8.0 ROOF DRAINAGE

8.1 DESIGN

The roof drainage system for a building consists of four separate parts:

- gutter or spouting
- outlet, sump, rain-water head
- downpipe
- drain.

N.B. Ground drainage is outside the scope of this Code of Practice.

This section specifies good trade practice for the design of roof drainage systems including eaves, valley and box gutters, sumps, rain-water heads and downpipes, based on the Average Recurrence Interval (ARI) ***(see 8.2.)*** and the applicable catchment area calculations.

The objective of roof drainage systems is to maintain a weatherproof building, to minimise risk of injury or inconvenience due to flooding, and to avoid potential monetary loss and property damage including the contents of buildings. Any ingress of moisture can lead to dampness that encourages the growth of moulds some of which are detrimental to health. Flooding, not necessarily related to the intensity of rainfall or the design of the drainage system, is often caused by gutter or spouting blockages arising from inadequate regular cleaning and inspection. Drainage systems as described in this section will not perform as required without on-going normal maintenance. ***(see maintenance section 13)***

Roof drainage design requires consideration of the following:

- rainfall intensity
- catchment area
- cross-sectional gutter area
- sump design
- cross-sectional area of downpipes
- water disposal from downpipes
- overflows
- roof cladding profile capacity
- roof pitch
- penetrations which obstruct water flow

This section details specific requirements for the sizing of all drainage components and for design purposes only, level gutter design is assumed.

8.2 RAINFALL INTENSITY

When calculating roof drainage where significant inconvenience or injury to people or damage to property, including building contents is unlikely the Average Recurrence Interval (ARI) used must be 10 years.

e.g. due to an overflow of external eaves gutters.

When calculating roof drainage where significant inconvenience or injury to people or damage to property, including building contents is likely the Average Recurrence Interval (ARI) used must be 50 years.

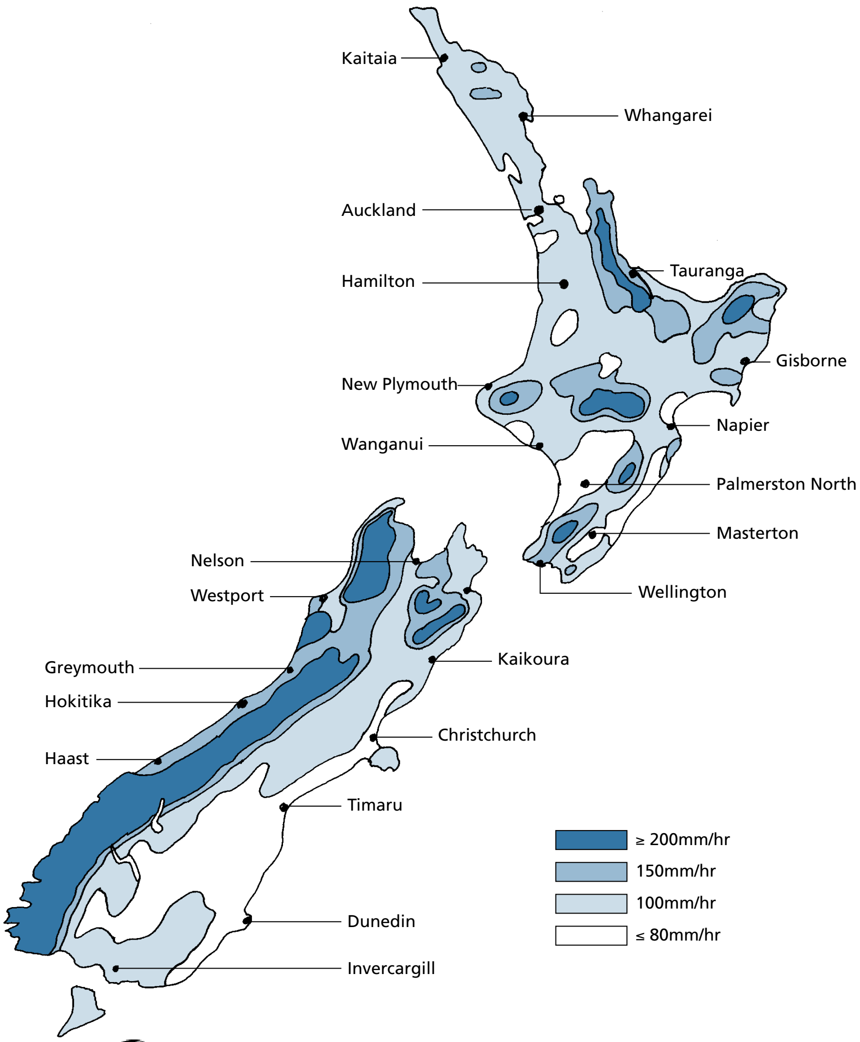
e.g. due to an overflow of internal gutters.

