitable for the head pressure of an installation.

11.4.3 Size

Charged rainwater harvesting systems shall —

(a) have a minimum diameter of DN 100; and

(b) not diminish in size in the direction of flow.

11.4.4 Graded pipework

Charged rainwater harvesting systems shall fall at a minimum gradient of 1:100 toward the flush point.

11.4.5 Inspection and maintenance

A sealed inspection opening shall be provided —

(a) at the head of system, elevated to finished ground level, and

(b) adjacent the inlet to the rainwater harvesting tank.

A flush point shall be provided at the lowest area of a charged rainwater harvesting system to facilitate drainage and cleansing of the system.

The outlet of a pit provided for a flush point drain shall be —

(i) connected to a stormwater drainage system, and

(ii) discharged to an approved disposal system.

11.4.6 Design and installation

Branch connections to charged downpipe drains shall be swept in the direction of flow.

11.5 Drainage system design to tanks

11.5.1 General

The soffit of the rainwater storage tank inlet connection pipe shall be located a minimum of 150 mm below the lowest gutter outlet or downpipe debris screen. This height differential shall be increased if the drainage system from the downpipes to the rainwater storage tank exceeds 100 m in lineal length of DN 100 pipe at a maximum flow rate of 3.5 L/s.

NOTE: For charged rainwater systems, the height differential should ensure that water does not surcharge out of the collection points during the anticipated rainfall event for the gutter design. The height differential is the difference in height between the soffit of the inlet pipe into the rainwater tank and the lowest open point collecting water within the system. A hydraulic grade line calculation for charged systems can be used to obtain a suitable height differential between the soffit of the tank inlet pipe and the lowest collection point within the system. Factors to consider when using a hydraulic grade line calculation to determine a suitable height differential include the catchment area, roof slope, rainfall intensity, velocity and pipe size.

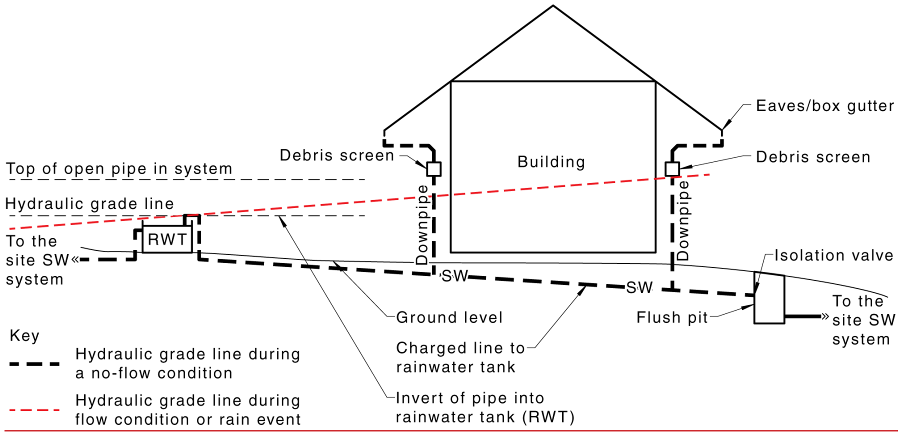

Figure 11.5.1 — Hydraulic grade line

11.5.2 Rainwater tank inlet and outlet

The invert level of a rainwater storage tank inlet connection for gravity and charged systems shall be located a minimum of 50 mm above the invert of the tank overflow pipe connection.

11.5.3 Interconnecting rainwater tanks

Commentary C11.5.3 First-flush diversion systems should be used to divert the first flush of harvested rainwater collected from the roof catchment during each rainfall event to the stormwater drainage system. First flush diverters may be installed at each individual downpipe or each combined downpipe, refer to AS/NZS 3500.1.

First flush diversion systems should —

(a) be installed before the rainwater storage tank inlet;

(b) be installed upstream of any charged stormwater pipework;

(c) have a capacity of not less than 0.3 L/m² of roof area served;

(d) be readily accessible for maintenance; and

(e) be fitted with a filter and slow-drip valve at the lowest point.

First flush diverters installed above ground should be suitably supported for the anticipated weight of the system when full.

First flush diverters installed below ground should meet the requirements of Clause 6.2 and be readily accessible immediately upstream and downstream of the first flush diverter.

First flush diverters should release the collected rainwater through a slow-drip valve to —

(i) a site stormwater pit connected to the stormwater system; or

(ii) a location that does not present a hazard or create a risk of damage to any building elements.

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Appendix A (informative)
Site-mixed concrete for minor works

Minor works are deemed to be works of a minor nature in which the strength of the concrete is not critical. For such works, the design may specify the proportions given in Table A.1. Strength tests are not required for minor works.

The proportions of fine and coarse aggregates given in Table A.1 may be adjusted, provided the stated ratio of total aggregate to cement is not changed.

Table A.1 — Concrete mix proportions for minor works

1	2	3	4	5	6
Mix proportions by mass for saturated surface-dry dense aggregate			Maximum slump	Maximum water/cement ratio by mass	Nominal strength
Cement	Fine aggregate	Coarse aggregate	mm		MPa
1	21/2	4	100	0.70	15
1	2	3	100	0.58	20
NOTE: The proportions listed ~~in this Table~~ do not apply to lightweight concrete and concrete made with blended cement.					

Appendix B (informative)
Stormwater drainage installation plans

B.1 Scope

This appendix sets out guidelines for the use ofprovides network utility operators to indicatewith the information that may be included in stormwater drainage installation plans.

Where requested, These plans may compriseinclude —

(a) a roof plan for all buildingbuildings to be fitted with rainwater goods;

(b) a site plan;

(c) a catchment plan; and/or

(d) computation sheets for the general method.

B.2 Roof plan

B.2.1 Building with fewer than four floor levels

Roof plans for buildings with fewer than four floor levels should be drawn to a scale not smaller than 1:100 and show —

(a) the extent and slope of roofs for each building and details of any adjacent parapets or vertical walls; and

(b) the proposed layout, sizes and gradients of gutters, downpipes, overflow devices and surcharge outlets.

B.2.2 Buildings with four or more floor levels

Roof plans for buildings with four or more floor levels should compriseinclude —

(a) the information listed in Clause ;B.2.1; and

(b) a drawing to show the catchment area, location, size and, the gradient of each downpipe.

B.3 Site plan

Site plans should be drawn to a scale not smaller than 1:500 and in Australia to the Australian Height Datum (AHD) or in New Zealand to the datum authorized by the network utility operator and show —

(a) boundaries and topography of the property (i.e. spot levels or contours to the appropriate datum);

(b) location of all existing and proposed buildings and the levels of ground and basement floors, to the appropriate datum;

(c) location(s) and invert level(s) of theany point(s) of connection for the property;

(d) proposed layout, sizes, invert levels and gradients of the elements, including overflow paths for storms of the surface water drainage system.;

(e) proposed layout and sizes of elements of the subsoil drainage system; and

(f) vehicular washing areas.

B.4 Catchment plan

Catchment plans should be drawn to a scale not smaller than that required by the network utility operator standards and show —

(a) the boundaries of the property; and

(b) the limits and topography of ~~the~~any catchment ~~area(s)~~areas draining to the property to the appropriate datum.

B.5 Computation sheets

Computation sheets under the general method should clearly show the basic assumptions and the calculations necessary for the sizing of the elements specified in Clauses B.2 and ~~.~~B.3.

Appendix C (informative)
Guidelines for determining rainfall intensities

C.1 Scope

This appendix provides guidelines for determining for any site ~~in~~ —

(a) in Australia, rainfall intensities for 5 min duration and AEPs of 5 % and 1 % (ARIs of 20 years and 100 years); and

(b) in New Zealand, rainfall intensities for 10 min duration and AEPs of 10 % and 2 % (ARIs of 10 years and 50 years).

C.2 Procedures

C.2.1 Australia

The procedure for ~~the determination of~~determining rainfall intensities~~, in~~ (mm/h~~,~~) for ~~the~~a location ~~considered~~ is as follows:

(a) If the location is listed in Table D.1, use the values given in the table for that location.

(b) If the location is not listed in Table D.1 —

(i) determine the latitude and longitude of the site;

(ii) go to the Bureau of Meteorology website and access the latest Intensity-Frequency-Duration (IFD) procedure that provides design rainfalls data; and

(iii) enter the latitude and longitude and obtain the rainfall intensity for the EY (exceedances per year) or AEP (annual exceedance probability), and for a duration of 5 min.

C.2.2 New Zealand

The procedure for ~~the determination of~~determining rainfall intensities~~, in~~ (mm/h~~,~~) for ~~the~~a location ~~considered~~ is as follows:

(a) If the location is listed in Table E.1, use the values given in the table for that location.

(b) If the location is not listed in Table E.1 —

(i) determine the location of the site;

(ii) go to the National Institute for Water and Atmospheric Research (NIWA) website and access the High Intensity Rainfall Design System (HIRDS) that provides design rainfall data; and

(iii) enter the site address or latitude and longitude and obtain an Intensity-Duration-Frequency output table. Determine the rainfall intensity (mm/hr) for the relevant ARI ~~(Average Recurrence Interval) or AEP (annual exceedance probability),~~or AEP and for a duration of 10 min from the table.

Appendix D (normative) Rainfall intensities for Australia

D.1 Scope

This appendix gives 5 min duration rainfall intensities for representative places in Australia~~,~~ obtained from the Bureau of Meteorology website~~,~~ that are used for the sizing of —

(a) rainwater goods, see Clause ~~;~~3.3.5.1; and

(b) surface water drainage systems, see Clause ~~(~~5.4.5(a).

D.2 Selected place references

For selected places in Australia, the latitude and longitude and AEP 5 ~~%(~~% (ARI 20 years) and AEP 1 % (ARI 100 years) rainfall intensities are given in Table D.1.

NOTE: The intensities in this table were obtained from the Bureau of Meteorology (BOM) website in October 2019. These may change with time, and updated intensities can be obtained from the BOM.

Table D.1 — 5 min duration rainfall intensities for various locations in Australia

Australian location	Latitude degrees	Longitude degrees	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h
AUSTRALIAN CAPITAL TERRITORY				
Canberra	35.29	149.14	143	192
Conder	35.46	149.09	149	214
Gungahlin	35.19	149.14	136	179
NEW SOUTH WALES				
Adaminaby	35.99	148.79	115	156
Albury	36.06	146.94	139	180
Appin	34.19	150.79	197	274
Armidale	30.51	151.66	178	238
Ballina	28.86	153.56	216	278
Balranald	34.64	143.56	141	212
Bangalow	28.69	153.51	220	285
Batemans Bay	35.71	150.19	192	267
Bathurst	33.41	149.56	124	164
Bega	36.69	149.84	176	244
Bellingen	30.44	152.91	250	339

Draft

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Bermagui	36.44	150.06	176	240
Berridale	36.36	148.84	134	186
Berrigan	35.66	145.81	152	207
Berry	34.76	150.69	205	289
Bingara	29.86	150.56	183	242
Bodalla	36.09	150.06	176	239
Bombala	36.91	149.24	166	232
Bourke	30.09	145.94	199	278
Braidwood	35.44	149.81	131	168
Brewarrina	29.96	146.86	217	303
Broken Hill	31.94	141.46	142	217
Bulahdelah	32.41	152.21	221	311
Bundarra	30.16	151.06	170	225
Bungendore	35.26	149.44	136	178
Byron Bay	28.64	153.61	219	282
Casino	28.86	153.06	213	278
Cessnock	32.84	151.36	182	254
Cobar	31.49	145.84	178	248
Cobargo	36.39	149.89	171	233
Coffs Harbour	30.29	153.11	277	384
Condobolin	33.09	147.16	158	216
Cooma	36.24	149.14	127	172
Coonabarabran	31.26	149.29	187	251
Coonamble	30.94	148.39	187	251
Cootamundra	34.64	148.04	134	181
Copacabana	33.49	151.44	223	316
Corowa	35.99	146.39	133	173
Cowra	33.84	148.69	140	190
Crookwell	34.46	149.46	102	129
Culburra Beach	34.94	150.76	200	280
Delegate	37.04	148.94	155	216
Dorrigo	30.34	152.71	209	271
Dubbo	32.24	148.61	166	221
Dungog	32.39	151.76	187	260
Eden	37.06	149.91	178	244

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Evans Head	29.11	153.44	210	272
Forbes	33.39	148.01	151	206
Forster-Tuncurry	32.19	152.51	232	319
Gilgandra	31.69	148.66	172	230
Glen Innes	29.74	151.74	167	218
Gloucester	32.01	151.96	192	262
Gosford	33.44	151.34	216	307
Goulburn	34.74	149.71	120	154
Grafton	29.69	152.94	202	267
Grenfell	33.89	148.16	141	190
Griffith	34.29	146.04	129	178
Gulgong	32.36	149.54	150	197
Gundagai	35.06	148.11	137	187
Gunnedah	30.99	150.26	157	211
Hay	34.49	144.84	120	166
Helensburgh	34.19	150.99	218	297
Hillston	33.49	145.54	143	198
Inverell	29.76	151.11	179	237
Ivanhoe	32.89	144.31	146	204
Jerilderie	35.36	145.74	145	199
Jindabyne	36.41	148.61	136	190
Junee	34.86	147.59	141	190
Kangaroo Valley	34.74	150.54	185	259
Katoomba	33.71	150.31	151	193
Kempsey	31.09	152.84	216	288
Kiama	34.66	150.86	225	320
Kyogle	28.61	153.01	207	274
Lake Cargelligo	33.29	146.36	151	207
Leeton	34.54	146.41	128	175
Lightning Ridge	29.44	147.99	207	281
Lismore	28.81	153.29	208	271
Lithgow	33.49	150.14	148	194
Lockhart	35.24	146.71	142	190
Maclean	29.46	153.21	212	278
Maitland	32.74	151.56	191	266

Draft

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Manilla	30.74	150.71	159	211
Marulan	34.71	150.01	140	184
Menindie	32.39	142.41	151	231
Merimbula	36.89	149.91	181	248
Merriwa	32.14	150.36	145	190
Milparinka	29.74	141.89	135	206
Mittagong	34.44	150.46	167	229
Moree	29.46	149.84	182	241
Moruya	35.91	150.09	183	252
Moss Vale	34.54	150.36	155	213
Mount Victoria	33.59	150.26	151	196
Mudgee	32.59	149.59	147	193
Mullumbimby	28.54	153.51	227	298
Murwillumbah	28.34	153.39	235	313
Muswellbrook	32.26	150.89	144	194
Nambucca	30.64	153.01	253	343
Narooma	36.21	150.14	177	240
Narrabri	30.34	149.76	178	237
Narrandera	34.74	146.56	125	169
Nelson Bay	32.71	152.14	240	340
Newcastle:				
Charlestown	32.96	151.71	221	311
Newcastle City	32.94	151.79	225	316
West Wallsend	32.91	151.59	208	293
Nimbin	28.59	153.21	214	284
Nowra	34.89	150.61	182	253
Nyngan	31.56	147.19	193	263
Oberon	33.69	149.86	134	178
Orange	33.29	149.11	141	186
Parkes	33.14	148.16	156	212
Picton	34.16	150.61	170	236
Port Macquarie	31.44	152.91	233	313
Queanbeyan	35.34	149.24	142	190
Quirindi	31.51	150.69	159	212
Raymond Terrace	32.76	151.76	213	299

Draft

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Scone	32.04	150.86	141	187
Shoalhaven Heads	34.84	150.74	202	284
Singleton	32.56	151.16	158	216
Springwood	33.69	150.56	186	255
Sussex Inlet	35.16	150.59	209	301
Swansea	33.09	151.64	220	314
Sydney:				
Avalon	33.64	151.31	210	287
Bankstown	33.91	151.04	162	204
Camden	34.04	150.69	161	219
Campbelltown	34.06	150.81	166	223
Cronulla	34.06	151.16	189	241
Hornsby	33.71	151.11	201	274
Liverpool	33.91	150.91	159	205
Manly	33.79	151.29	202	264
Maroubra	33.94	151.26	200	257
Parramatta	33.81	151.01	163	209
Penrith	33.74	150.69	178	240
Sutherland	34.04	151.06	179	228
Sydney City	33.86	151.21	201	262
Windsor	33.61	150.81	175	234
Tamworth	31.09	150.94	160	212
Taree	31.89	152.46	222	301
Temora	34.44	147.54	133	179
Tenterfield	29.04	152.01	182	242
The Entrance	33.34	151.51	225	324
Thredbo	36.51	148.31	126	174
Tibooburra	29.44	142.01	143	219
Tocumwal	35.81	145.56	143	195
Toronto	33.01	151.59	214	303
Tumut	35.29	148.21	136	188
Tweed Heads	28.16	153.54	252	332
Ulladulla	35.36	150.46	212	306
Vincentia	35.09	150.69	204	289
Wagga Wagga	35.11	147.36	154	208

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Walgett	30.04	148.11	191	258
Wanaaring	29.71	144.16	192	280
Warialda	29.54	150.59	188	250
Warren	31.69	147.84	181	245
Wellington	32.54	148.94	157	206
Wentworth	34.11	141.91	142	218
West Wyalong	33.91	147.21	140	189
Wilcannia	31.56	143.39	151	232
Wollongong:				
Bulli	34.34	150.91	218	313
Dapto	34.49	150.81	210	295
Kembla Heights	34.44	150.81	252	375
Port Kembla	34.49	150.91	218	308
Shellharbour	34.59	150.86	222	314
Wollongong City	34.41	150.89	218	311
Woolgoolga	30.11	153.21	273	377
Woy Woy	33.49	151.31	211	296
Wyong	33.29	151.41	221	320
Yamba	29.44	153.36	220	289
Yass	34.84	149.91	136	178
Young	34.31	148.31	132	178

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
NORTHERN TERRITORY				
Alice Springs	23.69	133.89	165	239
Daly Waters	16.26	133.36	192	236
Darwin	12.44	130.84	233	274
Jabiru	12.69	132.84	227	266
Kaltukatjara	24.86	129.09	175	258
Katherine	14.46	132.26	216	250
Mataranka	14.91	133.06	220	259
Nhulunbuy	12.19	136.79	226	271
Palmerston	12.49	130.99	231	270

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Tennant Creek	19.64	134.19	173	223
Yulara	25.24	130.99	214	322

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
QUEENSLAND				
Alpha	23.64	146.64	196	263
Barcaldine	23.56	145.29	194	260
Beaudesert	27.99	153.01	203	266
Bedourie	24.36	139.46	180	264
Biloela	24.39	150.51	204	259
Birdsville	25.89	139.36	137	212
Blackall	24.41	145.46	189	253
Blackwater	23.59	148.89	202	265
Boulia	22.91	139.91	176	247
Bowen	20.01	148.24	229	285
Brisbane:				
Beenleigh	27.71	153.21	232	305
Brisbane City	27.46	153.04	236	306
Manly	27.44	153.19	244	318
Redland Bay	27.61	153.31	245	322
Sandgate	27.31	153.06	241	313
Springfield Central	27.69	152.91	220	290
Bundaberg	24.86	152.36	266	339
Burketown	17.74	139.56	246	306
Caboolture	27.09	152.96	242	316
Cairns	16.91	145.76	230	279
Caloundra	26.79	153.11	261	341
Camooweal	19.91	138.11	177	232
Canungra	28.01	153.16	213	278
Cape York	10.69	142.54	269	316
Charleville	26.39	146.26	177	237
Charters Towers	20.06	146.26	199	249
Chinchilla	26.74	150.64	228	302

Australian location	Latitude degrees	Longitude degrees	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h
Clermont	22.81	147.64	200	257
Cloncurry	20.71	140.51	218	278
Cooktown	15.46	145.26	227	277
Crows Nest	27.26	152.06	204	264
Cunnamulla	28.06	145.69	197	278
Currumbin	28.14	153.49	251	331
Dalby	27.19	151.26	212	280
Dirranbandi	28.59	148.24	217	295
Eidsvold	25.36	151.11	216	281
Emerald	23.54	148.16	214	282
Gatton	27.56	152.29	212	281
Gladstone	23.84	151.26	214	271
Goondiwindi	28.54	150.31	193	257
Gympie	26.19	152.66	218	278
Hervey Bay	25.29	152.84	243	314
Hughenden	20.84	144.21	206	265
Hungerford	28.99	144.41	179	274
Ingham	18.64	146.16	245	308
Innisfail	17.51	146.04	248	302
Ipswich	27.61	152.76	212	277
Kilcoy	26.94	152.56	214	272
Kingaroy	26.54	151.84	220	284
Longreach	23.44	144.26	193	250
Mackay	21.14	149.19	250	315
Mareeba	16.99	145.44	197	245
Maroochydore	26.64	153.09	260	337
Mission Beach	17.86	146.11	241	293
Mission River (Weipa)	12.64	141.89	238	281
Mitchell	26.49	147.96	169	227
Moonie	27.71	150.36	208	280
Mount Isa	20.71	139.51	201	262
Mundubbera	25.59	151.31	232	301
Nambour	26.64	152.96	250	324
Nerang	27.99	153.34	242	319
Noosa Heads	26.39	153.09	258	332

Draft

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Normanton	17.66	141.09	227	283
Port Douglas	16.49	145.46	250	304
Proserpine	20.39	148.59	232	290
Quilpie	26.61	144.26	190	287
Ravenshoe	17.61	145.49	170	212
Richmond	20.74	143.14	215	275
Rockhampton	23.36	150.51	230	301
Roma	26.56	148.79	213	286
Southport	27.96	153.41	255	337
Springsure	24.11	148.09	211	281
St. George	28.04	148.59	222	299
Stanthorpe	28.64	151.94	183	244
Tambo	24.89	146.26	185	250
Tamborine Mountain	27.96	153.21	223	293
Texas	28.86	151.16	184	241
Thargomindah	27.99	143.81	180	277
Toowoomba	27.54	151.96	202	267
Townsville	19.26	146.81	235	300
Warwick	28.21	152.01	191	253
Windorah	25.44	142.66	173	265
Winton	22.39	143.04	216	299
Yarraman	26.84	151.99	213	274
Yeppoon	23.14	150.74	244	319

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
SOUTH AUSTRALIA				
Adelaide:				
Adelaide City	34.94	138.61	120	174
Christies Beach	35.14	138.46	118	169
Fairview Park	34.79	138.74	119	170
Gawler	34.59	138.76	111	158
Glenelg	34.99	138.51	120	175

Draft

Australian location	Latitude degrees	Longitude degrees	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h
Port Adelaide	34.84	138.51	124	184
Ardrossan	34.41	137.91	112	160
Balaklava	34.14	138.41	114	165
Berri	34.29	140.61	124	185
Blinman	31.09	138.69	151	226
Bordertown	36.31	140.79	115	165
Burra	33.69	138.94	115	167
Cape Jervis	35.61	138.11	120	170
Ceduna	32.14	133.69	114	167
Clare	33.84	138.61	113	162
Coober Pedy	29.01	134.76	115	174
Cowell	33.66	136.91	116	169
Delamere	35.56	138.21	129	184
Edithburgh	35.09	137.74	116	168
Goolwa	35.49	138.79	109	156
Hahndorf	35.04	138.81	114	157
Hawker	31.89	138.41	144	216
Iron Knob	32.74	137.16	128	191
Jamestown	33.19	138.61	110	159
Kadina	33.96	137.71	118	170
Keith	36.09	140.36	111	157
Kimba	33.14	136.41	109	158
Kingscote	35.64	137.64	112	159
Kingston SE	36.84	139.86	106	149
Leigh Creek	30.59	138.41	131	197
Loxton	34.46	140.56	124	184
Mannum	34.91	139.31	125	184
Marree	29.64	138.06	138	211
Meningie	35.69	139.34	111	160
Millicent	37.59	140.36	98.3	135
Morgan	34.04	139.66	123	182
Mount Gambier	37.84	140.79	103	144
Murray Bridge	35.11	139.26	120	177
Murray Town	32.94	138.24	118	172
Naracoorte	36.96	140.74	109	155

