DAM BUSTER®

Achieve Compliance & Conformance with

Dam Buster Products

NOTE: All Dam Buster® products are protected by various Australian and International Patents.

AUSTRALIAN OWNED #00581 CERTIFIED

This document is to be read in conjunction Dam Buster publications titled 'Product Technical Statement' and 'Installation Manual'. Together, these documents form Evidence of Suitability for both the BCA & PCA in accordance with governing provisions A5.2 & A5.3.

EVIDENCE OF SUITABILITY

Version 6.0 (22 April 2024)

AHSCA – Association of Hydraulic Services Consultants Australia – Research Foundation

CERTIFIED PRODUCT
(DAM BUSTER RAINHEAD)

For testing of the Overflow Performance of Dam Buster rectangular rainheads.

GOOD DESIGN AWARD® WINNER

PRODUCT DESIGN
HARDWARE AND BUILDING

DAM BUSTER RAINHEAD

"The Architectural Choice"

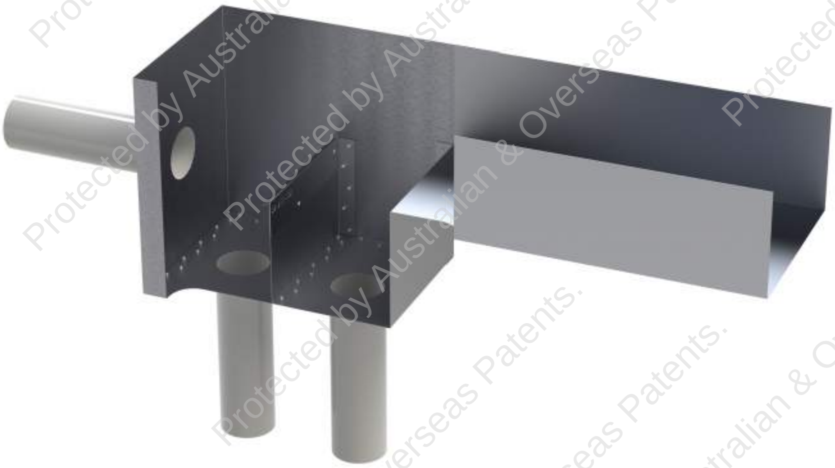
www.dambuster.com.au

Dam Buster Roof Drainage System - Product Range

Overflow devices (1 of 2)

Dam Buster Rainhead

Dam Buster Curved Fronted Rainhead



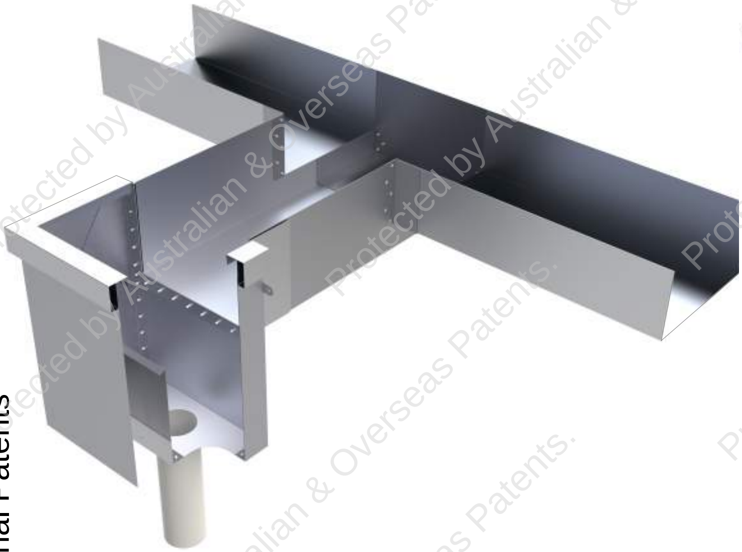
Dam Buster Sump

Dam Buster Back-to-Back Sump

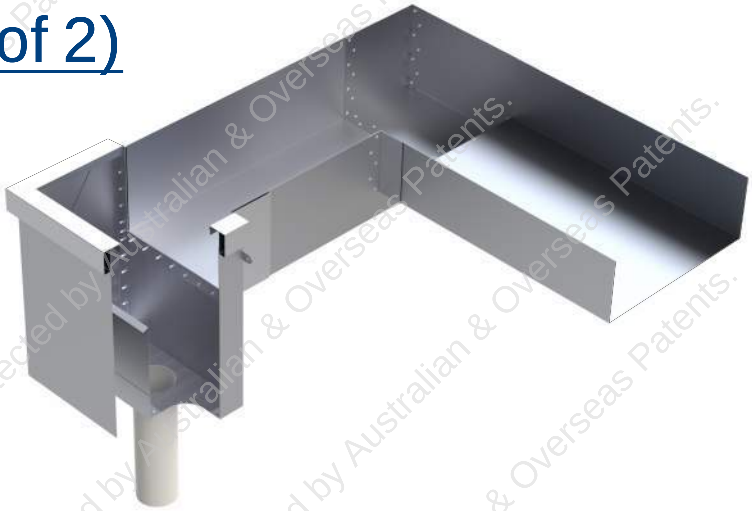
Dam Buster Continuous Sump

Dam Buster Roof Drainage System - Product Range (cont)

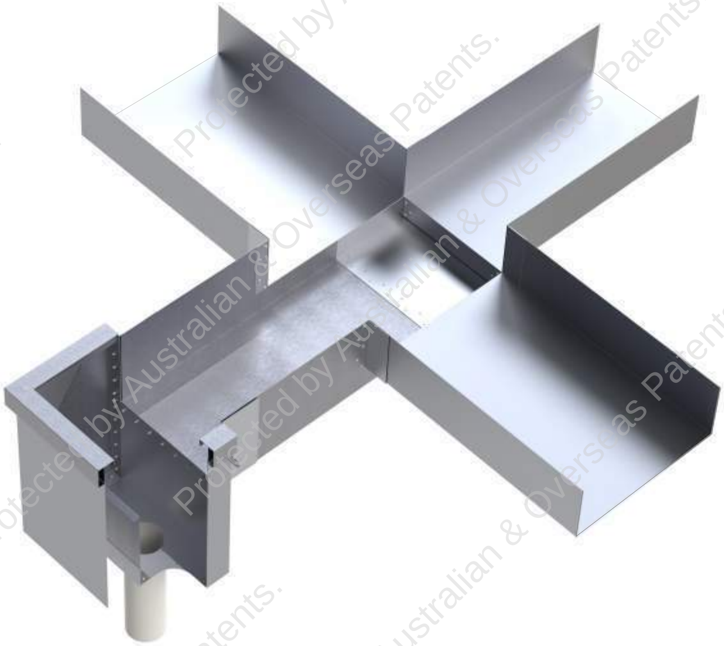
Overflow devices (2 of 2)



Dam Buster T Side Outlet & Rainhead



Dam Buster END Side Outlet & Rainhead
(LH & RH forms available)



Dam Buster CRUCIFORM Side Outlet & Rainhead

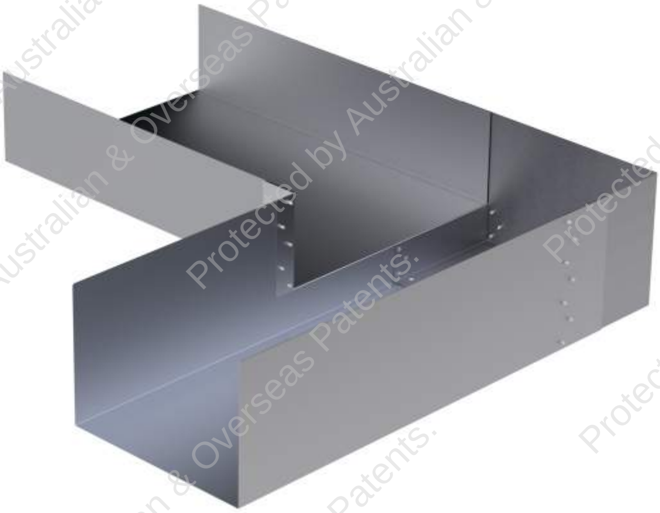
Dam Buster CORNER Side Outlet & Rainhead
(LH & RH forms available)

NOTE
The following Side Outlet & Sump combinations are also possible
Dam Buster T Side Outlet & Sump
Dam Buster Corner Side Outlet & Sump
Dam Buster Cruciform Side Outlet & Sump

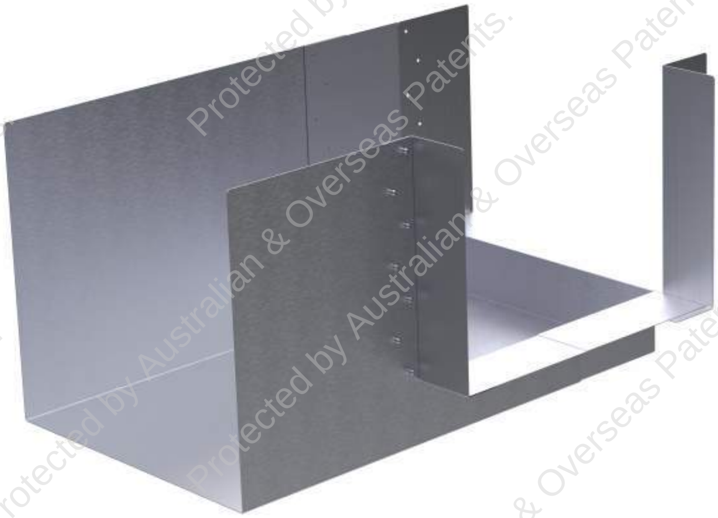
Dam Buster END Side Outlet & Sump
(LH & RH forms available)

Dam Buster Roof Drainage System - Product Range (cont)

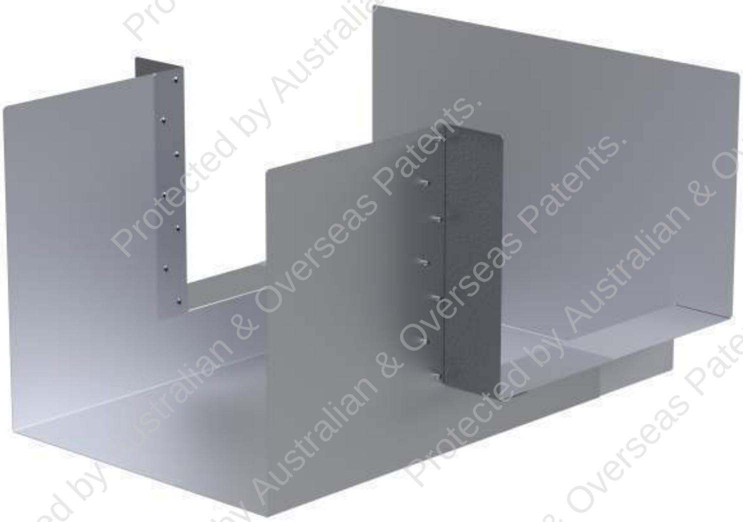
Upstream devices



Dam Buster Elbow



Dam Buster Corner Junction



Dam Buster T Junction

INDEX

NOTE

Where this document refers to any code, guide or manual, this reference should be interpreted as being for the current legal version of the code, guide or manual for the relevant state or territory, unless noted otherwise.

1.0 DAM BUSTER PRODUCTS

The components which form the Dam Buster Roof Drainage System can be used in both domestic (including multi-residential) and commercial roof plumbing applications.

Dam Buster products are comprised of Zincalume, Colorbond or other approved metal materials suitable for use in domestic and/or commercial roof drainage systems.

Models:

- Dam Buster **Rainhead**
- Overflow device comprising a **Dam Buster Side Outlet** (4 available types) and a **Dam Buster Rainhead** or a **Dam Buster Sump**
- Dam Buster **Sump**, **Continuous Sump** and **'Back-to-Back' Sump** ('free flow' sumps)
- Dam Buster **Elbow** & Dam Buster **Junctions** (2 available types)

2.0 COMPLIANCE WITH THE NCC

2.1 Governing requirements and Compliance Solutions

In all states and territories, roof drainage falls under the relevant sections of the NCC volumes 1 and 2 (i.e. the Building Code of Australia or BCA). However, in Victoria and Tasmania (only) there are state additions for roof drainage within the NCC Volume 3 (i.e. the Plumbing Code of Australia or PCA), enabling roof drainage to also be carried out as regulated plumbing work under the relevant state Plumbing Regulations.

There are different pathways through the NCC, but in all cases it is necessary to comply with both the **Governing Requirements** and the relevant **Performance Requirements** (which differ, but are similar, between the BCA and the PCA). Note that the Part A Governing Provisions of the NCC is the same for each volume.

Part A2 of the NCC, titled '**Compliance with the NCC**' explains the possible methods of demonstrating compliance with the NCC. It explains the various '**Compliance Solutions'** available, and the appropriate steps that must be taken for each of these pathways. Part A2 includes the following chapters:

- A2G1 Compliance
- A2G2 Performance Solutions
- A2G3 Deemed-to-Satisfy Solution
- A2G4 A combination of solutions

2.2 Part A2G1 Compliance

Part A2G1 states:

(1) Compliance with the NCC is achieved by complying with-

(a) the Governing Requirements of the NCC; and

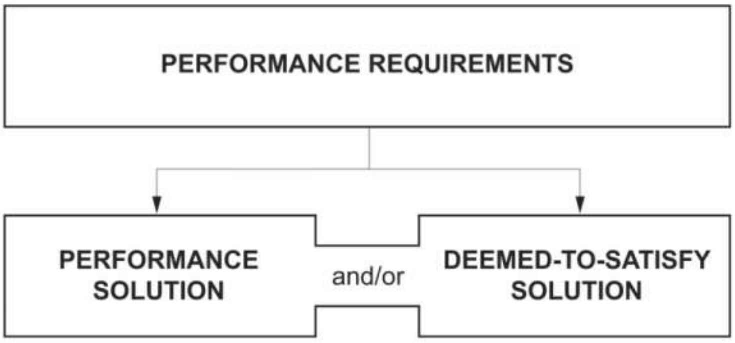
(b) the *Performance Requirements*

(2) *Performance Requirements* are satisfied by one of the following, as shown in Figure A2G1:

(a) Performance Solution

(b) Deemed-to-Satisfy Solution

(c) A combination of (a) and (b)



2.3 Part A2G2 Performance Solution

Part A2G2 Performance Solution states:

(1) A *Performance Solution* is achieved by demonstrating –

(a) compliance with all relevant *Performance Requirements;* or

(b) the solution is at least equivalent to the *Deemed-to-Satisfy Provisions*

(2) A *Performance Solution* must be shown to comply with the *Relevant Performance Requirements* through one or a combination of the following *Assessment Methods*:

(a) Evidence of suitability in accordance with Part A5 that show the use of material, product, plumbing and drainage product, form of construction or design meets the relevant Performance Requirements

(b) A *Verification Method* including the following:
  i. The *Verification Methods* provided in the NCC
  ii. Other *Verification Methods*, accepted by the appropriate authority that show compliance with the relevant Performance Requirements
(c) Expert Judgement
(d) Comparison with the *Deemed-to-Satisfy Provisions*

Section (4) of A2G2 provides details of the **Performance Solution Process** that is required to be followed when preparing a Performance Solution. The four main steps for this process are:

1. Prepare a **Performance Based Design Brief ('PBDB')**
2. Carry out an analysis
3. Evaluation the results
4. Prepare a **Final Report**

As discussed in section 3.2 of this document, it may be necessary to use Dam Buster products under a Performance Solution. However, Dam Buster has prepared Performance Solution templates for the PBDB and Final report, which make this process straightforward.

2.4 Part A2G3 Deemed-to-Satisfy Solution

Part A2G3 Deemed-to-Satisfy Solution states:

(3) A solution that complies with the *Deemed-to-Satisfy Provisions* is deemed to have met the Performance Requirements.

(4) A *Deemed-to-Satisfy Solution* can show compliance with the *Deemed-to-Satisfy Provisions* through one or more of the following *Assessment Methods:*

(a) Evidence of suitability in accordance with Part A5 that shows the use of a material, product, *plumbing* and *drainage product*, form of construction or design meets a *Deemed-to-Satisfy Provision*

(b) Expert Judgement

3.0 COMPLIANCE OF THE DAM BUSTER BOX GUTTER SYSTEM

3.1 Compliance of BOX GUTTERS discharging to a Dam Buster device

Box gutters discharging to all Dam Buster devices operate under 'free flow' in both the normal flow and overflow conditions. This means that all box gutters discharging to Dam Buster box gutter overflow devices must be designed in accordance with Appendix H, Figure H.1 of AS/NZS 3500.3-2021 in order to be certified as Deemed to Satisfy (DtS) solutions suitable for use with Dam Buster's free flow products.

The design of the upstream box gutter discharging to a Dam Buster Elbow is slightly different; it is designed for a flow rate equivalent to the total catchment area of the roof sections discharging to both the upstream and downstream box gutters, however it is still designed in accordance with Figure H.1. Note, it is not necessary to design the downstream box gutter from the Dam Buster Elbow, as it will automatically comply with Figure H.1 due to its increased depth as a direct result of the vertical drop within the Elbow. The Dam Buster Junctions are however designed slightly differently - please refer to the Product Technical Statement.

Note that all box gutters discharging to Dam Buster devices must be designed for a minimum of 3L/s and a maximum flow rate of 16L/s. If the calculated flow rate is less than 3 L/s, the minimum design flow rate of 3L/s should be adopted instead. Where more than one box gutter discharges into a Dam Buster box gutter overflow device, the overflow device is designed for the total of the actual design flows, but again not less than 3L/s.

The fact that all box gutters discharging to Dam Buster devices operate under free flow in both the normal flow and overflow conditions allows them to be designed 'independently' of the device itself.

In summary, all box gutters (which have been correctly designed for 'free flow' in accordance with Figure H.1, Appendix H, of AS/NZS 3500.3) utilised in conjunction with correctly sized and installed Dam Buster products are Deemed-to-Satisfy Solutions (unless otherwise covered by a separate box gutter Performance Solution, if necessary).

3.2 Compliance Solutions for Dam Buster DEVICES

Compliance of Dam Buster devices can be achieved by using either of the following **Compliance Solutions**:

1. Part A2G3(2)(b) – Deemed-to-Satisfy (‘DtS’) by Expert Judgement

   OR

2. Part A2G2 – Performance Solution

The first method, DtS by Expert Judgement, is preferred, however, if not accepted by the Regulatory Authority and / or Building Surveyor / Certifier, second method, Performance Solution can be used.

3.3 Compliance of Dam Buster DEVICES via Expert Judgement

All Dam Buster devices themselves have been certified as **Deemed-to-Satisfy by Expert Judgement** under part A2G3 (2)(b). Refer to section 6 for details of Dam Buster’s hydraulics expert, Adjunct Associate Professor Robert Keller (‘Keller’).

Keller has reviewed the Dam Buster Box Gutter System, and prepared a number of expert opinions, based on the following:

- Physical testing of Dam Buster rainheads in the overflow condition by Associate Professor Dr. Terry Lucke, AHSCA Research Foundation.
- Physical testing of Dam Buster devices, carried out by Dam Buster, under the supervision of Keller.
- Analyses of Dam Buster devices using hydraulics theory
- Comparison of the physical testing results with the analyses using hydraulics theory
- Benchmark comparison of Dam Buster device with the three DtS box gutter overflow devices in AS/NZS 3500.3, i.e.
  - Rainhead
  - Sump and Side Outlet
  - Sump / High-Capacity Overflow device
- Assessment of whether the Dam Buster devices comply with the general principles in AS/NZS 3500.3

3.4 Compliance of Dam Buster DEVICES via Performance Solution

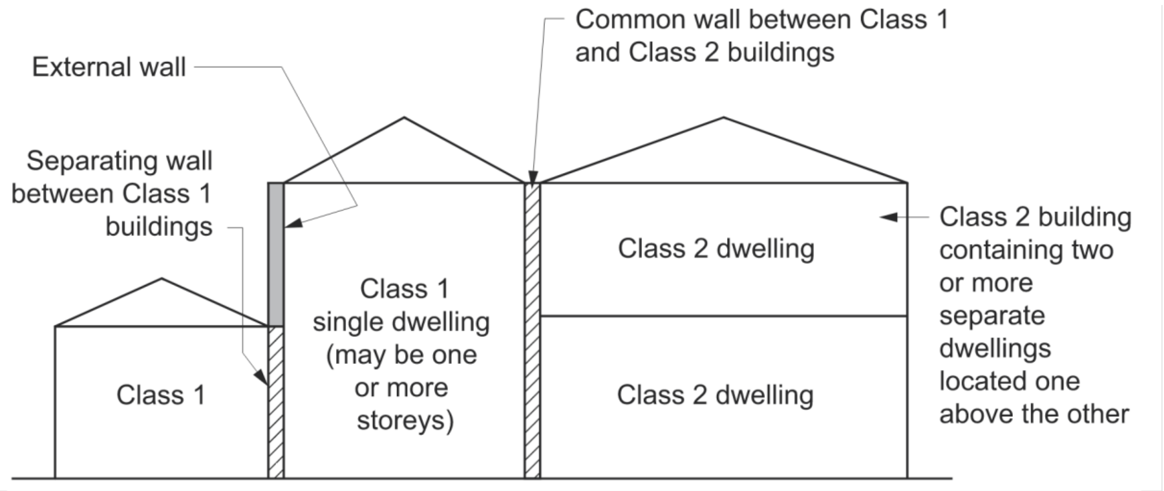
In order to simply the Performance Solution Process, Dam Buster has prepared the following templates, which may be downloaded from the website.

Performance Based Design Brief template

- This may be used for all volumes of the NCC
- It applies to all classes of buildings

Final Report templates

- The Performance Requirements between the different volumes of the NCC are similar, with some variations. Final report templates are available for
  - BCA Volume 1 – Class 2 to 9 buildings
  - BCA Volume 2 – Class 1 and Class 10 buildings
  - PCA (Victoria)
  - PCA (Tasmania)
- Notes-
  - Individual houses, including townhouse are Class 1
  - Where individual dwellings are located above or below other individual dwellings, they become Class 2, as shown below:



Class 1 & Class 2 dwellings

Refer to page 25 of Dam Buster's Quick Design Guide for a summary of the steps required in the **Performance Solution Process.**

4.0 TECHNICAL APPRAISAL OF THE DAM BUSTER ROOF DRAINAGE SYSTEM BY ADJUNCT ASSOCIATE PROFESSOR DR ROBERT KELLER

Adjunct Associate Profess Dr Robert Keller ('Keller') has prepared numerous expert opinions on Dam Buster's devices over a number of year, as product development proceeded.