A higher level of rainfall should be allowed when designing for higher risk situations.

The rainfall intensity in New Zealand is determined by the rainfall during a ten minute period measured in millimetres per hour, and different areas in New Zealand vary considerably in their rainfall intensity.

Although a rainfall of (say) 17mm in ten minutes (100mm/hr) is considered unlikely, the equivalent of 3mm in two minutes is likely and is therefore used as a basis to avoid flooding.

N.B. The local Territorial Authority can determine the rainfall intensity.



MAP 8.2.

Sourced from NZ Metal Roof and Wall Cladding Code of Practice, Version 2.2 / 2012

The NZ Rainfall Intensity Map 8.2 shows areas with a 10% probability that rainfall will exceed the specified mm/hr for a 10 minute duration for an ARI of 50 years.

During rainstorms, long periods of steady rainfall are interspersed with heavy downpours for short periods, and the roof-drainage system should be capable of handling the peak intensities without flooding. A considerable time-delay occurs on large low pitch roofs between the on-set of rain and when the water discharges at the downpipe. This time lag alters the rate of flow capacity required for the gutter and downpipe to discharge without overflow.

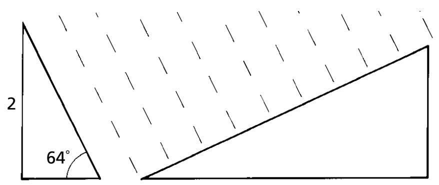
Gutter overflow is acceptable on eaves gutters or freely discharging downpipes if they are designed to do so, but cannot be permitted from internal gutters or downpipes.

When the site rainfall intensity shown on Map 8.2. is greater than 100mm/hour the gutter and downpipe cross-sectional areas must be proportionally increased as prescribed in Table 8.2.2.1.

8.2.1 CATCHMENT AREA

The rain catchment area for a roof, or roof and wall, is determined by the direction of wind-driven rain, and depends upon the descent angle of the rain or if there is a wall adjacent to the roof.

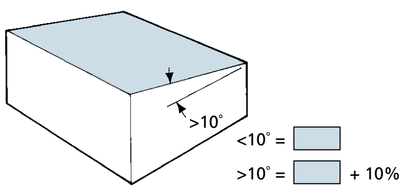
This allowance for the effect of wind on rainfall is required for all roofs with a greater pitch than 10˚ and a slope of 2:1 is used for this calculation. ***(This is the tangent of 64˚ see drawing 8.2.1.A)***



Drawing 8.2.1.A

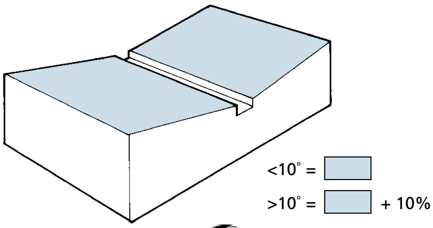
Adjustment to the roof catchment area is required because it is recognised that rain is usually accompanied by wind, which can effectively increase the catchment area. There are a number of formulae and slope factors that can be used to determine the wind drift effect specifically for each building, some of which are contained in AS/NZS 3500. This assumption assumes the worst scenario and provides a conservative answer because when the wind is in the opposite direction, shielding would decrease the catchment area.