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Normanville	35.44	138.31	120	171
Nuriootpa	34.46	138.99	110	156
Orroroo	32.74	138.61	123	182
Penola	37.36	140.84	104	146
Peterborough	32.96	138.84	120	177
Pinnaroo	35.26	140.91	122	178
Port Augusta	32.49	137.76	133	199
Port Broughton	33.59	137.94	122	180
Port Lincoln	34.74	135.86	98.7	138
Port Pirie	33.16	138.01	123	183
Port Wakefield	34.19	138.16	113	164
Renmark	34.19	140.74	127	190
Robe	37.16	139.76	105	147
Roxby Downs	30.56	136.91	143	217
Snowtown	33.79	138.21	115	168
Strathalbyn	35.26	138.91	113	163
Tailem Bend	35.26	139.46	116	170
Victor Harbour	35.54	138.61	110	156
Waikerie	34.19	140.01	129	192
Whyalla	33.04	137.54	130	194
Wudinna	33.04	135.46	104	153
Yalata	31.49	131.81	106	155
Yorketown	35.01	137.61	115	166

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
TASMANIA				
Brighton	42.69	147.26	83.2	114
Burnie	41.04	145.91	128	178
Campbell Town	41.94	147.49	82	111
Deloraine	41.51	146.66	108	145
Devonport	41.19	146.36	118	162
Flinders Island	39.99	148.06	124	167
George Town	41.11	146.84	107	144

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Hobart	42.89	147.31	86.9	120
Huonville	43.04	147.06	87.2	121
Launceston	41.41	147.14	91	123
New Norfolk	42.79	147.06	78.8	108
Oatlands	42.29	147.36	83.1	114
Port Arthur	43.14	147.86	84.5	114
Port Sorell	41.16	146.54	113	153
Queenstown	42.09	145.56	93.5	120
Smithton	40.84	145.14	107	143
Sorrell	42.79	147.56	86.9	119
Southport	43.44	146.96	81.1	110
St. Helens	41.31	148.26	134	183
St. Marys	41.56	148.19	150	207
Strahan	42.14	145.31	82.7	105
Swansea	42.14	148.06	108	147
Zeehan	41.89	145.36	91	116

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
VICTORIA				
Apollo Bay	38.74	143.66	101	135
Avalon	38.04	144.44	106	148
Bacchus Marsh	37.66	144.44	108	149
Bairnsdale	37.81	147.64	143	197
Ballarat	37.54	143.86	134	192
Benalla	36.54	145.99	146	194
Bendigo	36.76	144.29	145	214
Bright	36.74	146.96	146	189
Camperdown	38.24	143.16	104	143
Cape Otway	38.84	143.51	101	135
Casterton	37.59	141.41	110	157
Castlemaine	37.06	144.21	136	198
Colac	38.34	143.59	93.9	127
Echuca	36.14	144.76	130	186

Draft

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Edenhope	37.04	141.29	112	160
Foster	38.64	146.21	112	152
Geelong	38.14	144.36	103	143
Hamilton	37.74	142.01	115	164
Heathcote	36.91	144.71	144	208
Hopetoun	35.74	142.36	140	207
Horsham	36.71	142.21	121	173
Johanna	38.76	143.39	95.5	129
Kerang	35.74	143.91	139	205
Kinglake	37.54	145.34	134	187
Kyneton	37.24	144.46	139	201
Lakes Entrance	37.86	147.99	145	199
Leongatha	38.46	145.94	108	143
Macarthur	38.04	142.01	119	168
Mallacoota	37.56	149.76	171	237
Mansfield	37.04	146.09	133	174
Maryborough	37.04	143.74	124	180
Melbourne:				
Craigieburn	37.59	144.94	128	186
Dandenong	37.99	145.21	133	181
Frankston	38.14	145.11	123	165
Hastings	38.31	145.19	112	145
Melbourne City	37.81	144.96	132	187
Oakleigh	37.89	145.09	132	182
Portsea	38.31	144.71	106	140
Sunbury	37.59	144.74	122	171
Sunshine	37.79	144.84	131	186
Warrandyte	37.74	145.21	126	172
Meredith	37.84	144.09	117	167
Mildura	34.19	142.14	142	219
Morwell	38.24	146.41	123	172
Mount Macedon	37.39	144.59	130	177
Nelson	38.04	141.01	105	145
Nhill	36.34	141.66	125	180
Omeo	37.09	147.61	117	160

Draft

Australian location	Latitude degrees	Longitude degrees	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h
Orbost	37.69	148.46	147	198
Ouyen	35.06	142.31	135	202
Packenham	38.09	145.49	126	168
Phillip Island	38.49	145.21	106	135
Port Campbell	38.61	143.01	97.2	130
Port Fairy	38.39	142.24	125	180
Portland	38.34	141.61	116	161
Queenscliff	38.26	144.66	107	144
Robinvale	34.59	142.76	142	215
Rutherglen	36.04	146.46	135	175
Sale	38.11	147.06	136	198
Seymour	37.01	145.14	132	183
Shepparton	36.39	145.41	130	175
St. Arnaud	36.61	143.26	133	197
Stawell	37.04	142.79	130	187
Sunbury	37.59	144.74	122	171
Swan Hill	35.34	143.56	144	218
Venus Bay	38.69	145.81	110	145
Wangaratta	36.36	146.31	138	179
Warracknabeal	36.24	142.41	134	196
Warragul	38.16	145.94	111	147
Warrnambool	38.39	142.49	119	169
Wedderburn	36.41	143.61	142	212
Werribee	37.89	144.66	122	173
Winchelsea	38.24	143.99	96.9	134
Wodonga	36.14	146.89	139	180
Wonthaggi	38.59	145.59	119	157
Wycheproof	36.09	143.21	147	222
Yarram	38.56	146.69	132	185
Yarrawonga	36.01	146.01	134	177

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
WESTERN AUSTRALIA				
Albany	35.04	117.89	127	179
Augusta	34.31	115.16	149	200
Bremer Bay	34.39	119.39	131	185
Bridgetown	33.96	116.14	121	169
Brookton	32.36	117.01	119	173
Broome	17.94	122.24	232	287
Bunbury	33.31	115.64	147	198
Busselton	33.64	115.34	169	223
Canarvon	24.89	113.66	136	201
Carnarmah	29.69	115.89	119	168
Cervantes	30.49	115.06	129	177
Collie	33.36	116.16	125	165
Dalwallinu	30.29	116.66	123	176
Denham	25.91	113.54	137	203
Denmark	34.96	117.36	117	163
Derby	17.31	123.66	211	256
Dongara	29.24	114.94	127	174
Dumbleyung	33.31	117.74	116	169
Eneabba	29.81	115.26	118	163
Esperance	33.86	121.89	115	162
Eucla	31.69	128.86	156	234
Fitzroy Crossing	18.19	125.56	207	250
Geraldton	28.76	114.61	138	194
Halls Creek	18.21	127.66	202	251
Harvey	33.09	115.91	138	184
Hopetoun	33.94	120.11	118	166
Jurien Bay	30.29	115.04	128	176
Kalbarri	27.71	114.16	129	183
Kalgoorlie	30.74	121.49	136	204
Karratha	20.74	116.86	141	194
Katanning	33.69	117.56	125	181
Kununurra	15.79	128.74	202	244
Lake Grace	33.09	118.46	121	175
Lake King	33.09	119.69	116	166

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Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Lancelin	31.01	115.34	134	186
Leinster	27.91	120.71	138	214
Leonora	28.89	121.34	136	210
Madura	31.89	127.01	132	198
Mandurah	32.54	115.74	134	169
Marble Bar	21.16	119.74	173	231
Margaret River	33.94	115.06	161	210
Meekatharra	26.59	118.51	143	221
Menzies	29.69	121.04	142	218
Merredin	31.49	118.29	127	184
Mingenew	29.19	115.44	117	166
Moora	30.64	116.01	105	147
Morawa	29.21	116.01	120	172
Mount Barker	34.64	117.66	116	163
Mount Magnet	28.06	117.86	131	200
Mukinbudin	30.91	118.21	128	187
Mullewa	28.54	115.51	114	164
Mundaring	31.89	116.16	125	166
Narrogin	32.94	117.16	115	168
New Norcia	30.96	116.21	110	154
Newman	23.36	119.74	158	213
Norseman	32.19	121.79	113	160
Northam	31.64	116.66	110	158
Northampton	28.34	114.64	116	161
Ongerup	33.96	118.49	126	183
Onslow	21.64	115.11	185	259
Pemberton	34.44	116.04	121	166
Perenjori	29.44	116.29	118	169
Perth:				
Armadale	32.14	116.01	135	179
City Beach	31.94	115.76	132	174
~~Freemantle~~Fremantle	32.04	115.76	131	173
Joondalup	31.74	115.76	133	180
Midland	31.89	116.01	122	164
Perth City	31.96	115.86	129	172

Australian location	Latitude	Longitude	5 % AEP (20 years ARI) intensity	1 % AEP (100 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Rockingham	32.29	115.74	136	175
Upper Swan	31.76	116.04	114	156
Port Hedland	20.31	118.61	168	232
Ravensthorpe	33.59	120.06	117	165
Southern Cross	31.24	119.34	127	186
Tom Price	22.69	117.81	138	182
Walpole	34.99	116.74	113	162
Warburton	26.11	126.59	153	231
Wiluna	26.59	120.21	150	231
Wongan Hills	30.89	116.71	118	167
Woodridge	31.34	115.59	136	190
Wyndham	15.49	128.11	210	253
Yanchep	31.54	115.64	140	194
York	31.89	116.76	110	159

~~NOTE: The intensities in this table were obtained from the Bureau of Meteorology (BOM) website in October 2019. These may change with time, and updated intensities can be obtained from the BOM.~~

Appendix E (normative)
Rainfall intensities for New Zealand — 10 min duration

E.1 Scope

This appendix gives 10 min duration rainfall intensities for any place in New Zealand, based on the National Institute of Water and Atmospheric Research (NIWA) data, used for the sizing of —

(a) rainwater goods, see Clause ;3.3.5.2; and

(b) surface water drainage systems, see Clause (5.4.5(b).

E.2 Selected place references

For selected places in New Zealand, the latitude and longitude and 10 % AEP (10 years ARI) and 2 % AEP (50 years ARI) rainfall intensities are given in Table E.1.

Table E.1 — 10 min duration rainfall intensities for various locations in New Zealand

New Zealand location	Latitude degrees	Longitude degrees	10 % AEP (10 years ARI) intensity mm/h	2 % AEP (50 years ARI) intensity mm/h
NORTHLAND				
Taipa Bay-Mangōnui	–35	173.5	86	117
Awanui	–35.05	173.25	85	116
Kaeo	–35.1	173.78	91	123
Kaitaia	–35.11	173.26	86	117
Ahipara	–35.17	173.17	86	116
Kerikeri	–35.23	173.95	101	135
Russell	–35.27	174.12	109	147
Paihia	–35.29	174.09	110	148
Ōkaihau	–35.32	173.77	97	130
Ōhaeawai	–35.35	173.88	99	132
Moerewa	–35.38	174.02	108	144
Kawakawa	–35.38	174.07	110	147
Rawene	–35.4	173.5	85	114
Kaikohe	–35.41	173.81	94	125
Ōmāpere and Opononi	–35.51	173.4	85	114
Whangārei	–35.72	174.3	103	140
Maungatapere	–35.75	174.2	101	137
Dargaville	–35.95	173.87	82	110
Te Kōpuru	–36.03	173.92	83	112
Mangawhai Heads	–36.05	174.59	94	130

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Kaiwaka	–36.1	174.39	90	123
Maungaturoto	–36.12	174.35	89	121
Ruawai	–36.13	174.03	83	112
AUCKLAND				
Leigh	–36.19	174.63	95	130
Snells Beach	–36.21	174.69	93	127
Algies Bay-Mahurangi	–36.26	174.76	92	124
Wellsford	–36.3	174.52	100	135
Parakai	–36.38	174.45	95	128
Warkworth	–36.4	174.66	99	134
Muriwai Beach	–36.52	174.69	98	129
Helensville	–36.68	174.45	95	125
North Shore	–36.81	174.79	98	129
Waiheke Island	–36.81	175.12	102	137
Auckland	–36.87	174.77	97	127
Waitākere	–36.91	174.69	97	128
Manukau	–36.97	174.82	93	121
Bombay	–37.05	174.95	97	129
Pukekohe	–37.2	174.9	97	131
Waiuku	–37.25	174.73	92	122
WAIKATO				
Coromandel	–36.74	175.5	96	132
Pauanui	–37.02	175.86	97	137
Te Puru-Thornton Bay	–37.04	175.52	91	127
Thames	–37.14	175.53	88	124
Whangamatā	–37.21	175.86	97	137
Ngatea	–37.27	175.5	88	123
Kerepehi	–37.3	175.53	87	121
Meremere	–37.32	175.07	96	132
Paeroa	–37.38	175.67	88	125
Te Kauwhata	–37.4	175.15	92	127
Waihi	–37.4	175.83	107	152
Te Aroha	–37.53	175.7	94	135
Huntly	–37.56	175.16	91	125

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Waitoa	−37.6	175.63	90	129
Morrinsville	−37.65	175.53	91	130
Waharoa	−37.75	175.75	89	129
Hamilton	−37.78	175.27	92	129
Raglan	−37.8	174.86	89	121
Matamata	−37.82	175.77	89	129
Cambridge	−37.89	175.45	91	129
Te Awamutu	−38.02	175.32	92	129
Putāruru	−38.05	175.78	85	121
Mamaku	−38.06	176.05	102	143
Otorohanga	−38.18	175.19	94	132
Tokoroa	−38.23	175.84	85	121
Te Kuiti	−38.33	175.17	96	136
Mangakino	−38.38	175.74	75	107
Piopio	−38.47	175.02	95	134
Reporoa	−38.5	176.36	84	121
Taupō	−38.7	176.07	73	107
Tūrangi	−38.99	175.79	71	103
BAY OF PLENTY				
Waihi Beach	−37.4	175.93	99	141
Island View-Pios Beach	−37.46	175.99	95	136
Katikati	−37.56	175.9	93	133
Tauranga	−37.68	176.17	101	145
Maketu	−37.77	176.45	109	156
Te Puke	−37.78	176.33	103	148
Paengaroa	−37.82	176.42	106	152
Te Kaha	−37.82	177.67	96	136
Matatā	−37.89	176.75	116	163
Edgecumbe	−37.97	176.83	112	160
Whakatāne	−37.97	176.99	100	142
Ōpōtiki	−38.01	177.28	102	146
Te Teko	−38.03	176.8	98	139
Tāneatua	−38.07	176.98	95	135
Kawerau	−38.1	176.7	95	136
Rotorua	−38.14	176.26	96	136

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Kaingaroa Forest	−38.36	176.68	91	128
Murupara	−38.45	176.7	84	119
GISBORNE				
Ruatoria	−37.9	178.32	80	119
Tokomaru Bay	−38.12	178.3	68	103
Patutahi	−38.38	177.53	59	83
Tolaga Bay	−38.37	178.3	61	93
Manutuke	−38.41	177.55	52	74
Te Karaka	−38.47	177.87	47	73
Gisborne	−38.66	178.02	67	102
MANAWATU-WHANGANUI				
Ōhura	−38.85	174.98	86	124
Taumarunui	−38.88	175.26	84	123
Ohakune	−39.41	175.41	77	111
Raetihi	−39.42	175.27	90	130
Waiouru	−39.47	175.67	62	91
Taihape	−39.68	175.78	65	97
Whanganui	−39.93	175.03	68	100
Hunterville	−39.93	175.57	70	103
Rātana	−40.03	175.17	66	96
Marton	−40.08	175.38	69	101
Halcombe	−40.13	175.48	73	107
Bulls	−40.17	175.38	71	102
Sanson	−40.22	175.42	70	102
Feilding	−40.22	175.57	69	101
Dannevirke	−40.21	176.09	77	119
Rongotea	−40.3	175.42	67	97
Himatangi Beach	−40.32	175.24	66	93
Woodville	−40.33	175.87	66	99
Palmerston North	−40.36	175.62	65	94
Pahiatua	−40.45	175.83	61	91
Foxton	−40.47	175.28	71	100
Tokomaru	−40.47	175.5	68	98
Shannon	−40.55	175.4	70	100
Levin	−40.61	175.27	74	104

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Te Horo	−40.63	175.19	76	107
Eketāhuna	−40.65	175.7	73	105
HAWKES BAY				
Tuai	−38.82	177.15	69	98
Frasertown	−38.97	177.4	70	103
Wairoa	−39.04	177.42	82	121
Nūhaka	−39.03	177.75	84	126
Napier	−39.5	176.89	69	105
Hastings	−39.64	176.83	62	95
Ōtāne	−39.9	176.62	69	106
Waipawa	−39.95	176.57	67	104
Waipukurau	−40	176.56	65	100
Takapau	−40.03	176.35	72	113
TARANAKI				
Waitara	−39	174.23	98	136
Urenui	−39	174.38	95	133
New Plymouth	−39.05	174.07	100	138
Egmont Village	−39.14	174.12	114	158
Inglewood	−39.15	174.2	117	163
Ōkato	−39.2	173.88	111	153
Rahotu	−39.28	173.78	99	137
Stratford	−39.35	174.27	99	138
Kaponga	−39.43	174.15	94	132
Eltham	−39.43	174.3	97	137
Ōpunake	−39.46	173.84	87	121
Manaia	−39.55	174.12	83	117
Hāwera	−39.59	174.28	84	119
Pātea	−39.75	174.47	79	112
Waverley	−39.77	174.63	80	115
TASMAN				
Tākaka	−40.85	172.8	78	108
Riwaka	−41.05	173	77	108
Motueka	−41.11	173.02	68	94
Brightwater	−41.38	173.1	80	115
Wakefield	−41.4	173.05	81	117

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Murchison	–41.8	172.33	56	85
WELLINGTON				
Ōtaki	–40.75	175.13	82	114
Kapiti	–40.94	174.99	75	103
Masterton	–40.95	175.67	54	80
Carterton	–41.02	175.52	57	83
Greytown	–41.08	175.45	57	82
Upper Hutt	–41.12	175.07	72	99
Featherston	–41.12	175.32	63	88
Porirua	–41.13	174.83	76	105
Mākara-Ohariu	–41.2	174.75	74	102
Lower Hutt	–41.21	174.91	72	100
Martinborough	–41.22	175.44	54	77
Wellington	–41.28	174.77	70	97
WEST COAST				
Hector-Ngakawau	–41.63	171.87	84	122
Westport	–41.75	171.58	101	145
Reefton	–42.11	171.87	71	103
Blackball	–42.3	171.49	92	132
Dobson	–42.39	171.44	93	133
Greymouth	–42.45	171.21	95	133
Hokitika	–42.72	170.97	104	144
Ross	–42.9	170.82	110	149
Franz Josef/Waiau	–43.38	170.17	92	124
Fox Glacier	–43.42	170.05	99	133
NELSON				
Nelson	–41.27	173.3	77	107
MARLBOROUGH				
Havelock	–41.28	173.77	70	98
Picton	–41.3	174.01	59	83
Blenheim	–41.52	173.95	48	69
Seddon	–41.67	174.07	49	70
CANTERBURY				
Kaikōura	–42.4	173.69	53	79
Hanmer Springs	–42.52	172.83	46	72

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Culverden	−42.77	172.85	43	67
Cheviot	−42.81	173.26	45	70
Amberley	−43.15	172.72	42	65
Rangiora	−43.3	172.6	46	71
Oxford	−43.3	172.18	60	93
Woodend	−43.32	172.67	42	65
Cust	−43.32	172.37	53	84
Darfield	−43.48	172.12	47	75
Christchurch	−43.53	172.62	39	62
Rolleston	−43.58	172.38	48	77
Lyttelton	−43.60	172.72	26	41
Burnham Military Camp	−43.61	172.32	47	75
Lincoln	−43.63	172.48	51	82
Methven	−43.63	171.63	54	83
Dunsandel	−43.67	172.2	46	74
Tai Tapu	−43.68	172.54	41	65
Aoraki/Mt Cook	−43.66	170.17	72	102
Rakaia	−43.75	172.02	48	76
Leeston	−43.77	172.3	47	75
Akaroa	−43.81	172.97	45	69
Southbridge	−43.82	172.25	46	72
Ashburton	−43.88	171.76	52	80
Lake Tekapo	−44	170.5	33	53
Geraldine	−44.1	171.23	48	75
Fairlie	−44.1	170.83	55	86
Temuka	−44.23	171.27	44	71
Pleasant Point	−44.27	171.13	47	75
Twizel	−44.25	170.1	37	58
Timaru	−44.4	171.26	46	73
Pareora	−44.47	171.22	48	77
Omarama	−44.48	169.97	35	57
Otematata	−44.6	170.18	38	61
Waimate	−44.74	171.06	42	65
Kurow	−44.73	170.47	42	65
OTAGO				

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Wanaka	−44.7	169.13	26	40
Arrowtown	−44.93	168.83	32	50
Oamaru	−45.09	170.98	42	65
Cromwell	−45.05	169.2	36	59
Queenstown	−45.04	168.65	34	53
Ranfurly	−45.12	170.1	52	85
Kakanui	−45.18	170.9	42	65
Clyde	−45.18	169.32	45	75
Alexandra	−45.25	169.38	44	73
Hampden	−45.33	170.82	43	67
Palmerston	−45.48	170.72	45	71
Roxburgh	−45.53	169.32	53	90
Waikouaiti	−45.6	170.68	44	69
Karitane	−45.63	170.65	44	70
Warrington	−45.72	170.59	43	68
Waitati	−45.75	170.57	43	69
Outram	−45.87	170.23	51	81
Dunedin	−45.89	170.5	47	73
Lawrence	−45.92	169.68	54	87
Tapanui	−45.95	169.27	54	90
Milton	−46.12	169.97	56	88
Clinton	−46.2	169.38	53	86
Balclutha	−46.23	169.73	55	87
Stirling	−46.25	169.78	54	85
Kaitangata	−46.28	169.85	54	85
Owaka	−46.45	169.65	49	77
SOUTHLAND				
Te Anau	−45.42	167.72	48	75
Manapouri	−45.57	167.62	51	78
Lumsden	−45.73	168.43	52	87
Riversdale	−45.9	168.73	50	84
Ohai	−45.93	167.95	50	80
Gore	−46.1	168.93	57	95
Winton	−46.15	168.32	47	76
Tuatapere	−46.13	167.68	45	71

New Zealand location	Latitude	Longitude	10 % AEP (10 years ARI) intensity	2 % AEP (50 years ARI) intensity
	degrees	degrees	mm/h	mm/h
Otautau	−46.15	168	46	74
Edendale	−46.32	168.78	48	80
Wyndham	−46.33	168.85	49	82
Riverton/Aparima	−46.36	168	49	77
Invercargill	−46.41	168.32	54	87
Bluff	−46.49	168.29	51	81

Appendix F (informative) Examples of (normative) Overflow design for eaves gutters

F.1 Scope

This appendix sets out design procedures for eaves gutter overflow measures for eaves gutterson roof catchments up to 400 m².

NOTE: Four hundred square metres is a suitable value for residential and small commercial buildings.

F.2 Overflow volume

The design overflow volume (Q^*) required to be dispersed by overflow measures shall be calculated for each catchment using the design procedure in Clause 3.5.3.

$$Q^* = Ac \times \frac{R}{3\,600} \qquad \text{F.2}$$

where

Q^* = design overflow volume expressed in litres per second, L/s

Ac = catchment area, in metres square

R = design rainfall intensity, in millimetres per hour

NOTE 1: Table 3.3.4 nominates AEP at 1 % for determining the rainfall rate for overflow design.

NOTE 2: Debris build up in gutters and the presence of snow, hail or ice at the time of peak overflow volume may reduce the effectiveness of all overflow measures and is not considered in the design.

F.3 Overflow design

Eaves gutter overflow measures for each catchment shall be designed to accommodate the design overflow volume as follows:

$$Q^* \leq Q \qquad \text{F.3}$$

where

Q^* = design overflow volume expressed in litres per second for the relevant catchment determined from Clause F.2

Q = capacity of the overflow measures for the relevant catchment determined from either Clause F.4 or F.5 or both

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F.4 Continuous overflow measures

F.4.1 General

Continuous overflow measures for each catchment and eaves gutter element shall be designed as specified in Clause F.2 and using one of the measures provided in Clauses F.4.2 to F.4.5.

For capacity Q for continuous overflow measures for a catchment, the value derived from Clauses F.4.2 to F.4.4 shall be multiplied by the length of eaves gutter serving the catchment.