Once product development was essentially completed (i.e. no additional device types were anticipated), Keller prepared a very detailed document titled:

'***Technical Appraisal – Assessment of Dam Buster Roof Drainage Products for Box Gutters'***, February 2004 ('the Technical Appraisal').

Refer to Appendix A for a copy of this document. Note Addendum 2 of the Technical Appraisal includes a copy Dam Buster's Product Technical Statement, version 6.0 (19 February 2024), which was current at the time of preparation of Keller's advice. The current version of this document is version 6.2 (31 March 2024), and contains some minor changes, however, the hydraulic design philosophy is unchanged.

Keller's Technical Appraisal makes reference to his previous opinions, however, as these opinions contain commercially sensitive information, they are not included within the Technical Appraisal.

The Technical Appraisal includes a very detailed comparison of Dam Buster's devices to AS/NZS 3500.3-2021 ('3500.3') and Addendum 1 of the technical Appraisal reviews Dam Buster's devices in relation to 3500.3 in a tabulated format.

A condensed / simplified explanation of the key principles with the Technical Appraisal is provided in the following sections.

4.1 Hydraulic operation

- All Dam Buster devices operate under 'Free flow' in both the 'design flow' and 'overflow' conditions. This compares to the three prescribed DtS devices as follows:
  - *Rainhead*
    - Free flow in the design flow and overflow conditions
  - *Sump & Side Outlet* ('SSO') and Sump / *High-Capacity Overflow* ('HCO') devices:
    - Free flow in the design flow condition
    - Backwatering is required in the overflow condition. This flow regime is hydraulically very complicated.

  Consequently, the nature of the flow within Dam Buster's devices is not as complex as the SSO and HCO devices.
- 3500.3 requires that the overflow capacity be at least equal to the design flow capacity. All Dam Buster overflow devices have an overflow capacity at least equal to (or greater than) their design flow capacity.

4.2 Design flow range

- 3500.3 is limited to a maximum of 16 L/s.
- All Dam Buster devices are designed for:
  - A minimum of 3 L/s
  - A maximum of 16 L/s
- Dam Buster adopts the philosophy that for flows less than 3 L/s, the device is designed for 3L/s. 3500.3 does not specifically state that the minimum design flow is 3L/s, however, in general, solutions are only provided for flow between 3 L/s to 16 L/s. The Victorian Building Authority (VBA) has also endorsed this approach in recent webinars and fact sheets.

4.3 Sizing

- 3500.3 requires the width of box gutters to be in the range 200mm to 600mm
- The width of all Dam Buster products is also in the range 200mm to 600mm.
- It is noted that 3500.3, clause 3.7 Box Gutter Systems, sub-clause *3.7.3 Limitations*, NOTE 3, states *'The minimum width of box gutters used for commercial construction is 300mm. Box gutters 200mm wide may be used for domestic construction, but they are more prone to blockages. Additional height is recommended where possible.'* This clause implies the higher risk of blockage in a narrower gutter can be mitigated by adopting a deeper box gutter (than required).
- This is essentially the philosophy adopted in the design of the DB *Side Outlet, Elbow* and *Junction* devices i.e. the '*Downstream*' or '*Outlet*' box gutter is significantly deeper than that required by Figure H.1 of 3500.3 in recognition of the possible increased risk in blockage due the effective change in direction. However, this risk is also mitigated by the step in the device itself, due to the turbulence created within the open sided 'sump'.
- The depth of the '*Downstream*' box gutter is greater than the depth of the '*Upstream*' box gutter by the height of the step in the above noted device.
- Analyses show that backflow cannot occur within the 'Upstream' box gutter.
- As a consequence of the above noted geometrical constraints, and design philosophy, the freeboard in the '*Downstream*' box gutter (excluding the device itself) is greater than that implied when designed in accordance with Figure H.1 of 3500.3 by an amount which is equal to, or greater than, the height of the step in the device, plus the fall in the '*Upstream*' box gutter.
- As a further consequence of the above noted geometrical constraints and design philosophy, the depth of the '*Downstream*' box gutter (excluding the device itself) automatically exceeds the depth required by Figure H.1 of 3500.3.

4.4 Dam Buster Rainhead

In the design flow condition, the Dam Buster rainhead is designed and constructed in accordance with 3500.3, Figures H.1, H.2 and H.3. The construction of the Dam Buster rainhead, having a box gutter receiver, also facilitates a compliant seal (in accordance with section 4 *Installation* of 3500.3) between the box gutter and the rainhead. It is noted that, in practice, box gutters are typically either not sealed to the rainhead, or not sealed in a compliant manner.

With reference to Figure H.2, NOTE 4 requires *the front of the rainhead to be left open above the overflow weir.* The Dam Buster rainhead complies with this requirement.

There are no other design restrictions specified in 3500.3.

Testing of Dam Buster Rainheads by the AHSCA Research Foundation

Independent testing of all Dam Buster rainheads was carried out by the AHSCA Research Foundation ('AHSCA-RF') at the stormwater research facility located at the University of the Sunshine Coast, Queensland. This testing was primarily for the overflow capacity of the rectangular rainheads, and all Dam Buster rectangular rainheads achieved overflow rates of at least 16 L/s.

The normal flow capacities of all Dam Buster rainheads have been determined in accordance with AS/NZS 3500.3 ('3500.3'), and the flow capacities have also been checked and independently certified by Dr Keller, in addition to the certifications issued by the AHSCA-RF.

Overflow Performance Test Certificates issued by Dr Terry Lucke and Mark Alexander are available on the AHSCA Research Foundation's website at the following web address:

https://www.ahscaresearch.com.au/dam-buster-rainheads/

NOTE: The AHSCA-RF also tested the 200-1 rainhead for normal flow capacity with a 100x50mm DP since although 3500.3 permits the usage of this size DP, the 3500.3 design charts have not been updated to include this size.

In summary, the Dam Buster rainhead complies with all the requirements of 3500.3 and is therefore considered to be DtS by Expert Judgement.

DAM BUSTER®

4.5 Dam Buster Sump

The Dam Buster Sump could be considered in general terms as an 'internal rainhead'.

In the design flow condition, the Dam Buster *Sump* operates in the same manner as a Rainhead.

In the overflow condition, the Dam Buster *Sump* operates in the same manner as a *Sump* to Figure H.4. Testing has confirmed that the overflow capacity of the Dam Buster *Sump* exceeds its design flow capacity.

The Dam Buster *Sump* has the following additional safety features:

- A minimum downpipe size of 100mm is adopted (even when a 90mm downpipe is hydraulically adequate)
- Where possible, an 'overflow indicator' is added by the installer. The purpose of this is to alert the building owner or occupant of the (unlikely) event that both the design and overflow downpipes are blocked, and also acts as a secondary overflow to a certain degree (but significantly less than the design flow)

In summary, the Dam Buster sump complies with all the requirements of 3500.3 and is therefore considered to be DtS by Expert Judgement.

4.6 Dam Buster Continuous Sump

The Dam Buster continuous sump is simply a series of Dam Buster Sumps connected in sequence. An additional safety feature is provided – the end wall of the overflow compartment, and the upstream wall of the next sump in the series are both cut down by 60mm (which is twice the freeboard specified in 3500.3), such as to allow overflow from the box gutter into the next sump in the series, if necessary.

4.7 Dam Buster Back-to-Back Sump

The Dam Buster Back-to-Back Sump is simply two Dam Buster Sumps joined back-to-back. The rear walls of the overflow compartments are also cut down by 60mm as an additional safety feature.

4.8 Change of Direction – Dam Buster Side Outlets, Elbows & Junctions

- 3500.3 states that:
  - Box gutters must be straight, without change in direction
  - Box gutters must discharge to a sump or a rainhead
- Correctly installed, all box gutters discharging to, and discharging from, a Dam Buster device are straight, and do not change direction.
- As discussed above, the Dam Buster *Side Outlet*, *Elbow* and *Junction* devices are considered to be shallow, open sided sumps, not box gutters, with the deeper '*Downstream*' or '*Outlet'* box gutter discharging through the one open side wall in the 'sump'. Critically, the open sided 'sump' component itself is entirely designed to facilitate an engineered change of direction and thereby transfer discharge from the (straight) '*Upstream*' box gutter to the (straight) '*Downstream*' box gutter. The open sided 'sump' is therefore not designed to retain any water.
- There are two critical aspects of the hydraulic design and operation of the above noted devices, as follows:
  - The depth of the 'sump' or 'step' into the device must exceed the energy loss which occurs within the device due to the change of direction being facilitated. Testing, as well as hydraulic analyses, confirms that this is true for all these devices.
  - The minimum required freeboard within the box gutter and device must be maintained at all locations within the device. Testing, as well as hydraulic analyses, also confirms this to be true for all these devices.

In summary, the *Side Outlet*, *Elbow* and *Junction* devices safely **facilitate** a change in direction, however critically the *Upstream* and *Downstream* box gutters **<u>do not change direction</u>** or contravene 3500.3 in any way. **<u>All box gutters are straight and discharge to either rainheads or sumps*</u>**

***** The Dam Buster Side Outlet, Elbow and Junction devices are all considered to be open ended sumps.

4.3.9 Summary

Keller's opinions include detailed comparisons of Dam Buster's devices with the DTS provisions within AS/NZS 3500.3 (i.e. for the design of box gutters and overflow devices within this standard). These comparisons indicate that Dam Buster devices are as safe as the DTS provisions.

In particular, it is demonstrated that the freeboard is always at least equal to, or greater than, the freeboard required by the standard. Additionally, the overflow capacity of Dam Buster's box gutter overflow devices significantly exceeds the normal flow capacity in all cases.

5.0 RESPONSIBILITY OF INSTALLING PLUMBER

It is the licensed roof plumber's responsibility to certify all works associated with the installation of the box gutters and Dam Buster devices in accordance with the specific requirements of that State or Territory.

6.0 DAM BUSTER'S EXPERT

Dam Buster's Expert, Adjunct Associate Professor Dr Robert Keller of Monash University. Dr Keller is a highly reputable hydraulic engineer with the qualifications and experience to determine that the Dam Buster roof drainage system devices meet the relevant Performance Requirements of the NCC. Dr Keller has over forty years of experience in Civil Engineering Hydraulics. Currently a consulting engineer, his main areas of expertise are steady and transient flow analyses of pipe network systems, physical and numerical modelling of river works and hydraulic structures, river stability, bank and bed protection, scour studies, and urban storm drainage analyses. He has conducted many technical courses for practising engineers in Australia, New Zealand and Southeast Asia.

Adjunct Associate Professor Dr Robert Keller

Dr Keller was previously an Associate Professor at Monash University, retiring in 2008, and is currently an Adjunct Associate Professor at Monash University who continues to consult in his area of expertise. Dr Keller is the author or co-author of over 120 technical papers in addition to numerous consulting reports and has received various honours and awards for his work.

7.0 EVALUATION METHODS

This Evidence of Suitability applies to all sizes of the following components of the Dam Buster Roof Drainage System:

A. Dam Buster **Rainhead** overflow device

B. Overflow device comprising a Dam Buster **Side Outlet** (4 available types) and a Dam Buster **Rainhead** or **Dam Buster Sump**

C. Dam Buster **Sump,** Dam Buster **Continuous Sump** or Dam Buster **Back-to-Back Sump** overflow devices

D. Dam Buster **Elbow** & Dam Buster **Junctions**

Testing of Dam Buster Rainheads by the AHSCA Research Foundation

Independent testing of all Dam Buster rainheads (product A above) was carried out by the AHSCA Research Foundation ('AHSCA-RF') at the stormwater research facility located at the University of the Sunshine Coast, Queensland. This testing was primarily for the overflow capacity of the rectangular rainheads, and all Dam Buster rectangular rainheads achieved overflow rates of at least 16 L/s.

The normal flow capacities of all Dam Buster rainheads have been determined in accordance with AS/NZS 3500.3 ('3500.3'), and the flow capacities have also been checked and independently certified by Dr Keller in addition to the certifications issued by the AHSCA-RF.

Overflow Performance Test Certificates issued by Dr Terry Lucke and Mark Alexander are available on the AHSCA Research Foundation's website at the following web address:

https://www.ahscaresearch.com.au/dam-buster-rainheads/

NOTE: The AHSCA-RF also tested the 200-1 rainhead for normal flow capacity with a 100x50mm DP since although 3500.3 permits the usage of this size DP, the 3500.3 design charts have not been updated to include this size.

DAM BUSTER®

Testing of Dam Buster box gutter overflow devices B and C by Dr Keller

Dam Buster P/L carried out testing of overflow devices B (overflow device comprising a Dam Buster Side Outlet and a Dam Buster Rainhead) and C (Dam Buster Sump) in a custom built flow test rig located in Clayton, Victoria and assembled by Dam Buster P/L.

The flow rates were measured using a Flexim Fluxus F601 ultrasonic transit time flow meter, sourced from PriCam Automation P/L, and installed by a technical representative from this company. The flow meter has a stated accuracy of +/- 1%.

All testing was independently supervised and witnessed by Dr Keller, and this testing formed the basis of his Expert Opinion for devices B and C.

Evaluation of Dam Buster device D (Dam Buster Elbow) by Dr Keller

Development of device D (the Dam Buster Elbow) was initiated on the basis of the results of the physical testing of the Dam Buster device C, as the Elbow is hydraulically similar to the Side Outlet device B.

A numerical analysis of the Dam Buster Elbow was carried out by Dr Keller to ensure backwatering (i.e. the impeding of hydraulic free flow) could not occur in the Dam Buster Elbow. The calculations demonstrated that the head loss in the bend is always significantly less than the step down / ‘drop’ between the ‘upstream’ (or ‘upper’) and the ‘downstream’ (or ‘lower’) box gutter. This modelling and analysis by Dr Keller formed the basis of the certification and constraints associated with the usage of the Dam Buster Elbow device.

Physical testing of device D was later carried out in a purpose-built test rig located in Kalorama (Victoria), and the flow rates were also measured using the same instrument as for devices B and C. This testing was supervised and witnessed by Dr Keller.

The physical testing produced results which aligned well with the theoretical hydraulic analyses by Dr Keller. Of particular interest was the maximum water level in the Elbow, which occurred at and near the outer corner of the Elbow where the water changes directions (i.e. immediately downstream of the step down, at the Elbow wall impacted by the discharge).

An analysis of the water level at this location, taking into account Dam Buster's design criteria and Elbow geometry, identified that the freeboard at this critical design location was more than satisfactory, and well within the expectations of 3500.3. The detailed review and commentary of the Elbow by Dr Keller also considered the potential effects of debris within the gutter and noted that "*the turbulence generated by the drop was expected to assist with preventing debris from accumulating in the Elbow and clearing debris in the Elbow".*

8.0 MANUFACTURE OF DAM BUSTER PRODUCTS

All Dam Buster licensed manufacturers are subject to strict manufacturing requirements, and Dam Buster maintains close communication with its fabricators to provide technical assistance, and also to ensure that a high quality of the Dam Buster products is maintained. All manufacturing and assembly is carried out in Australia using Australian BlueScope steel products. Sealed aluminium rivets used in assembly of Dam Buster products. All Dam Buster products carry clear identification.

9.0 DESIGN & INSTALLATION OF DAM BUSTER PRODUCTS

Design of Dam Buster products should only be carried out in accordance with the **Product Technical Statement** by competent users of AS/NZS 3500.3.

All Dam Buster products must be installed strictly in accordance with the **Dam Buster Roof Drainage System Installation Manual** and the associated box gutters must all be installed in accordance with all relevant codes and standards, as prescribed by the relevant state or territory.

Failure for the Dam Buster devices not to be selected / designed as specified above, or failure to install the devices in accordance with Dam Buster's Installation Manual, will void any warranty on the Dam Buster products and further, Dam Buster Pty Ltd and Dam Buster IP Pty Ltd will not be responsible for any losses whatsoever arising from such failure/s, no matter what their nature, nor how caused.

10.0 LIMITATIONS AND CONDITIONS

Dam Buster products are designed for use in strict compliance with all relevant Australian and New Zealand standards including, but not restricted to, AS/NZS 3500.3. They must not be used for any other purpose or in any way except as permitted in the publication titled '*Dam Buster Product Technical Statement'.* It is the responsibility of the roof plumber and builder to ensure full compliance with this document and with all relevant Australian and New Zealand standards.

11.0 INTELLECTUAL PROPERTY AND KNOW-HOW

Dam Buster is a registered Trademark both in Australia and Overseas, and all Dam Buster products are also protected by a comprehensive range of Australian and Overseas patents. Breaches of Intellectual Property and Know-How rights are serious and will be pursued by Dam Buster Pty Ltd / Dam Buster IP Pty Ltd against any infringers.

With the exception of the AHSCA-RF Overflow Performance Certificates, Dam Buster has chosen not to make testing data, and the various associated Expert Opinions prepared by Keller publicly available, due to this being confidential information. Note that Keller's expert opinions are referred to in his Technical Appraisal of the Dam Buster Roof Drainage System but are not included within this document.

Appendix A

DAM BUSTER ROOF DRAINAGE SYSTEM

Technical Appraisal – Assessment of Dam Buster Roof Drainage Products for Box Gutters

prepared by

Adjunct Associate Professor Dr Robert Keller – February 2024

DAM BUSTER ROOF DRAINAGE SYSTEM

Technical Appraisal – Assessment of Dam Buster Roof Drainage Products for Box Gutters

R. J. Keller & Associates,
211 Nepean Highway,
Edithvale,
VIC 3196
AUSTRALIA
Phone: **+61 412 525264**
Email: **rjkeller@optusnet.com.au**

February 2024

TABLE OF CONTENTS

1 Introduction

1.1 The purpose of this technical appraisal is to assess the Dam Buster ('DB') roof drainage products for box gutters by making detailed comparisons with the design of box gutter systems to AS/NZS 3500.3:2021 *Storm water drainage code* ('3500.3'). This appraisal:

(i) Assesses to what extent Dam Buster products comply with the key hydraulic principles and limitations of 3500.3.

(ii) Assesses and comments on the extent to which the Dam Buster products fall outside the limitations or scope of 3500.3, noting that the products are innovative.

(iii) Confirms that the design methodology for the Dam Buster products is hydraulically sound and that the design tables and procedures are correct.

(iv) Comments, to the extent possible, on the safety of the Dam Buster products compared with the safety of box gutter systems designed to 3500.3.

1.2 To assess the Dam Buster devices with respect to 3500.3, it has been necessary to carry out a review of technical papers relating to the formulation of design criteria and limitations associated with 3500.3. Much of this information is not referenced within the code itself. Section 2 of this appraisal comprises a discussion of the key hydraulic principles and limitations of 3500.3. It is noted that most of the research and development leading to 3500.3 was carried out in the 1990's. The major contributions were made by Dr. Ralph Jones with other key contributions from Dr Geoffrey O'Loughlin and Dr Simon Beecham. The key research elements are summarised in Section 3.

1.3 This appraisal is intended to form the basis of assessment of Dam Buster products in relation to compliance with the National Construction Code, the current version of which is NCC-2022.

1.4 The writer does not have specific expertise in building regulation or building surveying in Australia. However, the following is understood:

- The National Construction Code, NCC-2022 comprises the following volumes:
    - NCC Volume 1 i.e. BCA Volume 1 (i.e. Building Code of Australia v1)
    - NCC Volume 2 i.e. BCA Volume 2 (i.e. Building Code of Australia v2)
    - NCC Volume 3 i.e. PCA (i.e. Plumbing Code of Australia)
- Roof drainage falls within BCA volumes 1 & 2 and is a State Addition in the PCA in Victoria and Tasmania (only).
- In general, compliance with the NCC is met using one of the following methods:
    - A Performance Solution
    - A Deemed-to-Satisfy Solution
    - A combination of both of the above
- For each volume, the Deemed to Satisfy Provisions state that where a Deemed-To-Satisfy Solution is proposed, compliance with the relevant Performance Requirements is met by complying with 3500.3.
- For all solutions, adequate Evidence of Suitability is required.
- Evidence of Suitability may be provided by various means, as described in Governing Requirements of the NCC.

1.5 It is not the writer's intention to determine how compliance with the NCC is ultimately met with respect to the Dam Buster products. Rather, the aim is simply as stated in section 1.1, and it is for others to determine the appropriate compliance pathway through the NCC. This appraisal might, for example, be used to form the basis, or part of the basis, for an assessment of the products under the CodeMark Australia system.

1.6 Box gutter systems are designed for water which is potentially contaminated with debris. Roofs require regular maintenance and cleaning, as noted in Clause M.5, Appendix M, of 3500.3, which states:

'*Sizing of stormwater drainage installations assumes 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, builder's 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 sump*s.'

1.7 In general, this appraisal is based on the hydraulics of clean water, however, consideration is given to the potential effect of debris, particularly with respect to the minimum sizing of roof drainage components; refer to section 2.3 for a discussion on the minimum design flow rate. Refer also to section 3.4 for a paper by A/Prof Terry Lucke which includes discussion regarding debris within box gutter systems.

1.8 When assessing the relatively safety of Dam Buster devices compared to box gutter systems designed to 3500.3, it is assumed that regular inspection and cleaning is being carried out. However, some consideration is given to debris which can be present, despite a regime of regular maintenance and cleaning, such as that due to windblown debris during, or shortly prior to, a storm. It is noted that the maintenance and cleaning regime is also highly dependent on the presence of nearby trees, which may generate significant leaf and stick litter in a relatively short period of time. Of particular interest with respect to debris is the Dam Buster Elbow. With regular maintenance and cleaning, this device should not be significantly more prone to blockage than the straight box gutters. With poor / inadequate maintenance of box gutters, particularly those located where there is significant leaf litter, blockage can readily occur at any location along even a straight box gutter due to leaf litter, potentially resulting in overtopping of the gutter itself. Where adequate maintenance and cleaning is carried out, blockages can still occur, due to, for example, wind-blown debris such as plastic bags and rubbish, however, these blockages typically occur at the outlet, and would not be expected to occur specifically within a Dam Buster Elbow. It is for these reasons that the writer holds the opinion that the introduction of Dam Buster's Side Outlets and 'Upstream Devices' (both which facilitate a change of direction in the box gutter) will not significantly increase the risk of failure of the box gutter system.