The sloped roof catchment area for all sloped roofs with a pitch >10˚ and freely exposed to the wind, must be increased by 10% to allow for the wind drift effect. *(see drawing 8.2.1.B)*



Drawing 8.2.1.B

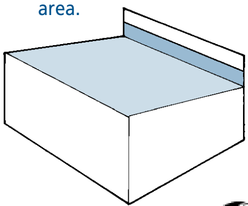
For multiple roofs some allowance can be calculated for shielding, however in the interests of simplicity, and because of the permutations of roof pitch and length, the sum of the sloped roof areas will give a conservative figure to be used when calculating the required internal gutter capacity. ***(see drawing 8.2.1.C)***



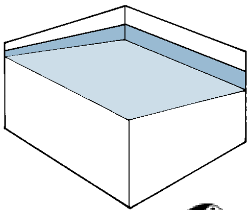
Drawing 8.2.1.C.

For roofs where there is a vertical wall adjacent to the roof slope there are three different situations.

- Where the roof pitch is < 10˚. The catchment area is the sum of the sloped surface area and 1/2 of the vertical wall surface area. ***(see drawing 8.2.1.D.)***
- Where the roof pitch is > 10˚. The catchment area is the sum of 1.1 x the sloped surface area and 1/2 of the vertical wall surface area. ***(see drawing 8.2.1.D.)***
- Where there are adjacent vertical walls at right angles to each other, the catchment area is the sum of the sloped surface area and 1/2 of both of the vertical wall surface areas. ***(see drawing 8.2.1.E.)*** The catchment area for high vertical walls such as a multi-storey building, may be considerably less than half its surface area.



Drawing 8.2.1.D.



Drawing 8.2.1.E.

When a high vertical wall is subsequently built adjacent to an existing gutter, it is likely that its capacity would be overloaded. In this case either the increased catchment area should be drained separately or the gutter should be redesigned.

All roofs freely exposed to the wind	< 10˚	= sloped roof area
Sloped roofs freely exposed to the wind	> 10˚	= sloped roof area x 1.1
Vertical wall/s adjacent to the roof slope	< 10˚	= sloped roof area + 1/2 wall area
Vertical wall/s adjacent to the roof slope	> 10˚	= sloped roof area + 1/2 wall area x 1.1

Table 8.2.1.

Catchment Area Calculation

After the catchment area has been determined by Table 8.2.1., the capacity of the gutters and downpipes can be calculated by two simplified methods:

- Method 1 Graph for pitches <10˚
- Method 2 Calculations for any pitch.

8.2.2 CAPACITY CALCULATIONS

Because the roof pitch, length of run, gutter and downpipe size, shape and fall are all inter related in the determination of the capacity of each other, the calculations in sizing these components can be complicated.

Assumptions can be made to provide a conservative and simple assessment of the capacity of spouting, gutter and downpipe for roof drainage by two methods.

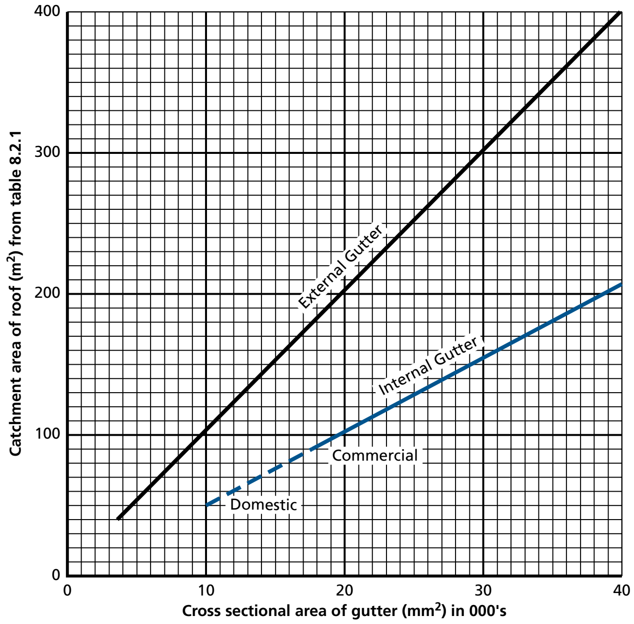
GUTTER AND DOWNPIPE CAPACITY DETERMINED BY GRAPH