The installation of continuous overflow devices shall provide a minimum margin above the maximum head on which the device relies of —

(a) 3 mm for eaves gutters with a slope greater than 1:500; or

(b) 6 mm for eaves gutters with a slope less than 1:500.

F.4.2 Gutter back gap overflow

For capacity Q for back gap overflow for a catchment, the value derived from Table F.1 shall be multiplied by the length of eaves gutter (including back gap) overflow serving the catchment.

NOTE: Figure F.1 illustrates the relationship between average bottom gap and head of water.

Table F.1 Gutter back gap overflow capacity

Head of water	Average bottom gap			
-	1.5 mm	3.0 mm	4.5 mm	6.0 mm
mm	L/s/m	L/s/m	L/s/m	L/s/m
4	0.6	0.8	0.8	0.8
6	1.0	1.2	1.3	1.3
8	1.4	1.6	1.7	1.8
10	1.8	2.0	2.1	2.2
12	2.0	2.4	2.5	2.6

NOTE: Average bottom gap is the width of the gap between the gutter and fascia expressed as the average of measurements at 300 mm intervals at the narrowest vertical location which is usually the gutter base.

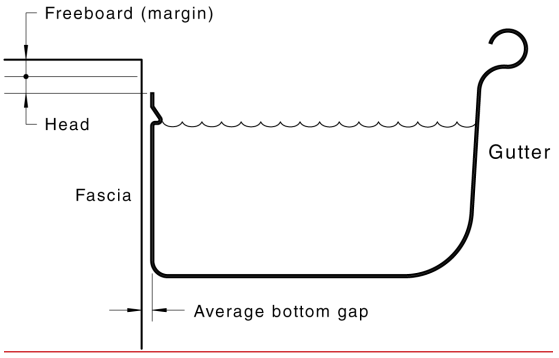


Figure F.1 Relationship between average bottom gap and head of water

F.4.3 Slotted gutters

Equation F.4.3 shall be used.

$$Q = 0.000032 C_{\mathrm{d}} A \sqrt{2gh} \qquad \text{F.4.3}$$

where

Q = flow rate from the slots expressed in L/s/m

C_d = discharge coefficient = 0.61

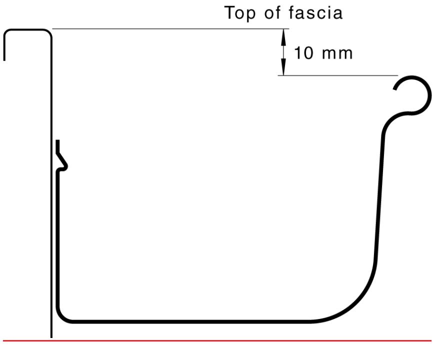
A = area of the slots expressed in mm²/m

g = gravitational constant = 9.81 m/s^2

h = effective head of water above slots expressed in mm

F.4.4 Front bead overflow

If the front bead of the eaves gutter is positioned a minimum of 10 mm below the fascia, the overflow capacity *Q* shall be taken as 1.5 L/s/m, see Figure F.2.



[SOURCE: ABCB Housing Provisions Figure 7.4.6c was provided by the Australian Building Codes Board © 2022 under the CC BY ND licence.]

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Figure F.2 Construction of controlled front bead height

F.4.5 Design by computational methods

NOTE: Computational Fluid Dynamics (CFD) is a field of engineering and applied mathematics that deals with the numerical simulation of fluid flow and heat transfer. It uses mathematical models and numerical methods to analyse and solve problems related to the behaviour of fluids, such as liquids and gases, in motion.

Appendix G (informative)
General method for design of eaves gutter systems — Example

E.3G.1 Scope

This appendix sets out examples of overflow measures for eaves gutters, see Clause .

E.4 Full length (continuous) overflows

Examples of acceptable full-length (continuous) overflows are as follows:

(a) The front bead not less than the dimension hf below the top of the fascia board as shown in Figure F.1 (a) (weir flow over front of gutter).

(b) The front bead not less than the dimension hf below the top edge of the back of the gutter (weir flow over front of gutter).

(c) Flashing as shown in Figure F.1 (b), with the top edge of the flashing not less than hf above the bead (weir flow over front of gutter).

(d) Combinations of Items (a), (b) and (c).

(e) The top edge of the back of the gutter not less than h_f below the top of the fascia board as shown in Figure F.1 (c) (weir flow over back of gutter).

(f) For concealed eaves gutters, the top edge of the fascia not less than hf below the top of the back of the gutter, or integral flashing (tail) with the top edge of the flashing not less than hf above the top of the fascia as shown in Figure F.1 (d) (weir flow over front of gutter).

The h_f value should be determined from Table F.1, where the average flow per metre is determined from the total flow shown in Figures 3.5.4(A) and 3.5.4(B) divided by the length of the eaves gutter served by the catchment.

NOTE: Blockages can and do occur anywhere along an eaves gutter causing overtopping that would not be affected by an overflow device located at the outlet of an eaves gutter, for example rainhead [see Figure 3.7.3 (a)]. The overflow devices given in Clause are located along an eaves gutter so that any overtopping is unlikely to cause loss of amenity, injury to persons or property damage. The AEPs for eaves gutters given in Table 3.3.4 assume the provision of overflow measures.

E.5 Specifically located overflows

Examples of specifically located overflows are holes and weirs.

Table F.1 — Minimum h_f values

Gutter gradient	Average inflow per metre of gutter, L/s/m				
-	0.2	0.4	0.6	0.8	1.0
0 to < 1:500	18	20	22	23	25
≥ 1:500	12	14	16	17	19
-			Minimum h_f mm		

NOTE: Minimum h_f is based on 1 % I_5 for Australia and 2 % I_{10} for New Zealand. This Table includes an allowance for water surface undulations and construction tolerances of 19 mm for level gutters and 13 mm for sloping gutters. Available research suggests that surface undulations may be limited to the range 5 mm to 8 mm, provided the discharge from metal cladding for all roof slopes is directed downwards by turning down the outside edge. Figure F.2 illustrates the effect.

~~Figure F.1 — Eaves gutter overflow methods~~

~~Figure F.2 — Illustration of flow patterns for metal roof cladding~~

Appendix F (informative)
General method for design of eaves gutter systems — Example

F.1 Scope

This appendix sets out an example that illustrates the application of the general method for design of solutions for eaves gutter systems and associated vertical downpipes, see Clause .3.5. Although the example is located in Australia, the same procedure can be applied in New Zealand with local rainfall intensities.

The calculations are presented in an explanatory form to assist first and occasional users. The adopted order of accuracy in the examples is consistent with the accuracy of the assumptions on which they are based.

NOTE: Appendix C gives guidelines for the determination for any place in —

(a) Australia, for rainfall intensities of 5 min duration and AEPs of 5 % and 1 % (ARIs of 20 and 100 years); and

(b) New Zealand, for rainfall intensities of 10 min duration and AEPs of 10 % and 2 % (ARIs of 10 and 50 years).

F.2G.2 Example

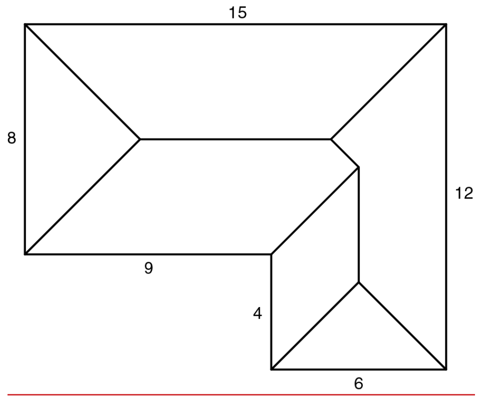
F.2.1G.2.1 Problem

A house, as shown in Figure G.1 is to be constructed at Merriwa, New South Wales, see .Appendix D. Determine the layout and size of the external eaves gutters and associated vertical downpipes that are to discharge to the surface water drainage system for the following cases:

Case 1: eaves gutter gradients of 1:500 and steeper.

Case 2: eaves gutter gradients flatter than 1:500.

Dimensions in metres



NOTE 1: Dimensions include width of eaves gutter.

NOTE 2: Pitch of roof 24° (1:2.3).

Figure G.1 — House plan

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~~F.2.2~~G.2.2 Case 1 — Sloping eaves gutter

~~F.2.2.1~~G.2.2.1 Calculation

The ~~calculation below illustrates~~following steps illustrate the application of the procedure shown in Figure 3.5.2 ~~and contains 12 steps labelled as Step 1, Step 2, etc., as follows:~~.

Step 1: From Table 3.3.4, select AEP 5 % (ARI 20 years) for Australia

Step 2: In Australia, the design rainfall intensity for external eaves gutters and associated vertical downpipes has a 5 min duration. The AEP 5 % (ARI 20 years) value for Merriwa, New South Wales, is determined from Table E.1 as ${}^{5\,\%}I_5$ = 145 mm/h.

Step 3: By physical observations, measurements or plans of the house, record, as shown on Figure G.1 —

(a) overall dimensions that include an allowance for the widths of the eaves gutters;

(b) pitch (slope) of the roof; and

(c) layout of the ridges and valleys.

Step 4: Determine for the roof of the house —

(a) from Figure G.1, the plan area (A_h) is 144 m^2; and

(b) from Equation 3.4.3.2(2) and the pitch of the roof, the catchment area (A_c) is 175 m^2.

Step 5: Select gradients for the eaves gutters.

Select 1:500 and steeper.

Step 6: Select eaves gutters from a manufacturer's technical data and note the effective cross-sectional areas (A_e).

A_e is 7 300 mm^2 (square fascia).

Step 7: Using Figure 3.5.~~4~~5(A), determine, for the selected size of eaves gutter, the maximum size of the roof catchment per vertical downpipe. This determination is illustrated in Figure G.2. The maximum catchment area A_{cdp} of roof per vertical downpipe is 51 m^2.

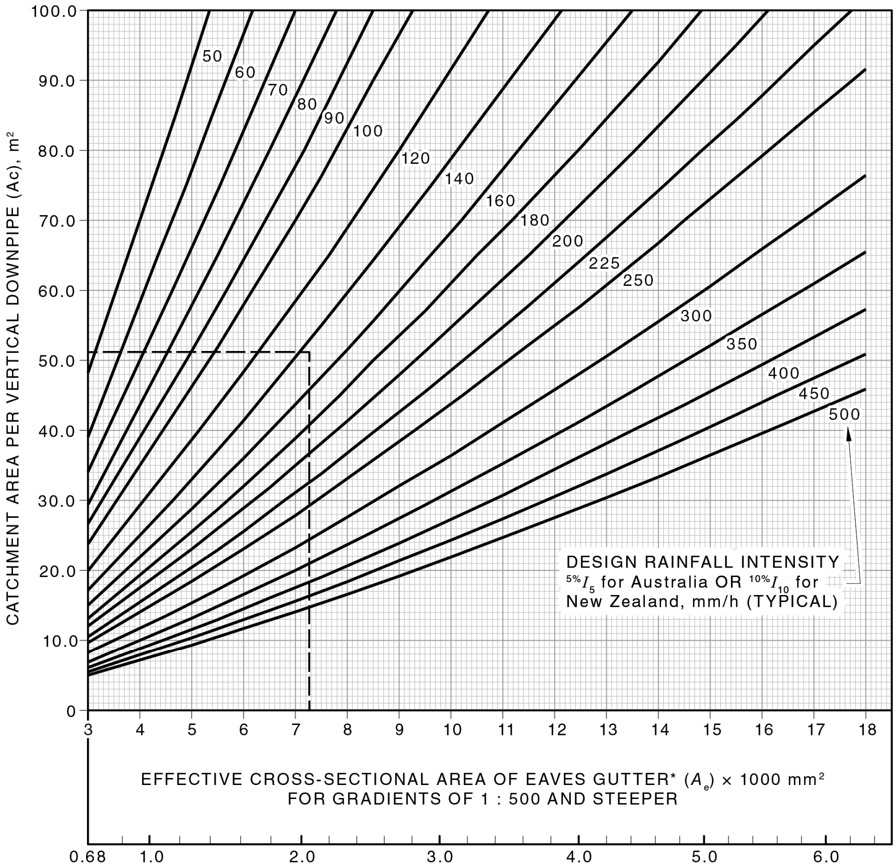

Figure G.2 — Application of Figure 3.5.~~4~~5(A)

Step 8: Determine for the selected sizes of eaves gutter (see Step 6) the minimum number of vertical downpipes from A_c/A_{cdp}.

175/51 = 3.4 adopt the next higher whole number, which is 4.

Step 9: Select locations, as shown in Figure G.3, for the minimum of four downpipes so that —

(a) ~~where~~if practicable, the subcatchments have about the same area; and

(b) a high point is located at an outlet to a valley gutter.

~~NOTE:~~ A_h and A_c for the selected subcatchments are tabulated in Table G.1.

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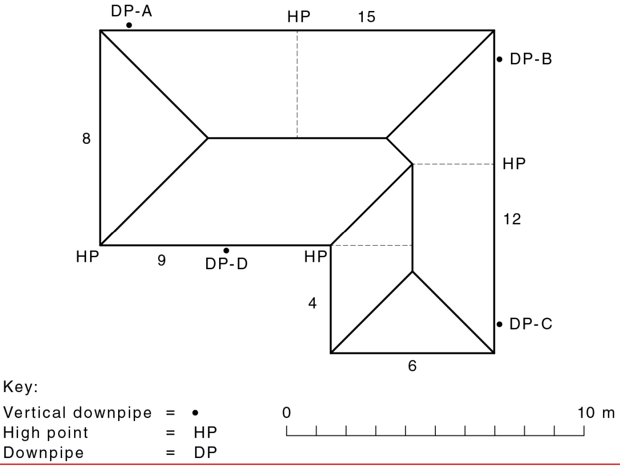


Figure G.3 — Roof Plan Case 1

Table G.1 — Subcatchment areas for downpipes

Vertical downpipe Vertical downpipe	Subcatchment — Case 1		
	Plan area ($A_{hs\text{-}c}$)	Eaves gutter area ($A_{s\text{-}c}$)	Length of gutter
	m²	m²	m
A	38.0	46	15.5
B	33.5	40	12.5
C	37.5	45	17
D	35.5	43	9
Total	144.0	174	54

NOTE: The subcatchment for the vertical downpipe at *D* has the largest ratio of catchment to gutter length.

Split Cells

Step 10: For this example, the catchment area for each subcatchment ($A_{s\text{-}c}$) is not greater than A_{cdp}. If the area of one or more catchment areas is greater than the A_{cdp} then, proceed in accordance with one or more of the following:by either —

(a) Increaseincreasing the number of vertical downpipes and repeat Steps 7 to 9.;

(b) Repositionrepositioning vertical downpipes and repeat Step 9.;

(c) Repositionrepositioning high points and repeat Step 9.; or

(d) Increaseincreasing the size of the eaves gutter (i.e. larger A_e) and repeat Steps 6 to 9.;

Step 11: From Table 3.5.2 the alternative sizes of the vertical downpipes for the selected gradients (see Step 5) and sizes (see Step 6) of eaves gutters are 100 mm diameter or 100 mm × 75 mm.

Step 12: Select overflow measures, see ~~Clause . See Clause (a).~~Clauses 3.5 and F.2. Determine the minimum height of fascia above the gutter overflow (h_f) to prevent water entering the building, as follows:

Determine from inspection of the plan the maximum inflow per metre of eaves gutter ~~from inspection of the plan~~. The maximum distance in plan from the eaves gutter to the ridge is 4 m. Therefore, the maximum catchment area per metre in plan is 4 × 1 = 4 m². The value for inflow per metre to be used should be not less than 4 × 145/3 600 = 0.16 L/s/m. Select downpipe *D* from Table G.1 ~~(see Table G.1 Note).~~.

(a) For downpipe *D* — A_{sc} is 43 m², see Table G.1.

(b) Rainfall intensity is 145 mm/h, see Step 2.

(c) From Figure 3.5.~~4~~5(A) total flow is 2.1 L/s.

(d) Length of gutter is 9 m, see Table G.1.

(e) Average flow per metre of gutter = 2.1/9 = 0.23 L/s.

(f) From Table F.1 (sloping gutter) minimum h_f = 14 mm.

~~F.2.2.2~~G.2.2.2 Solution

Adopt the following:

(a) Roof plan as shown in Figure G.3 with eaves gutter gradients for Case 1 of 1:500 and steeper.

(b) Eaves gutters with an effective cross-sectional area of 7 300 mm² (square fascia).

(c) Vertical downpipes of 100 mm diameter or 100 mm × 75 mm rectangular.

(d) Minimum height of fascia above gutter overflow is 14 mm.

~~F.2.3~~G.2.3 Case 2 — Flat eaves gutter

~~F.2.3.1~~G.2.3.1 Calculation

The following ~~calculation illustrates~~steps illustrate the application of the procedure shown in Figure 3.5.2:

Step 1: From Table 3.3.4, select 5 % AEP (20 years ARI) for Australia.

Step 2: Determine the 5 % AEP (20 years ARI) rainfall intensity for Bendigo, Victoria, from Table D.1 as $^{5\,\%}I_5$ = 145 mm/h.

Step 3: By physical observations, measurements or plans of the house, measure and record as shown on Figure G.1 —

(a) the overall dimensions that include an allowance for the widths of the eaves gutters;

(b) the pitch (slope) of the roof; and

(c) the layout of the ridges and valleys.

Step 4: Determine for the roof of the house —

(a) from Figure G.1, the plan area (A_h) is 144 m²; and

(b) from Equation 3.4.3.2(2) and pitch of the roof, the catchment area (A_c) is 175 m².

Step 5: Select gradients for the eaves gutters. Select flatter than 1:500.

Step 6: Select the eaves gutters from a manufacturer's technical data and note the effective cross-sectional areas (A_e); A_e is 7 300 mm² (square fascia).

Step 7: Determine~~, for the selected size of eaves gutter,~~ using Figure 3.4.2(C) the maximum size of the catchment of the roof per vertical downpipe~~.~~ for the selected size of eaves gutter. This ~~determination~~ is illustrated in Figure G.4. The maximum catchment area of roof per vertical downpipe (A_{cdp}) is 36 m².

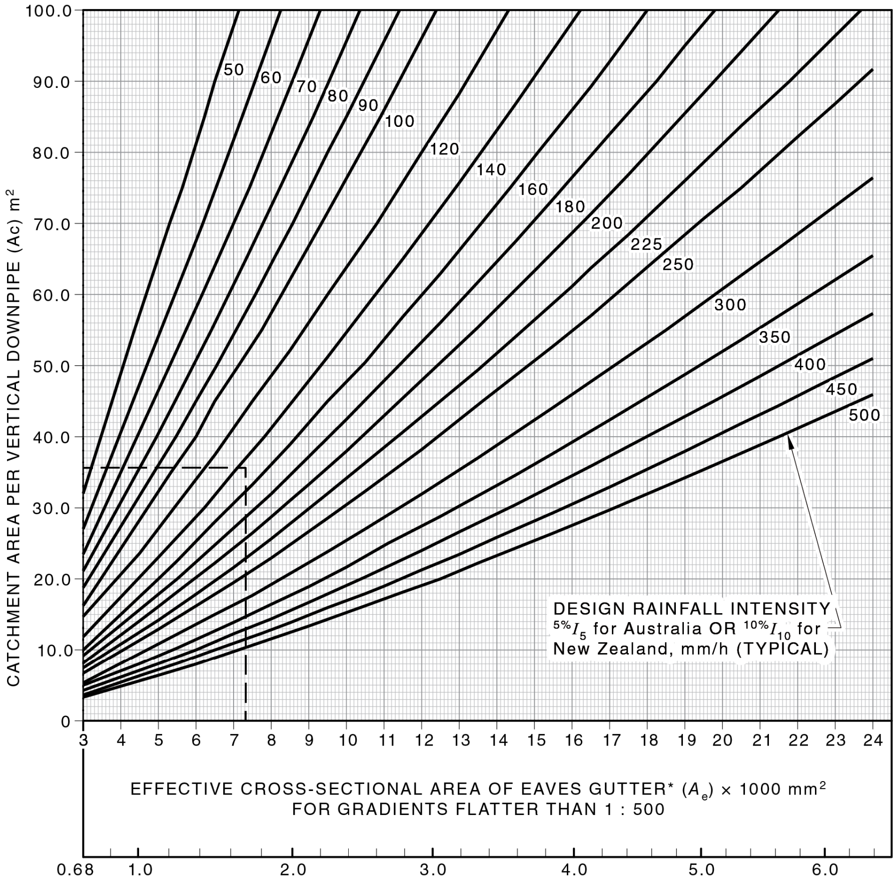


Figure G.4 — Application of Figure 3.5.~~4~~5(B)

Step 8: Determine for the selected sizes of eaves gutter (see Step 6) the minimum number of vertical downpipes from A_c/A_{cdp}.

175/36 = 4.9 adopt the next higher whole number, which is 5.

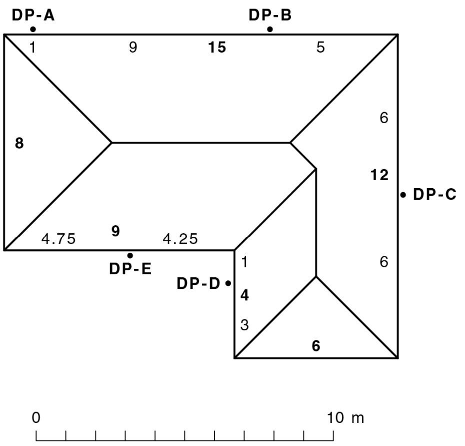
Step 9 Select locations, as shown in Figure G.5, for the minimum of five downpipes.

This layout requires precise positioning of the downpipes. In practice, it is unlikely that this could be achieved because of windows, doors and other features; however, it nevertheless demonstrates what happens if the same size eaves gutters are used for both Cases 1 and 2. With less precise positioning of the ~~5~~five downpipes, a larger eaves gutter would be required.

As there are no high points for flat eaves gutters to define the catchment areas for each downpipe and eaves gutter section, halve the total catchment area between adjacent downpipes to effectively create imaginary high points somewhere between the selected downpipes.

Therefore, if there are three downpipes in sequence numbered DP-1, DP-2 and DP-3, the catchment area of DP-2 is half the catchment area between DP-1 and DP-3, irrespective of the position of DP-2.

A_h and A_c for the selected subcatchments are tabulated in Table G.2.



NOTE: Total catchment between DP-D and DP-A (clockwise) = 72 m². Catchment area for DP-E = 36 m².

Figure G.5 — Roof plan — Case 2

Table G.2 — Subcatchment areas for downpipes

Vertical downpipe	Subcatchment — Case 2		
	Plan area ($A_{hs\text{-}c}$)	Eaves gutter area ($A_{s\text{-}c}$)	Length of ~~gutter~~[a]gutter [a]
	m²	m²	m
A	29.5	36	11.5
B	29	35	10
C	26.8	32	13
D	29.2	35	10
E	29.5	35	9.5

Vertical downpipe	Subcatchment — Case 2		
	Plan area (A_{hs-c})	Eaves gutter area (A_{s-c})	Length of ~~gutter[a]~~gutter [a]
	m²	m²	m
Total	144	174	54

[a] Based on half the length between downpipes.

NOTE: The subcatchment for the vertical downpipe at E has the largest for ratio of catchment to gutter length.

Step 10: For this example, the catchment area for each subcatchment (A_{s-c}) is not greater than A_{cdp}. If the area of one or more catchment areas is greater than the A_{cdp}, then increase the number of vertical downpipes and repeat Steps 7 to 9.

Step 11: From Table 3.5.2 the alternative sizes of the vertical downpipes for the selected gradients (see Step 5) and sizes (see Step 6) of eaves gutters are 85 mm diameter or 100 mm × 50 mm.

Step 12: Select overflow measures, see Clause ~~.~~3.7.5. See Clause ~~(a)~~F.2 for an acceptable full-length (continuous) overflow.

Determine the maximum inflow per metre of eaves gutter from inspection of the plan. The maximum distance in the plan from the eaves gutter to the ridge is 4 m. Therefore, the maximum catchment area per metre in the plan is 4 × 1 = 4 m². The value for inflow per metre to be used should be not less than 4 × 145/3 600 = 0.16 L/s/m. Select downpipe *E* from Table G.2 (see Table G.2 Note). Determine the minimum height of fascia above the gutter overflow (h_f) to prevent water entering the building, as follows:

(a) For downpipe *E* — A_{sc} is 36 m², see Table G.2.