1.9 Continuing from Section 3 of this appraisal, Section 4, addresses the lack of development of AS/NZS 3500.3 with respect to box gutter systems is discussed.

1.10 Section 5 examines the key innovations of Dam Buster products.

1.11 Section 6 categorizes the various Dam Buster box gutter devices.

1.12 In Section 7, previous opinions that are relevant to this appraisal are noted.

1.13 Section 8 presents a comparison of Dam Buster devices with key principles and limitations of 3500.3 and references Addendum 1 which is a comprehensive summary of the comparison of Dam Buster devices with the requirements of 3500.3.

1.14 In section 9, a schedule is presented comparing Dam Buster devices to the requirements of 3500.3.

1.15 In Section 10, an assessment of the risk of failure of Dam Buster devices compared to box gutter systems designed to 3500.3 is presented.

1.16 Conclusions, presented in Section 11, complete this appraisal.

2 Background to 3500.3 - Key Hydraulic Principles and Limitations

2.1 Definitions

The following definitions are adopted in this appraisal.

3500.3 AS/NZS 3500.3:2021

RH (Open fronted) rainhead according to Figure 3.7.3(a) and Figure H.2 of 3500.3

SSO Sump / side overflow device according to Figure 3.7.3(b) and Figure H.5 of 3500.3

HCO Sump / high-capacity overflow device according to Figure 3.7.3(c) and Figure H.7 of 3500.3

2.2 Hydraulic principles of 3500.3

A full understanding of the hydraulic principles underlying the design of box gutters to 3500.3 cannot be obtained from this code alone, as some information is 'hidden' from the reader. Additionally, there are some aspects of 3500.3 which are not clear and potentially open to misinterpretation. The key principles and limitations of 3500.3 are discussed in the following sections.

2.3 Minimum design flow rate

In general, the design charts in 3500.3 commence at 3.0 L/s, however, the code does not specifically state 3.0 L/s is the minimum design flow rate. A/Prof Terry Lucke examined this issue in a paper titled '*Box Gutter Design Using General Methods of AS/NZS.3:2018: Minimum Design Flowrates and Gutter Depths'* and concluded '*This paper has shown it is inappropriate to nominate minimum gutter and component sizing less than 3.0 L/s due to a disproportionate increase in blockage potential.'* The writer agrees with this expert opinion, and for the purpose of this appraisal, a minimum design flow rate of 3.0 L/s is assumed.

2.4 Maximum design flow rate

3500.3 limits the maximum design flow rate to 16 L/s. From a literature review (refer section 3), it is evident that this limit has been placed due to testing not being carried out above this flowrate in relation to the two 3500.3 box gutter overflow devices which require backwatering to occur in the overflow condition (SSO & HCO). The hydraulics associated with these devices is very complicated in the overflow condition, compared with free flow which relates to box gutters discharging to rainheads.

2.5 Freeboard

Freeboard is not clearly defined in 3500.3. Clause 3.7.2 states '*The freeboard, (hf) for box gutters shall be 30mm in accordance with Figure I.5'*. However, this is only correct in relation to the overflow condition for the SSO. A literature review (refer section 3) identifies that the following freeboards apply:

Box gutter discharging to a RH:

Design flow condition	60mm (free flow per Figure H.1)
Overflow condition	60mm (as free flow is maintained)

Box gutter discharging to an SSO:

Design flow condition	60mm (free flow to Figure H.1)
Overflow condition	30mm (backwatering occurs)

Box gutter discharging to an HCO:

Design flow condition	60mm (free flow to Figure H.1)
Overflow condition	45mm (backwatering occurs)

2.6 <u>Change of direction in box gutters</u>

Clause 3.7.6 (g) (i) states '*Box gutters shall be straight (without change in direction)'* and for good reason. The problems with changing directions (without an accompanying increase in depth) are twofold:

i. There will be an energy loss in the bend, potentially resulting in backwatering and therefore loss of 'free flow' within the gutter.
ii. The freeboard will be reduced towards the outer corner of the change in direction.

There is however no sound hydraulic reason why box gutters cannot change direction, whilst maintaining 'free flow', provided the following conditions are met:

1. The change in direction is accompanied by a step or drop in the box gutter, which is greater than the energy loss in the bend.
2. The magnitude of the step is such that the freeboard is not reduced at any location.

It is noted that in the overflow condition for the SSO, the water changes direction by 90 degrees as it discharges from the box gutter/sump and through the overflow duct. In the overflow condition, it is assumed that the sump does not operate due to a blocked outlet, and in effect the box gutter changes direction by 90 degrees into a duct with a smaller area and with no increase in depth.

A box gutter which changes direction having a step/drop large enough to satisfy items 1 and 2 above is significantly simpler hydraulically than the overflow condition of the SSO.

It follows that there is no fundament reason why box gutters cannot change direction. The only reason that 3500.3 does not permit box gutters to change direction is that no design rules have been developed to permit a change of direction accompanied by a step/drop (increasing the box gutter depth).

2.7 <u>Jointing a box gutter along its length to increase its depth</u>

Section 4.7 *Joints for metal components*, part 4.7.1 *General* of 3500.3 states '*Gutters shall not be jointed along the length to increase gutter depth'.* It is assumed that this means that a stepped gutter with joints cannot be used in lieu of a tapered box gutter. The reasons for this are not certain, but may be as follows:

- Unnecessarily introducing joints into a box gutter unnecessarily increases the risk of failure
- Steps in box gutters can result in 'splashing'
- Steps in the sole of the box gutter should not be used to create the fall, as the sections would be flat and a constant fall is required to prevent ponding and reduce the ability for debris to accumulate in the gutter.
- A step down in one location could cause the flow to change from subcritical to supercritical and increase the risk of the flow changing back to subcritical further downstream with an associated hydraulic jump. Refer to the paper by Verstraten, Lucke and O'Loughlin (refer section 3.5) which includes discussion on hydraulic jumps, and notes:

- *'Hydraulic jumps increased water depths, negating any additional hydraulic capacity associated with an increased slope. The underlying assumption, found in all of the design guidelines, that increased gutter slope results in reduced gutter water depth, is not always valid'* and.
- *'Further investigations into the generation of hydraulic jumps in sloping gutters is therefore warranted.'*

2.8 Slope

The slope of gutters designed to 3500.3 is limited to the range 1 in 200 (minimum) to 1 in 40 (maximum). These limitations relate to the testing carried out in relation to the development of 3500.3.

2.9 Box gutter widths

The charts in 3500.3 provide graphs for nominal box gutter widths of 200mm, 300mm, 375mm, 450mm and 600mm. The writer has been advised that these box gutter widths are not necessarily adhered to. In practice it is common for box gutter widths between these nominal dimensions to be used.

The Dam Buster team has advised me that some practitioners opine that interpolation of the graphs is not permitted, and that where a box gutter's width falls between two nominal widths, the design value for the lower box gutter width should be adopted. This is a conservative approach, but also entirely unnecessary. A review of Dr Ralph Jones' notes (refer section 1.2) identifies that specific mathematical equations have been used to create the graphs in Figure H.1, and these equations include the box gutter width as a variable. Thus, these equations could readily be used to generate graphs for any box gutter width in the range 200mm to 600mm and for any slope between 1:40 and 1:200. Consequently, there is no reason why design depths cannot be interpolated for widths between the nominated design widths.

2.10 Minimum design depth applies at the upstream end of box gutter.

3500.3 does not make it clear that the box gutter design depth, determined in accordance with the General Method, applies at the upstream end of the box gutter. Figures H.5 *Sump / side overflow* device and H.7 *Sump / high-capacity overflow* device provide longitudinal sections through these devices, showing the box gutter sloping and having a constant depth i.e. both the top and bottom of the box gutters slope.

The handbook SAA/SNZ HB114:1998 *Guidelines for the design of eaves and box gutters* (**HB114**) includes design examples for the SSO and HCO. These examples include diagrams which are essentially identical to Figure H.5 and H.7 of 3500.3, except that in both cases, the figures include the additional note '*Applies to full length of box gutter'*. That is to say, the design depth applies at the upstream end. It is not known why this note is not included in Figures H.5 and H.7 of 3500.3. Furthermore, the handbook SA HB39-2015 includes wording which can be easily misinterpreted to assume an arbitrary depth of 75mm may be adopted at its upstream end. It is the writer's understanding that this poor wording, combined with the omission of the note above in Figures H.5 and H.7, has led many practitioners to incorrectly assume that the design depth applies at the downstream end of the box gutter, and that an arbitrary depth of 75mm can be adopted at the upstream end of the box gutter. This would explain why many existing box gutters are found in practice to have an upstream depth of 75mm.

The writer understands that NCC-2022 Volume 3 (PCA) states that where there is a conflict between SA HB39:2015 and 3500.3, then 3500.3 takes precedence. This removes the potential confusion regarding the 75mm depth to some extent. However, the note '*Applies to full length of box gutter'* remains absent from Figures H.5 and H.7 in 3500.3, and consequently 3500.3 remains open to genuine misinterpretation.

2.11 Overflow capacity

3500.3 Clause 3.7.7.1 Hydraulic capacity, states that '*the overflow capacity of an overflow device shall not be less than the design flow for the associated gutter'*.

The depicted open-fronted RH clearly has a very high overflow capacity, and indeed much higher than that required by a box gutter designed to 3500.3, whereas the SSO and HCO are designed to have an overflow capacity equal to the design flow capacity, albeit with reduced freeboards of 30mm and 45mm respectively (compared to the 60mm assumed for the RH box gutter). Fundamentally however, the overflow capacity of the RH is limited by the hydraulic capacity of the box gutter itself, which will fail once the freeboard has been used up with increased flow.

3 Literature Review

The following literature items have been considered in detail as part of this appraisal.

3.1 Memos and notes by Dr. Ralph Jones

The writer, along with the Dam Buster development team, has had access to a collection of memos, notes, and letters from the 1990's, relating to the development of AS/NZS 3500.3.2-1998 which has provided added depth of understanding and insight. The design charts for box gutters and overflow device charts have not changed between the 1998 and the current 2021 version. These notes identify that for free flow,

- A freeboard of 50mm is adopted.
- An additional 10mm is assumed, with the notes stating: "*Allowance for variations above mean due to turbulence = 10mm*"

Consequently, within 3500.3, box gutters designed for free flow have a total freeboard allowance of 60mm.

As discussed in section 2.8, these notes also identify that mathematical equations have been used to generate the graphs in Figure H.1, and these equations include the box gutter width as a variable. Thus, these equations could readily be used to generate graphs for any box gutter width in the range 200mm to 600mm for each of the slopes of 1:40, 1:100, 1:150 and 1:200.

3.2 Paper by Ralph Jones and Eugene Kloti titled '*A high-capacity overflow device for internal box gutters of roofs*', Proceedings – 8th International Conference On Urban Storm Drainage – Sydney 1999

This paper identifies that an allowance of 45mm was made for "*freeboard and other variations*".

3.3 Paper by Assoc/Prof Terry Lucke titled '*Box Gutter Design Using General Methods of AS/NZS.3:2018: Minimum Design Flowrates and Gutter Depths'*

As noted in section 2.3, this paper opines that the minimum design flow rate from 3500.3 is 3.0 L/s. Minimum box gutter depths for free flow (i.e. design per Figure H.1) are provided for each nominal box gutter width of 200mm, 300mm, 375mm, 450mm and 600mm.

3.4 Paper by Assic/Prof Terry Lucke titled '*Performance Solutions*: *Is it appropriate to use the overflow equations from AS/NZS 3500.1 to design box gutter systems as per AS/NZS 3500.3?*

This paper contains discussion about debris within box gutter systems, and is provided in relation to the discussion in section 1.6.

3.5 Paper by Verstraten, Lucke and O'Loughlin titled '*Comparing empirical water depth observations of a box gutter roof drainage system to three different international design guidelines'*.

This paper contains discussion around the formation of hydraulic jumps in box gutter systems and is relevant to the discussion regarding jointing a box gutter along its length to increase its depth, refer to section 2.7.

3.6 CSIRO – EBS Notes NSB 151 to 153, September 1978, Roof drainage.

These notes were used by many practitioners for roof drainage design prior to the introduction of AS/NZS 3500.3.2:1998.

4 Lack of Development of AS/NZS 3500.3 with respect to Box Gutter Systems

4.1 The following discussion includes information provided by the Dam Buster team during various discussions.

4.2 There has essentially been no significant further development of AS/NZS 3500.3 in the last 25 years with respect to box gutter systems. The design procedure for box gutters in AS/NZS 3500.3:2021 is almost identical to that provided in AS/NZS 3500.3.2:1998.

4.3 In contrast to the static nature of 3500.3 regarding box gutters systems, the exponential proliferation of so-called 'contemporary' building design has changed significantly in the last 25 years, and it is apparent to the writer that the code has not kept pace with these changes. For example, there are no design examples whatsoever in 3500.3 which address box gutter systems for multi-residential buildings. The writer is aware that box gutters are increasingly being used in residential developments due to planning regulations. Allowable building setback profiles from boundaries are resulting in building forms more suitable to 'Christmas tree' or 'tiered wedding cake' type building profiles, which result in the incorporation of parapet walls and box gutter systems that are generally situated directly above habitable building space. There has also been a significant increase in multi-residential developments, which are subject to similar planning controls, also resulting in increased usage of complex box gutter systems. The lack of development of the code, combined with inflexibility in roof design resulting from the three prescribed (normative) box gutter overflow devices only, has indirectly led to the innovations of the Dam Buster products, referenced in Section 5, which have primarily been developed in the first instance to provide a means of cost-effective retrospective rectification of already identified non-compliant box gutter drainage systems.

5 Innovation of Dam Buster Products

5.1 There are essentially two key innovations associated with Dam Buster products, as discussed below.

5.2 Dam Buster rainhead

The key innovative features of the DB rainhead are (i) the vertical overflow chute and (ii) the box gutter receiver. Prior to these innovations, virtually all installed rainheads, particularly on domestic contemporary style dwellings took the form of what could colloquially be referred to as a 'Ned Kelly' or 'Bush Ranger' style rainhead. However, this form of the rainhead has always been non-compliant with respect to the requirements of 3500.3. Dam Buster understands that the 'normative' references in 3500.3 is considered by the Victorian regulator (the VBA) to be 'prescriptive', meaning that, to meet the DtS requirements any rainhead is required to take the precise form of the open fronted rainhead depicted in illustration in Figure H.2 of 3500.3 (referred to as 'normative'). Nevertheless, this 'prescription' has historically not been practically enforced by the VBA nor any other state-based regulator in Australia.

In the writer's opinion, the Dam Buster rainhead complies with 3500.3 (via Expert Judgement), for the following reasons:

- The rainhead has been designed in accordance with the calculations contained within the General Method in 3500.3.
- The rainhead incorporates a full width overflow weir, set 25mm below the sole of the box gutter receiver.
- The overflow capacity of the rainhead significantly exceeds the design capacity as stated in the Dam Buster rainhead design table for each rainhead size/downpipe combination.
- The overflow capacity of the open-fronted weir design as currently depicted in Figure H.2 of 3500.3 is clearly very high. However, as discussed in section 8.5, it has no advantage over the Dam Buster rainhead design, because the box gutter itself will fail at a flow rate significantly lower than the overflow capacity of the Dam Buster rainhead (and the open-fronted rainhead). Note, the failure flow rate is the theoretical hydraulic capacity of the box gutter, determined using the equations for defining the free flow curves in Figure H.1, and assuming there is no freeboard.
- As required by Note 4 in Figure H.2. of 3500.3, there is nothing above the weir.
- Due to the size, and geometry of the (vertical) overflow chute, the risk of obstruction of the overflow chute is insignificant.
- The Dam Buster rainhead also incorporates a built-in device to seal the rainhead very effectively to the box gutter.

On 30 July 2021, amendment 1 of SA HB 39-2015 was issued. This amendment removed Clause 5.7.3 and Figure 5.7.3, which depicted a manifestation of the so-called Ned Kelly style rainhead. The writer understands that up until the release of amendment 1, this now deleted figure had been widely used to justify this general style of rainhead - which was by no means being used in a prescriptive manner. However, the design procedure provided was unclear; no formulas were provided to calculate the flow depth, and the configuration was also inconsistent with 3500.3 and HB114 (both of which post-dated the original release of HB39 in 1997).

5.3 Change of direction devices

The second principal innovation of Dam Buster's products involves a change in direction of the box gutter flow i.e. the Side Outlet and Rainhead combination devices, and the 'Upstream' devices (i.e. the Elbow and the Junctions). Refer also to section 6 for a summary of the Dam Buster products.

The requirement to be able to change direction in a box gutter system is driven by the increasing complexity of particularly smaller roof sections in contemporary building designs. An ability to change direction also provides far greater flexibility for building designers.

As discussed in section 2.6, it is the writer's opinion that there is no fundamental hydraulic reason why box gutters - which are essentially open channel drains - cannot change direction. It appears that the only reason box gutters are not permitted to change directions in 3500.3 is that no design rules have been developed to permit a change of direction which must, by necessity, be accompanied by a step / drop (increasing the box gutter depth). Additionally, as discussed in section 1.8, in the writer's opinion, there is no material increase in the risk of blockages for box gutter systems using the Dam Buster change of direction devices, as long as they are regularly maintained and cleaned as required by 3500.3.

As discussed in section 2.7, the clause in 3500.3 which states that box gutters cannot be jointed along their length to increase their depth is not relevant to Dam Buster devices, which have been designed and tested with a specific, 'engineered' increase in depth at the change in direction. It is noted that that the change in depth ranges between 50mm and 70mm. Consequently, as observed under test conditions, very little, if any, splashing occurs as a result of the depth change.

6 Dam Buster Box Gutter Devices

6.1 This assessment is made based on the information provided in the following document:

Dam Buster Product Technical Statement version 6.0, dated 19 February 2024 refer Addendum 2.

6.2 Dam Buster devices are categorized broadly as follows:

Box Gutter Overflow devices

- ***DB Rainhead***
  - R-www - Rectangular rainhead
  - CR-www - Curve fronted rainhead
- ***DB Side Outlet and DB Rainhead combination***
  - TSO-www - Tee Side Outlet
  - ESO-www-h - End Side Outlet
  - CSO-www-h - Corner Side Outlet
  - XS0-www - Cruciform Side Outlet
- ***DB Sump***
  - SU-www-ddd - Singular sump

The DB Sump can also be arranged as a 'Continuous Sump' or a 'Back-to-back' sump.

Change of direction devices

- ***DB Elbow***
  - ELB-www-h
- ***DB Junction***
  - TJN-www - Tee Junction
  - CJN-www-h - Corner Junction

where	'www'	denotes the box gutter width
	'ddd'	denotes the sump depth
	'h'	denotes the hand, L or R

7 Previous opinions

7.1 The following previous opinions have been prepared, which are relevant to this appraisal:

(1) 1 October 2020

- Opinion regarding whether Dam Buster P/L and Dam Buster IP P/L box gutter overflow devices may be considered to be Deemed-To-Satisfy Solutions to the relevant Performance Requirements of NCC-2019
- These opinions also include reference to the Dam Buster Rainhead Overflow Performance Certificates (for rectangular Dam Buster rainheads only) prepared by the AHSCA Research Foundation, refer https://www.ahscaresearch.com.au/dam-buster-rainheads/
- Note that this opinion includes a number of previous opinions.
- One of these previous opinions, dated 28 January 2020, contains an opinion regarding the overflow capacity of the Curve fronted Dam Buster rainheads, confirming their overflow capacities exceed 16 L/s.
- This opinion also refers to a previous opinion titled '*The T-Side Outlet Addendum*', dated 30 September 2020, which provided a recommendation that the maximum permitted length of the SBG ('short box gutter' or outlet box gutter) was 600mm. At the time of writing this opinion, the step / drop for the 200mm Side Outlet series was 40mm. However, this was subsequently increased to 50mm. Of the three Side Outlet sizes (200mm, 300mm and 400mm), the 200mm size was critical, as the calculated value for 95% of the uniform depth exceeded the drop (whereas, for the 300mm and 400mm series, this value was less than the step / drop). With an increase in the drop of the 200mm series to 50mm, this is no longer the case (i.e., 95% of the uniform depth is now less than the step / drop). Consequently, the writer has re-assessed the maximum length of the 'SGB' and advises this may be increased to 1200mm (the Dam Buster team queried whether this value may be acceptable with the increased step/drop in the 200mm Side Outlet series).

(2) 29 January 2021

- The Dam Buster (DB) Elbow

(3) 18 July 2023

- Opinion re DTS Solution to NCC-2022
- This opinion confirms that previous opinions (1) and (2) above, which were based on NCC-2019 (and AS/NZS 3500.3-2018) remain valid for NCC-2022 (and AS/NZS 3500.3:2021)

7.2 Opinions (1) and (2) contain commercially sensitive information and (as advised by Dam Buster) are consequently not made available, except under a confidentiality agreement.

7.3 Since preparing the above noted opinions, the Dam Buster product range has been extended as follows:

- Back-to-back Sump added
- Junctions added

These devices generally follow the same principles as the other devices and have been reviewed as part of this appraisal.

7.4 Previous opinions have considered Dam Buster devices to be Deemed-To-Satisfy by Expert Judgement. This pathway whilst referenced, is not clearly defined in NCC-2019 or NCC-2022, and the writer understands that Dam Buster is considering alternative pathways. The compliance pathway(s) adopted does(do) not affect this technical appraisal.

7.5 AS/NZS 3500.3-2018 included the following statement in the Preface:

'PROVISION FOR REVISION
This Standard necessarily deals with existing conditions, but is not intended to discourage innovation or to exclude materials, equipment and methods that may be developed in future. Revisions will be made from time to time in view of such developments and amendments to this edition will be made only when absolutely necessary.'