METHOD 1

When using the simplified graphs 8.2.2. the following assumptions have been made:

- **roof pitches 3˚ – <10˚ (for greater pitch see *table 8.2.2.C.*)**
- **roof area 50m² – 300m²**
- **minimum cross-sectional area of gutter = 4000mm²**
- **flat gutter or spouting (for design purposes only)**
- **no restrictions – no spouting, gutter or downpipe angles**
- **fre discharge – weir into a sump or R.W.H. with overflow**
- **rainfall intensity = 100mm/hour (for greater rainfall see *table 8.2.2.A.*)**
- **external vertical downpipes**

Given these assumptions the design capacity of gutters and downpipes is given in graph 8.2.2

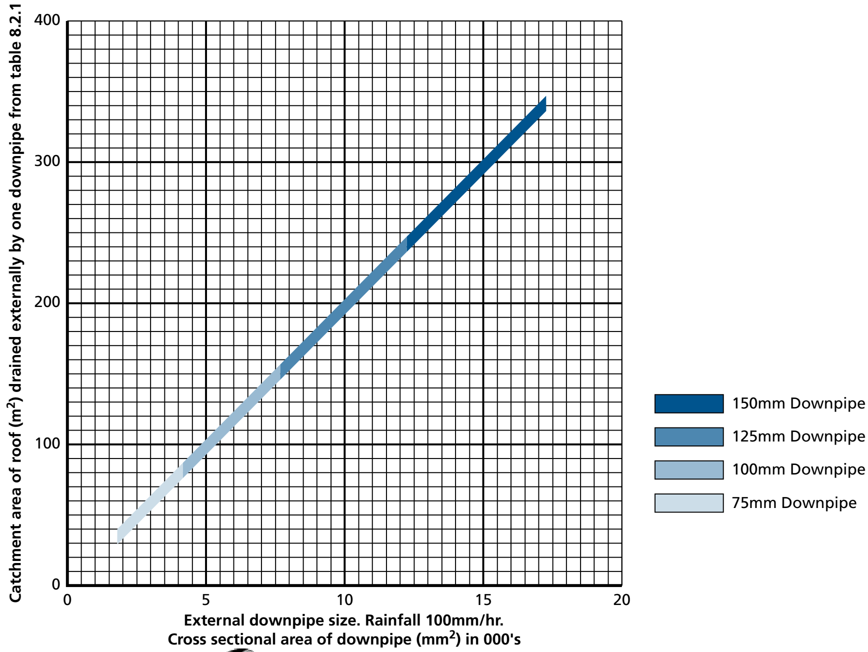


These graphs are suitable for roof pitches up to 10° and a rainfall intensity of 100mm/hr.

For other roof pitches and rainfall intensities see the example.

Graph 8.2.2. is based on 100mm/hr for other intensities refer to table 8.2.2.B.

For internal gutters a safety factor of 2 has been used.



Graph 8.2.2.

Sourced from NZ Metal Roof and Wall Cladding Code of Practice, Version 2.2 / 2012

GUTTER AND DOWNPIPE CAPACITY DETERMINED BY CALCULATIONS

METHOD 2

After the catchment area has been determined by table 8.2.1., the capacity of the gutters and downpipes can be determined by using the tables below.

Table 8.2.2.A Cross-sectional area per m² for rainfall 100mm/hr

external gutter or spouting	= 100mm^2
internal gutter	= 200mm^2
vertical external downpipe	= 50mm^2
horizontal downpipe <15°	= 100mm^2

Table 8.2.2.B Rainfall

For rainfall >100mm/hr the catchment area must be factorised to allow for the increased rainfall as per map 8.2.

80mm/hr	multiply by a factor	0.8
100mm/hr	multiply by a factor	1.0
150mm/hr	multiply by a factor	1.5
200mm/hr	multiply by a factor	2.0

Table 8.2.2.C Roof pitch

For roof pitches >10° the catchment area must be increased to allow for the increased rate of run-off.