(b) Rainfall intensity is 145 mm/h, see Step 2.

(c) From Figure 3.5.~~4~~5(B) the total flow is 1.7 L/s.

(d) Length of gutter is 9.5 m, see Table G.2.

(e) Average flow per metre of gutter = 1.7/9.5 = 0.18 L/s.

(f) From Table F.1 (level gutter), minimum h_f = 18 mm.

The minimum h_f values may not provide sufficient protection where valley gutters discharge to eaves gutters with zero slope. In such cases, it is recommended that h_f be increased in the vicinity of the valley gutters. The reason for this is that the valley gutter discharges into an eaves gutter that may already contain water.

~~F.2.3.2~~G.2.3.2 Solution

Adopt the following:

(a) Roof plan as shown in Figure G.5 with eaves gutter gradients for Case 2 flatter than 1:500.

(b) Eaves gutters with an effective cross-sectional area of 7 300 mm².

(c) Vertical downpipes of 85 mm diameter or 100 mm × 50 mm.

(d) Minimum height of fascia above gutter overflow is 18 mm.

~~Appendix G~~Appendix H (normative) Box gutter systems — General method, design graphs and illustrations

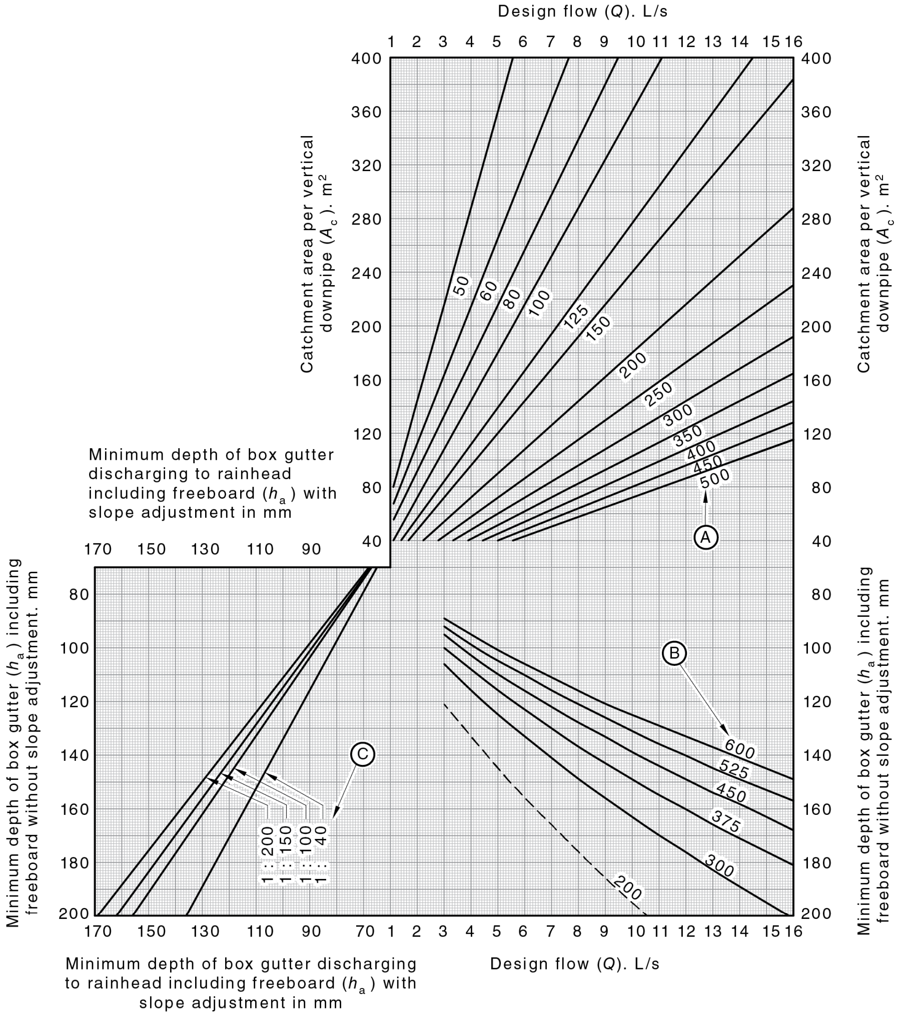
Figures H.1 to H.8 of this appendix apply, within the limitations of Clause ~~,~~3.7.1, to the general method [see Figures 3.7.4(A), 3.7.4(B) and 3.7.4(C)] for the design of solutions for —

(a) box gutters, see Figure H.1; and

(b) rainheads, see Figures H.2 and H.3; or

(c) sumps with either side overflow devices, see Figures H.4, H.5 and H.6, or high-capacity overflow devices, see Figures H.7 and H.8.

NOTE: Applications of this appendix are illustrated in Clauses ~~,~~I.2, I.3 and I.4 (Examples 1, 2 and 3 given).



Key:

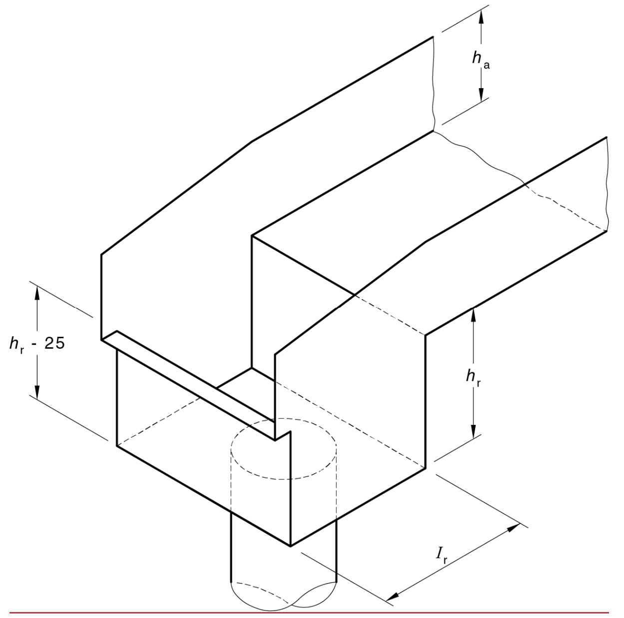
(A) = Design rainfall intensity ($^{1\%}I_5$) OR ($^{2\%}I_{10}$) in mm/h (typical)

(B) = Width of box gutter (W_{bg}) in mm (typical)

(C) = Gradient of box gutter (typical)

NOTE: In Australia, box gutters 200 mm wide may be used for domestic construction only, see Clause 3.7.1.

Figure H.1 — Design graph for a freely discharging box gutter



NOTE 1: This figure applies to $h_r \geq 1.25D_e$ or $1.25D_i$.

NOTE 2: For h_r and l_r, see Figure H.3.

NOTE 3: The width of rainhead is equal to the width of box gutter.

NOTE 4: The rainhead shall be fully sealed to the box gutter and the front of the rainhead left open above the overflow weir.

Figure H.2 — Rainhead

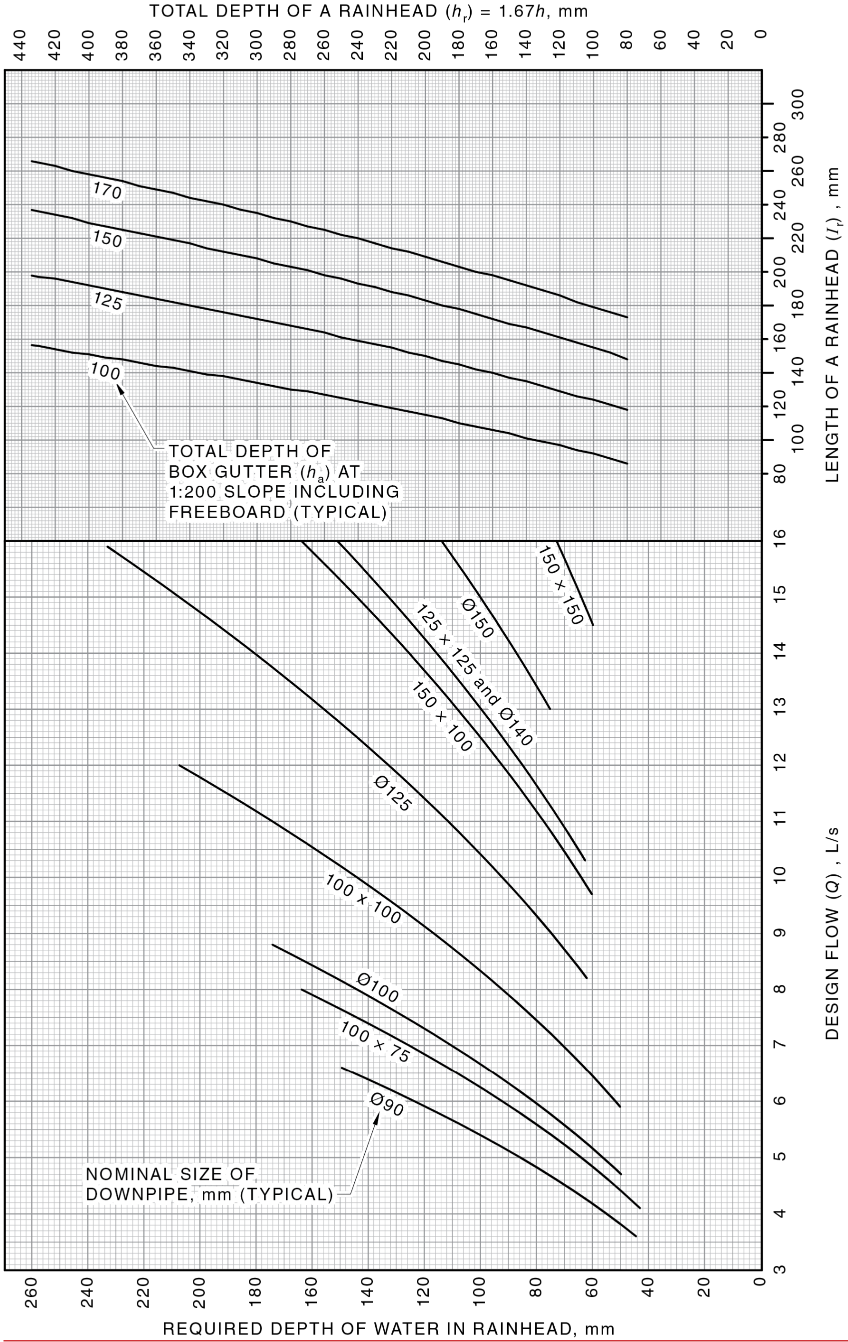

TOTAL DEPTH OF A RAINHEAD (h_r) = 1.67h, mm
LENGTH OF A RAINHEAD (l_r), mm
DESIGN FLOW (Q), L/s
REQUIRED DEPTH OF WATER IN RAINHEAD, mm
170
150
125
100
TOTAL DEPTH OF BOX GUTTER (h_a) AT 1:200 SLOPE INCLUDING FREEBOARD (TYPICAL)
150 × 150
Ø150
125 × 125 and Ø140
150 × 100
Ø125
100 × 100
Ø100
100 × 75
Ø90
NOMINAL SIZE OF DOWNPIPE, mm (TYPICAL)

Figure H.3 — Design graph for rainhead

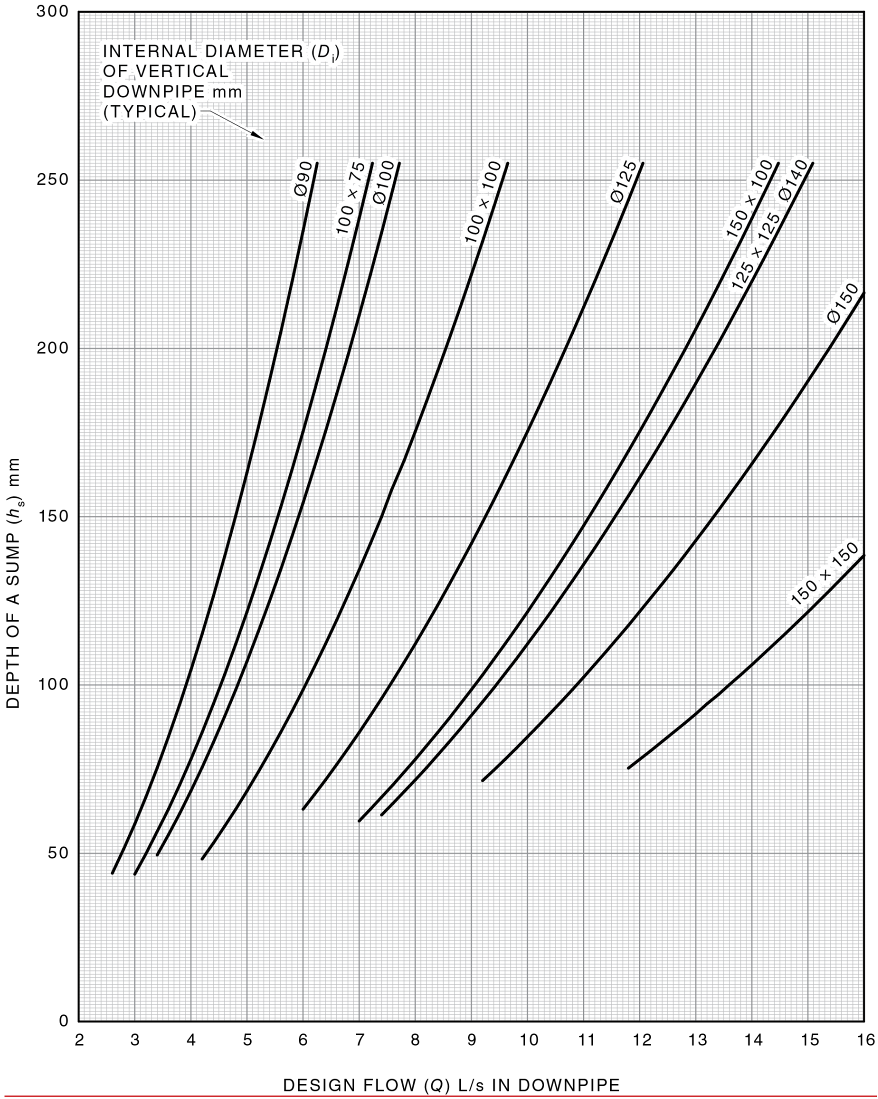
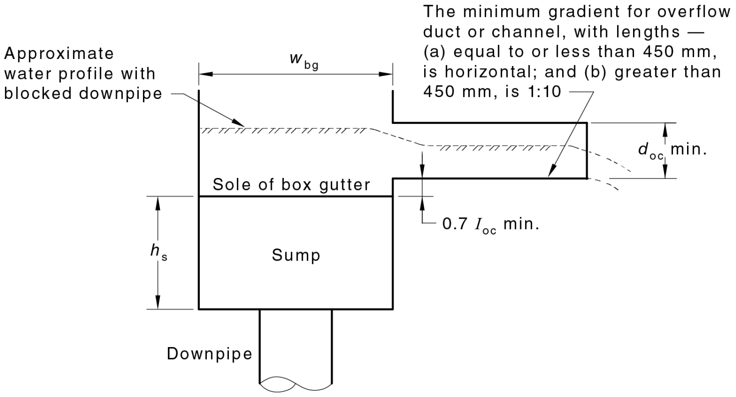
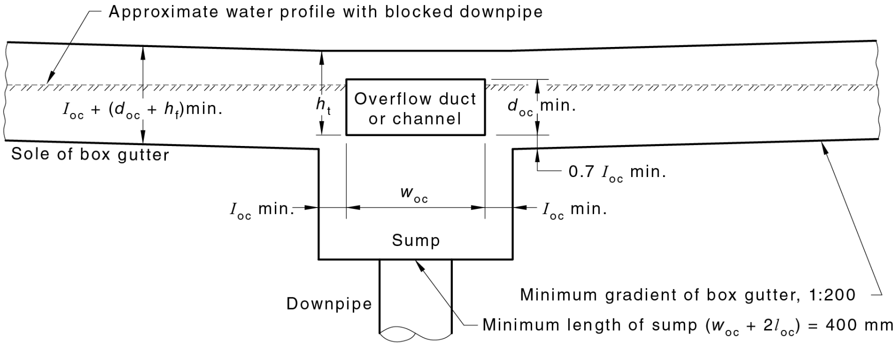


Figure H.4 — Design graph for sump



(a) Section showing overflow duct or channel

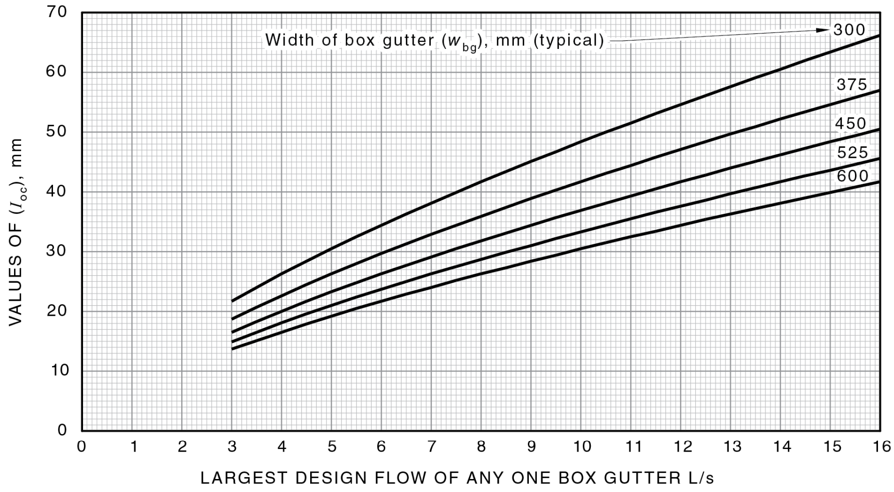


(b) Side view of box gutter

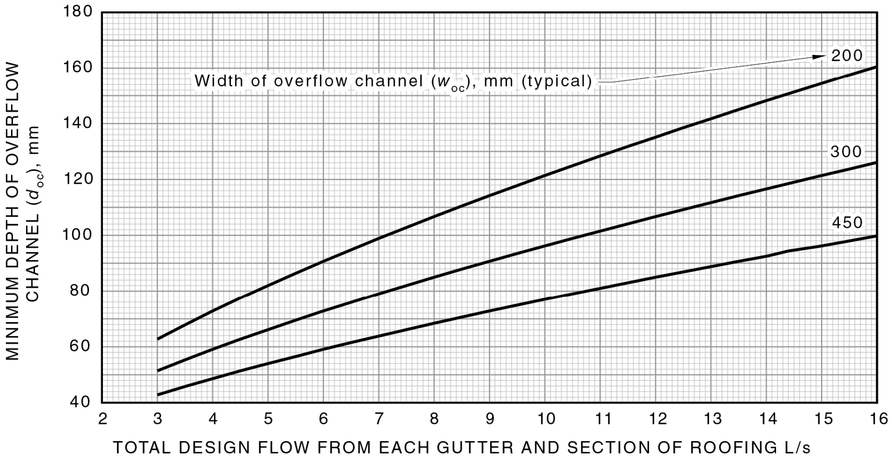
NOTE 1: The sump and overflow channel shall be fully sealed to the box gutter.

NOTE 2: h_f = freeboard (30 mm).

Figure H.5 — Sump/side overflow device



(a) Determination of values for I_{oc}

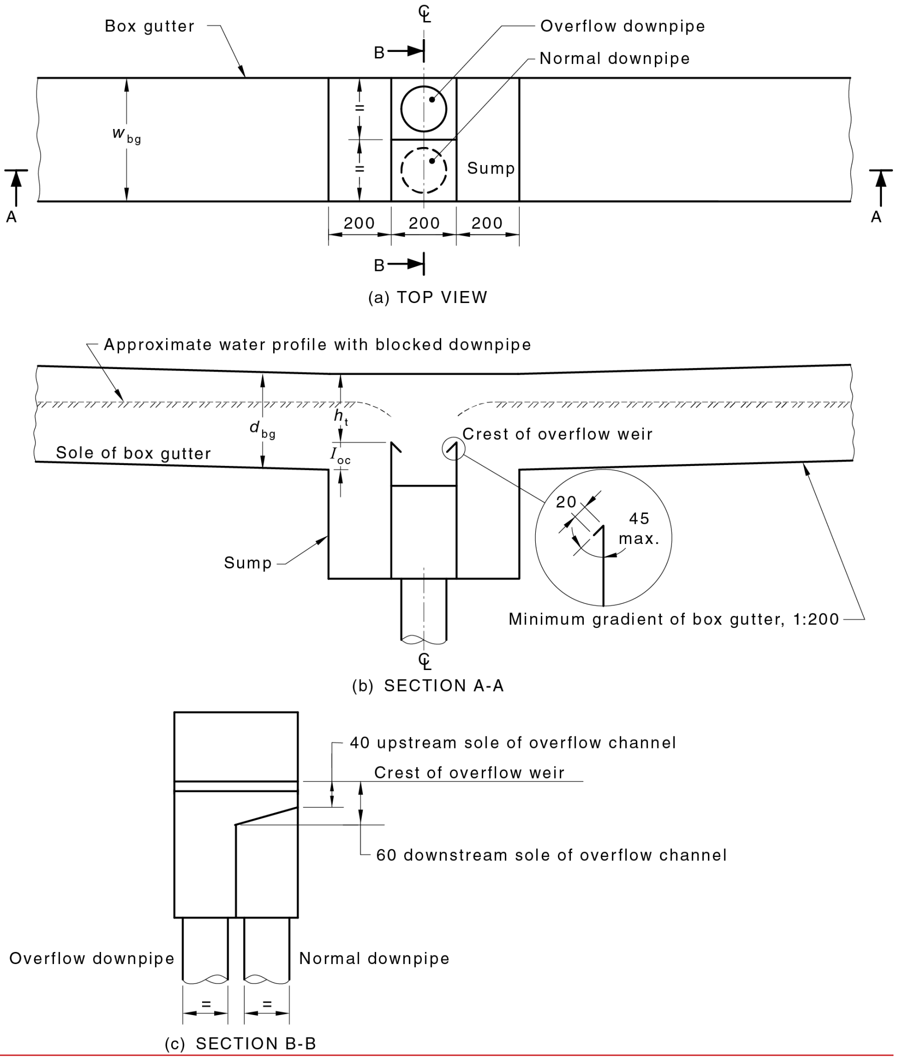


(b) Determination of values for d_{oc}

NOTE: Graph (a) applies to both sump/side overflow device, and sump/high-capacity overflow device.