As discussed later in this opinion, the Dam Buster products fall partly outside the scope of 3500.3 by virtue of introducing the concept that box gutters can change direction when accompanied by an appropriate step/drop. Due to the discussion above regarding provision for innovation, it was considered that this extension of the scope could be considered as being a Deemed-To-Satisfy Solution by Expert Judgement. Note that for an unknown reason, the above statement which had consistently been in earlier editions of 3500.3 was removed from the 2021 version of the code.

7.6 Ultimately the compliance pathway is a matter for building surveying professionals and building authorities.

8 Comparison of Dam Buster devices with key principles and limitations of 3500.3.

8.1 Various aspects of the hydraulic design and operation of Dam Buster's devices are discussed below in relation to 3500.3.

8.2 <u>Design flow range</u>

- 3500.3 is limited to 16 L/s.
- All Dam Buster devices are designed for:
  - A minimum of 3 L/s
  - A maximum of 16 L/s
- Dam Buster adopts the philosophy that for flows less than 3 L/s, the device is designed for 3L/s. Also refer Section 2.3.

8.3 <u>Hydraulic operation</u>

- All Dam Buster devices operate under 'Free flow' in both the 'design flow' and 'overflow' conditions. This compares to hydraulic operation of the three DtS devices in 3500.3 as below:
  - *Rainhead*
    - Free flow in the design flow and overflow conditions (60mm freeboard)
  - *SSO and HCO*
    - Free flow in the design flow condition (60mm freeboard)
    - Backwatering is required in the overflow condition, with 30mm and 45mm freeboards respectively. This flow regime is hydraulically very complicated.

  Consequently, the nature of the flow within Dam Buster's devices is significantly less complex than the SSO and HCO devices.

- The design of all box gutters discharging to Dam Buster devices is independent of the overflow device (because free flow is maintained). This means that all box gutters discharging to Dam Buster overflow devices can be designed to 3500.3 Figure H.1, noting that where a change of direction is made, the downstream box gutter component (i.e. the box gutter section downstream of the Dam Buster device itself) will be deeper than that required by the code.

- 3500.3 requires that the overflow capacity of the box gutter overflow device be at least equal to the design flow rate (for a 1% AEP event). All Dam Buster overflow devices have an overflow capacity at least equal to their design flow rate. As discussed in section 8.6, the overflow capacity of the Dam Buster rainhead is much higher than its stated design flow capacity (for each rainhead size and downpipe size combination in the Dam Buster rainhead design table), and additionally, the 'open fronted' rainhead depicted in Figure H.2 has no advantage over the Dam Buster rainhead because the box gutter will fail before the overflow capacity of the Dam Buster rainhead is reached.

8.4 <u>Sizing</u>

- 3500.3 requires the width of box gutters to be in the range 200mm to 600mm.

- The width of all Dam Buster products is also in the range 200mm to 600mm.
- It is noted that 3500.3, clause 3.7 *Box Gutter Systems*, sub-clause 3.7.3 *Limitations*, NOTE 3, states '*The minimum width of box gutters used for commercial construction is 300mm. Box gutters 200mm wide may be used for domestic construction, but they are more prone to blockages. Additional height is recommended where possible.*' This clause implies the higher risk of blockage in a narrower gutter can be mitigated by adopting a deeper box gutter (than required) however no details regarding the additional depth are given.
- For the DB Side Outlet, Elbow and Junction devices:
  - The depth of the 'Downstream' box gutter (excluding the device itself) is greater than that required by Figure H.1 by an amount which is equal to, or greater than, the height of the step in the device (plus the fall in the 'Upstream' box gutter).
  - The 'Downstream' box gutter (excluding the device itself) is therefore safer than a box gutter designed to Figure H.1 due to the additional freeboard.

8.5 Dam Buster Rainhead

In the design flow condition, the Dam Buster rainhead is designed and constructed in accordance with 3500.3, Figures H.1, H.2 and H.3. The construction of the Dam Buster rainhead, having a box gutter receiver, facilitates a compliant seal (in accordance with 3500.3, section 4 *Installation*) between the box gutter and the rainhead. It is noted that, in practice, box gutters are typically either not sealed to the rainhead, or not sealed in a compliant manner.

In the overflow condition, the Dam Buster rectangular rainhead has been tested by the AHSCA Research Foundation, which demonstrated that the overflow capacity of the smallest Dam Buster rainhead, the R-200 (for a 200mm wide box gutter) exceeds 16 L/s. Overflow test certificates are available at https://www.ahscaresearch.com.au/dam-buster-rainheads/

As noted in section 5.2, the overflow capacity of the 3500.3 'open-fronted' rainhead is limited by the hydraulic capacity of the box gutter itself. Refer to Figure 1 below, which shows how the box gutter will over top and fail if the flow rate is gradually increased until all the freeboard has been used up. It is also important to note, that with respect to debris, and ignoring failure of the box gutter itself, the open-fronted rainhead does not have unlimited capacity, since there is an inevitable 'catch point' for debris where any box gutter passes through the parapet wall (noting that the downstream end parapet wall is not shown in the Figures of 3500.3).

As an example, the Dam Buster R-200 rainhead has a maximum design flow rate of 5.0 L/s when fitted with a 100mm diam. downpipe. At 5.0 L/s, the design box gutter depth is 119mm for a slope of 1 in 100. If the box gutter depth is increased by 60mm (to 179mm), the design flow rate becomes 14.5 L/s, which is less than 16 L/s. Hence, the box gutter fails before the Dam Buster rainhead fails. This demonstrates that there is no advantage of having an open fronted rainhead over a Dam Buster rainhead for even the (smallest) 200mm size. Analyses of the other Dam Buster rainheads indicates that this holds true for the other sizes.

Note that due to the size and nature of the vertical overflow chute in a Dam Buster rainhead, it is considered very unlikely that the overflow chute would become blocked with debris. Furthermore, there is the advantage of being able to visually observe the status of the overflow chute from ground level.

As discussed in section 5.2, in the writer's opinion, the Dam Buster rainhead range complies with all the hydraulic requirements of 3500.3 and is therefore considered by the writer to be DtS by Expert Judgement. Refer to section 11.2 for further comments.

8.6 Dam Buster Sump

The Dam Buster Sump may be considered in general terms as an 'internal rainhead'.

The Dam Buster '*Continuous Sump'* is an extension of the use of the *Sump* to continuous one-way flow.

The Dam Buster '*Back-to-Back Sump'* is essentially a double Dam Buster '*Sump*'.

In the design flow condition, the Dam Buster *Sump* operates in the same manner as a Rainhead.

Testing has confirmed that the overflow capacity of the Dam Buster *Sump* exceeds its design flow capacity.

The Dam Buster *Sump* has the following additional safety features:

- For box gutters 300mm wide or greater, a minimum downpipe size of 100mm is adopted (even when a 90mm downpipe is hydraulically adequate)
- Where possible, a 90mm diameter 'overflow indicator' is added. The purpose of this is to alert the building owner or occupant of the (albeit unlikely for a well-maintained box gutter) event that both the design and overflow downpipes are blocked, and acts as a secondary overflow to a certain degree (but may be significantly less than the design flow). Note that an overflow indicator may only be used where the sump is located immediately adjacent to an external wall.

The following safety comparisons are made between the Dam Buster Sump and the HCO

- Where a Dam Buster Sump is located immediately adjacent to an external wall, and an overflow indicator is used:
  - The Dam Buster Sump is considered safer compared to the HCO (where the overflow indicator pipe is fitted).
- Where the Dam Buster Sump is located internally:
  - And it is an individual sump, its safety is similar to the HCO.
  - And it is used as a 'Continuous' or 'Back-to-Back' Sump, the safety of the sump is similar to a series of HCO's due to the cut down in the end wall of the overflow chamber and upstream end of the box gutter for the Continuous Sump,
    - For the Continuous Sumps, water can flow from one box gutter to an adjacent box gutter if both the primary and overflow downpipes' become blocked.
    - For the Back-to-back Sump, water can flow from one overflow chamber to the adjacent overflow chamber.

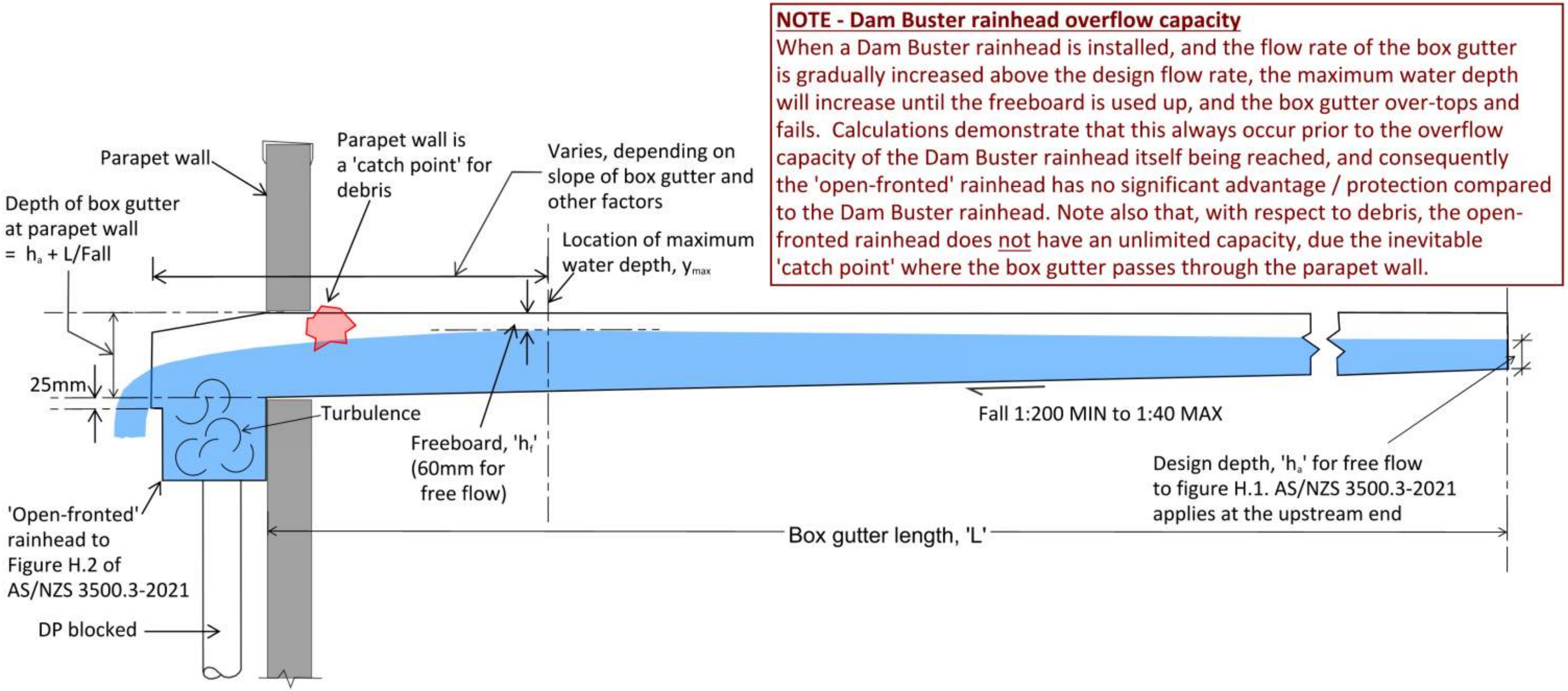


FIGURE 1 - Section through box gutter with 'open-fronted' rainhead per Figure H.2 of AS/NZS 3500.3-2021 in the overflow condition, with the flow rate equal to the design flow

8.7 Change of Direction devices – Dam Buster Side Outlet, Elbow and Junction devices

These devices may be considered in two ways:

- Change of direction devices
- Shallow 'sumps'*, having a deeper 'outlet' box gutter discharging through the one open side wall in the 'sump'. The box gutter discharging to the 'sump' is referred to as the '*Upstream*' box gutter and the (deeper) box gutter discharging from the 'sump' is referred to as the '*Downstream*' (or '*Outlet*') box gutter.

  * Note that a sump is traditionally effectively a local increase in the box gutter depth for the purpose of increasing the hydraulic capacity of the outlet. Hence, the first description above is considered more appropriate.

Regardless of the description, the hydraulic operation of these devices is sound, as discussed in section 8.3.

It is noted that in the overflow condition for the SSO, the water changes direction and discharges through an overflow duct, having a smaller size than the box gutter, and without a step / drop.

There is no hydraulic reason for why box gutters cannot change directions, provided there is an accompanying adequate step/drop to allow for any local head losses, and the hydraulic design criteria discussed in section 2.6 are met.

Also, as discussed in section 2.6, it follows that the only reason box gutters are not permitted to change directions in 3500.3 is that no design rules have been developed to permit a change of direction accompanied by a step/drop (increasing the box gutter depth).

In section 2.7, 3500.3 does not permit box gutters to be jointed along their length to increase their depth. This is not considered to be relevant to Dam Buster's change in direction devices.

8.8 Freeboard

Refer to section 2.5 for a discussion of the freeboard assumed for the 3500.3 devices in the primary and overflow conditions.

All box gutters discharging to Dam Buster devices are designed for free flow in accordance with Figure H.1, and therefore have the same freeboard of 60mm in the normal flow and overflow conditions.

The freeboard in the critical outer corner of a Dam Buster Elbow (and similarly, the Dam Buster End Side Outlet) has been determined by testing to be greater than 60mm, and this is also supported by theoretical calculations carried out by the writer which estimate the energy loss in the bend and determine the water depth by conservatively assuming zero velocity at this location.

For Dam Buster's change of direction devices, the freeboard exceeds 60mm within the lower portion of the device.

9 Schedule summarizing the comparison of Dam Buster devices to 3500.3

9.1 Refer to Addendum 1 for a summary of the comparison of Dam Buster devices to the requirements of 3500.3.

10 Risk of failure of Dam Buster devices compared to box gutter systems designed to 3500.3.

10.1 The following comparisons are made between the Dam Buster box gutter devices, and box gutter systems designed to 3500.3.

10.2 Straight box gutter to a Dam Buster rainhead

- The 'open-fronted' rainhead depicted in Figure H.2 of 3500 is not considered to be significantly safer than the DB rainhead, because the DB rainhead has much greater capacity in the overflow condition than in the design condition. It can be demonstrated that the box gutter itself will fail by overtopping prior to the DB rainhead reaching its overflow capacity.
- The DB rainhead has a box gutter receiver, which facilitates a compliant seal between the box gutter and the rainhead. This is in accordance with the Installation section of the code which deals with lap seal joints in box gutters and eaves gutters. Although 3500.3 requires that the box gutter is sealed to the rainhead, it is not made clear in the section of the code that deals with rainheads as to how this should be achieved. As a result, box gutters are typically poorly sealed to non-DB rainheads, creating a potential point of water entry into the building when the rainhead becomes blocked.
- In summary, the DB rainhead is considered to be equally as safe as the 3500.3 'open-fronted' rainhead in theory. However, in practice, due to the innovative box gutter receiver facilitating a good seal between the box gutter and the rainhead, the DB rainhead is safer.
- Referring to Figure 1 above, a 'catch point' for debris is where the box gutter passes through the parapet wall. When designing to 3500.3, the box gutter depth, including fall, could be as low as 120mm (for example, a 400mm wide box gutter, 6m long, having a slope of 1:200, and designed for the minimum flow rate of 3 L/s, would have a depth of 90 + 30 = 120mm at the parapet wall). Dam Buster has adopted a minimum depth of the penetration through the parapet wall of 150mm for a straight box gutter discharging to a rainhead.

10.3 Dam Buster Side Outlet and Rainhead combinations.

- As previously discussed, where the roof is adequately maintained and cleaned, the safety of the Side Outlet is not considered to be significantly less safe than a straight box gutter, noting that the outlet box gutter is significantly deeper than required for free flow by Figure H.1.

10.4 Dam Buster Sump, Continuous Sump and Back-to-Back Sump

- Refer to section 8.6 for a discussion of the safety of the DB Sumps compared to the HCO.
- In relation to the HCO:
    - Where located immediately adjacent to an external wall, and the overflow indicator is used, the DB sump is considered safer than the HCO
    - Where located internally, the DB sump is considered as safe as the HCO.
- Where a Dam Buster Sump is used immediately adjacent to an external wall in lieu of an SSO:
    - Where an overflow indicator is used, the safety of the DB sump is considered to be as safe as the SSO
    - Where an overflow indicator is not used, the SSO is considered to be safer than the DB Sump which is why the incorporation of an overflow indicator is recommended.

10.5 Dam Buster Upstream Devices

- The depth of the downstream box gutter of all 'upstream devices' (i.e. the DB Elbow and Junctions) is significantly greater than required by Figure H.1
- Consequently, where the box gutters are maintained as required by 3500.3, the DB Upstream Devices are not considered to be less safe than a straight box gutter.

10.6 Summary

The discussion below regarding current practice is informed by the Dam Buster team members.

The safety of each box gutter system will vary, depending on the roof layout and its various constraints. In general, box gutters designed using the Dam Buster roof drainage system will be as least as safe as box gutter systems designed to 3500.3.

The Dam Buster products provide the building designer with much greater flexibility and consequently it is often much easier to find a solution complying with the NCC when Dam Buster products are used.

Current practice is such that roof drainage is often not designed using the General Method at building permit stage, and therefore sizing and other details are not properly coordinated with the architecture and structure. The roof plumber typically does not become involved in a project until 'framing stage', by which time it is commonly very difficult, if not impossible, to achieve a compliant solution (because there has been no coordination with the architecture or structure). This leads to the installation of non-compliant roof drainage, resulting in a higher risk of failure. This is evident in the current environment, where non-compliant roof drainage and the resulting water damage is being frequently reported on social media as well as formally documented in university research publications.

To improve the quality of roof drainage systems incorporating box gutters, the following is required:

- Detailed design at Building Permit stage, to allow proper coordination with the architecture and the structure.
- Dam Buster products should be available for use in addition to the 3500.3 devices, noting that the DB devices provide much greater flexibility for architects/building

designers than the 3500.3 devices in the context of the ongoing proliferation of contemporary and high-density building designs.

11 Conclusions

11.1 The following is a summary of the outcomes of this appraisal with respect to the aims listed in section 1.1.

(i) Assess to what extent Dam Buster products comply with the key hydraulic principles and limitations of 3500.3.
All Dam Buster products comply with all the key hydraulic principles of 3500.3.

(ii) Assess and comment on the extent to which the Dam Buster products fall outside the limitations or scope of 3500.3, noting that the products are innovative.
The Dam Buster Side Outlet and Upstream devices (Elbow and Junctions) allow a change of direction in the box gutter in conjunction with the introduction of a step / drop within the device, designed such that (i) the height of the step is greater than the energy loss in the bend and (ii) the required freeboard is maintained in all locations within the device.

It is the writer's finding that the only reason box gutters are not permitted to change direction in 3500.3 is that no design rules have been developed to permit a change of direction accompanied by a step/drop (increasing the box gutter depth). It is noted that, in the overflow condition for the sump / side outlet to 3500.3, the water changes direction into an outlet having a significantly smaller area than the box gutter, and without a step. In comparison, not only do the above noted Dam Buster devices incorporate a step, but the outlet box gutter is also deeper than the inlet box gutter.

(iii) Confirm that the design methodology for the Dam Buster products is hydraulically sound and that the design tables and procedures are correct.
The writer has reviewed the design tables and procedures for Dam Buster products, as set out in the Dam Buster Product Technical Statement version 6.0, dated 19 February 2024, and found this information to be correct.

(iv) Comment, to the extent possible, on the safety of the Dam Buster products compared with the safety of box gutter systems designed to 3500.3.
In general, box gutters designed using the Dam Buster roof drainage system are considered at least as safe as box gutter systems designed to 3500.3. Furthermore, the following common non-compliances should be eliminated from use in the building industry:

- Usage of non-compliant 'Ned Kelly' style rainheads, noting that prior to the Dam Buster rainhead there was no aesthetically acceptable and compliant rainhead available in the marketplace
- Box gutters not adequately sealed to the rainhead.

11.2 The compliance pathway through the NCC for Dam Buster products should be determined by a Building Surveying professional. However, in the writer's opinion, Dam Buster products generally comply with 3500.3, except for the change of direction in box gutters, which is considered to be a hydraulically sound extension of the scope of 3500.3. The preface of the 2018 version of AS/NZS 3500.3 stated:

'*This Standard necessary deals with existing conditions, but is not intended to discourage innovation or to exclude materials, equipment and methods that may be developed in future.*'

Whilst interpretation of this statement may be subjective, the writer remains of the opinion that it could be inferred from this statement that the Dam Buster products may be considered to be Deemed-To-Satisfy by Expert Judgement, with the added proviso that an opinion from a building surveying professional is also required to confirm this. Furthermore, approval may also be required from the relevant state or territory building regulator.

11.3 It is important to note that because all Dam Buster devices operate under free flow in both the primary and overflow conditions, all box gutters can be sized for their design flow in accordance with Figure H.1 of AS/NZS 3500.3-2021. This contrasts with the SSO and HCO devices, where design of the box gutter using the General Method is an integral part of the design of the overflow device.