Pitches		
10° – 25°	multiply by a factor	1.1
25° – 35°	multiply by a factor	1.2
35° – 45°	multiply by a factor	1.3
45° – 55°	multiply by a factor	1.4

Example: Calculation to find capacities using simplified method.

Given:	Freely exposed monoslope roof Tauranga Sloping rafter length 5.9m Length of building 10m Roof pitch 24°	
Step 1	Find rainfall intensity from map 8.2 From table 8.2.2.B	150mm/hr factor = 1.5
Step 2	Roof pitch from table 8.2.2.C.	factor = 1.1

Step 3 To find the factorised catchment area from Table 8.2.1.

59m² x 1.1 = 65m²

Calculation 65 x 1.5 x 1.1 = 107m²

External gutter	= 100mm² x 107	= 10,700mm²
Internal gutter	= 200mm² x 107	= 21,400mm²
Vertical downpipe	= 50mm² x 107	= 5,350mm²
Horizontal downpipe <15°	= 100mm² x 107	= 10,700mm²

Step 4 From table 8.2.2.3. Find suitable spouting and downpipe.

Standard gutter

	mm²
125mm 1/4 round	5,000
125mm x 75mm rectangular	9,375
175mm x 125mm rectangular	21,875
300mm x 125mm rectangular	37,500

Standard downpipes

Round	mm²	Rectangular/square	mm²
65mm	3,318	100 x 50mm	4,500
80mm	5,027	100 x 75mm	6,750
100mm	7,854	100 x 100mm	9,000
125mm	12,272	(N.B. square and rectangular downpipe capacities have been depreciated by 10%)	
150mm	17,671		

Table 8.2.2.3.

External gutter or spouting = standard 175 rectangular.............................. O.K.

One vertical downpipe = 100mm round or 100mm x 75....................... O.K.

OR 1/4 round with two downpipes (one at either end ***see drawing 8.2.2.***)........................... O.K.

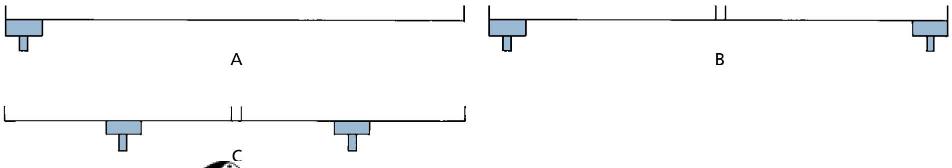
Two vertical downpipes = 63mm round .... O.K.

Step 5 Internal gutter = custom-made = 220 x 100 = 22,000 .... O.K.

An internal gutter normally requires 20mm freeboard, however using this simplified calculation method for rainfall areas >100mm/hr, having the catchment basis of 200mm/hr, an internal gutter would be over designed if additional free-board was added. Similarly internal downpipes having no overflow to the exterior of the building could be underd-esigned and their capacity should be increased by 25%. N.B. Flooding usually occurs due to the incapacity of the drain rather than the downpipe.

For domestic and small commercial buildings, standard spouting, gutters and downpipes represent the most economical method of complying with the capacity requirements, but if large gutters are required these should be custom made to specific dimensions.

The position of the outlet can make a significant difference to the size of the gutter required.



Drawing 8.2.2.

As can be seen in drawing 8.2.2. when the catchment area is identical, the gutter capacity at A can be reduced by half at B and to one quarter at C. The downpipe capacity required at both B and C is half that of A.

The preferred proportion for an internal gutter is 2:1 i.e. the sole of the gutter should be twice the height. The minimum height of an internal gutter should be 70mm however the height is recommended to be 1/60 of the length. Recommended maximum length of a coated steel gutter without an expansion provision should be 12m. However 6m can be the maximum length if the outlets are spaced at 12m as shown in drawing 8.2.2. Non-ferrous metal gutters have restrictions on their length depending on their thickness.

When an external spouting has a dropper outlet or an external angle, the capacity of the spouting should be depreciated by an allowance of 10% for each outlet or angle. Outlets should be placed within 2m of an angle.

Dropper outlets must not be used on internal gutters.

Sumps or Rain Water heads must be used to drain all internal gutters and also be placed at gutter angles.