Figure H.6 — Design graph for sump/side overflow device

Dimensions in millimetres



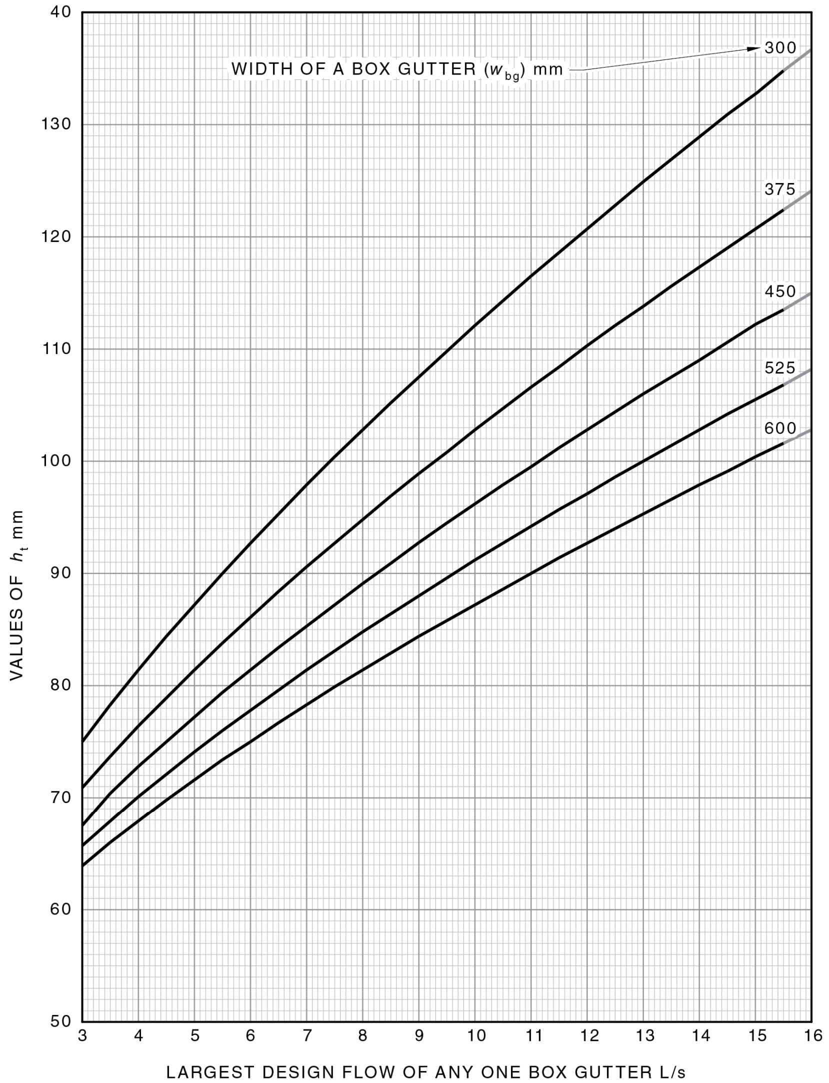
NOTE 1: The depth of the sump (h_s) shall be measured — (a) if l_{oc} < 60, from the sole of the box gutter at the sump; or (b) if l_{oc} > 60, the downstream sole of the overflow channel (i.e. 60 – l_{oc} below the sole of the box gutter at the sump).

NOTE 2: The sump shall be fully sealed to the box gutter.

NOTE 3: See Clause 3.7.5 for ~~criteria~~requirements for overflow devices.

NOTE 4: The normal outlet may be moved longitudinally to enable better inspection and maintenance access, see Clause ~~(~~3.7.4(f).

Figure H.7 — Sump/high-capacity overflow device



Key

Q = design flow of stormwater

A_c = catchment area of roof and vertical surface

NOTE: Additional values may be calculated using the following equation:

$Q = A_c \times {}^{1\%}I_5/3\,600$

Figure H.8 — Design graph for sump/high-capacity overflow device

~~Appendix H~~Appendix I (informative) Box gutter systems — General method — Examples

~~H.1~~I.1 Scope

This appendix sets out examples that illustrate the application of the general method (see Clause ~~)~~3.7) for the sizing of solutions for the following:

(a) Example 1 — Box gutters, rainheads and downpipes.

(b) Example 2 — Box gutters, sump/side overflow devices and downpipes.

(c) Example 3 — Box gutters, sump/high-capacity overflow devices and associated vertical downpipes.

The calculations are presented in an explanatory form to assist first and occasional users. The adopted order of accuracy in the examples is consistent with the accuracy of the assumptions on which they are based.

NOTE: Appendix C gives guidelines for the determination for any place in —

(a) Australia of rainfall intensities for 5 min duration and AEPs of 5 % and 1 % (ARIs of 20 and 100 years); and

(b) New Zealand of rainfall intensities for 10 min duration and AEPs of 10 % and 2 % (ARIs of 10 and 50 years).

~~H.2~~I.2 Example 1 — Box gutters, rainheads and downpipe

~~H.2.1~~I.2.1 Problem

A building as shown in Figure I.1 is to be constructed at Doncaster, a suburb of Melbourne, Victoria, see ~~.~~Appendix D. Determine the size of the box gutters and associated vertical downpipes with rainheads that are to discharge to the site stormwater drains of the surface water drainage system. To assist the understanding of this example the application of Figure H.1 and H.3 is shown in Figure I.2.

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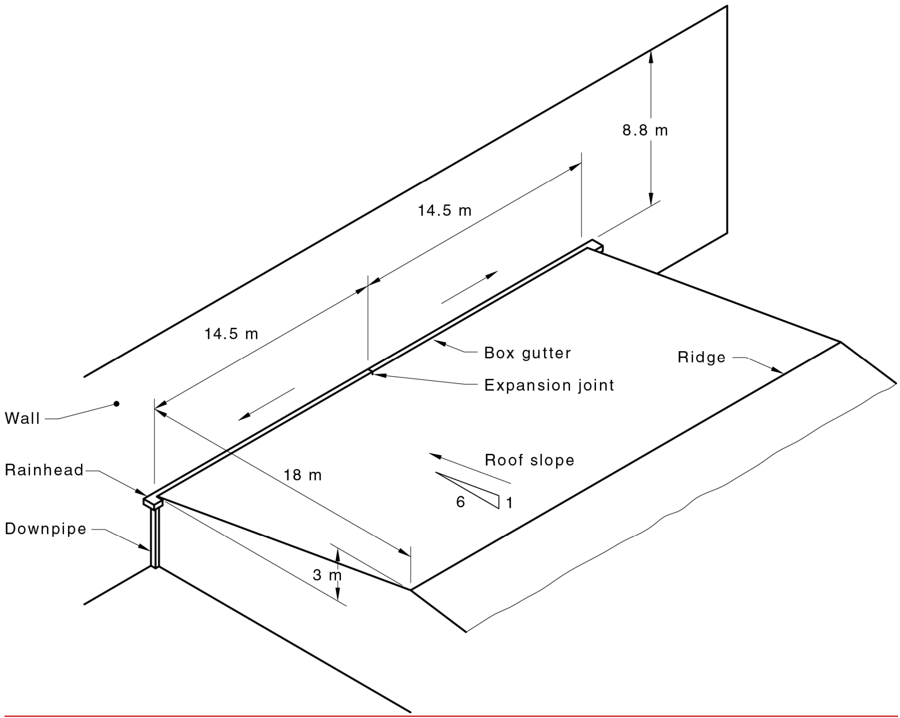
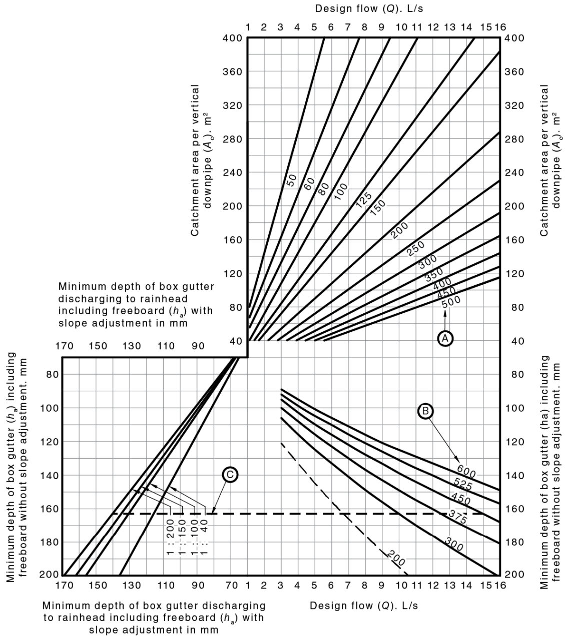
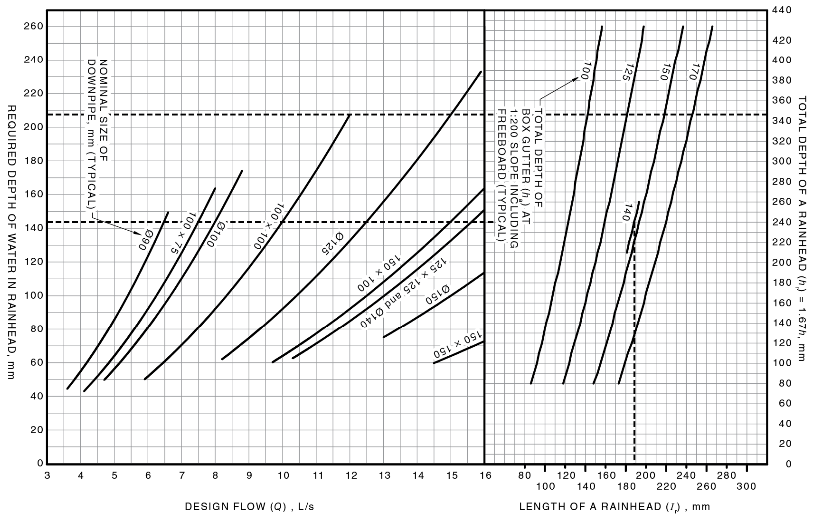


Figure I.1 — Building plan



DESIGN GRAPH FOR A FREELY DISCHARGEING BOX GUTTER

(a) Application of Figure H.1



DESIGN GRAPH FOR RAINHEAD

(b) Application of Figure H.3

NOTE: ~~The~~These figures ~~above~~ have been reproduced in reduced size for ~~the purpose of~~ this example only. Use the figures in Appendix H when designing or checking components of box gutter systems.

Figure I.2 — Example 1 — Application of Figures H.1 and H.3

~~H.2.2~~I.2.2 Calculation

The following ~~calculation illustrates~~steps illustrate the application of the procedure shown in Figure 3.7.4(A) ~~and contains 13 Steps labelled as Step 1, etc., referred to in the list below:~~).

Step 1: From Table 3.3.4, select 1 % AEP for Australia, and 2 % AEP for New Zealand.

Step 2: The latitude and longitude of the hypothetical site at Doncaster, Victoria (in Melbourne), are 37.78°S and 145.17°E.

From the Bureau of Meteorology procedure ~~described~~ in Appendices D and E, the 5 min duration, 1 % AEP rainfall depth for the given latitude and longitude is 14.9 ~~mm.~~ mm. This corresponds to an intensity of 14.9 × 60/5 = 179 mm/h. Take as 180 mm/h.

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~~This corresponds to an intensity of 14.9 × 60/5 = 179 mm/h. Take this as 180 mm/h. Hence,~~Hence, $^{1\,\%}I_5$ = 180 mm/h.

- ~~$^{1\,\%}I_5$ = 180 mm/h.~~

Step 3: The dimensions and other relevant data are shown on Figure I.1.

Step 4: Select position of expansion joint and rainheads as shown in Figure I.1.

Step 5: See Figure 3.7.4(A).

Roof A_h = 14.5 m × 18 m = 261 m².

Roof slope 1:6.

Rise = 1/6 × 18 m = 3 m.

Roof A_{v1} = 14.5 m × 3 m = 43.5 m².

Wall A_{v2} = 14.5 m × 8.8 m.

= 127.6 m².

$A_c = A_h + 1/2\ (A_{v2} \times A_{v1})$.

A_c = 261 m² + 1/2 (127.6 – 43.5) m².

A^c = 303 m².

Step 6: From Step 2, $^{1\,\%}I_5$ = 180 mm/h. From Step 5, A_c = 303 mm².

From Figure H.1, Q = 15 L/s.

Step 7: Is the design flow Q > 16 L/s~~.?~~? In this example, the answer is no, so ~~proceed~~go to Step 8.

If the answer was yes and this was the first trial, the A_c would have to be reduced. If the answer was yes and this was after subsequent trials, stop the trial as it is beyond the scope of this general method.

From Figure H.1, for Q = 15 L/s, select sole width of box gutter (w_{bg}) = 450 mm and gradient = 1:200.

Step 8: From Figure H.1, for Q = 15 L/s, select sole width of box gutter (w_{bg}) = 450 mm and gradient = 1:200.

Step 9: From Figure H.1, for Q = 15 L/s, w_{bg} = 450 and gradient = 1:200, the actual minimum depth of box gutter including freeboard (h_a) = 140 mm.

As each box gutter discharges to a rainhead that is designed to divert the design flow away from the building in the event of a total blockage of the downpipe, without increasing the depth of flow in the box gutter, this is the minimum depth required for the box gutter.

Use box gutters 450 mm × 140 mm minimum with a gradient 1:200.

Step 10: The design flow in each box gutter is also the design flow in the rainhead. From Step 6, Q = 15 L/s.

Select 125 mm diameter downpipe. From Figure H.3, depth of water in rainhead = 207 mm, total depth of rainhead h_r = 345 mm.

Alternatively, select 150 mm × 100 mm downpipe. From Figure H.3, depth of water in rainhead = 144 mm, total depth of rainhead h_r = 240 mm. Use total depth of rainhead = 250 mm.

Step 11: Check if the total depth of rainhead (h_r) needs to be adjusted as stated in Figure H.2 Note 1.

Step 12: From Figure H.3, for h_a = 140 mm, length of rainhead (l_r) = 185 mm (use 200 mm), and total depth of rainhead (h_r) = 250 mm.

Step 13: See Figures H.2 and 3.7.3(a). Final dimensions of rainhead, h_r = 250 mm, h_r − 25 = 225 mm, h_a = 150 mm, l_r = 200 mm.

~~H.3~~I.3 Example 2 — Box gutters, sump/side overflow devices and downpipes

~~H.3.1~~I.3.1 Problem

A building as shown in Figure I.3 is to be constructed in a city in Queensland. Determine the size of the box gutters and the associated vertical downpipe with sump/side overflow device that is to discharge to the site stormwater drains of the surface water drainage system. To assist the understanding of this example, Figure I.4 shows the application of Figures H.4 and H.6.

~~To assist the understanding of this example, the application of Figures H.4 and H.6 is shown in Figure I.4.~~

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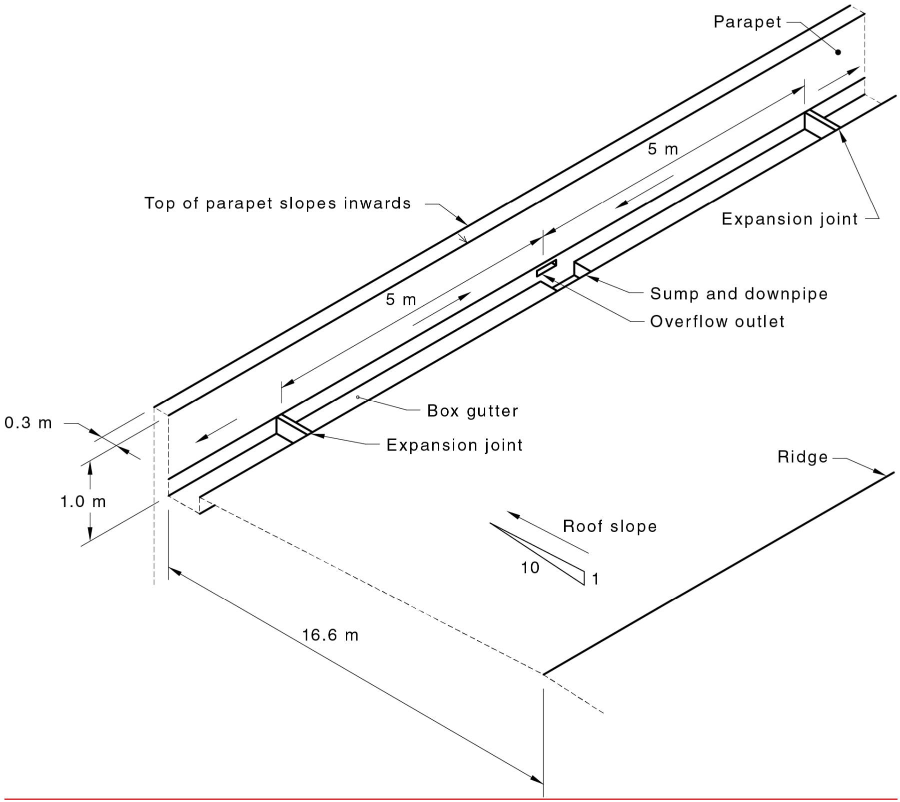

Figure I.3 — Roof plan

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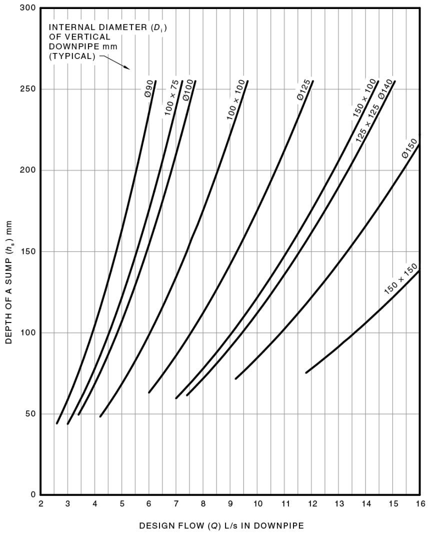
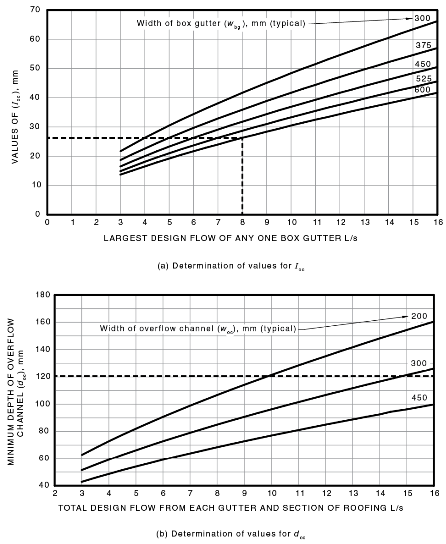




DESIGN GRAPH FOR SUMP

DESIGN GRAPH FOR SUMP/SIDE OVERFLOW DEVICE

(a) Application of Figure H.4

(b) Application of Figure H.6

NOTE: The figures above have been reproduced in a reduced size for ~~the purpose of~~ this example only. Use the figures in Appendix H when designing or checking components of box gutter systems.

Figure I.4 — Example 2 — Application of Figures H.4 and H.6

~~H.3.2~~I.3.2 Calculation

The following ~~calculation illustrates~~steps illustrate the application of the procedure shown in Figure 3.7.4(B~~):~~).

Step 1: From Table 3.3.4, select 1 % AEP for Australia~~,~~ and 2 % AEP for New Zealand~~,~~ for box gutters with a normal factor of safety.

Step 2: Assume that the 1 % AEP rainfall intensity ($_{1\%}I_5$) for the location is 330 mm/h.

Step 3: The dimensions and other relevant data are shown in Figure I.3.

Step 4: Expansion joints are installed at 10 m intervals along the box gutter near the parapet with sumps and downpipes midway between the expansion joints, see Figure I.3.

Step 5: ~~With reference to~~In Figure 3.7.4(B), the 300 mm wide parapet directs rain falling on top surface into the box gutter. Therefore, include as catchment area, see Clause ~~.~~3.4.

Length of roof + parapet = 16.9 m.

Roof A_h = 5 m × 16.9 m = 84.5 m^2.

Roof slopes at 1:10.

Roof rise = 1/10 × 16.6 m = 1.7 m.

Roof A_{v2} = 5 m × 1.7 m = 8.5 m².

Parapet A_{v1} = 5 m × 1 m = 5 m².

$A_c = A_h + 1/2\ (A_{v2} - A_{v1})$

A_c = 84.5 + 1/2 (8.5 m² − 5 m²)

A_c = 86.3 m²

Step 6: From Step 2, $^{1\,\%}I_5$ = 330 mm/h. From Step 5, A_e = 86.3 mm².

From Figure H.1, Q = 8 L/s for each gutter.

Step 7: Sole width = 600 mm, gradient of box gutters = 1:200.

Step 8: Is the total design flow through the outlet Q > 16 L/s? In this example, the answer is no, so proceed to Step 9. If the answer was yes and this was the first trial, the A_c would have to be reduced. If the answer was yes and this was after subsequent trials, stop the trial as it is beyond the scope of this general method.

Step 9: Are the gradients of the box gutters flatter than 1:200? In this example, the answer is no, so proceed to Step 10. If the answer is yes and this was after subsequent trials, stop the trial as it is beyond the scope of this general method.

Step 10: Total design flow = 2 × 8 = 16 L/s. Select 150 mm diameter downpipe. From Figure H.4 and H.5, h_s = 220 mm.

Step 11: For either box gutter, the maximum flow rate is $Q_{max.}$ = 8 L/s. From Figure H.6(a), loc = 26 mm.

Step 12: Select width of overflow weir w_{oc} = 300 mm.

Step 13: Total design flow = 16 L/s.

From Step 12, w_{oc} = 300 mm. From Figure H.6(b), d_{oc} = 132 mm. From Step 11, l_{oc} = 26 mm.

$h_t = [l_{oc} + (d_{oc} + 30)] - (0.7 l_{oc})$ = 170 mm.

Alternatively, if w_{oc} = 450 mm, from Figure H.6(b), d_{oc} = 102 mm, h_t = 140 mm.

Step 14: From Step 11, l_{oc} = 26 mm.

For w_{oc} = 300 mm, $d_{bg} = l_{oc} + (d_{oc} + 30)$ = 188 mm.

For w_{oc} = 450 mm, $d_{bg} = l_{oc}$ + (doc + 30) = 158 mm. Select ~~appropriate~~relevant option, for example d_{bg} = 188 mm. Go to Step 15.

Step 15: See Figures H.5 and 3.7.4(A). Sump details.

From Step 10, depth of sump h_s = 220 mm. Width of sump = w_{oc} + 2 l_{oc} = 300 + 2 × 26 = 352 mm min. This is less than the allowable minimum of 400 mm, see Figure H.5. Use 400 mm.

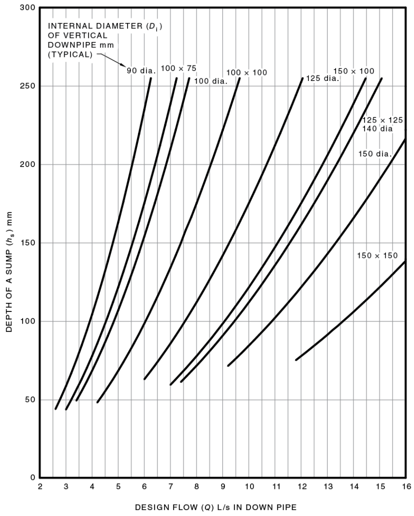
Overflow duct details. For w_{oc} = 300, d_{oc} = 132 mm. Therefore, overflow duct opening 300 mm × 132 mm for depth of box gutter = 188 mm. Bottom edge of duct 0.7 × 26 = 18 mm above sole of gutter.

~~H.4~~I.4 Example 3 — Box gutters, sump/high-capacity overflow devices and downpipes

~~H.4.1~~I.4.1 Problem

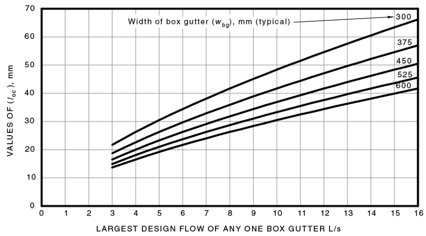
A sump/high-capacity overflow device is to be fitted to the outlet of 5.0 m long and 3.8 m long box gutters with gradients of 1:200 and sole widths of 600 mm. Inflow from the catchment area of the roof is at the rate of 1.7 L/s/m. Determine the size of the box gutters and the sump/high-capacity overflow device, including the normal and overflow vertical downpipes.

To assist the understanding of this example, Figure I.5 shows the application of Figures H.4, H.6(a) and H.8 ~~is shown in Figure I.5~~.

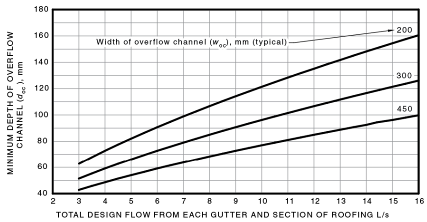


DESIGN GRAPH FOR SUMP

(a) Application of Figure H.4



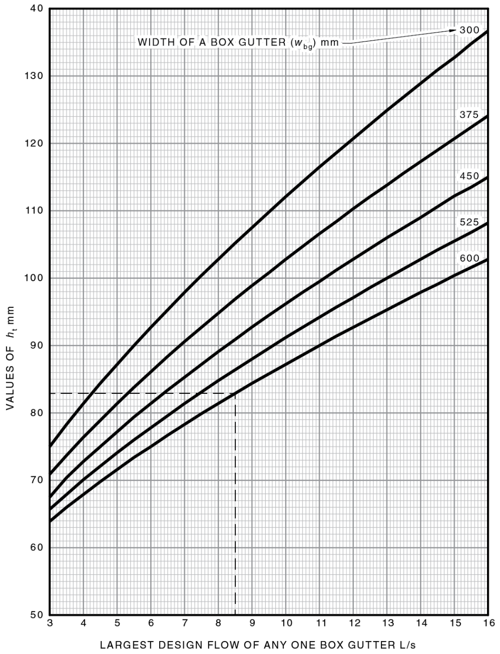
(a) Determination of values for l_{oc}



(b) Determination of values for d_{oc}

DESIGN GRAPH FOR SUMP/SIDE OVERFLOW DEVICE

(b) Application of Figure H.6



DESIGN GRAPH FOR SUMP/HIGH-CAPACITY OVERFLOW DEVICE

(c) Application of Figure H.8

NOTE ~~The~~: These figures ~~above~~ have been reproduced in a reduced size for ~~the purpose of~~ this example only. Use the figures in Appendix H when designing or checking components of box gutter systems.