Dr R. J. Keller

20th February 2024

ADDENDUM 1 - Schedule comparing Dam Buster devices to AS/NZS 3500.3-2021

Clause	Sub clause	Requirement	Comments
			Notation: 3500.3 = AS/NZS 3500.3:2021, SSO = Sump / Side overflow to 3500.3, HCO= Sump / high capacity overflow to 3500.3
3.7.1 General		Box gutter systems shall incorporate overflow devices in accordance with Clause 3.7.7	Dam Buster has two types of devices, as follows: Box gutter overflow devices All box gutter overflow devices have provision for overflow. Refer to appraisal section 8.5 which discusses the Dam Buster rainhead and shows that there is no advantage of the 'open-fronted' rainhead to 3500.3. Note that the overflow device comprising a Side Outlet and a Rainhead is a effectively a change of direction device plus a box gutter overflow device. Upstream devices The upstream devices comprise the Elbow and Junctions. These devices allow a change of direction. Refer to appraisal sections 5.3 and 8.7. All upstream device discharge to box gutter overflow devices. In summary, any box gutter system using Dam Buster devices incorporate provision for overflow which is compliant and comparable to the 3500.3 devices. Refer to appraisal section 10 for a discussion on the risk of failure of Dam Buster devices compared to 3500.3 devices.
3.7.2 Freeboard		Freeboard for the sump and side overflow is required to be 30mm.	The freeboard assumed by 3500.3 is mostly hidden but has been identified in full as a result of a literature review, refer to appraisal section 2.5. As discussed in appraisal section 8.8, all box gutters discharging to Dam Buster devices are designed for free flow in accordance with Figure H.1, and therefore have the same freeboard of 60mm in the normal flow and overflow conditions. For Dam Buster's change of direction devices, the freeboard exceeds 60mm with the lower portion of the device.
3.7.3 Limitations	(a) Gradients	Box gutter gradients to be in the range 1:40 to 1:200	All box gutters discharging to Dam Buster devices must comply with 3500.3 and are designed for free flow in accordance with Figure H.1. Dam Buster provides box gutter design charts for each gradient 1:200, 1:100, 1:150 and 1:40. Dam Buster devices were tested using box gutters with slopes of 1 in 200. The experimental results agreed with hydraulic analysis. Hydraulic analysis of other allowable slopes indicated that the Dam Buster devices would perform equally well and there would be no reduction, or no significant reduction, of freeboard in the change of direction devices for the higher slopes.
	(b) Rainheads	(i) design flows not to exceed 16 L/s (ii) downpipes to be per Figure H.3	The design flow rates for Dam Buster rainheads do not exceed 16 L/s and the downpipes sizes are limited to those in Figure H.3. Refer to further comments below. Design of Dam Buster rainheads Dam Buster rainheads are designed fully in accordance with 3500.3. For each tabulated rainhead / DP / maximum flowrate combination (for a particular rainhead size), the length and depth required were determined in accordance with Figure H.3. The largest of these values were then used to set the length and depth of the rainhead (i.e. the dimensions of the main compartment, excluding the vertical overflow chute). Hence, the rainhead dimensions are 'pre-designed' for each rainhead size / DP / maximum flowrate combination. As a result, no design is required for the rainhead, and the rainhead size / DP combination is selected to ensure the design flow rate is equal or less than the maximum allowable flow rate for the selected combination. Or in other words, the Dam Buster rainhead is pre-designed to 3500.3.
	(c) Sump DPs	Sump DPs are limited to those in Figure H.3	Dam Buster sumps are only used with the DPs listed in Figure H.3. Furthermore, the DPs are limited to circular DPs. Rectangular DPs are not permitted, as these would be fabricated from metal, which is more prone to leakage and therefore not considered suitable for internal usage.
	NOTE 1	Figure H.6 & H.8 assume that box gutter slopes are in the range 1:40 and 1:200	These figures relate to the design of the HCO are not directly relevant to the Dam Buster devices
	NOTE 2	This note relates to the criteria for box gutter overflow devices and refers to Clause 3.7.7 and Figure 3.7.3.	Refer below for a discussion clause 3.7.7. Figure 3.7.3 depicts the three code box gutter overflow devices. This appraisal compares DB devices to the three code devices.
	NOTE 3	The minimum width for box gutters is 300mm, however 200mm may be used for domestic construction.	Dam Buster devices use standard widths of 200mm, 300mm, 400mm, 500mm and 600mm. It is the responsibility of the designer to select an appropriate box gutter width.
	NOTE 4	Examples of the General Method are provided in Appendix I	This does not apply to Dam Buster devices. However the following is noted in relation to the General Method, as this cannot be understood without knowledge of the 'hidden' freeboards assumed by 3500.3. The general method requires that the SSO and HCO are firstly designed for free flow in accordance with Figure H.1 and then the overflow is designed. The freeboard implied for free flow is 60mm, but only 30mm and 45mm respectively for the SSO and HCO. In the overflow condition, free flow is lost, as the water level must rise up to either discharge through the overflow duct of the SSO or flow over the weir in the HCO. In both cases backwatering occurs. It is not obvious whether the design box gutter depth will be greater during the design flow or in the overflow condition, and this is why both cases must be checked.

Clause	Sub clause	Requirement	Comments
Figure 3.7.3	(a) Rainhead	Diagram of rainhead	The diagram of the rainhead is incomplete as it does not include the parapet wall. Refer to appraisal section 8.5 and Figure 1. The diagram of the rainhead is misleading because it gives the impression that there is unlimited overflow capacity of the rainhead. This is incorrect for two reasons: Firstly, with increasing flows above the design flow, the box gutter will fail due to loss of freeboard and Secondly, there is a 'catch point' for debris where the rainhead passes through the wall. For the Dam Buster rainhead, it can be shown that, as the flow rate increases above the maximum design flow rate for the rainhead / DP combination, the box gutter will fail before the overflow capacity is reached. Consequently, the open-fronted rainhead has no advantage over a Dam Buster rainhead.
	(b) Sump / side overflow device	Diagram of sump / side overflow device	It is noted that in the overflow condition, the water must change directions and flow out of the box gutter / sump through a duct which has a smaller area than the box gutter. As discussed in appraisal section 8.7, there is no hydraulic reason for why box gutters cannot change directions, a provided there is an accompanying step / drop, and the hydraulic design criteria discussed in appraisal section 2.6 are met.
	(c) Sump / high capacity overflow device	Diagram of sump / high capacity overflow device	The Dam Buster Sump is a much simpler device than the HCO, because free flow also occurs in the overflow condition. In practice the HCO is rarely constructed, and instead a 'non-compliant' vertical piped overflow is installed, which cannot be designed to 3500.3. This has been occurring for 25 years, since the introduction of AS/NZS 3500.3.2-1998.
3.7.4	(a), (b) & (c)	General method for the design of the three box gutter overflow devices	As discussed above, in the design flow condition the Dam Buster rainhead is (pre) designed in accordance with general method.
3.7.5 Hydraulic capacity		The hydraulic capacity (eg. maximum design flow) of a box gutter is based on the sole width and gutter depth, the gradient and the type of overflow devices.	Box gutters discharging to Dam Buster devices operate under free flow in the design and overflow conditions. Consequently, the design of the box gutter is carried out in accordance with 3500.3 and is not dependent on the type of Dam Buster overflow device or type of Upstream device.
3.7.6 Layout requirements for box gutter systems	(a)	The location and size of box gutter shall be taken into consideration	This applies to all box gutter systems designed using Dam Buster devices.
	(b)	The size of the support system shall be taken into consideration	This applies to all box gutter systems designed using Dam Buster devices.
	(c)	Provision for thermal expansion	Box gutters discharging to Dam Buster devices must contain provision for expansion in accordance with section 4 of 3500.3
	(d)	Consideration for the location of vertical downpipes with sumps	This applies to all box gutter systems designed using Dam Buster devices.
	(e)	The minimum depth of the HCO is 150mm	This is not relevant to Dam Sumps. Standard depth for Dam Buster sumps are 100mm, 125mm, 150mm and 200mm.
	(f)	The normal outlet may be moved longitudinally to clear the overflow channel for the SSO. The outlet shall not be moved laterally to cross the longitudinal centreline of the overflow device.	The reason for the second requirement is not clear. Section 6.02 *Swirl* of the CSIRO-ESB 1978 Roof drainage note '*The performance of an outlet with h > 1/3 D will be reduced if swirl occurs at the outlet. Swirl can be eliminated and the diameter reduced by about 10 percent if the outlet is placed at a distance equal to or less than its diameter from the nearest vertical side (see Fig 3). Swirl can be ignored at outlets with h < 1/3 D'*.
	(g) (i)	Box gutters shall be straight	All box gutter discharging to Dam Buster devices are straight. Dam Buster Side Outlets and Upstream devices (Elbows and Junctions) include a step down which is greater than the energy loss at the change of direction and the required freeboard is maintained (in fact, exceeded) throughout the device. Refer appraisal sections 5.3 and 8.7.
	(g) (ii)	Have a horizontal constant base (sole) width with vertical sides in cross-section	All box gutters discharging to Dam Buster devices must comply with 3500.3.
	(g) (iii)	Have a constant slope between 1:200 and 1:40	All box gutters discharging to Dam Buster devices must comply with 3500.3.
	(g) (iv)	Discharge at the downstream end without a change in direction (i.e. not to the side)	All box gutters discharging to Dam Buster devices must comply with 3500.3.
	(g) (v)	Be sealed to the rainheads and sumps	Dam Buster rainheads and sumps include box gutter receivers which facilitate a good seal between the box gutter and the rainhead and sump. It is noted that 3500.3 is not clear on how a box gutter is sealed to a rainhead. In practice, the majority of box gutters are either not sealed, or inadequately sealed to the rainhead, and this is a common leakage point into the building. Commonly, a rectangular opening is cut in the back of the rainhead, and the box gutter is inserted into this opening, often protruding a distance into the rainhead, thereby effectively reducing the length of the rainhead. The seal commonly comprises silicone only between the box gutter and rainhead, with no laps and no rivets. In many instances there is not even any silicone. This issued has not been adequately addressed in the last 25 years.

Clause	Sub clause	Requirement / second sub-clause	Comments
3.7.7 Overflow devices	3.7.7.1 Hydraulic capacity	The hydraulic capacity of the overflow is required to be at least equal to the design flow for the gutter(s).	The Dam Buster rainhead has a much higher overflow capacity than the maximum allowable design flowrate for the largest DP which may be used with the rainhead size. As previously discussed, for a number of reasons, there is no advantage of the 'open-fronted' rainhead to 3500.3 over the Dam Buster rainhead. The overflow capacity of the Dam Sumps is either equal to, or exceeds, the design flow.
	3.7.7.2 Operation	There shall be an increase of flow in the box gutter devices that discharge to the SSO or HCO	
3.7.8 Downpipes	(a)	DPs to be at least 90mm DIAM or 100x50mm	This applies for all Dam Buster devices, except for the R-200 rainhead, which allowable flow rates are provided for an 80mm DIAM DP, based on testing carried out by AHSCA research foundation. In this case, the overflow capacity of the rainhead is more than four times the design flow capacity.
	(b)	DPs to discharge to a surface water drainage system with the capacity to convey run-off from a 1% AEP storm event	This applies to all box gutter systems.
4.7 Joints for metal components	4.7.1	Gutters shall not be jointed along their length to increase gutter depth	Refer to appraisal section 2.7
	4.7.2 Type of joints	4.7.2.1 Soldered	Dam Buster products do not utilise (nor recommend) soldered joints.
		4.7.2.2 Sealant	Dam Buster products have sealant joints applied in compliance with this section of the code. Dam Buster have elected to specifically utilise rivets as the mechanical fasteners at maximum 40mm centres with sealant sandwiched between the lap joints on all assembled products.
		4.7.2.3 Laps	Dam Buster products have a minimum of 25mm laps at all joints and mechanical fasteners are spaced at maximum 40mm centres and set no closer than 10mm from the edge of a joint in compliance with this section of the code.

ADDENDUM 2 - Dam Buster Product Technical Statement version 6.0 dated 19th February 2024

Achieve Compliance & Conformance with

Dam Buster Products

NOTE: All Dam Buster® products are protected by various Australian and International Patents.

This document it to be read in conjunction with the Dam Buster publications titled 'Evidence of Suitability' and 'Installation Manual' and sets out the design requirements, as well as usage conditions and limitations for the use of Dam Buster's products.

PRODUCT TECHNICAL STATEMENT

Version 6.0 (19 February 2024)

CERTIFIED PRODUCT
(DAM BUSTER RAINHEAD)

For testing of the Overflow Performance of Dam Buster rectangular rainheads.

GOOD DESIGN AWARD® WINNER 2018

PRODUCT DESIGN
HARDWARE AND BUILDING
DAM BUSTER RAINHEAD

"The Architectural Choice"

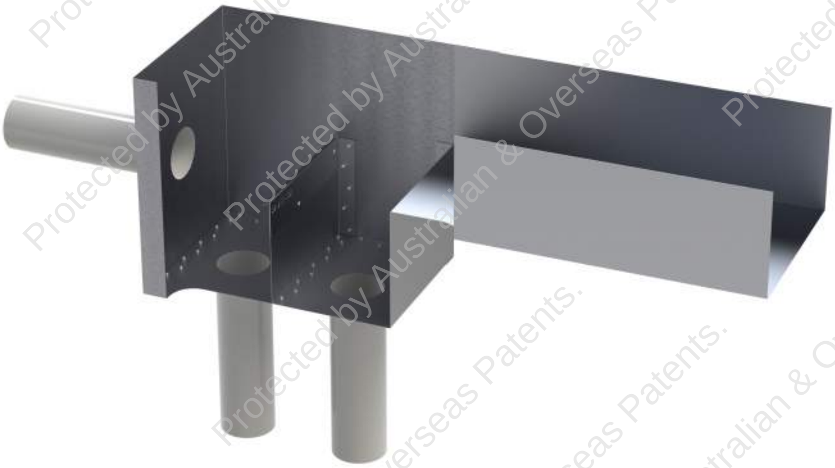
www.dambuster.com.au

Dam Buster Roof Drainage System - Product Range

Overflow devices (1 of 2)

Dam Buster Rainhead

Dam Buster Curved Fronted Rainhead



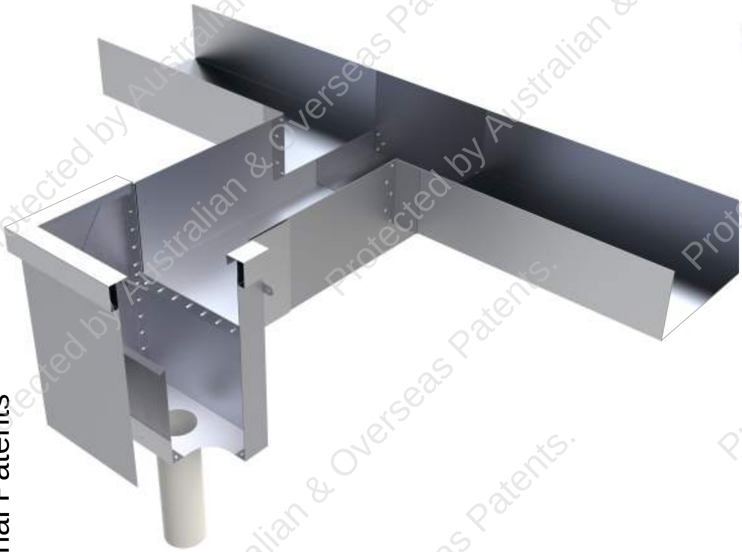
Dam Buster Sump

Dam Buster Back-to-Back Sump

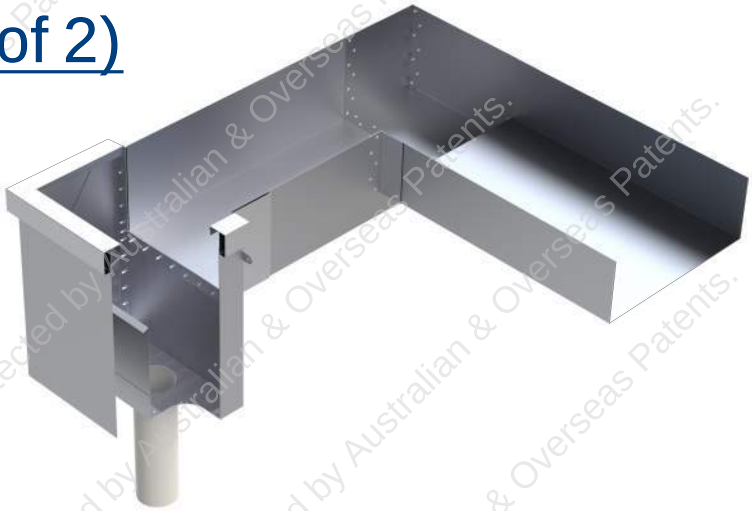
Dam Buster Continuous Sump

Dam Buster Roof Drainage System - Product Range (cont)

Overflow devices (2 of 2)

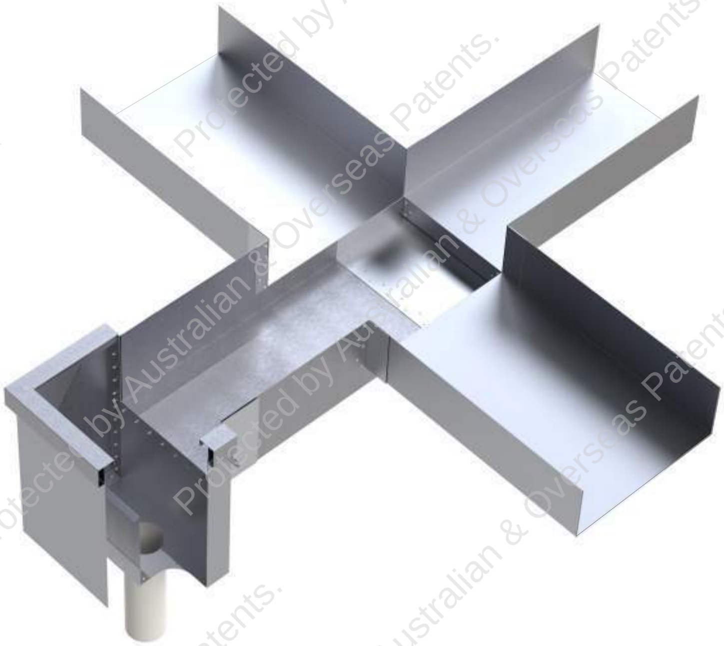


Dam Buster T Side Outlet & Rainhead



Dam Buster END Side Outlet & Rainhead
(LH & RH forms available)

Dam Buster CORNER Side Outlet & Rainhead
(LH & RH forms available)



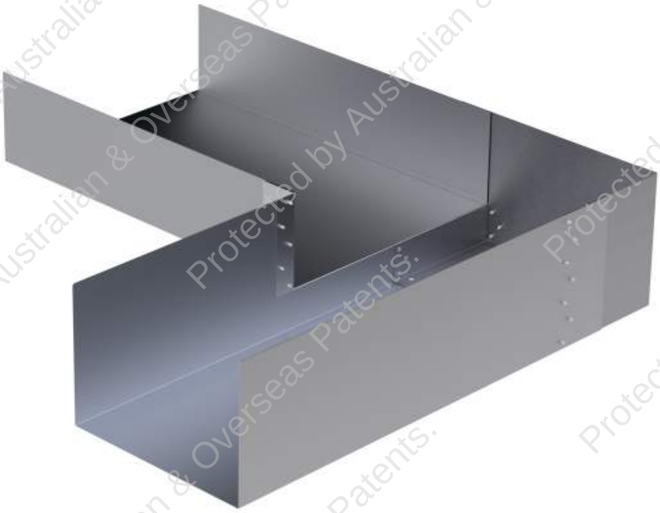
Dam Buster CRUCIFORM Side Outlet & Rainhead

NOTE
The following Side Outlet & Sump combinations are also possible
Dam Buster T Side Outlet & Sump
Dam Buster Corner Side Outlet & Sump
Dam Buster Cruciform Side Outlet & Sump

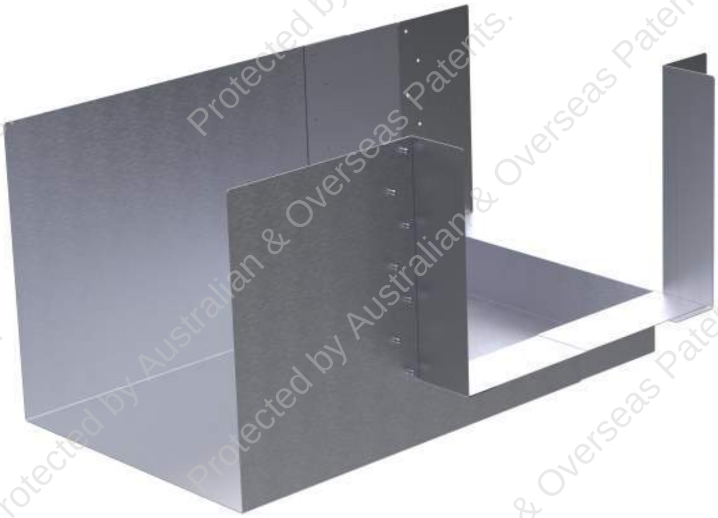
Dam Buster END Side Outlet & Sump
(LH & RH forms available)

Dam Buster Roof Drainage System - Product Range (cont)

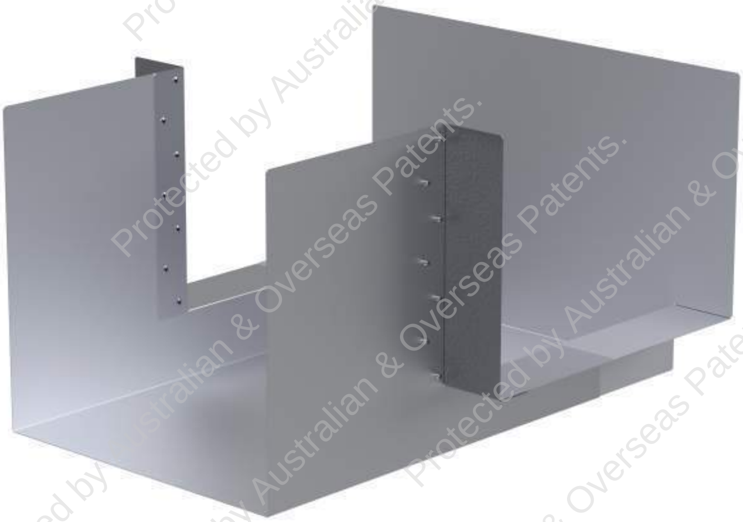
Upstream devices



Dam Buster Elbow



Dam Buster Corner Junction



Dam Buster T Junction

INDEX

NOTE

Where this document refers to any code, guide or manual, this reference should be interpreted as being for the current legal version of the code, guide or manual for the relevant state or territory, unless noted otherwise.

1. PRODUCT DESCRIPTIONS

Dam Buster products are comprised of Zincalume, Colorbond or other approved metal materials suitable for use in domestic and/or commercial roof drainage systems.