Figure I.5 — Example 3 — Application of Figures H.4, H.6(a) and H.8

Table I.1 — Data for example 3

Item	**Length**	**Design flow**		**Minimum depth of a box gutter that discharges to a rainhead (h_a) from Figure H.1**	**Width (w_{bg})**
	m	**L/s**		**mm**	**mm**
Box gutter					
(a)	5.0	8.5[a]	(1.7 × 5.0)	105	600
(b)	3.8	6.5	(1.7 × 3.8)	98	600
Sump	0.6	1.0	(1.7 × 0.6)	—	—
	(see Figure H.7)				
Total	9.4	16.0[b]		—	—

[a] Largest design flow from any one box gutter.

[b] Total design flow from each box gutter and section of roofing.

~~H.4.2~~I.4.2 Calculation

The following ~~calculation illustrates~~steps illustrate the application of the procedure shown in Figure 3.7.4(C~~) and includes 17 Steps:~~).

Step 1: From Table 3.3.4, select 100 years 1 % AEP (100 years ARI) for Australia, and 2 % AEP (50 years ARI) for New Zealand, for box gutters with a normal factor of safety.

Steps 2~~-~~–7: Determine the catchment areas and design flows in accordance with Examples 1 (Clause ~~)~~I.2) and 2 (Clause ~~).~~I.3). The procedure for the determination of the minimum depth of box gutter (h_a) for free flow conditions is the same as for a box gutter served by a rainhead, as shown in Example 1. Table I.1 summarizes the results of these procedures for a selected width of box gutter (w_{bg}) = 600 mm.

Step 8: Is the total design flow through the outlet > 16 L/s? In this example, the answer is no, so proceed to Step 9.

If the answer was yes and this was the first trial, the A_c, would have to be reduced. If the answer was yes and this was after subsequent trials, stop the trial as it is beyond the scope of this general method.

Step 9: Select 1:200 min. gradient of box gutters. Go to Step 10.

Step 10: Total design flow = 16 L/s. From Figure H.4 for a 150 mm diameter downpipe, the depth of sump (h_s) = 217 mm. Adopt 220 mm.

Step 11: $Q_{max.}$ = 8.5 L/s for any box gutter. Width of box gutter = 600 mm. From Figure H.6(a) l_{oc} = 27 mm.

Step 12: If the downpipe ceases to function because of a blockage, the water level at the ends of the box gutters will increase to discharge the design flow across the overflow weirs. From Table I.1, the largest flow in any box gutter is Q = 8.5 L/s. From Figure H.8, for Q = 8.5 L/s and w_{bg} = 600 mm, the minimum height of the box gutter above the top of the overflow weirs (h_t) = 83 mm.

Step 13: The depth of box gutter has to contain the flow under overflow conditions without overtopping. Usually, the minimum total depth of gutter (d_{bg}) required for this condition is more than the minimum total depth of gutter (ha) required when there are no blockages. But for wide gutters this is not always the case, partly because of different levels of freeboard incorporated in the graphs.

From Step 7 (shown on summary Table I.1), h_a = 105 mm. From Step 12, h_t = 83 mm. From Step 11, l_{oc} = 27 mm. $h_t + l_{oc}$ = 110 mm.

Is $h_a(105) < h_t + l_{oc}$ (110)? Go to Step 14.

Step 14: The minimum depth of box gutter $d_{bg} = h_t + l_{oc}$ = 110 mm.

Step 15: Is l_{oc} > 60? Go to Step 16.

Step 16: The datum level for depth of the sump is the sole of the box gutter.

Step 17: See Figure H.7 for sump details. From Step 10, depth = 220 mm min. below sole of gutter, length = 600 mm, width = 600 mm.

Overflow weirs. From Step 11, crest of weir above sole of gutter = 27 mm.

From Step 14, depth of box gutter = 110 mm minimum.

~~Appendix I~~Appendix J (informative)
Surface water drainage systems — Nominal and general methods — Examples

~~I.1~~J.1 Scope

This appendix ~~sets out~~provides examples that illustrate the application of the nominal method (see Clause ~~)~~5.5) and the general method (see Clause ~~)~~5.4) for the design of solutions for surface water drainage systems.

The calculations are presented in an explanatory form to assist first and occasional users. The adopted order of accuracy in the examples is consistent with the accuracy of the assumptions on which they are based.

NOTE 1: Appendix C provides guidelines for determining for any site in —

(a) Australia, rainfall intensities for 5 min duration and AEPs of 5 % and 1 % (ARIs of 20 and 100 years); and

(b) New Zealand, rainfall intensities for 10 min duration and AEPs of 10 % and 2 % (ARIs of 10 and 50 years).

NOTE 2 The design solution examples for surface water drainage systems shown in Appendix J do not reflect requirements in New Zealand.

~~I.2~~J.2 Example 1 — Nominal method

~~I.2.1~~J.2.1 Problem

A house on an urban allotment with an area not exceeding 1 000 m² as shown in Figure J.1 is to be located in Australia. Design the surface water drainage system constructed with non-metal products.

~~I.2.2~~J.2.2 Solution

~~I.2.2.1~~J.2.2.1 Layout

The layout of the surface water drainage system (see Clause ~~)~~5.3) is shown in Figure J.1~~,~~ and has the overland flow directed away from the building~~; for example,~~, e.g. the cross-fall of a paved path along rear of the building is to be away from the building.

~~I.2.2.2~~J.2.2.2 Site stormwater drains

For the site stormwater drains, the following applies:

(a) The minimum size is as follows, see Clause ~~:~~6.3.3:

(i) Between a downpipe outlet and a stormwater or inlet pit, DN 90.

(ii) Between the stormwater, pits A and B, DN 150.

(iii) Between pit B [see Clause ~~(~~7.5.1.2(b)] and the street kerb, two DN 100.

(b) The minimum cover is as follows, see Table 6.2.5:

(i) Within the property —

(A) other than under the driveway, 100 mm; and

(B) under the paved driveway, 75 mm below the underside of the pavement.

(ii) Outside the property under the paved footpath, 50 mm below the underside of the pavement.

(c) The minimum gradient for Australia is DN 90, DN 100 and DN 150, 1:100, see Table 6.3.4.

~~I.2.3~~J.2.3 Stormwater pits

For stormwater pits —

(a) the minimum internal dimensions are at A and B (see Table 7.5.2.1), 450 mm × 450 mm (depth to invert of outlet less than 600 mm); and

(b) the minimum fall across each pit is 20 mm, see Figure 7.5.3 (a).

Dimensions in metres

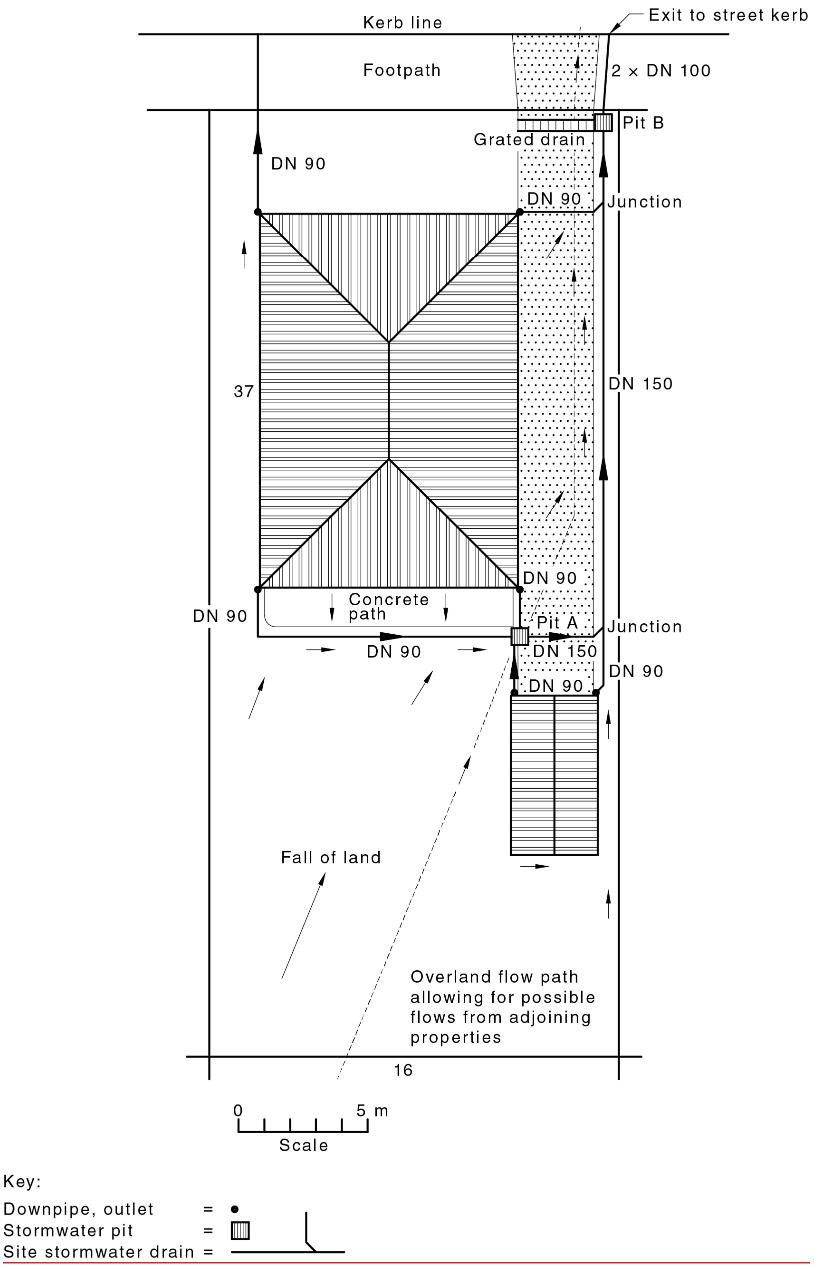


Figure J.1 — Stormwater drainage installation plan — Example 1

~~I.3~~J.3 Example 2 — General method — Villa home development

~~I.3.1~~J.3.1 Problem

A three-unit villa home development is to be located in Melbourne, Victoria, on a property with an area of 912 m^2 (48 m × 19 m) as shown in Figure J.2. The property slopes away from the street, and ~~since~~as there is some risk of flooding of the garage for Unit 3, a grated drain is provided in front of this. For the same reason, an AEP of 18 % (5 years ARI) should be adopted for the sizing of the surface water drainage system.

~~I.3.2~~J.3.2 Assumptions

It is assumed that there is little chance of overflows from the street gutter coming through this property. However, the site drainage path has to be well established, with any overflows being collected in pits or directed beside buildings to the easement drain running through the lower part of the site. Specifically, there should be gaps under fences adjacent to Pits 2 and 4, so that any overflows can escape without ponding against fences.

Roof water is collected from the vertical downpipes. Each downpipe for the villa house may be assumed to drain 25 % of the associated roof. Downpipes on garages may be assumed to collect all of the rainwater from a roof plane.

It is assumed that the paved areas will be reinforced concrete and be capable of taking medium vehicle loads. Thus, cover depths can be small — a minimum of 100 mm below the pavement (say 200 mm overall) will apply. In courtyards without paving, a cover of 100 mm will be necessary, see Table 6.3.4.

~~I.3.3~~J.3.3 Solution

~~I.3.3.1~~J.3.3.1 Preliminary

For an AEP of 18 % (5 years ARI), determine values for the following:

(a) The rainfall intensity for a 5 min duration ($^{18\,\%}I_5$) is 87 mm/h, see Clause ~~(~~5.4.5(a).

(b) Assuming loam soils, the run-off coefficient for the unroofed pervious area (C_p) is 0.147 × 0.95 = 0.14 for a $^{10\,\%}I_{60}$ of 28.6 mm/h, see Equation 5.4.6.

~~I.3.3.2~~J.3.3.2 Procedure

A trial surface water drainage system is shown in Figure J.2. In this case, it is most convenient to establish this as two subsystems, running on either side of the lower Unit 3. Plastics pipes are assumed to be used, having a roughness coefficient k = 0.015 mm, see Table 5.4.11.2.

Table J.1 may be set up on a spreadsheet program that enables the automatic determination of the values shown in the shaded areas. The column numbers below refer to Table J.1:

Column 1 identifies the limits for each section of the site stormwater drain.

Column 2 gives for each section the length.

Columns 3, 4 and 5 give the catchment area for each section, respectively, for the upstream —

(a) roof, the plan area irrespective of the roof slope;

(b) unroofed impervious (paved) area; and

(c) unroofed pervious area.

Column 6 gives for each section the equivalent impervious area calculated from the following equation:

$$\Sigma CA = C_r A_r + C_i A_i + C_p A_p \qquad \text{J.3.3.2(1)}$$

where

ΣCA	=	equivalent impervious area of all upstream areas on the property, in metres square
C_r	=	run-off coefficient, for a roofed area
A_r	=	total roofed catchment area, in metres square
C_i	=	run-off coefficient for an unroofed impervious (paved) area
A_i	=	total unroofed impervious (paved) catchment area, in m^2
C_p	=	run-off coefficient for an unroofed pervious (paved) area
A_p	=	total unroofed pervious catchment area, in m^2

In Australia, C_r and C_i are equal to 1.0 and 0.9 respectively (see Clause),5.4.6), and for Example 2, C_p is equal to 0.14 [see Clause (J.3.3.1(b)].

Column 7 gives for each section the cumulative equivalent impervious area (see Column 6 and Figure J.2). This has to be determined byin the designerdesign, allowing for branching.

Column 8 gives for each section the design flow calculated from the following equation (see Clause 5.4.8 and Equation 5.4.8):

$$Q = \frac{\Sigma CA^{18\,\%}I_5}{3\,600} \qquad \text{J.3.3.2(2)}$$

where

Q	=	design flow, in litres per second
ΣCA	=	equivalent impervious area of all upstream areas on the property, in metres square
$^{18\,\%}I_5$	=	rainfall intensity for a duration of 5 min and an AEP of 18 % (ARI of 5 years), in millimetres per hour

Column 9 gives for each section the selected minimum pipe diameter, see Clause .6.3.3.

Column 10 gives for each section the pipe gradient (see Clause)6.3.4) determined from Figure J.2 and the minimum cover (see Clause).6.2.5).

Column 11 gives for each section the hydraulic capacity of the pipe determined from Figure 5.4.11.2(a) for the selected diameter (see Column 9) and adopted gradient (Column 10). The hydraulic capacity for each selected minimum diameter pipe is, in this example, significantly greater than design flow (see Column 8).

Column 12 gives for each section the full-pipe velocity for the design flow (see Column 8) calculated from the following equation:

$$v = \frac{4\,000Q}{\Pi \;\; D^2} \qquad \text{J.3.3.2(3)}$$

where

v	=	full-pipe velocity, in metres square
Q	=	design flow, in litres per second
D	=	diameter of the site stormwater drain, in millimetres

If, for other than steep gradients, the full pipe velocity exceeds 1.5 m/s for other than steep gradients, select a larger pipe diameter (see Column 9) and repeat Columns 10, 11 and 12.

Column 13 gives for each pit the minimum fall from the upstream to the downstream invert levels of 20 mm, see Clause .7.5.3.

Columns 14 and 15 give for each pit, downpipe outlet and junction the finished surface level determined in Figure J.2.

Columns 16 and 17 give for each section the following:

(a) Upstream invert level determined by one of the following:

(i) The minimum cover, see Clause).6.2.5.

(ii) The fall along the immediate upstream section determined from the product of the length and gradient, see Columns 2 and 10.

(b) Downstream invert level determined by one of the following:

(i) The minimum cover as for Item (a)(i).

(ii) The minimum fall across a pit, see Column 13., provided the upstream invert levels at —

provided the upstream invert levels at —

(A) a junction, are the same; and

(B) a pit, whereif practicable, are the same, or the pipe with the higher invert level drops within the pit.

Columns 18 and 19 give for each section the upstream and downstream covers determined from the difference between the relevant surface level (see Columns 14 and 15) and invert level (see Columns 16 and 17) less the pipe diameter (see Column 9).

Before proceeding to the sizing of the next section, check that each cover for conformance tomeets the requirements of Clause 6.2.5 and, whereif necessary, increase the cover by lowering the corresponding invert level to satisfy this requirement.

For the minimum internal dimensions of the pits, see Table 7.5.2.1.

Dimensions in metres

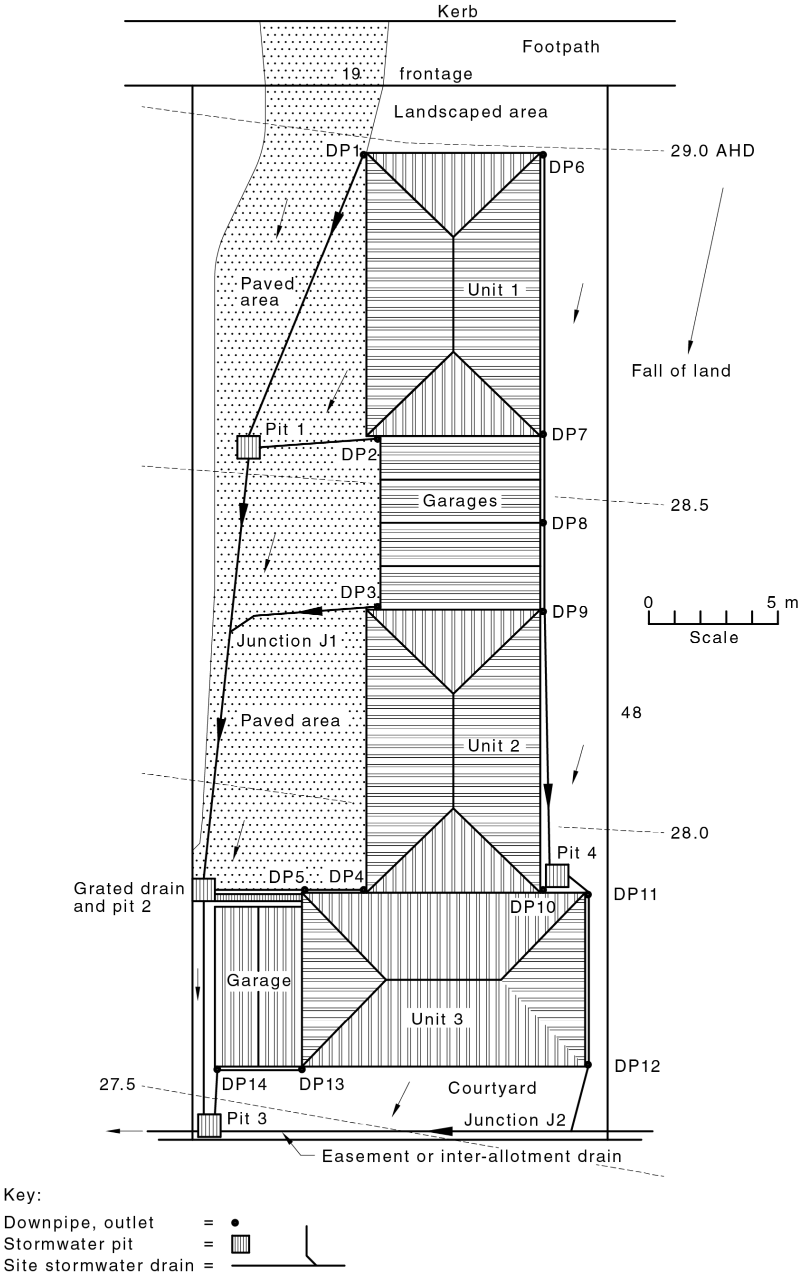


Figure J.2 — Stormwater drainage installation plan — Example 2

Table J.1 — Calculation sheet — Example 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Conduit	Length	Roof area	Paved area	Previous area	Equivalent impervious area, m²		Design flow	Pipe diam.	Pipe gradient	Pipe capacity	Full-pipe velocity	Min. fall across U/S pit	U/S surface level	D/S surface level	U/S invert	D/S invert	Cover, mm	
	m	m²	m²	m²	Sub-catchment	Cumulative	L/s	mm	1:…	k = 0.015mm L/s	m/s	m	m	m	m	m	U/S pipe end	D/S pipe end
DP1 to Pit 1	14.2	26	0	0	26	26	0.6	90	25	12	0.10	N/A	28.95	28.55	28.61	28.04	0.25	0.42
DP2 to Pit 1	5.7	26	0	0	26	26	0.6	90	21	14	0.10	N/A	28.60	28.55	28.31	28.04	0.20	0.42
Pit 1 to J1	19.4	0	96	64	95	147	3.6	150	67	28	0.20	0.02	28.50	28.25	28.02	27.73	0.33	0.37
DP3 to J1	6.9	26	0	0	26	26	0.6	90	25	12	0.10	N/A	28.30	28.25	28.01	27.73	0.20	0.43
J1 to Pit 2	11.5	0	0	0	0	173	4.2	150	25	48	0.24	N/A	28.25	27.80	27.73	27.27	0.37	0.38
DP4, DP5 to Pit 2	7.1	52	0	0	52	52	1.3	90	24.5	12	0.20	N/A	27.85	27.80	27.56	27.27	0.20	0.44
Pit 2 to Pit 3	10.2	0	154	21	142	367	8.9	150	25	48	0.50	0.02	27.80	27.45	27.25	26.84	0.40	0.46
DP13 to DP14		41	0	0	41	41	1.0	90	67	7.5	0.16	N/A	27.55	27.53	27.26	27.26	0.20	0.18
DP14 to Pit 3	2	15	0	0	15	56	1.4	90	20	14	0.21	N/A	27.53	27.45	27.20	27.10	0.24	0.26
DP6 to DP7	13	26	0	0	26	26	0.6	90	25	12	0.10	N/A	29.00	28.60	28.71	28.19	0.20	0.32
DP7 to DP8	4	41	0	0	41	67	1.6	90	25	12	0.25	N/A	28.60	28.45	28.19	28.03	0.32	0.33
DP8 to DP9	4	30	0	0	30	97	2.3	90	33	11	0.37	N/A	28.55	28.35	28.03	27.91	0.43	0.35
DP9 to Pit 4	12	41	0	0	41	138	3.3	90	25	12	0.52	N/A	28.35	27.90	27.91	27.43	0.35	0.38

Draft

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Conduit	**Length**	**Roof area**	**Paved area**	**Previous area**	**Equivalent impervious area, m²**		**Design flow**	**Pipe diam.**	**Pipe gradient**	**Pipe capacity**	**Full-pipe velocity**	**Min. fall across U/S pit**	**U/S surface level**	**D/S surface level**	**U/S invert**	**D/S invert**	**Cover, mm**	
	m	**m²**	**m²**	**m²**	**Sub-catchment**	**Cumulative**	**L/s**	**mm**	**1:...**	**k = 0.015mm L/s**	**m/s**	**m**	**m**	**m**	**m**	**m**	**U/S pipe end**	**D/S pipe end**
Pit 4 to DP11	1.4	26	0	102	40	178	4.3	150	33	40	0.24	0.02	27.90	27.90	27.43	27.39	0.32	0.36
DP11 to DP12	8	26	0	0	26	204	4.9	150	33	40	0.28	N/A	27.90	27.60	27.39	27.15	0.36	0.30
DP12 to J2	3	26	0	0	26	230	5.6	150	33	40	0.31	N/A	27.60	27.55	27.15	27.06	0.30	0.34
Pit to easement	0	0	0	73	10	29	0.7	—	—	—	—	—	27.45	—	—	—	—	—
Sums =		402	250	260														
		Total area = 912 m²																

~~Key~~

U/S = upstream

D/S = downstream

N/A = not applicable

~~I.4~~J.4 Example 3 — General method — Warehouse

~~I.4.1~~J.4.1 Problem

A warehouse building with a plan area of 1 344 m^2 is to be located in Penrith, New South Wales, on a property with an area of 2 482 m^2 (73 m × 34 m) as shown in Figure J.3. The property slopes to the street.

~~I.4.2~~J.4.2 Assumptions

It is assumed that —

(a) overflow from the adjoining properties and Pits A and B will follow the overland flow path shown in Figure J.3; and

(b) the roof of the building falls to the east with the roof water collected at five vertical downpipes that discharge to the site stormwater drains connected to the street pit with an invert level of 13.00 m AHD.

~~I.4.3~~J.4.3 Solution

~~I.4.3.1~~J.4.3.1 Preliminary

Determine, for an AEP of 39 % (two years ARI), values for the following:

(a) The rainfall intensity for a 5 min duration ($^{18\,\%}I_5$) is 96 mm/h, see Clause ~~(~~5.4.5(a).

(b) The run-off coefficient for the unroofed pervious area (C_p) is 0.348 × 0.85 = 0.30 for a $^{10\,\%}I_{60}$ of 28.6 mm/h, see Equation 5.4.6. To allow for clay soils at the site, 0.1 is added so C_p = 0.30 + 0.10 = 0.40.

~~I.4.3.2~~J.4.3.2 Procedures

A trial surface water drainage system is shown in Figure J.3. The site stormwater drains should be of FRC pipes, having a roughness coefficient k = 0.15 mm.

Table J.2 may be set up on a spreadsheet program that enables the automatic determination of the values shown in the shaded areas. The explanation of the application, but not the values for Example 2, given in Clause J.3.3.2 are also applicable to Table J.2.

In some cases, the pipe diameter (see Column 9) and the cover (see Columns 18 and 19) could be reduced; however, since the clearance of blockages and replacement of pipes may be costly, the preferred layout is shown in Figure J.3.

Dimensions in metres

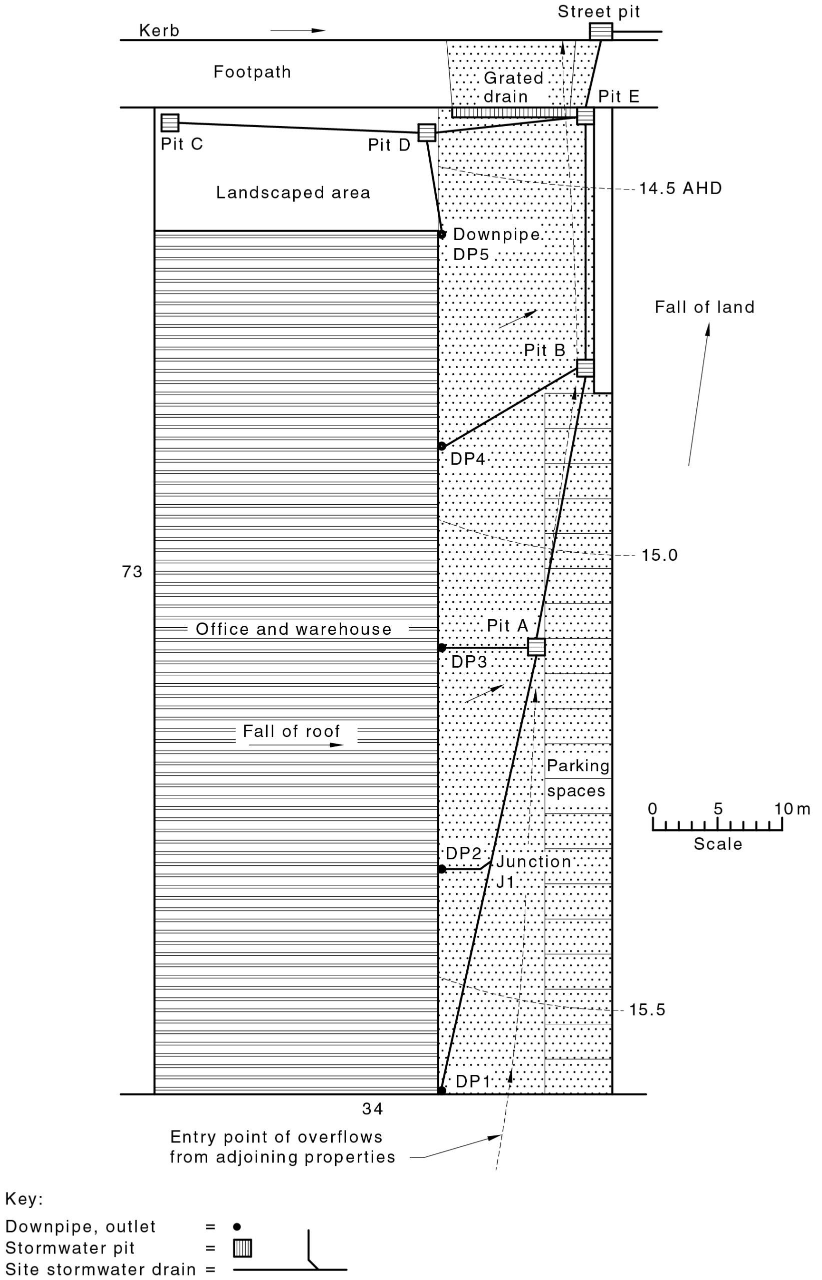


Figure J.3 — Stormwater drainage installation plan — Example 3

Table J.2 — Calculation sheet — Example 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Conduit	**Length**	**Roof area**	**Paved area**	**Previous area**	**Equivalent impervious area, m²**		**Design flow**	**~~Pip~~ ePipe diam.**	**Pipe gradient**	**Pipe capacity**	**Full-pipe velocity**	**Min. fall across U/S pit**	**U/S surface level**	**D/S surface level**	**U/S invert**	**D/S invert**	**Cover, mm**	
	m	**m²**	**m²**	**m²**	**Sub-catchment**	**Cumulative**	**L/s**	**mm**	**1:...**	**k = 0.015 mm L/s**	**m/s**	**m**	**m**	**m**	**m**	**m**	**U/S pipe end**	**D/S pipe end**
DP1 to J1	16.7	168	0	0	168	168	4.5	150	37	34	0.25	N/A	15.60	15.35	15.25	14.80	0.20	0.40
DP2 to J1	3.8	336	0	0	336	336	9.0	150	19.2	50	0.51	N/A	15.35	15.35	15.00	14.80	0.10	0.40
J1 to Pit A	15.8	0	0	0	0	504	13.5	150	50	30	0.76	0.02	15.35	15.15	14.80	14.48	0.40	0.52
DP3 to Pit A	7.1	336	0	0	336	336	9.0	150	22	45	0.51	N/A	15.15	15.15	14.80	14.48	0.20	0.52
Pit A to Pit B	19.6	0	403	0	363	1 203	32.1	200	50	62	1.02	0.02	15.15	14.80	14.46	14.07	0.49	0.53
DP4 to Pit B	11.6	336	0	0	336	336	9.0	150	22	45	0.51	N/A	14.95	14.80	14.60	14.07	0.20	0.58
Pit B to Pit E	20.8	0	260	0	234	1 773	47.3	225	50	83	1.19	0.02	14.80	14.40	14.05	13.63	0.53	0.54
Pit C to Pit D	19.2	0	0	63	25	25	0.7	100	100	7	0.09	N/A	14.50	14.48	14.20	14.01	0.20	0.37
DP 5 to Pit D	6.7	168	0	0	168	193	5.2	100	23	15	0.66	N/A	14.60	14.48	14.30	14.01	0.20	0.37
Pit D to Pit E	11.3	0	0	126	50	243	6.5	150	31	37	0.37	0.02	14.48	14.40	13.99	13.63	0.34	0.62
Pit E to Street Pit	5.7	0	251	35	240	2 256	60.2	225	25	120	1.51	0.02	14.40	—	13.61	13.38	0.57	—
Sums =		1 344	914	224														
		Total area = 2 482 m²																

~~Key~~

U/S = upstream

D/S = downstream

N/A = not applicable

~~Appendix J~~Appendix K (informative) Example calculation — Pumped system

LOCATION — BRISBANE

Contributing area (A)	=	1 000 m^2 = 0.1 ha
AEP	=	10 % (10 years ARI)
Storm period (T)	=	120 min
Rainfall intensity (I)	=	44.4 mm/h
Coefficient of run-off (C_r)	=	0.9

Peak discharge calculated using the rational method:

$$Q = C_r \times I = 0.9 \times 44.4$$

$$Q = 39.96 \text{ (say 40 L/h/m}^2\text{)}$$

Volume for 2 h storm:

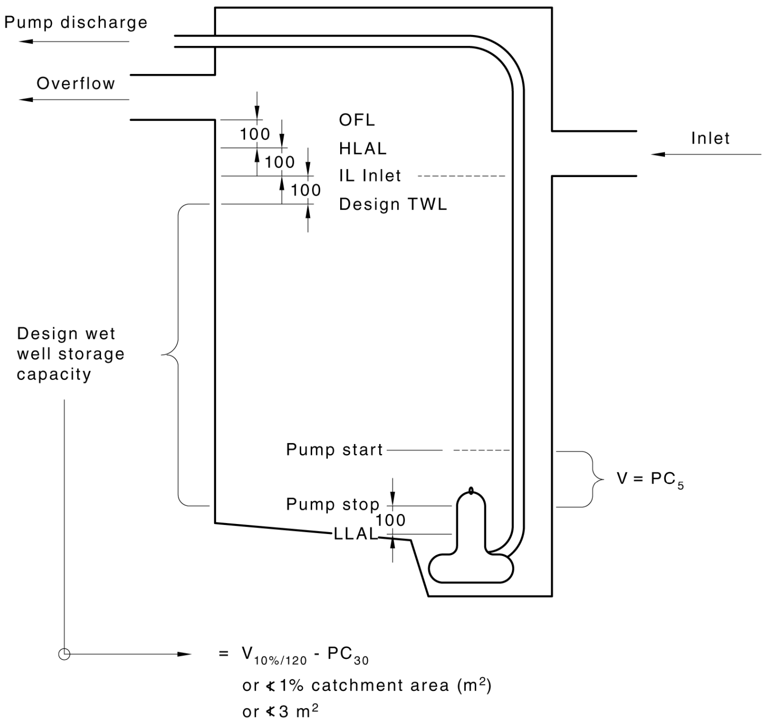
$$V = Q \times T \times A = (40/1\,000) \times 2 \times 1\,000 = 80 \text{ m}^3$$

ALTERNATIVE PUMP CAPACITY — WET WELL VOLUME COMBINATIONS

Site area	1 000 m^2
Combined effective storage volume	80 m^3

Pump capacity L/s	Volume pumped in 30 min m^3	Required wet well volume m^3
40	72	10
30	54	26
20	36	44
10 (min)	18	62
NOTE: See Figure K.1.		

Dimensions in millimetres



Key

OFL	=	overflow level
HLAL	=	high-level alarm level
LLAL	=	low-level alarm level
$V_{10\,\%/120}$	=	volume in 10 % AEP (10 year ARI), 120 min storm
PC_{30}	=	pump capacity over 30 min
PC_{5}	=	pump capacity over 5 min

Figure K.1 — Pump system

~~Appendix K~~Appendix L (informative) Subsoil drainage systems — Design

~~K.1~~L.1 Scope

This appendix provides guidance for the design of subsoil drainage systems. ~~Because~~Design decisions are dependent on particular site or soil conditions; therefore, detailed design of such systems is complex and~~,~~ should be undertaken with advice from a competent person unless otherwise required to be authorized by the regulatory authority~~, should be undertaken with advice from~~. An example of a ~~suitably qualified~~ competent person is a professional engineer specializing in geotechnical engineering.

Commented [eXtyles34]: Please review use of term (regulatory authorities): regulatory

This appendix does not cover —

(a) the subsurface drainage of large areas of land, such as playing fields;

(b) systems for removal of stormwater by adsorption or infiltration into permeable soils; and

(c) drainage systems behind retaining walls.

~~An example of a suitably qualified competent person is a professional engineer specializing in geotechnical engineering.~~

~~K.2~~L.2 Purpose

The purpose of the subsoil systems covered in this document is to drain away groundwater and, possibly, surface water in the vicinity of buildings in order to —

(a) increase the stability of the ground and footings of buildings by inducing a more stable moisture regime and reducing foundation movements due to variations in the soil moisture content;

(b) mitigate surface water ponding and waterlogging of soils by lowering water tables;

(c) increase soil strength by reducing its moisture content; and

(d) ~~where applicable,~~ prevent damage due to frost heave of subsoil ~~(~~, where applicable. This generally applies to sites 1 km or more above sea level~~)~~.

The investigation and design of subsoil drainage systems are uncertain processes. Only in a very limited number of situations will the need for subsoil drainage be identified without detailed subsurface investigations involving excavations, field observations and soil tests. One important factor indicating a need for subsoil drainage is the presence of a water table high enough to have an adverse effect on the development.

In clay soils, subsoil drains can alter long-term soil moisture regimes so that building foundations are adversely affected by removing water~~,~~ or, in some cases, by introducing water. In ~~such~~these conditions, subsoil drains should only be used ~~where there are~~if no other options ~~for solving a~~exist to solve dampness ~~problem~~problems.

Consideration should be given to the possible effects of intermittent or permanent reduction in groundwater levels on adjacent lands. In soils with a clay content exceeding 20 %, lowering water tables can cause soil shrinkage and damage to structures. AS 2870 recommends against placing subsoil drains too close to buildings on clayey sites.

~~K.3~~L.3 Types

The types of subsoil drains commonly used are shown in Figure L.1. These may be installed on flat ground, in a sag or depression, or on sloping ground. The basic parts of a subsoil drain are shown in Figure L.1 (a) — a trench and fill or filter material, commonly sand or gravel. This simple arrangement is called a rubble drain or French drain.

Figure L.1 (b) shows the addition of a geotextile lining to prevent external fine soil particles being washed into the filter material and clogging it. Figure L.1 (c) shows the addition of a pipe to promote more rapid drainage. This is a typical subsoil drain. The pipe is perforated to allow easy entry of water and may be rigid or flexible. Figure L.1 (d) shows two further variations — an impervious cap for situations where the drain is intended to collect only subsurface flows and bedding material for cases where the base of the excavation is unsuitable as a pipe support.

~~Figures~~Figure L.1 (e), ~~L.1~~ (f) and ~~L.1~~ (g) show greater elaboration. The pipe may be wrapped in geotextile to prevent piping and loss of filter material. Geocomposite drains of various configurations and manufacture may be provided~~. These~~ and are usually of plastics wrapped in geotextile, and various proprietary systems are available.

~~Finally,~~ Figure L.1 (h) shows an external layer of filter material provided around the geotextile encompassing the filter material, which may be used ~~where~~if there is a likelihood of fine particles or deposits, ~~for example~~e.g. iron precipitates, clogging the geotextile.

In general, subsoil drains connect into a pit, which is part of a surface water drainage system, with the subsoil drainpipe or strip drain penetrating the pit wall. Weep holes with a suitable geotextile filter may also be used to admit water from the filter materials into the pit.

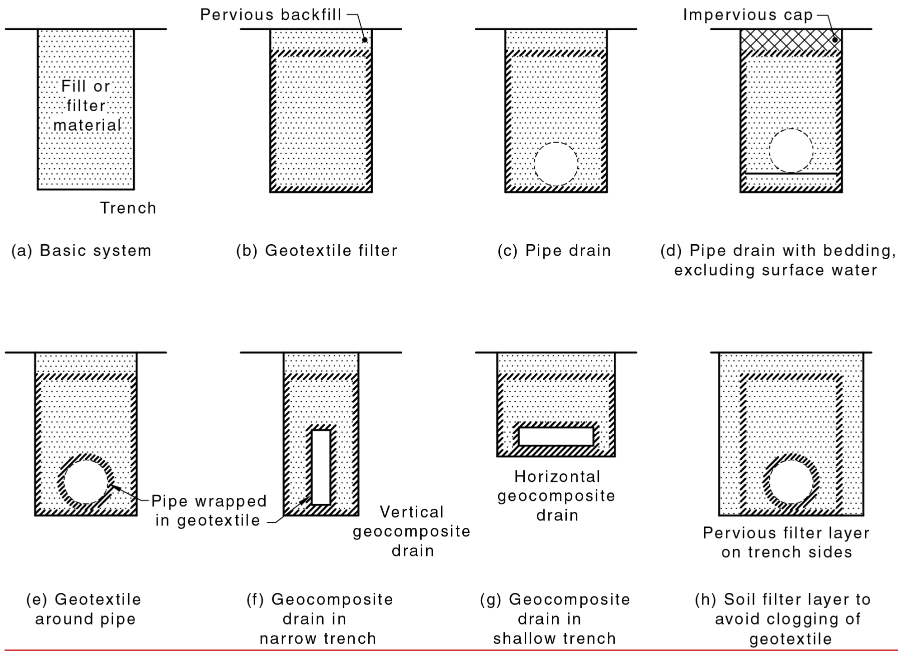


Figure L.1 — Types of subsoil drains

~~K.4~~L.4 Layout

~~K.4.1~~L.4.1 General arrangement

Layouts for the types of subsoil drainage systems covered include —

(a) subsoil drains on one or more sides of a building or cutting, including cut-off drains for interception of groundwater flows from higher land; and

(b) drainage systems for mitigating waterlogging or lowering watertables on small to medium areas of land, for example less than 500 m^2.

These may involve branch subsoil drains connecting to a main subsoil drain. Main subsoil drains often follow natural depressions.

The layout is directly related to the topography, the location of buildings and access points, the geology (nature of subsoil and level of groundwater), and the area of a property. Subsoil drains should connect to a stormwater pit or a point of connection and be consistent with the layouts for the site stormwater drain and the external stormwater drainage network.

Suggested maximum spacing for branch subsoil drains are given in Table L.1.

Table L.1 — Suggested maximum spacing of branch subsoil drains

Soil type	Depth of invert of main subsoil drains	
	0.8 to 1.0 ~~m~~	1.0 to 1.5 ~~m~~
	Maximum spacing, m	
Sand	—	45 to 90
Sandy loam	—	30 to 45
Loam	16 to 20	20 to 30
Clay loam	12 to 16	15 to 20
Sandy clay	6 to 12	—
Clay	2 to 6	—
[SOURCE: EN 752:2008]		

~~K.4.2~~L.4.2 Drains

Subsoil drains should —

(a) be laid with even gradients and straight runs, with a minimum number of changes to these and with any changes made at an appropriate ~~a~~ fitting or at a pit;

(b) have a cover, see Clause ~~;~~6.2.5;

(c) be sized in accordance with Clause ~~;~~L.5; and

(d) have clean-out points, see Clause ~~(~~6.4.1(c).

For subsoil drains under or in proximity to buildings, see Clause ~~.~~6.2.8. For subsoil drains in proximity to other services, see Clause ~~.~~6.2.6.

~~K.4.3~~L.4.3 Specifications — Filters

For filter materials and geotextiles, see Clause ~~.~~2.12.

~~K.5~~L.5 Design considerations

~~K.5.1~~L.5.1 Drain dimensions and spacings

The depth of a subsoil drain is dictated by either the groundwater conditions or the amount by which the groundwater level is to be lowered. The following criteria are recommended:

(a) Interceptor drains that aim to remove flows from a particular soil stratum or an aquifer should completely penetrate the stratum and extend to a depth of 150 mm to 300 mm into the impervious strata below.

(b) WhereIf the subsoil drain is intended to lower the general groundwater level, the determination of the depth of drain depends on whether there is a single or a multi-drain system as shown in Figure L.2.

Analysis in these cases depends on knowledge of the hydraulic properties of the soil, and on theoretical solutions. In critical cases, a professional engineer with geotechnical expertise should carry out the design work.

For less critical situations, the drawdown curve for a single drain may be assumed to have the characteristics given in Table L.2.

For multi-drain systems, the drain spacings given in Table L.3 may be used in less critical applications.

Clay soils present particular problems as they may be too impermeable for any drawdown to occur, and so expert geotechnical advice should be sought.

(c) WhereIf circular pipes are used, trench widths should be a minimum of 300 mm. A minimum width of 450 mm is necessary wherefor human access is required. Where, If a trench is deeper than 1.5 m, shoring as specified by relevant construction safety acts and regulations should be used.

For geocomposite drains set vertically, as shown in Figure L.1 (f), the minimum trench width should be 100 mm.

(d) Drains should be constructed with the base of the trench at an even slope, so that the trench acts as a rubble drain even if the pipe or geocomposite drain is blocked.

(e) WhereIf a subsoil drainpipe or geocomposite drain connects to a pit or a pump-out sump, there should be access for easy inspection of flows so that the performance of the subsoil drain can be monitored. For drains in critical locations, a means of back-flushing should be provided to clear blockages.

(f) Subsoil drains should not be directly connected to street kerbs and gutters or street stormwater drains in cases where backflow might cause damage.

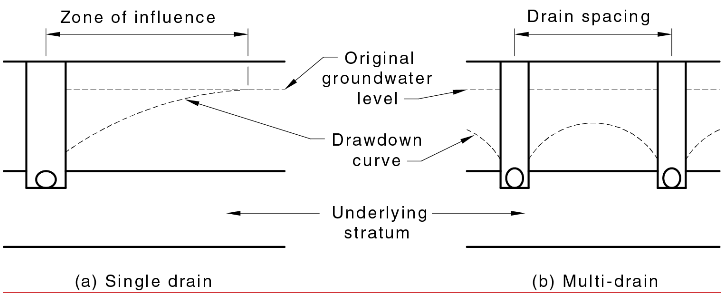


Figure L.2 — Water table drawdowns to single- and multi-drain systems

Table L.2 — Typical drawdown values associated with a single drain

Soil type	Zone of influence, m	Typical gradient of drawdown curve
Coarse gravel	150	—

Medium gravel	50	1:200 to 1:100
Coarse sand	40	1:100 to 1:33
Medium sand	15 to 30	1:50 to 1:20
Fine sand	8 to 15	1:20 to 1:5
Silt/clay	Variable	1:5 to 1:2.5

Table L.3 Typical drain spacings

Soil type	**Depth** m ~~m~~	**Spacing** m ~~m~~
Sand	1 to 2	50 to 90
Sandy loam	1 to 1.5	30 to 40
Clay loam (i.e. a clayey silt)	0.5 to 1	12 to 16

~~K.5.2~~L.5.2 Design of conduits

Pipes or other conduits associated with subsoil drains should meet the following criteria:

(a) The size of conduits should be related to the expected flows through them. These flows will be very small in fine-grained soils, but will be larger ~~where~~if —

(i) the drain is located in a pervious stratum such as sand that is permanently fed by a nearby water body or fed over a prolonged period by heavy rainfall; or

(ii) the drain cuts off flow in an aquifer.

(b) ~~Where~~If circular pipes are used in subsurface drains, a minimum pipe size of DN 90/100 is to be used with larger sizes necessary for long runs of drains or in ~~situation such~~situations as ~~those described~~ in Item (a~~) above.~~).

In the case of the larger flows described in Item (a), advice should be sought from a ~~suitably~~ competent person, such as a professional engineer~~,~~ with geotechnical expertise.

~~K.5.3~~L.5.3 Pipe gradient

The gradients of subsoil drains should be determined by the topography of the site rather than by consideration of self-cleansing velocities.

~~Appendix L~~Appendix M (informative) General information

~~L.1~~M.1 Scope

This appendix provides additional information to users of the document. The related clauses should be read in conjunction with this appendix.

~~L.2~~M.2 Protection of works

~~L.2.1~~M.2.1 Roof drainage systems

Roof drainage systems installed adjacent to or below brickwork, which could be damaged during wash-down with acid or similar chemical, should be protected.

~~L.2.2~~M.2.2 Surface water drainage and subsoil drainage systems

Whenever the ground is opened, measures should ~~to~~ be taken to protect the surface water drainage and subsoil drainage systems from damage, and to prevent the entry of —

(a) soil, sand, or rock;

(b) sewage, including the contents of any septic tank, or trade waste; or

(c) any other substance that could damage or impede the operation of the stormwater drainage network.