Models:

- *Box gutter overflow devices*
  - Dam Buster **Rainhead**
  - Overflow device comprising a Dam Buster **Side Outlet** and a Dam Buster **Rainhead** or a **Dam Buster Sump**
  - Dam Buster **Sump, Continuous Sump** and **Back-to-Back Sump** ('free flow' sumps)
- *Ancillary products*
  - Dam Buster **Elbow**
  - Dam Buster **Junctions**

2. APPLICATION AND INTENDED USE

The components which form the Dam Buster Roof Drainage System can be used in both domestic and commercial roof plumbing applications. Dam Buster products should only be specified by building design professionals and plumbers who have a good understanding of the relevant codes, and in particular, AS/NZS 3500.3. Dam Buster products should only be installed by licensed roof plumbers.

3. COMPLIANCE WITH THE NATIONAL CONSTRUCTION CODE

Roof drainage falls under NCC Volumes 1 and 2 (i.e. the BCA), however, in Victoria and Tasmania, roof drainage also falls under NCC Volume 3 (i.e. the PCA) as state additions.

Refer to Dam Buster's Evidence of Suitability document for the compliance pathways available for Dam Buster's products. Briefly, these are:

Box Gutters	Deemed-to-Satisfy ('DtS') (designed to AS/NZS3500.3)
Dam Buster Devices	Deemed-to-Satisfy by Expert Judgement * OR Performance Solution

* DtS by Expert Judgement is the preferred pathway for Dam Buster devices, however, if this is not acceptable to the Regulatory Authority and / or Building Surveyor / Certifier, a Performance Solution can be prepared using Dam Buster's Performance Solution templates.

DAM BUSTER®

4. LIMITATIONS OF USE

Dam Buster products are suitable for use within all building classes 1 to 10, regardless of height or size. The following limitations apply to Dam Buster Products:

- Dam Buster products must comply with the Instructions for Design in this document.
- Dam Buster products must be installed in accordance with the Dam Buster Installation Manual.
- In Victoria and Tasmania, roof plumbing must also comply with the current version of SA HB39 *Installation code for metal roof and wall cladding.*
- In Victoria, roof plumbing must also comply with HB114.
- Dam Buster products must be installed by a building professional or roof plumber with a good understanding of AS/NZS 3500.3, and where applicable, SA HB39 and HB114.

5. CONDITIONS OF USE

The building contractor / plumber must only use Dam Buster products in accordance with this Product Technical Statement and install the products in accordance with Dam Buster's Installation Manual. Additionally, the installing plumber must ensure the type of material used provides adequate corrosion protection for the exposure classification. Further information can be obtained from the following BlueScope publications:

- Technical Bulletin 1A - '*Steel roofing products – selection guide.'*
- Technical Bulletin 35 - '*Australian salt marine classifications.'*

The installing plumber must also ensure compatibility of materials to prevent dissimilar metal corrosion.

More generally, the entire roof drainage installation must comply with all relevant requirements of AS/NZS 3500.3, SA HB39 (as applicable*) and SAA/SNZ HB114 (as applicable*).
* HB39 and HB114 are not applicable in all states and territories.

6. INSTRUCTIONS FOR DESIGN

A - BOX GUTTER(S) TO A DAM BUSTER OVERFLOW DEVICE

i. Straight box gutters to Dam Buster Rainhead
ii. Box gutter(s) to a Dam Buster Side Outlet & Rainhead combination
iii. Box gutter(s) to a Dam Buster Side Outlet & Sump combination

Design procedure

Follow STEPS 1 to 4 below.

STEP 1 - Determine the design rainfall intensity for the location

Option 1

Australia

Select a 1% AEP (annual exceedance probability) design rainfall intensity for a time of concentration of 5 minutes for the location in accordance with Appendix D of AS/NZS 3500.3.
This value is referred to as $_{100}I_5$

New Zealand

Select a 2% AEP design rainfall intensity for a time of concentration of 10 minutes for the location in accordance with Appendix E of AS/NZS 3500.3. This value is referred to as $_{50}I_{10}$.

Option 2 (for Australia only)

a) Determine the longitude and latitude for the site
b) Determine the 1% AEP design rainfall intensity for a 5 minute duration using the Bureau of Meteorology's IFD (Intensity-Frequency-Duration) website:-
http://www.bom.gov.au/water/designRainfalls/revised-ifd/

STEP 2 - Determine the roof catchment area and design flow rate for each box gutter associated with the Dam Buster device

NOTE

Each Dam Buster device and its associated box gutter(s) should generally be designed one at a time for the roof drainage project, although the depths of box gutters will need to be rationalised to match as / where required.

For each box gutter discharging to a Dam Buster Box Gutter Overflow device

a) Determine the roof catchment area in accordance with section 3.4 Catchment area of AS/NZS 3500.3
b) Convert the catchment area to a flow rate in litres per second:

$$Q = \frac{CA \times Intensity}{3600}$$

where

CA = catchment area (m^2).
Q = the design flow rate in L/s
Intensity =$_{100}I_5$ or $_{50}I_{10}$ mm/h per step 1

Notes

1) 1mm water depth over $1m^2$ equates to 1 litre
2) The factor 3600 converts the rainfall intensity from L/hour to L/s

6. INSTRUCTIONS FOR DESIGN (cont.)

A - BOX GUTTER(S) TO A DAM BUSTER OVERFLOW DEVICE (cont.)

STEP 3 - Design each box gutter associated with the device

a) Design each box gutter for 'free flow' in accordance with Appendix I, Figure H.1 of AS/NZS 3500.3 to determine the upstream depth. Note, it is recommended this value be rounded up to the nearest 5mm.
Refer to Appendix F for Dam Buster Box Gutter Design Charts.

b) Determine the increase in depth of the box gutter over its length, based on its slope (which must be between 1 in 200 to 1 in 40), and round this value up to the nearest 5mm.

c) Add the result in (b) to (a) to determine the design downstream box gutter depth (note, it is assumed the top of the box gutter is level, and the sides are tapered due to the fall).

NOTES

1) Box gutters with design flow rates less than 3L/s must be designed for the minimum design flow rate of 3L/s.

2) Where there is more than one box gutter discharging to an overflow device comprising a Dam Buster Side Outlet and a Dam Buster Rainhead, the design flow rate is the sum of the actual design flow rates for each box gutter. For example, for a T Side Outlet, if the design flow rates of the two box gutters are 1.5 L/s and 2.0 L/s, both box gutters are designed for 3L/s, however, the rainhead is designed for 1.5 + 2.0= 3.5 L/s (not 6L/s).

STEP 4 - Design the Dam Buster device

Dam Buster Rainhead

Select the rainhead / downpipe combination from Table 1 below, such that the design flow rate is less than the allowable flow rate.

Overflow device comprising Dam Buster Side Outlet and a Dam Buster Rainhead

No design of the Side Outlet itself is required, provided
(i) the Dam Buster Rainhead is selected as above and
(ii) the Side Outlets are used within their allowable ranges i.e.
200 Side Outlet - expansion range is 200mm to 300mm (step= 50mm)
300 Side Outlet - expansion range is 300mm to 450mm (step= 60mm)
400 Side Outlet - expansion range is 400mm to 600mm (step= 70mm)

Overflow device comprising Dam Buster Side Outlet and a Dam Buster Sump

Apart from one exception noted below, no design of the Side Outlet itself is required, provided
(i) the Dam Buster Sump is selected from Table 2 below,
(ii) the Side Outlets are used within their allowable ranges i.e.
200 Side Outlet - expansion range is 200mm to 300mm (step= 50mm)
300 Side Outlet - expansion range is 300mm to 450mm (step= 60mm)
400 Side Outlet - expansion range is 400mm to 600mm (step= 70mm)

EXCEPTION to Design Method

For the 200mm Dam Buster Side Outlet and Sump combination (only), the maximum flow rate is limited 5.0 L/s i.e. it is the lessor of the value in Table 2 and 5.0 L/s.

6. INSTRUCTIONS FOR DESIGN (cont.)

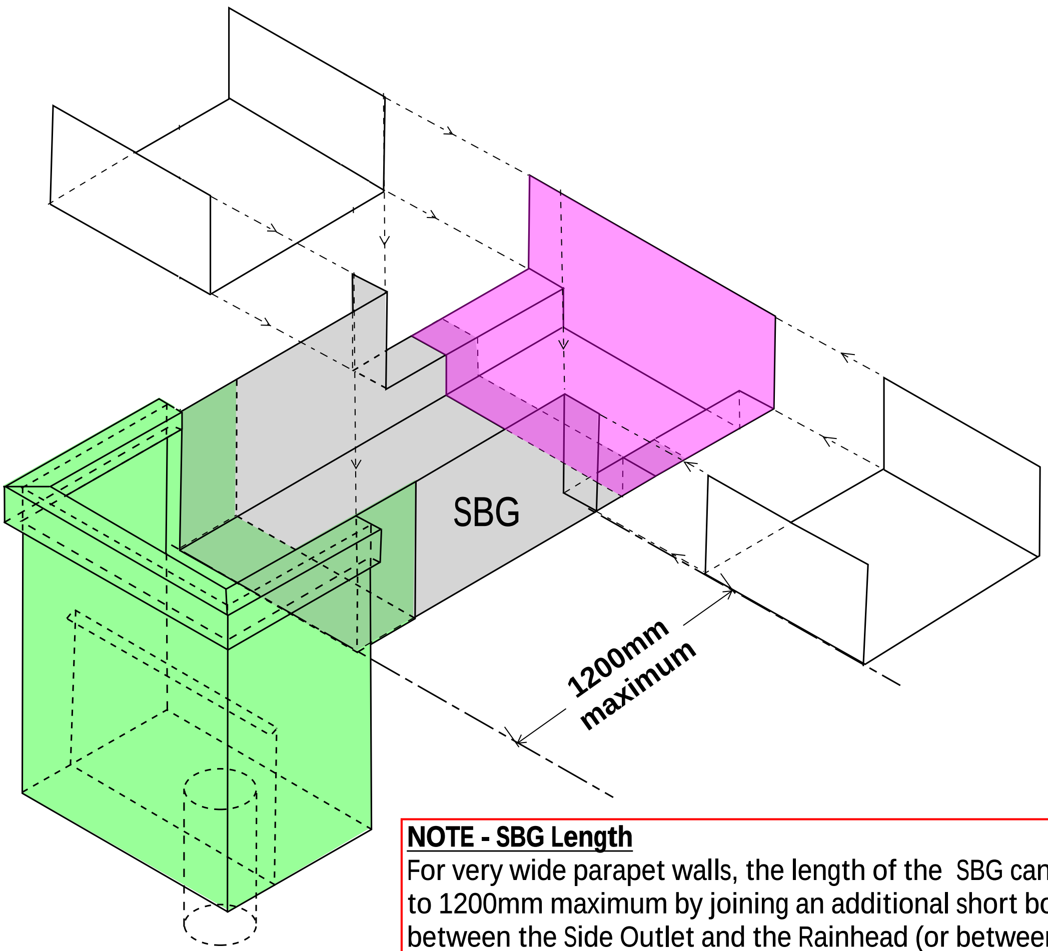
A - BOX GUTTER(S) TO A DAM BUSTER OVERFLOW DEVICE (cont.)

STEP 4 - Design the Dam Buster device (continued)

Dam Buster Sump
Select the sump / downpipe combination from Table 2 below, such that the design flow rate is less than the allowable flow rate.
Design the aerial overflow pipe. **Refer to Appendix G for a design chart.**

Dam Buster Continuous Sump
The Dam Buster Continuous Sump provides an practicable (and more cost effective) alternative to the AS/NZS 3500.3 DtS Sump / High Capacity Overflow device ('HCO'). This device is designed in the exactly the same way as the Dam Buster Sump. The flow occurs in one direction only, and when this device is located on building grids, one device may be eliminated, as there is no device at the first upstream end.

Dam Buster Back-to-Back Sump
The Dam Buster Back-to-Back Sump is effectively a double Sump, and has double the capacity of the Dam Buster Sump, provided the aerial overflow pipe is designed for the total flow in both sumps. The Back-to-Back Sump provides a very high hydraulic capacity and significantly exceeds the hydraulic capacity of the HCO for a similar sump depth.



NOTE - SBG Length
For very wide parapet walls, the length of the SBG can be increased to 1200mm maximum by joining an additional short box gutter section between the Side Outlet and the Rainhead (or between the Side Outlet and the Sump). This applies to all Side Outlets.

Maximum Length of Short Outlet Box Gutter ('SBG')

6. INSTRUCTIONS FOR DESIGN (cont.)

A - BOX GUTTER(S) TO A DAM BUSTER OVERFLOW DEVICE (cont.)

TABLE 1 – Dam Buster Rainhead

Downpipe size	Equivalent diameter	Dam Buster Rainhead size(1)				
		R-200	R-300	R-400	R-500	R-600
100 x 50	79	4.00(2)	4.00(3)	Refer note (iv)		
80 diam.	80	4.00(2)	4.00(3)			
90 diam.	90	4.70	6.50			
100 x 75	97	5.00	7.30	8.00		
100 diam.	100	5.00	7.60	8.80	8.80	
100 x 100	112		8.80	12.0	12.0	
125 diam.	125		9.50	14.2	15.4	15.9
150 x 100	137	Refer note (v)		15.8	16.0	16.0
150 diam.	150			16.0	16.0	16.0
Overflow Capacity of Device (L/s)		>16.0	>16.0	>16.0	>16.0	>16.0

(1) Curved fronted rainheads CR-www have the same capacity as rectangular rainheads
(2) Capacities determined by testing by the AHSCA Research Foundation
(3) Capacities adopted for R-200 (R-300 not tested yet for these DPs)

Maximum permissible flow rates (litres / sec)

NOTES

(i) Values in black have been determined in accordance with AS/NZS 3500.3

(ii) Values in red were determined by testing by the AHSCA Research Foundation

(iii) Values in blue were also determined by testing by the AHSCA Research Foundation. Note, AS/NZS 3500.3 permits the use of a 100x50 DP, however, no design charts are provided within the standard for this downpipe size, and consequently testing was required.

(iv) For the R-400, R-500 & R-600, smaller downpipes than noted in the table may be used, provided the maximum permissible capacity is adopted as that for the next lowest rainhead size for which a value in the table is provided, for the same DP size. For example, for a 600 Rainhead, and 90 mm diam. DP, the maximum flow rate is 6.50 L/s.

(v) These combinations are not possible

(vi) Rectangular downpipes are considered to be 98% as effective as circular downpipes. Hence the equivalent diameter is based on 0.98 times the area of the rectangular downpipe.

(vii) The capacities of **STRETCHED** rainheads are the same as for the non-stretched versions. For example, the capacity of a R-300-450 rainhead is the same as for the R-300 rainhead i.e. the stretched versions do <u>not</u> have additional capacity.

6. INSTRUCTIONS FOR DESIGN (cont.)

A - BOX GUTTER(S) TO A DAM BUSTER OVERFLOW DEVICE (cont.)

TABLE 2 – Dam Buster Sump

Normal downpipe size	Overflow Downpipe size	Sump Depth (mm)	Dam Buster Sump width (mm)				
			200	300	400	500	600
90 diam.	90 diam.	100	2.85				
“ “	“ “	125	(3.20)			Refer Note 4	
“ “	“ “	150	3.60				
90 diam.	100 diam.	100	3.40	(3.40)			
“ “	“ “	125	(4.60)	4.60			
“ “	“ “	150	5.05	(5.05)	5.05		
“ “	“ “	200	(5.90)	5.90	5.90		
100 diam.	100 diam.	125	(5.70)	5.70	(5.70)		
“ “	“ “	150	6.25	(6.25)	6.25	6.25	6.25
“ “	“ “	200		7.30	7.30	7.30	7.30
150 diam.	150 diam.	150	Refer Note 5		12.2	12.2	12.2
“ “	“ “	200			16.0	16.0	16.0

Maximum permissible flow rates (litres / sec)

Notes

1) denotes sump size not currently available as a standard size. Refer to available standard sizes in table below.
2) There is one exception to the table above. When used in conjunction with a Side Outlet, the maximum flow rate in the 200 Dam Buster Sump should be limited to 5.0 L/s.
3) Aerial overflow downpipes must be designed and installed at adequate grade to achieve the required flow rates. The minimum grades for critical flow rates specified in the design table (for PVC pipes) are provided in the table below for information purposes. These values have been determined from standard calculators based on the Colebrook-White equation. Note, these values apply to straight pipes with no additional bends than the bend below the sump. Where there are additional bends, obtain advice from a hydraulic engineer.

Pipe size	Flow rate	Min grade
90 diam	3.60	1 in 200
“ “ “	4.60	1 in 150
100 diam	5.50	1 in 200
“ “ “	7.30	1 in 120
150 diam	16.0	1 in 200

Refer also Appendix F for an Aerial downpipe design chart.

4) These combinations may be used, however, provided the maximum flow rates stated for the same DP combinations in the same row of the table are adopted.
5) These combinations are not possible.
6) **IMPORTANT** – AERIAL OVERFLOW PIPES MUST DISCHARGE VISIBLY TO ATMOSPHERE IN ORDER TO ALERT THE BUILDNG MANAGER / BUILDING OWNER / BUILDING OCCUPANT THERE IS A BLOCKAGE IN THE SYSTEM.

Dam Buster sump standard sizes

Depth \ Width	200 mm	300 mm	400 mm	500 mm	600 mm
100 mm	SU-200-100				
125 mm		SU-300-125			
150 mm	SU-200-150		SU-400-150	SU-500-150	SU-600-150
200 mm		SU-300-200	SU-400-200	SU-500-200	SU-600-200

6. INSTRUCTIONS FOR DESIGN (cont.)

B - DAM BUSTER ELBOW

Design procedure

a) Repeat Steps 1 & 2 on page 8
b) Determine the total flow rate in the Upstream and Downstream box gutters, and check that this is less than the maximum allowable flow rate in Table 3
c) Design the Upstream box gutter for the total flow rate noted above in accordance with AS/NZS 3500.3, Appendix H, Figure H.1
d) Note, there is no need to design the Downstream box gutter due to the increase in depth due to the Step-Down in the Elbow

TABLE 3 – Dam Buster Elbow

Device Size	Maximum Flow Rate (L/s)	Contraction Range for Upstream Gutter	Maximum box gutter depth at Entry (mm)	Drop within Elbow (mm)	Maximum box gutter depth at Exit (mm)
ELB-200	5.0	200	180	50	230
ELB-300	9.5	300 -> 200	215	60	275
ELB-400	16.0	400 -> 300	230	70	300
ELB-500	16.0	500 -> 300	230	70	300
ELB-600	16.0	600 -> 400	230	70	300

NOTES

1. The upstream box gutter is designed (in accordance with figure H.1 of AS/NZS 3500.3) for a flow rate equivalent to the total catchment area of the upstream and downstream box gutters. It is not necessary to design the downstream box gutter.
2. The top of the upstream box gutter, the Elbow, and the downstream box gutter must all be level. Hence the upstream depth of the downstream gutter is equal to the downstream depth of the upstream gutter, plus the drop (and small amount fall within the Elbow itself).
3. The Elbow is trimmed to match the designed downstream depth of the upstream box gutter. Refer to the Installation Manual.
4. All Elbows are supplied as 'Sliding' Elbows (i.e. supplied in two-piece / adjustable) by default. Sliding Elbows are able to contract for the upstream box gutter width within the specified range (all sizes except 200)
5. 'Fixed' Elbows are also for special larger volume orders (over 20 units), however fixed Elbows are not adjustable for the upstream box gutter.
6. **ONLY THE UPSTREAM BOX GUTTER MAY BE CONTRACTED. THE DOWNSTREAM BOX GUTTER MAY NOT BE NARROWER THAN THE UPSTREAM BOX GUTTER.**

6. INSTRUCTIONS FOR DESIGN (cont.)

C - DAM BUSTER JUNCTIONS

Design procedure

a) Repeat Steps 1 & 2 on page 8.
b) Determine the total flow rate in the Upstream and Downstream box gutters, and check that this is less than the maximum allowable flow rate in Table 4
c) Design the Upstream box gutter having the greater catchment area (the 'critical' upstream box gutter) for the flow rate to this box gutter, plus the flow rate to the downstream box gutter, in accordance with AS/NZS 3500.3, Appendix H, Figure H.1.
d) The other Upstream box gutter having the lower catchment area (i.e. the 'non-critical' box gutter) is then sized to match the 'critical' box gutter at the entry to the Junction.
e) Note, there is no need to design the Downstream box gutter due to the increase in depth due to the Step-Down in the Junction

TABLE 4 – Dam Buster Junctions

Device Size	Maximum Design Flow Rate (L/s)	Contraction Range for Upstream Gutter	Maximum box gutter depth at Entry (mm)	Drop within Junction (mm)	Maximum box gutter depth at Exit (mm)
JUN-200	5.0	200	180	50	230
JUN-300	9.5	300 -> 200	215	60	275
JUN-400	16.0	400 -> 300	230	70	300

NOTES

1. The maximum box gutter depth at Entry to the device is the maximum allowable downstream depth of the 'critical upstream box gutter' (refer note 3).
2. The Junction is trimmed to match the design downstream depth of the 'critical upstream box gutter'. Refer to the Installation Manual.
3. The upstream box gutter with the larger catchment area (the 'critical upstream box gutter') only is designed, and the opposite upstream box gutter ('non-critical box gutter') is sized to match the 'critical box gutter'. It is not necessary to design the downstream box gutter.
4. The 'critical box gutter' is designed (in accordance with figure H.1 of AS/NZS 3500.3) for the the catchment area to this gutter, plus any additional catchment area flowing directly into the downstream box gutter.
5. The total flow rate in all gutters must not exceed the Maximum Design Flow rate in the table.
6. All Junctions are supplied as 'Sliding' Junctions (i.e. supplied in two-piece / adjustable) by default. Sliding Junctions are able to contract for the upstream box gutter width within the specified range (all sizes except 200)
7. 'Fixed' Junctions are also for special larger volume orders (over 20 units), however fixed Junctions are not adjustable for the upstream box gutter.
8. **ONLY THE UPSTREAM BOX GUTTERS MAY BE CONTRACTED. THE DOWNSTREAM BOX GUTTER MAY NOT BE NARROWER THAN THE UPSTREAM BOX GUTTERS.**

7. INSTRUCTIONS FOR INSTALLATION

Dam Buster products must be installed in accordance with the Dam Buster Installation Manual. Additionally, roof drainage installations should comply with Section 4 of AS/NZS 3500.3 '*Roof drainage systems – Installation'.* It is the licensed roof plumber's responsibility to certify all works associated with the installation of the box gutters and Dam Buster devices in accordance with the specific requirements of that State or Territory.

Overflow pipes to the Dam Buster Sump must discharge visibly to atmosphere, in order to alert the building owner / occupant to a blockage. Where possible, the Dam Buster Sump should also be fitted with a 90mm diameter 'Full Blockage Overflow Indicator', as shown on the standard detail sheets. This overflow indicator is supplied by the installing plumber typically fitted on the end wall of the sump but may also be fitted on a side wall (so long as the centreline of the pipe is level with the sole of the box gutter). There may be situations where it is not possible or desirable to incorporate the Full Blockage Overflow Indicator, and the building designer and plumber should consider this on a case by case basis. Note, that the Dam Buster Sump has a similar safeguard with regards to blockage as the DTS Sump / High Capacity overflow device, and the Full Blockage Overflow indicator is recommended for additional safety.

8. RISK MANAGEMENT (DESIGN) & MAINTENANCE OF BOX GUTTER SYSTEMS

The are numerous ways in which the risk of failure of box gutter systems can be minimized. Refer to Appendix E for a discussion on Risk Management (Design).

Regular maintenance of box gutter systems is essential to ensure they continue to function as intended. The frequency of maintenance required will depend on the presence and type of nearby vegetation, and other factors such as prevailing wind directions and vulnerability to debris, rubbish, nesting material etc. For example, more regular maintenance may be required for school buildings, where balls may block downpipes. Refer also Appendix E for further discussion on the maintenance of box gutter systems.

9. INTELLECTUAL PROPERTY AND KNOW-HOW

Dam Buster is a registered Trademark both in Australia and Overseas, and all Dam Buster products are also protected by a comprehensive range of Australian and Overseas patents. Breaches of Intellectual Property and Know-How rights are serious and will be pursued by Dam Buster Pty Ltd and Dam Buster IP Pty Ltd against any infringers.

With the exception of the AHSCA-RF Overflow Performance Certificates, Dam Buster has chosen not to make testing data which supports compliance of the Dam Buster products publicly available, due to the documents and information being Dam Buster 'Intellectual Property'.

10. SUPPORT

Refer to Dam Buster's website www.dambuster.com.au

11. APPENDICES

Appendix	Description
A	Dam Buster Products Names
B	Design Example – Dam Buster Rainhead
C	Dam Buster Standard drawing details
D	Dam Buster Product Data Sheets
E	Risk Management (Design) & Maintenance of Box Gutter Systems
F	Box Gutter Design Charts
G	Aerial Downpipe Design Chart

Appendix A

Dam Buster Product Names

Dam Buster Product Names

Label	Name	Sizes				
		Rainheads				
R-www	Rainhead	R-200	R-300	R-400	R-500	R-600
CR-www	Curved Rainhead	CR-200	CR-300	CR-400	CR-500	CR-600
R-www-F	Flat Back Rainhead	R-200-F	R-300-F	R-400-F	R-500-F	R-600-F
CR-www-F	Flat Back Curved Rainhead	CR-200-F	CR-300-F	CR-400-F	CR-500-F	CR-600-F
		Stretched Rainheads				
R-200-www	Stretched R-200 Rainhead (1)	R-200-300				
R-200-www-F	Stretched FB R-200 Rainhead (1)	R-200-300-F				
R-300-www	Stretched R-300 Rainhead (1)	R-300-350	R-300-380	R-300-400	R-300-450	R-300-500
R-300-www-F	Stretched FB R-300 Rainhead (1)	R-300-350-F	R-300-380-F	R-300-400-F	R-300-450-F	R-300-500-F
		Sumps				
SU-www-ddd	Sump	SU-200-100	SU-300-125	SU-400-150	SU-500-150	SU-600-150
		SU-200-150	SU-300-200	SU-400-200	SU-500-200	SU-600-200
		Side Outlets				
TSO-www	T Side Outlet	TSO-200	TSO-300	TSO-400	n/a	n/a
ESO-www-L	End Side Outlet, LH	ESO-200-L	ESO-300-L	ESO-400-L	n/a	n/a
ESO-www-R	End Side Outlet, RH	ESO-200-R	ESO-300-R	ESO-400-R	n/a	n/a
CSO-www-L	Corner Side Outlet, LH	CSO-200-L	CSO-300-L	CSO-400-L	n/a	n/a
CSO-www-R	Corner Side Outlet, RH	CSO-200-R	CSO-300-R	CSO-400-R	n/a	n/a
XSO-www	Cruciform Side Outlet	XSO-200	XSO-300	XSO-400	n/a	n/a
		Elbows				
ELB-www-L	Elbow, LH	ELB-200-L	ELB-300-L	ELB-400-L	ELB-500-L	ELB-600-L
ELB-www-R	Elbow, RH	ELB-200-R	ELB-300-R	ELB-400-R	ELB-500-R	ELB-600-R
		Junctions				
TJN-www	Tee Junction	TJN-200	TJN-300	TJN-400	n/a	n/a
CJN-www-L	Corner Junction, LH	CJN-200-L	CJN-300-L	CJN-400-L	n/a	n/a
CJN-www-R	Corner Junction, RH	CJN-200-R	CJN-300-R	CJN-400-R	n/a	n/a
		Ancillary Products				
BGA-www-WWW	Box Gutter Adaptor	BGA-200-300		BGA-300-500		n/a
CL-www	Chute Lid	CL-200	CL-300	CL-400	CL-500	CL-600
SC-www	Sump cover	SC-200	SC-300	SC-400	n/a	n/a

NOTES

1. The R-300 is also available in a number of (non-standard) widths between up to 500mm wide, in a 'stretched' form such that the width of the rainhead (and box gutter receiver) in increased, but all other dimensions remained the same. The 'stretched' rainheads currently available are R-300-**350**, R-300-**380**, R-300-**400**, R-300-**450** & R-300-**500**. Refer also to the Product Data Sheets. Other 'non-standard' sizes may become available in the future, however Custom rainhead sizes are also available, contact Dam Buster for further information. The R-200 is available as one stretched width, R-200-**300.**
2. All Side Outlets and Elbows are supplied as 'Sliding' (i.e. two-piece / adjustable). However, these products can also be supplied as 'Fixed' (i.e. one-piece) for special larger volume orders (over 20 units).

Appendix B

Design Example – Dam Buster Rainhead

Roof Drainage Design & Rainhead Selection Example

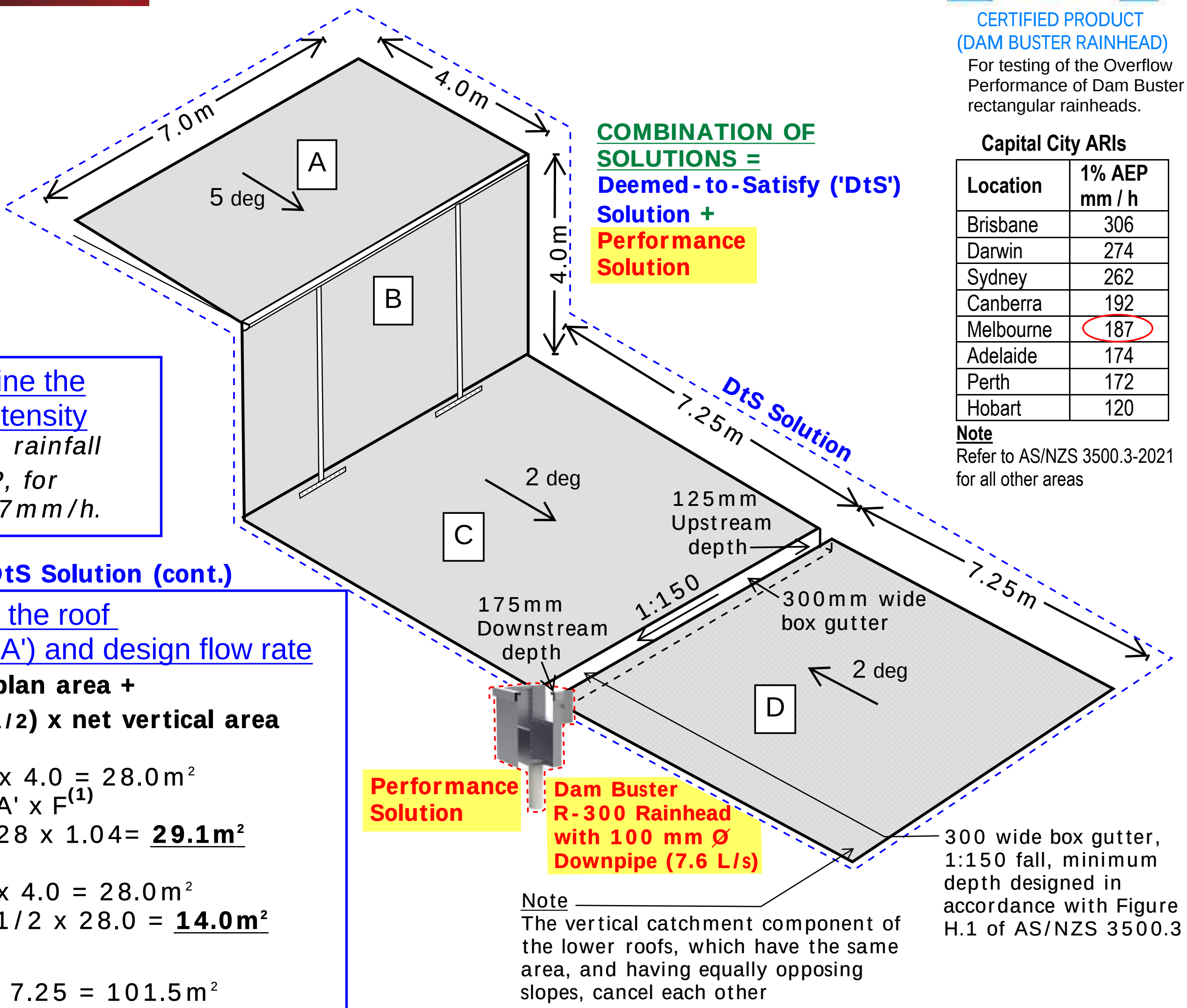
CERTIFIED PRODUCT
(DAM BUSTER RAINHEAD)
For testing of the Overflow Performance of Dam Buster rectangular rainheads.

Capital City ARIs

Location	1% AEP mm / h
Brisbane	306
Darwin	274
Sydney	262
Canberra	192
Melbourne	187
Adelaide	174
Perth	172
Hobart	120

Note
Refer to AS/NZS 3500.3-2021 for all other areas

COMBINATION OF SOLUTIONS =
Deemed-to-Satisfy ('DtS') Solution +
Performance Solution



DtS Solution

Step 1 - Determine the design rainfall intensity

Adopt the design rainfall intensity, 1%AEP, for Melbourne of 187mm/h.

DtS Solution (cont.)

Step 2 - Determine the roof catchment area ('CA') and design flow rate

Catchment Area = plan area + (1/2) x net vertical area

Roof A
Roof area 'A' = 7.0 x 4.0 = 28.0m²
Catchment area = 'A' x F(1)
= 28 x 1.04= **29.1m²**

Wall B
Wall area 'B' = 7.0 x 4.0 = 28.0m²
Catchment Area = 1/2 x 28.0 = **14.0m²**

Roofs C & D
Roof area = 2 x 7 x 7.25 = 101.5m²
Catchment Area = **101.5m²**

Total Catchment Area = **144.6m²**

Q = (CA x 1% AEP) / 3600
= (144.6 x 187) / 3600
= 7.**51 litres / sec**

DtS Solution (cont.)

Step 3 - Design the (300mm W) box gutter ('BG')

From Figure H.1 of AS/NZS 3500.3, a slope of 1 in 150(2), and a flow rate of 7.51 L/s, the design upstream BG depth is 122mm (rounded to 125mm) (OR refer to Appendix F of the Product Technical Statement for BG design charts). The fall over 7.0m is 7000/150=47mm (rounded to 50mm).
ADOPT
300mm wide x (125 min to 175 max) deep BG

Performance Solution

Step 4 - Select the rainhead & DP combination

Referring to Table 1, select a *Dam Buster R-300 Rainhead with a 100mm diameter downpipe.*
Q(allowable)= 7.6 L/s > 7.51 L/s => OK
NOTE
The rainhead may be either a R-300 or CR-300
Refer also Appendix A of the Product Technical Statement, 'Product Names'.

CALCULATIONS - NOTE
Steps 1 to 3 are calculations required in relation to the DtS component of the 'Combination of Solutions'.
Step 4, which is a Selection process only (highlighted in yellow), represents the Performance Solution component.

Step (1) & (2) notes
(1) Refer to Table 3.4.3.2 of AS/NZS 3500.3-2021 for the factor 'F'. This factor depends on the roof slope, and takes into account the extra catchment area for the roof due to the slope i.e. half the projected vertical area of the sloping roof.
Note, 'F' can also be calculated: F= 1.0 + 0.5 x tan (slope) (a scientific calculator is required to calculate F)
(2) Dam Buster recommends a minimum fall of 1 in 150 to allow for possible minor future building movements, particularly on reactive clay sites.

Dam Buster Rainhead Design Table

Downpipe size	Equivalent diameter	Dam Buster Rainhead size(1)				
		R-200	R-300	R-400	R-500	R-600
100 x 50	79	4.00(2)	4.00(3)		Not recommended or not possible	
80 diam.	80	4.00(2)	4.00(3)			
90 diam.	90	4.70	6.50			
100 x 75	97	5.00	7.30	8.00		
100 diam.	100	5.00	7.60	8.80	8.80	
100 x 100	112		8.80	12.0	12.0	
125 diam.	125		9.50	14.2	15.4	15.9
150 x 100	137			15.8	16.0	16.0
150 diam.	150			16.0	16.0	16.0
Overflow Capacity of Device (L/s)		>16.0	>16.0	>16.0	>16.0	>16.0

(1) Curved fronted rainheads CR-www have the same capacity as rectangular rainheads
(2) Capacities determined by testing by the AHSCA Research Foundation
(3) Capacities adopted for R-200 (R-300 not tested yet for these DPs)

Maximum permissible flow rates (litres / sec)

Appendix C

Dam Buster Standard drawing details

NOTE
All Dam Buster products are protected by various Australian and International Patents.
Refer to www.dambuster.com.au to order, and for the following documents:
- **Product Technical Statement**
- **Evidence of Suitability**
- **Installation Manual**

Sheet Number	Title
SD001	Typical box gutter discharging to a Dam Buster overflow device
SD002	Typical Dam Buster Rainhead
SD003	Typical Dam Buster Rainhead – Long & deep box gutter
SD004	Typical Overflow Device comprising a Dam Buster Rainhead and a Dam Buster Side Outlet
SD004A	Section XX through Side Outlet
SD005	Dam Buster T Side Outlet & Rainhead combination
SD006	Dam Buster End Side Outlet & Rainhead combination
SD007	Dam Buster Corner Side Outlet & Rainhead combination
SD008	Dam Buster Cruciform Side Outlet & Rainhead combination
SD009	Dam Buster T Side Outlet & Sump combination
SD010	Dam Buster End Side Outlet & Sump combination
SD011	Dam Buster Corner Side Outlet & Sump combination
SD012	Dam Buster Cruciform Side Outlet & Sump combination
SD013	Typical Dam Buster Sump
SD014	Typical Dam Buster Continuous Sump
SD015	Typical Dam Buster Continuous Sump with optional expansion joint
SD015A	Section X-X. SD011 – Detail WITHOUT expansion joint
SD015B	Section X-X, SD011 – Detail WITH expansion joint
SD016	Dam Buster Sump used in lieu of rainhead – Option A
SD017	Dam Buster Sump used in lieu of rainhead – Option B
SD018	Dam Buster Elbow
SD019	Dam Buster Tee Junction
SD020	Dam Buster Corner Junction

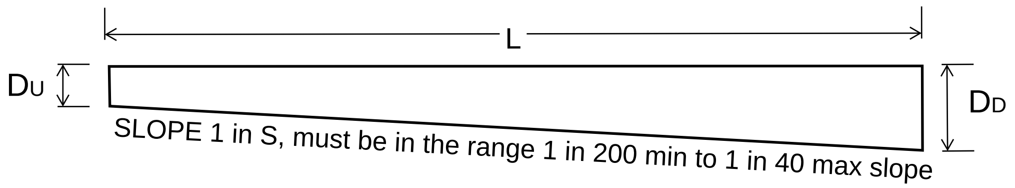
List of Dam Buster Standard Details

DAM BUSTER®

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

DESIGNED		DRAWN	
CHECKED			
SCALE NTS @A4	DATE 01.02.2023	REVISION 4	
JOB No.		SHEET No. SD000	

TITLE: Standard Details Sheets



Typical box gutter profile

Box gutter sizes are specified as:

W_{BG} mm Wide x (D_U MIN to D_D MAX) mm Deep,where:-

W_{BG} = the box gutter width

L = the box gutter length

S = slope (1 in S)

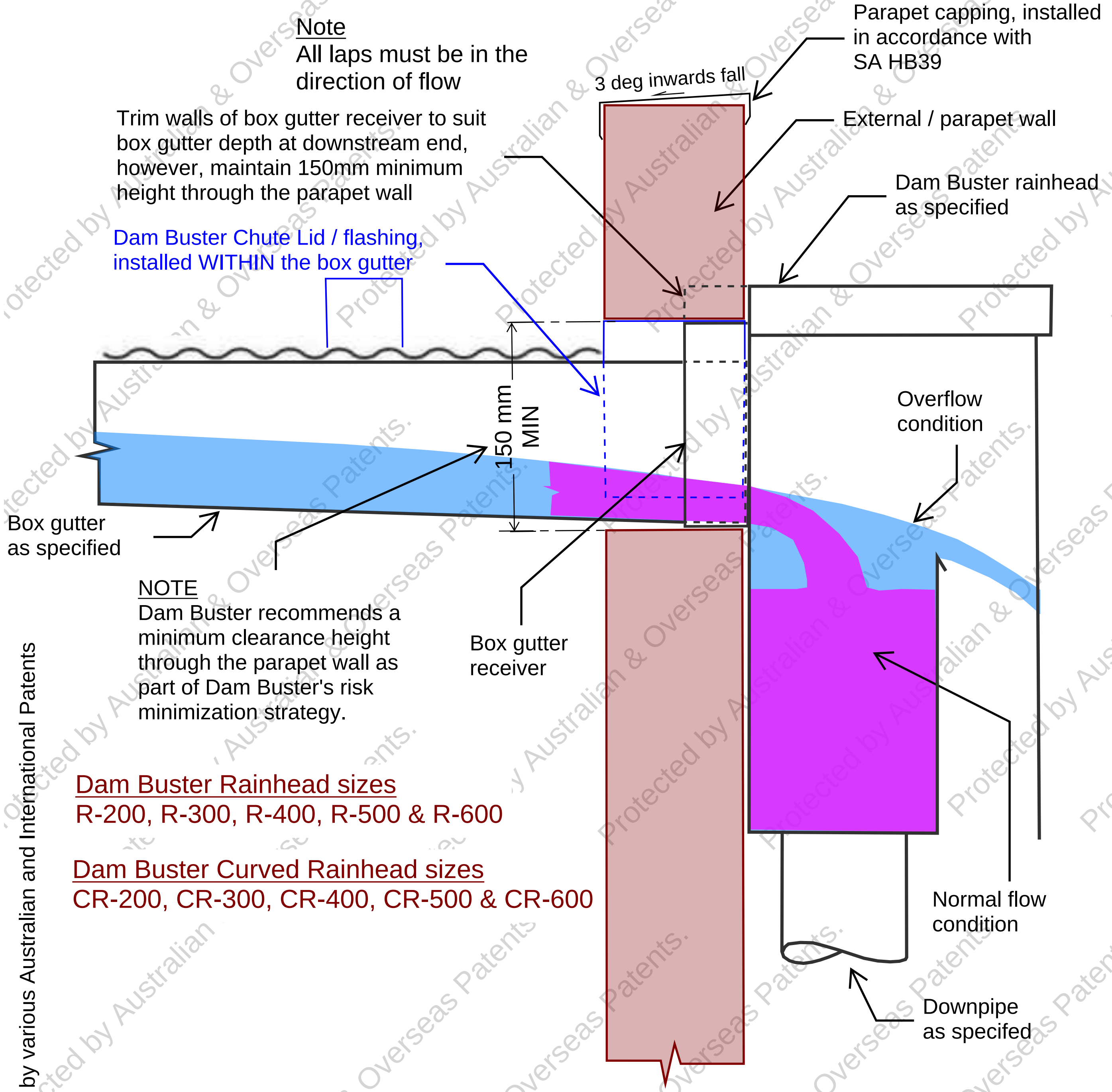
D_U = depth at the upstream end
= minimum design box gutter depth to AS/NZS 3500.3, (rounded up to nearest 5 mm)

D_D = depth at the downstream end
= the maximum box gutter depth, calculated as D_U + L / S (also rounded up to the nearest 5 mm)

NOTES

1) All Dam Buster box gutters should be designed for a minimum flow rate of 3L/s and a maximum flow rate of 16L/s
2) Where the Engineer's drawings specify the upstream and downstream depths, these values take precedence (however, the slope must be within the range 1 in 200 min to 1 in 40 max).
3) Roof plumber to check box gutter length on site, and confirm the downstream depth, D_D provides the required / design slope.
4) The roof plumber may increase the downstream depth, D_D as necessary, however, the minimum depth at the upstream end, D_U, cannot be reduced (and the fall must not exceed 1 in 40).
5) For buildings constructed in reactive clay soils, consideration should be given to increasing the box gutter slope in order to allow for potential building movements due to differential changes in foundation soil moisture contents. Dam Buster recommends a minimum slope of 1 in 150 for reactive clay sites.