~~L.3~~M.3 Discharge ~~point criteria~~points

~~L.3.1~~M.3.1 Position and ~~manner~~method of discharge

The following apply:

(a) The authority having jurisdiction may determine the position and ~~manner~~method of discharge of the stormwater drainage system.

(b) ~~Point(s)~~Points of connection to the stormwater system for a property should conform to the following:

  (i) They should be located —

    (A) within the property; or

    (B) external to the property, that is the surface water drain extends beyond the property; and

  (ii) They should transfer stormwater by gravity or pumping, or both, from the site stormwater drain to the stormwater drainage network.

(c) The forms of points of connection should include —

  (i) a direct connection to a street kerb and gutter; or

  (ii) connection to an element of the external stormwater drainage network, e.g. a conduit or open channel located in a street or easement.

(d) ~~Where~~If the stormwater from a property discharges through a mountable kerb to the gutter of a roadway, the design and materials used to create the outfall (pipe) should have sufficient strength and durability to withstand the loads to which the outfall will be subjected throughout the service life of the kerb. The structural adequacy of the preformed outlets should be verified by load testing or structural analysis. Any preformed outlet should be approved by the network utility operator before being installed. ~~Where~~If practicable, for new kerb construction, outlets should be installed in conjunction with the forming of the kerb.

(e) ~~Where~~If the network utility operator has determined an operating water level within its own external stormwater drainage network for a gravitational point of connection, care should be taken to ensure that any floor or basement level is above this level and that the site stormwater system has suitable outlets to operate as surcharge outlets.

(f) ~~Where~~If the recommendations of Item (d) above cannot be applied, consideration should be given to the installation of —

(i) a reflux valve; or

(ii) a pumped system.

~~L.3.2~~M.3.2 Stormwater drainage plans

Typical information that may be required for a stormwater plan is given in ~~.~~Appendix B.

~~L.4~~M.4 Transport, handling and storage

Roof drainage system components and support systems should be transported, handled and stored with care so that no damage occurs during these operations. When stored on site, they should be in sheltered and secure positions.

~~L.5~~M.5 Inspection and cleaning

Sizing of stormwater drainage installations assumes that the responsible owner or manager arranges regular inspection and cleaning to remove any obstructions that could reduce the installation's hydraulic capacity or design lifetime, or both.

Obstructions that could cause partial or complete reduction in the hydraulic capacity are windborne plastics, drink cans, builders' refuse, balls, bird nests, items deposited by birds, dead birds, leaves, moss, mortar, silt or similar obstructions.

Guards on gutters and gutter outlets and screens on outlets from on-site stormwater detention (OSD) facilities are installed to prevent reduction in hydraulic capacity due to obstructions. Installation of such guards and screens does not eliminate the need for regular inspection and cleaning. Guards used with rainwater goods might collect debris during high intensity storms, in spite of regular inspection and cleaning, and for this reason it might be better not to install such guards, particularly on box gutter sumps.

~~L.6~~M.6 Alterations and disconnection

Disused roof drainage system components, including overflow devices, should be removed and any resulting openings to the remaining roof drainage system or surface-drainage system should be sealed in a manner ~~appropriate~~suitable for the material remaining in use.

Disused accessories and fasteners should be removed and any damage to the building made good in a manner ~~appropriate~~suitable for the material damaged.

~~L.7~~M.7 Layout

~~L.7.1~~M.7.1 General

Layouts of surface water drainage systems should take full advantage of the existing and proposed topography of the site and the position and level of the point or points of connection to the stormwater drainage network.

~~L.7.2~~M.7.2 Influences on layout

Factors that determine a layout include the following:

(a) Site conditions, including —

(i) the intended uses of existing and proposed buildings;

(ii) location of downpipes and overflow devices surcharge outlets and outlets of any internal drainage or pump-out systems;

(iii) any stormwater discharges from adjacent land;

(iv) location of existing and proposed pervious and impervious areas, such as paved areas, parking lots and gardens;

(v) soil types and strata, and vegetative cover and trees;

(vi) locations of access to the site, and to ground-level and below-ground floors of buildings, see Clause ~~;~~5.3.4;

(vii) location of existing and proposed services (e.g. sanitary drains, water services and similar);

(viii) works necessary to protect buildings and other services during the installation of the surface water drainage system;

(ix) works necessary to protect the surface water drainage system during the construction of proposed buildings and other services;

(x) location of special drainage facilities, such as on-site stormwater detention storage areas and tanks; and

(xi) location of existing and proposed arresters to reduce contaminants (e.g. petroleum products and leachate from rubbish tips on industrial or commercial sites).

(b) Provision for overland flow paths for the safe disposal of stormwater flows due to discharge from —

(i) roof drainage system overflow devices due to blockages of downpipes;

(ii) surcharged site stormwater drains or point(s) of connection (i.e. surcharge outlets or inlet pits); or

(iii) rainfall events with an AEP greater than the design AEP, allowing for possible discharges from adjacent areas.

~~L.8~~M.8 Surface water drainage systems — Design

~~L.8.1~~M.8.1 Concentrated discharges to streets

~~Where~~If the network utility operator places a limit on the discharges that can be made to a street gutter at a single point, the surface water drainage system will have to be altered if it is found that the discharge exceeds such a limit. Alterations would usually involve the division of a pipe system into two or more systems, discharging independently to the street.

~~L.8.2~~M.8.2 Snowfall effects

In regions subject to snowfalls there is no special effect on the sizes of elements of surface water drainage systems, but precautions should be taken to minimize the entry of stormwater run-off or meltwater into buildings or ponding against buildings as a result of accumulated snow.

~~L.9~~M.9 Subsoil drainage systems — Design

A method of subsoil drainage system design is outlined in .Appendix L.

Detailed designs of subsoil drainage systems are complex and dependent on particular site or soil conditions. Such systems should be undertaken with advice from a suitably qualified competent person. An example of a suitable qualified competent person is a professional engineer specializing in geotechnical engineering.

L.10M.10 Erosion and sediment controls

During construction, precautions to minimize soil erosion and the escape of sediment from the site, due to rainfall and stormwater, should be considered. These precautions may include —

(a) covering exposed or disturbed surfaces with vegetation or meshes to prevent erosion and mobilization of sediments;

(b) surface grading of sites and the direction of stormwater flow paths through construction sites so that erosion is minimized, including limits on slopes and lengthening of flow paths using barriers;

(c) provision of sediment barriers along flow paths and watercourses, such as silt fences, hay bales and porous stone filters; and

(d) construction of temporary sediment traps or basins (usually near site boundaries) to collect sediments for removal.

L.11M.11 Other than stable grounds

WhereIf excessive soil movement due to filled, unstable or water-charged ground may affect the performance of any site stormwater drain or subsoil drain, then suchthe drain should be installed in accordance with the plans and specifications based on a geotechnical report and calculations.

In proclaimed mine subsidence districts, site stormwater drains larger than DN 225 should conform to the requirements of the relevant authority.

L.12M.12 Above-ground systems

For OSD systems located above the ground, the following criteria are recommended:

(a) In landscaped areas —

   (i) a desirable minimum slope for surfaces draining to an outlet to be 1:60, and an absolute minimum slope to be 1:100;

   (ii) the desirable maximum depth of ponding under design conditions to be 300 mm;

   (iii) storage volumes in landscaping areas to be increased by 20 % to allow for vegetation growth, construction inaccuracies and possible filling;

   (iv) subsoil drains to be provided around outlets to prevent the ground becoming saturated during prolonged wet weather; and

   (v) whereif the storage is located in areas where frequent ponding would causecauses maintenance problems or inconvenience, the first 10 % to 20 % of the storage should be in an area that can tolerate frequent inundation, such as a paved outdoor entertainment area, a small underground tank, a permanent water feature or a rockery.

(b) In driveway and car park storages —

   (i) depths of ponding to not exceed 200 mm under design conditions;

   (ii) transverse paving slopes within storages to be not less than 1:140; and

(iii) ~~where~~if the storage is located in commonly used areas where ponding ~~would cause~~causes inconvenience, part of the storage should be provided in an area or form that will not cause a nuisance.

~~Appendix M~~Appendix N (informative) Operation of siphonic roof drainage systems

~~M.1~~N.1 General

Siphonic systems for drainage of roofs may achieve economies, saving of space and other benefits. They increase flow rates that can be conveyed by downpipes by ensuring that a piped system operates with full pipe flow. Their operation is complex, and the system becomes “primed” or mostly filled with water. This is achieved by using suitable inlets located in roof gutters and selecting appropriate pipe sizes and fittings.

Usually, flows pass through vertical tailpipes, horizontal pipework and vertical pipes before discharging to an underground pipe system. A siphonic system operating as a conventional gravity drainage system (i.e. non-siphonically) is shown in Figure N.1.

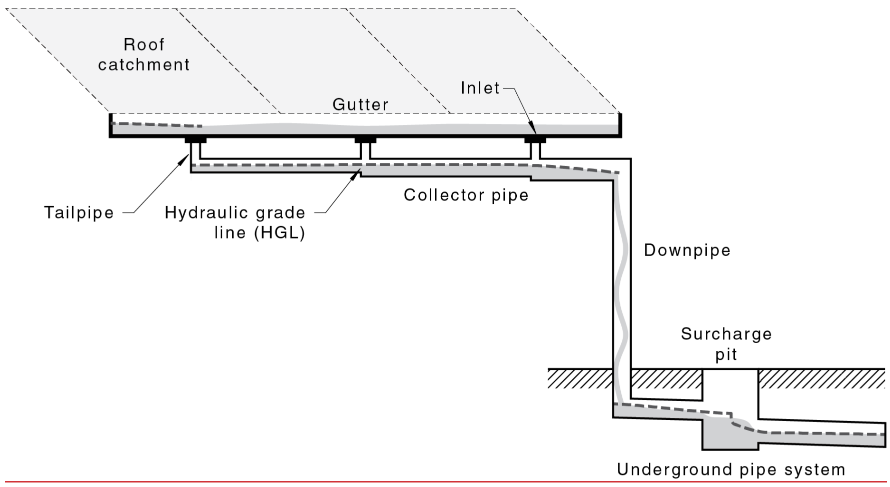


Figure N.1 — Siphonic piped roof drainage system — Flowing part-full

This system generally flows part-full when rainfall intensities are lower than approximately 40 % of the maximum design values. Under these below-design flow conditions, the operation is similar to that of a conventional gravity drainage system (Figure N.1). Gutter flows drain into tailpipes and enter horizontal pipes flowing part full. These connect to a vertical pipe that operates like a conventional downpipe, with spiralling (annular) flow running down the pipe walls, and a core of air being dragged down with the roof water. Air passes through the system, as well as water.

Hydraulic grade lines (HGLs) are used to define flow rates in pipes. In part-full flows, they usually coincide with the water surface. The HGL in the horizontal pipe is indicated approximately in Figure N.1; the HGL detail is quite complex, because flow rates are different in the three pipe segments between the tailpipes. There is a break in the HGL at the vertical pipe, and it continues again in the underground pipe system.

Once flow rates through siphonic systems increase beyond approximately 40 % of the maximum design flow rates, the system can start to prime causing short durations of full pipe flow (plug-flow) to occur through the system pipework. This causes cyclic periods of siphonic action (full-pipe) and non-siphonic action (partially full pipe with air pockets) to occur within the system. As the flow rate increases further, the durations of full-pipe, siphonic action also increases. As the flow rate in the system approaches approximately 70 %–% to 80 % of the design value, the system will generally be operating under full siphonic conditions. However, there will still be large amounts of air drawn into the pipework through the gutter outlets. The volume of air entrained into the system reduces as the flow rate gets closer to the system design value.

Figure N.2 shows the operation of the system at design rainfall intensities, when the pipe flows are sufficient to prime the system. Under these conditions, little air passes through the pipes. The HGL is now continuous, as all pipes are flowing full and under pressure.

The HGL can be drawn down to a position below the horizontal pipe, creating a negative pressure or suction that allows more flow to pass through the system.

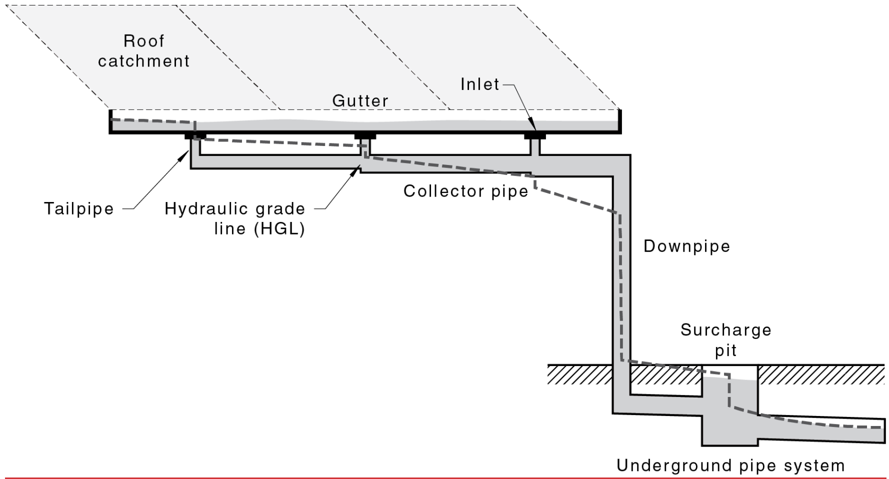


Figure N.2 Siphonic piped roof drainage system — Flowing full at design flow rates

At the start of a storm event, pipe flows are part-full then, as flow rates increase, a transition stage occurs, when parts of the pipework become submerged and air pockets or bubbles form. As flow rates increase further, air is flushed out of the system, the pipes prime and full-pipe flow occurs. However, this stage is not always stable, and air can be pulled through the pipes as surges occur in the vertical pipe.

Design of siphonic systems involves the careful and well-informed selection of pipe materials, diameters and fittings. The vertical downpipe may be designed with pipe diameters that are smaller than the horizontal upstream pipe, which aids in priming the system. The available head that drives the system is assumed to be the difference between the gutter level and a point of discharge at ground level, such as the open pit shown in Figure N.2. This design work is complex using specialized design software, and those designing the siphonic system should have knowledge of siphonic system hydraulics and be able to analyse systems to ensure that they operate as intended.

A water depth vs. inflow relationship is needed for the gutter inlets to ensure that water in gutters remains at safe depths.

As in all roof drainage systems, rainfalls that exceed design storm intensities or blocked inlets can cause overflows of gutters drained by siphonic systems. Due to the possibility of overflows entering a building, a secondary system of inlets is essential.

This may be a conventional drainage system or a duplicate siphonic system, with inlets in gutters placed at higher levels than those of the primary system. It should be sized to convey the same design flows as the primary system, without overflowing.

Siphonic primary and overflow drainage systems may be utilized for all types of roofs, e.g. concrete roofs, membrane decks or tiled balconies/terraces. A regular maintenance and inspection regime is necessary to avoid failures.

~~M.2~~N.2 General design procedure for siphonic roof drainage systems

~~M.2.1~~N.2.1 Design procedure

The purpose of the general design procedure is to —

(a) determine suitable catchment areas, set out a system of roof gutters, siphonic inlets, overflow devices and pipework, and determine vertical distances to discharge points;

(b) make use of ~~the appropriate~~ design tools ~~to analyse~~suitable for analysing and ~~balance~~balancing the siphonic system. ~~Designers~~Designs should also take into account gutter depths or concrete/membrane falls, and upstream and downstream water levels before and during siphonic operation;

(c) as necessary, vary the components and system layout until the design objectives are achieved; and

(d) provide plans and documents on the designed system and results of the analysis.

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~~M.2.2~~N.2.2 Design parameters

~~M.2.2.1~~N.2.2.1 Basis for calculations

The system design may be based on a steady-state depressurized condition ~~where~~if the piping is flowing at full bore with little or no entrained air (less than 10 % by volume) ~~utilizing~~using Bernoulli's Equation.

NOTE: Bernoulli's Equation is mentioned in many fluid mechanics textbooks.

~~M.2.2.2~~N.2.2.2 Gutter/inlet/pipe sizing

Gutters should be designed to contain accumulated water while the pipe system primes and have capacity to hold water without overtopping (to the level of the overflow) at the design rainfall intensity. The siphonic system should also be designed to the depth and width of the box gutter.

For gutter inlet rating curves and for defining inflows into gutter inlets for a given depth for specific fittings or devices, the manufacturer's data should be consulted.

Programs used for designing siphonic systems should cater for the gutter flow profiles.

It should be noted that gutter and overflow sizing methods provided in this document based on the "general method" are not suitable for use in siphonic roof drainage systems.

~~M.2.2.3~~N.2.2.3 Priming

Systems should be designed to prime (run full) quickly to ensure that gutter water levels do not rise above the primary drainage zone shown in Figure N.3.

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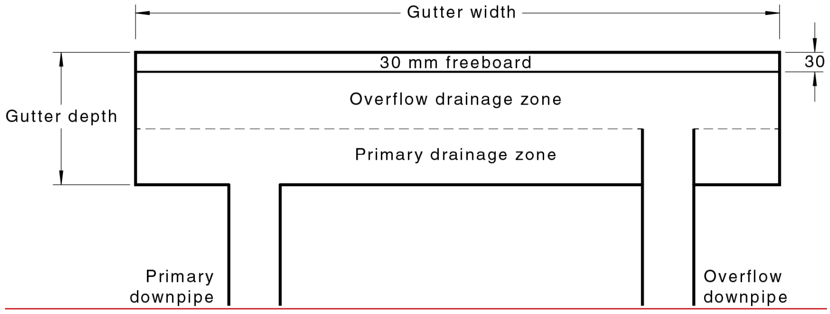


Figure N.3 — Guide to typical box gutter drainage zones

~~M.2.2.4~~N.2.2.4 Sloping gutters

Sloping gutters with sumps have limited storage capacity during the priming process, which should be taken into consideration in the design of the system.

~~M.2.2.5~~N.2.2.5 Low flow conditions

Siphonic roof drainage systems operate as normal atmospheric drainage systems at low flow conditions (lower than design rainfall conditions).

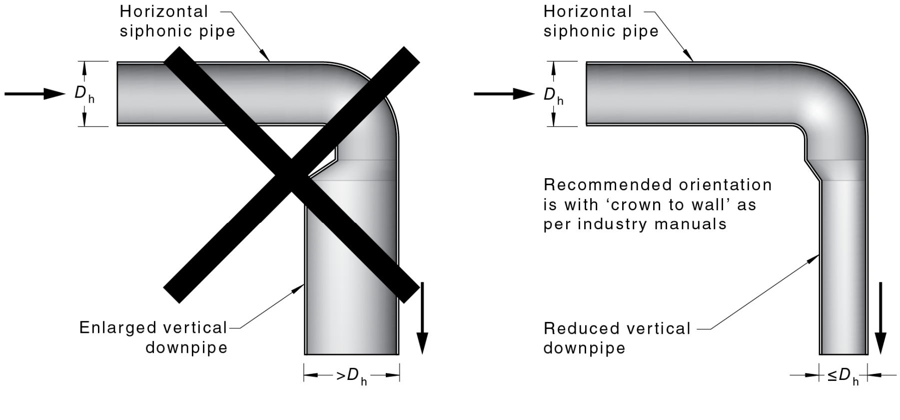
Siphonic roof drainage systems are designed to operate under full bore flow at the design rainfall conditions; however, systems go through various stages from atmospheric drainage, plug flow, bubble flow to full bore flow depending on the storm event. This enables the pipes to be horizontal and self-cleaning at the plug-flow stage.

~~M.2.2.6~~N.2.2.6 Siphonic roof inlet positions

Siphonic inlets should be positioned to minimize flow depths and placed such that flow rates from each direction are approximately equal and installed relatively flat < 1:100; otherwise, sumps with flat floors may be provided.

~~M.2.2.7~~N.2.2.7 Downpipes

There should be no expansions at the top of downpipes to a size larger than the horizontal pipe, see Figure N.4.



(a) Incorrect design (b) Correct design

Figure N.4 — Enlarged vertical downpipe

~~M.2.3~~N.2.3 Components

~~M.2.3.1~~N.2.3.1 Inlets

Siphonic inlets are critical to the operation of the system as the baffle (anti vortex/air excluder) would greatly increase the efficiency and generate siphonic action more quickly. They should be secured and in the correct position, as is the debris guard.

~~M.2.3.2~~N.2.3.2 Access points for cleaning

There should be no access points for cleaning or inspection along the entire siphonic system. Rodding to remove blockages should be done from the roof inlets; otherwise, the pipe may be cut and reinstated.

~~M.2.3.3~~N.2.3.3 Pipe/fittings

Pipe and fittings should be designed to suit all internal and external environmental and operational conditions.

Horizontal piping should be carefully installed to ensure it does not have even a small uphill gradient, which will trap water and delay priming.

External temperature is also a consideration for the pipe support system in order to take into account expansion and contraction.

~~M.2.3.4~~N.2.3.4 Reducers or expanders

Any reducers or expanders in horizontal collector pipes should be configured to prevent the formation of entrapped air pockets during the priming process.

~~M.2.4~~N.2.4 Validation of design — Outline checks

Calculation results and certification should be provided for validation purposes. The installed system should include signed as-built drawings showing the installed conditions. System certification should include the following:

(a) Design rainfall intensity (AEP).

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(b) Pipework material and grade/class.

(c) Minimum and maximum system pressures.

(d) Maximum system imbalance.

(e) Minimum velocity.

(f) Discharge velocity.

(g) Maximum water level flow depth on the roof or gutter.

~~M.2.5~~N.2.5 Installation

~~M.2.5.1~~N.2.5.1 Blockage prevention

During construction, measures should be taken to prevent the entry of debris into the pipework through the use of temporary caps, with leaf guards and baffles removed and stored ~~where~~if necessary.

~~M.2.5.2~~N.2.5.2 Reducers or expanders

Reducers or expanders should be eccentric. The soffit of the fitting should be in common alignment with the soffit of the pipe to which it is connected, see Figure N.5.

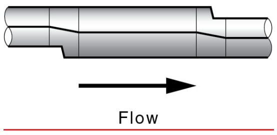

Figure N.5 — Orientation of reducers in a siphonic system

~~M.2.5.3~~N.2.5.3 Fixings and support

The pipe support system should be capable of withstanding both live and dead loads as well as forces generated during the systems operation. ~~Where~~If the collector pipe ~~if greater~~is more than 100 mm from the supporting structure, the use of continuous rail along the pipe is recommended.

~~M.2.5.4~~N.2.5.4 Changes during construction

During construction, the installation should not deviate from the design layout, pipe material and pipe sizes. If changes to the layout (such as an additional bend to avoid an obstruction) are unavoidable, the whole system should be analysed to ensure the design parameters are not adversely affected.

~~M.2.6~~N.2.6 Testing and commissioning

~~M.2.6.1~~N.2.6.1 Inspection

The completed siphonic drainage system should be inspected to ~~ensure~~confirm it ~~fully conforms to~~meets the design specification.

~~M.2.6.2~~N.2.6.2 Hydrostatic/air test

For hydrostatic/air tests, refer to the testing of sanitary plumbing and sanitary drainage installations as specified in ~~accordance with~~ Clause 9.4.2 for a period of 30 min.

~~M.2.6.3~~N.2.6.3 Condition of system on commissioning

The whole system should be placed in fully operational condition. In particular, all baffle plates and debris guards should be in place.

~~M.2.7~~N.2.7 Maintenance, inspection and cleaning

~~M.2.7.1~~N.2.7.1 Frequency

The siphonic drainage system should be inspected and cleaned at least every six ~~months or more frequently where~~if the potential for blockage is likely. Supports and fixings should be inspected and tightened~~, and~~. Baffles should be checked to ~~ensure~~confirm they are in the correct position, clean and reinstalled.

~~M.2.7.2~~N.2.7.2 Documentation

An inspection log should be maintained and kept with building records.

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<std>AS/NZS 1665, *Welding of aluminium structures*</std>

<std>AS/NZS 2312, *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*</std>

<std>AS/NZS 4020, *Testing of products for use in contact with drinking water*</std>

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<std>EN 752, *Drain and sewer systems outside buildings — Sewer system management*</std>

<std>ASTM A240, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*</std>

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<unknown>New Zealand Building Code (NZBC), Acceptable Solution E2/AS1</unknown>