SD001 - Typical box gutter discharging to a Dam Buster overflow device (NTS)



Dam Buster Rainhead sizes
R-200, R-300, R-400, R-500 & R-600

Dam Buster Curved Rainhead sizes
CR-200, CR-300, CR-400, CR-500 & CR-600

SD002 - Typical Dam Buster Rainhead (NTS)

NOTES

1. Refer to the current Dam Buster P/L technical manual for installation details

DAM BUSTER®

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

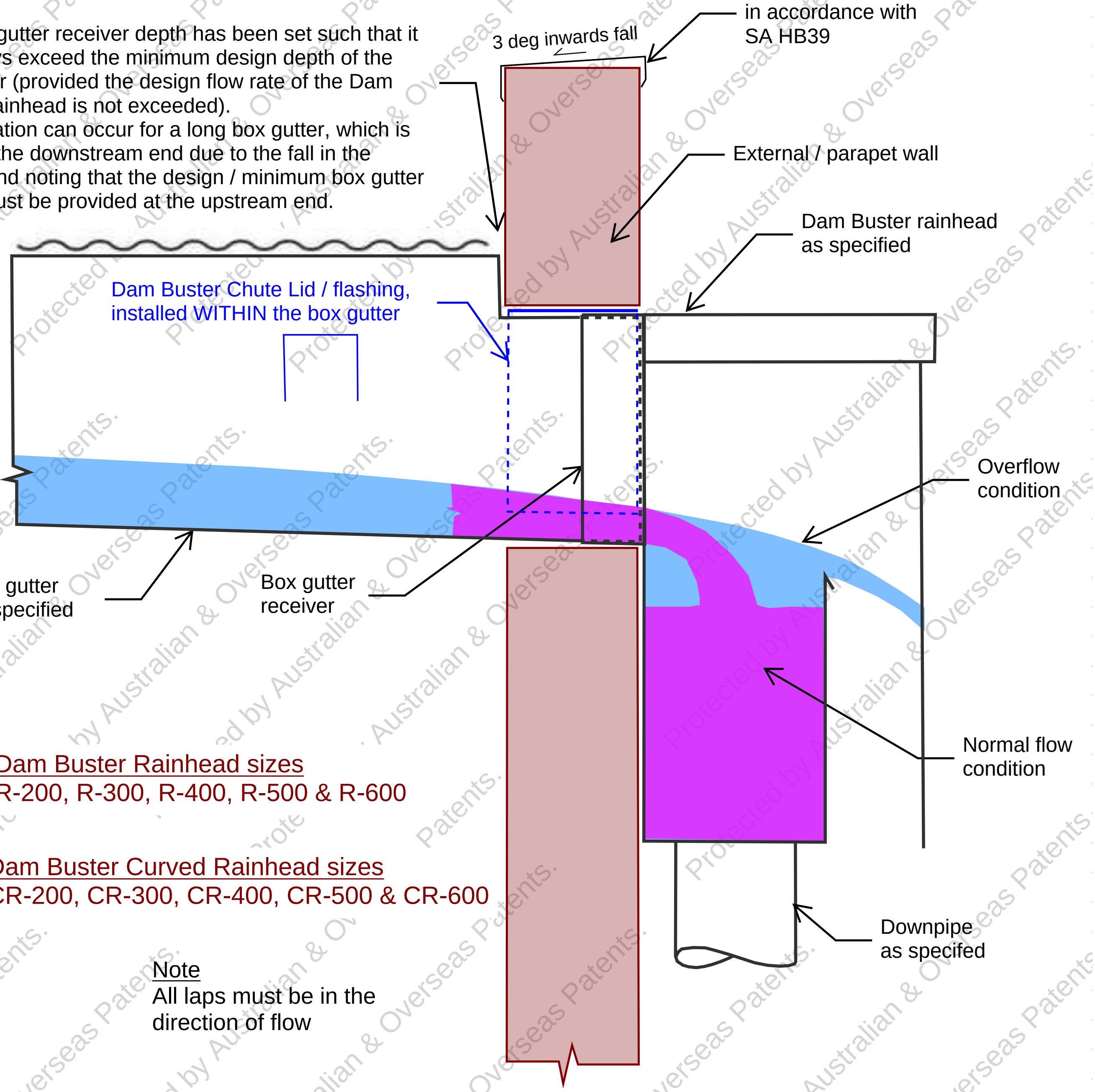
TITLE: Standard Details Sheets	DESIGNED		DRAWN
	CHECKED		
	SCALE NTS @A4		REVISION 4
	DATE 01.02.2023		
	JOB No.	SHEET No. SD002	

Trim top of box gutter to level of top of rainhead / box gutter receiver.

NOTES

1) The box gutter receiver depth has been set such that it will always exceed the minimum design depth of the box gutter (provided the design flow rate of the Dam Buster rainhead is not exceeded).

2) This situation can occur for a long box gutter, which is deep at the downstream end due to the fall in the gutter, and noting that the design / minimum box gutter depth must be provided at the upstream end.



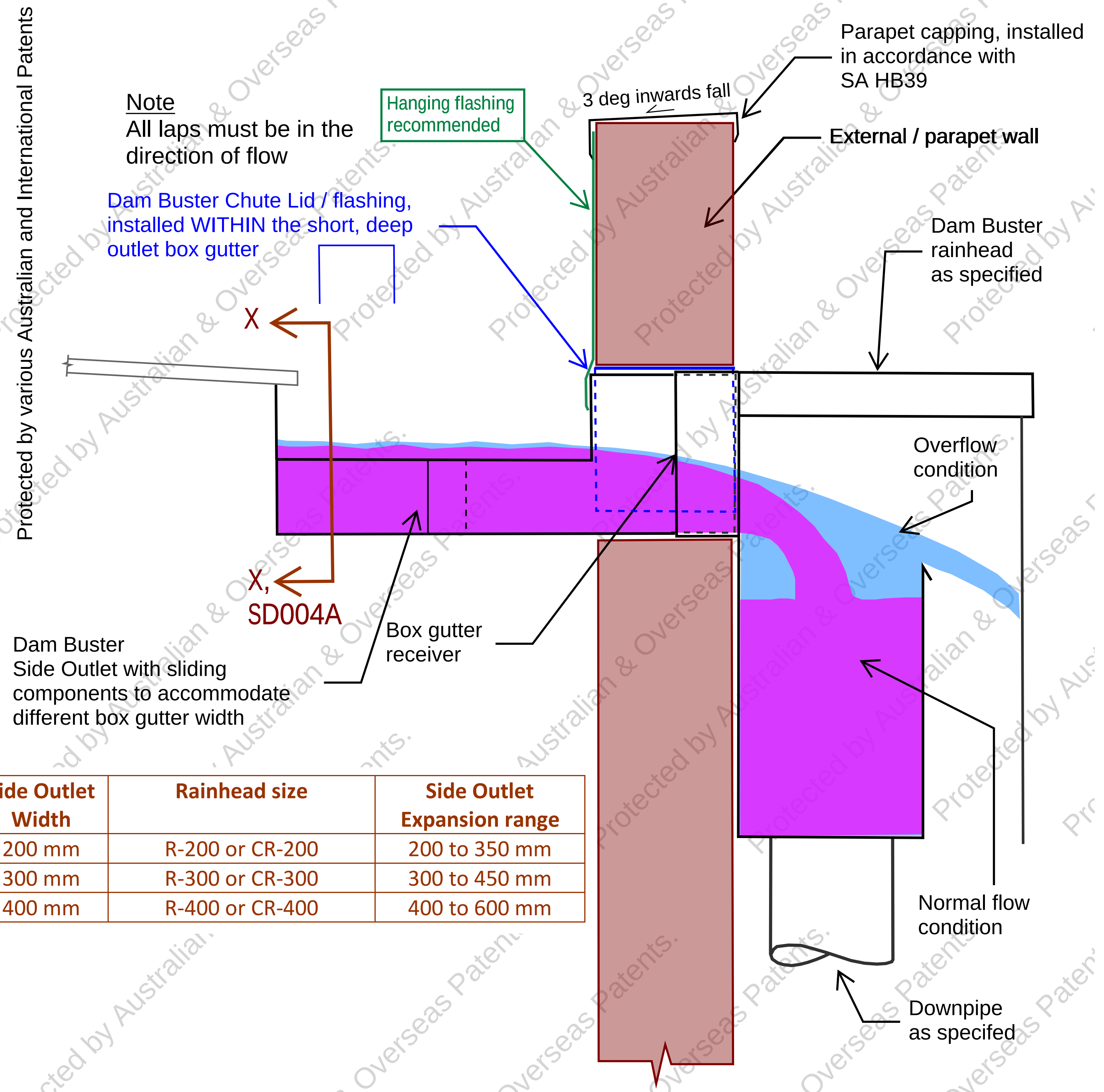
Dam Buster Rainhead sizes
R-200, R-300, R-400, R-500 & R-600

Dam Buster Curved Rainhead sizes
CR-200, CR-300, CR-400, CR-500 & CR-600

Note
All laps must be in the direction of flow

SD003 - Typical Dam Buster Rainhead - Long & deep box gutter (NTS)

NOTES
1. Refer to SD002 for all details not noted



Side Outlet Width	Rainhead size	Side Outlet Expansion range
200 mm	R-200 or CR-200	200 to 350 mm
300 mm	R-300 or CR-300	300 to 450 mm
400 mm	R-400 or CR-400	400 to 600 mm

SD004 - Typical Overflow Device comprising a Dam Buster Rainhead and a Dam Buster Side Outlet (NTS)

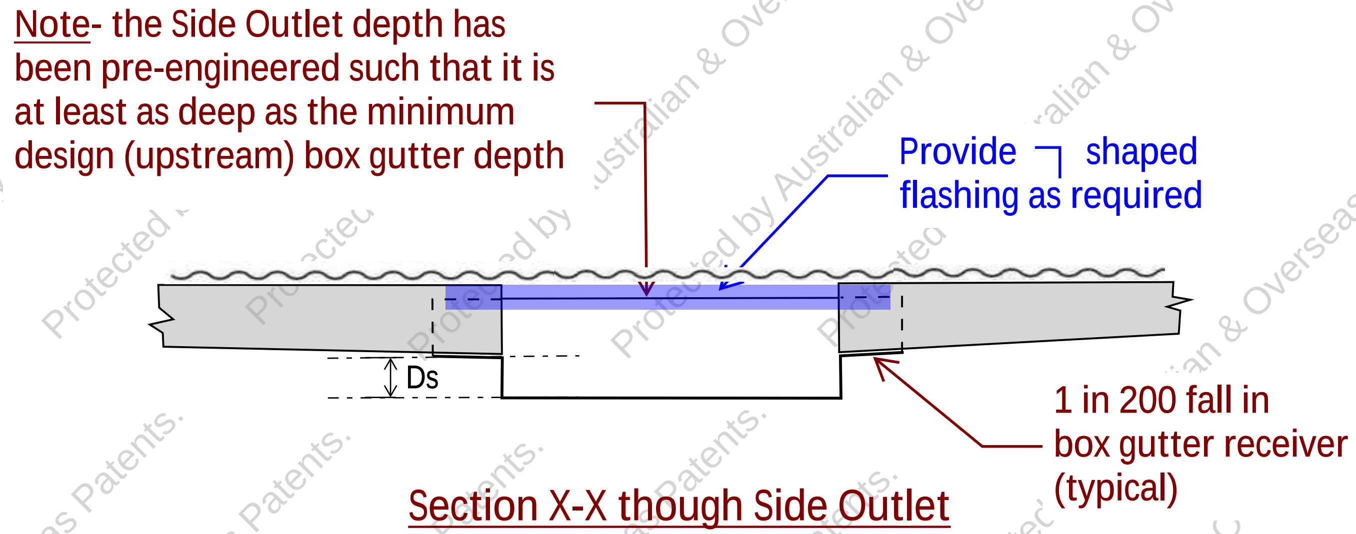
NOTES

1. Refer to the current Dam Buster P/L technical manual for installation details

DAM BUSTER ®

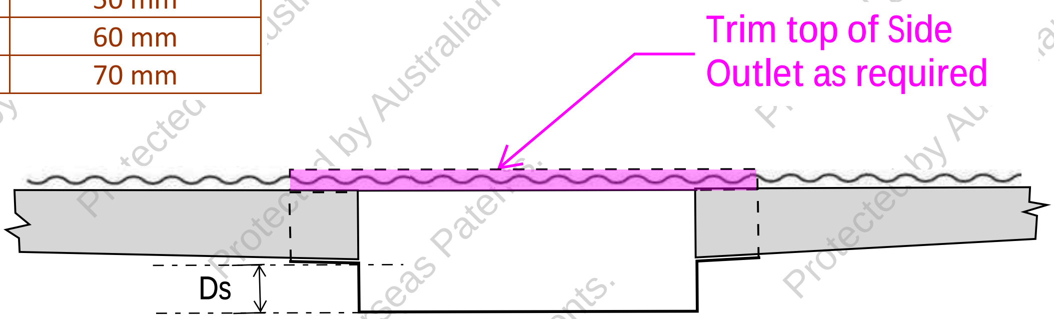
Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets	DESIGNED		DRAWN
	CHECKED		
	SCALE NTS @A4		REVISION 4
	DATE 01.02.2023		
	JOB No.	SHEET No. SD004	



Section X-X though Side Outlet
Box gutter(s) deeper than Side Outlet

Side Outlet Width	Side Outlet Depth 'Ds'
200 mm	50 mm
300 mm	60 mm
400 mm	70 mm

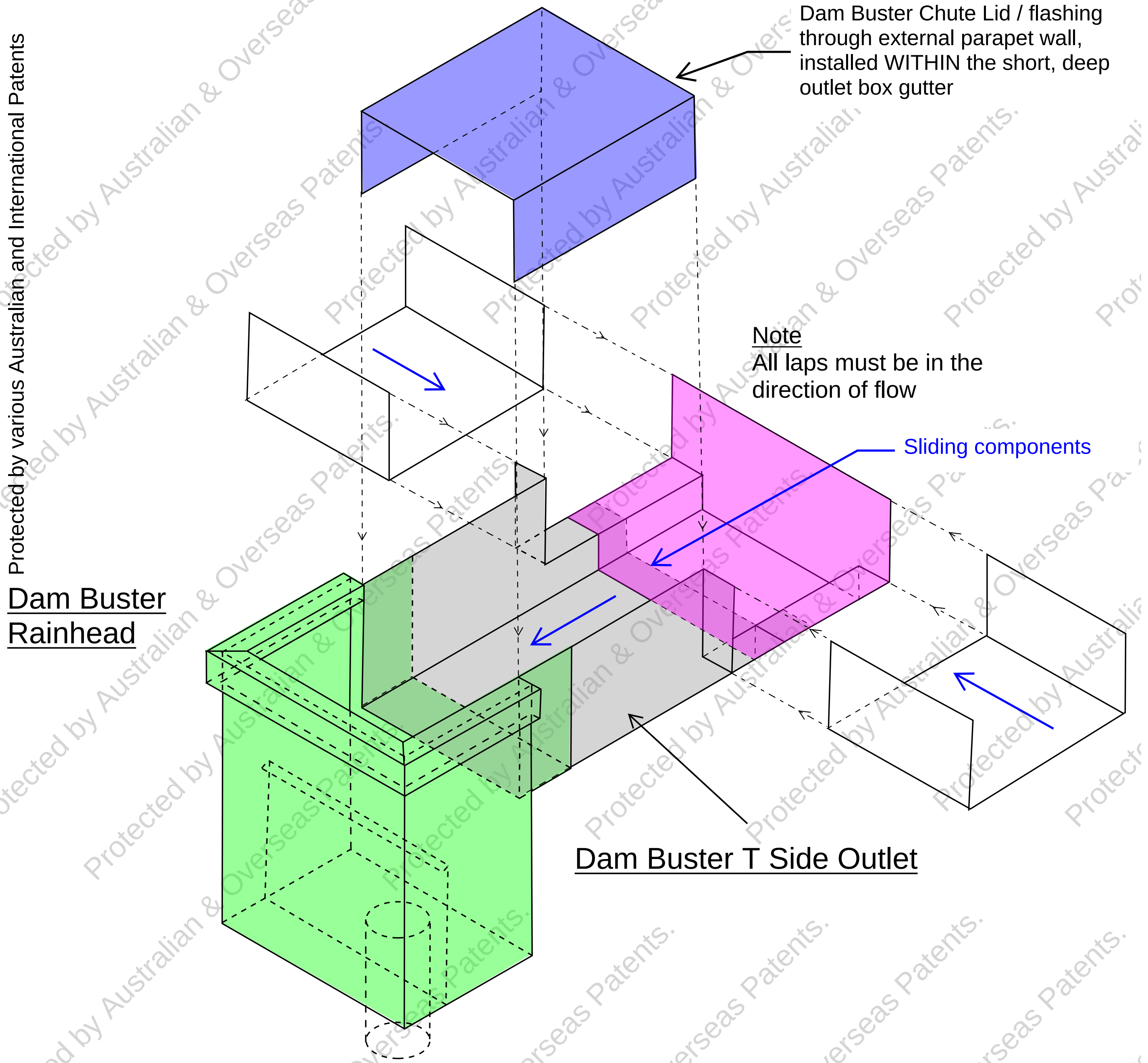


Section X-X though Side Outlet
Side Outlet deeper than Box gutter(s)

SD004A - Typical Overflow Device comprising a Dam Buster Rainhead and a Dam Buster Side Outlet (NTS)

NOTES

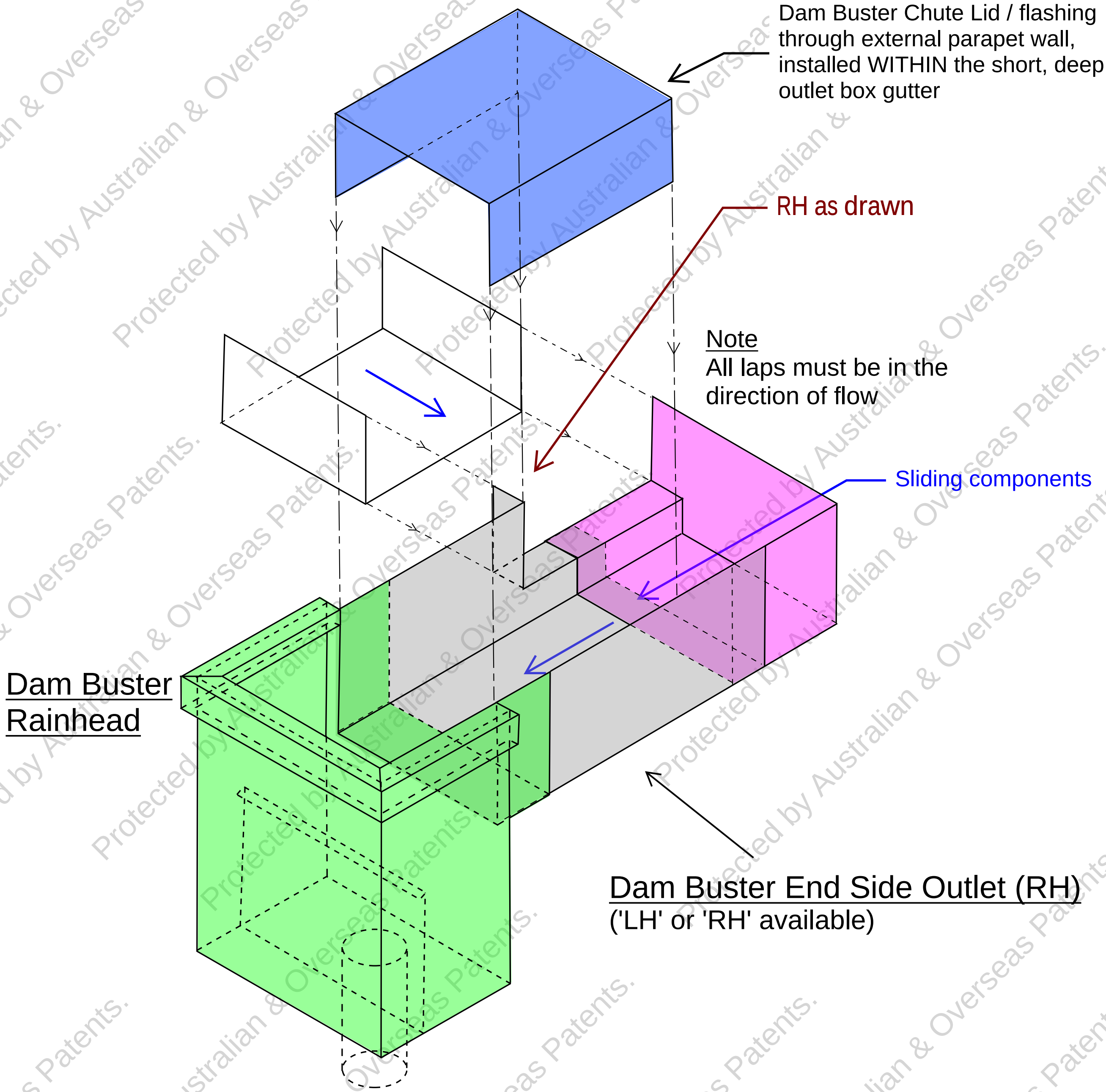
1. Refer to the current Dam Buster P/L technical manual for installation details



T Side Outlet Size	Side Outlet Width	Rainhead size	Side Outlet Expansion range
TSO-200	200 mm	R-200 or CR-200	200 to 350 mm
TSO-300	300 mm	R-300 or CR-300	300 to 450 mm
TSO-400	400 mm	R-400 or CR-400	400 to 600 mm

SD005 - Dam Buster T Side Outlet & Rainhead combination (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details



End Side Outlet Size	Side Outlet Width	Rainhead size	Side Outlet Expansion range
ESO-200-(L or R)	200 mm	R-200 or CR-200	200 to 350 mm
ESO-300-(L or R)	300 mm	R-300 or CR-300	300 to 450 mm
ESO-400-(L or R)	400 mm	R-400 or CR-400	400 to 600 mm

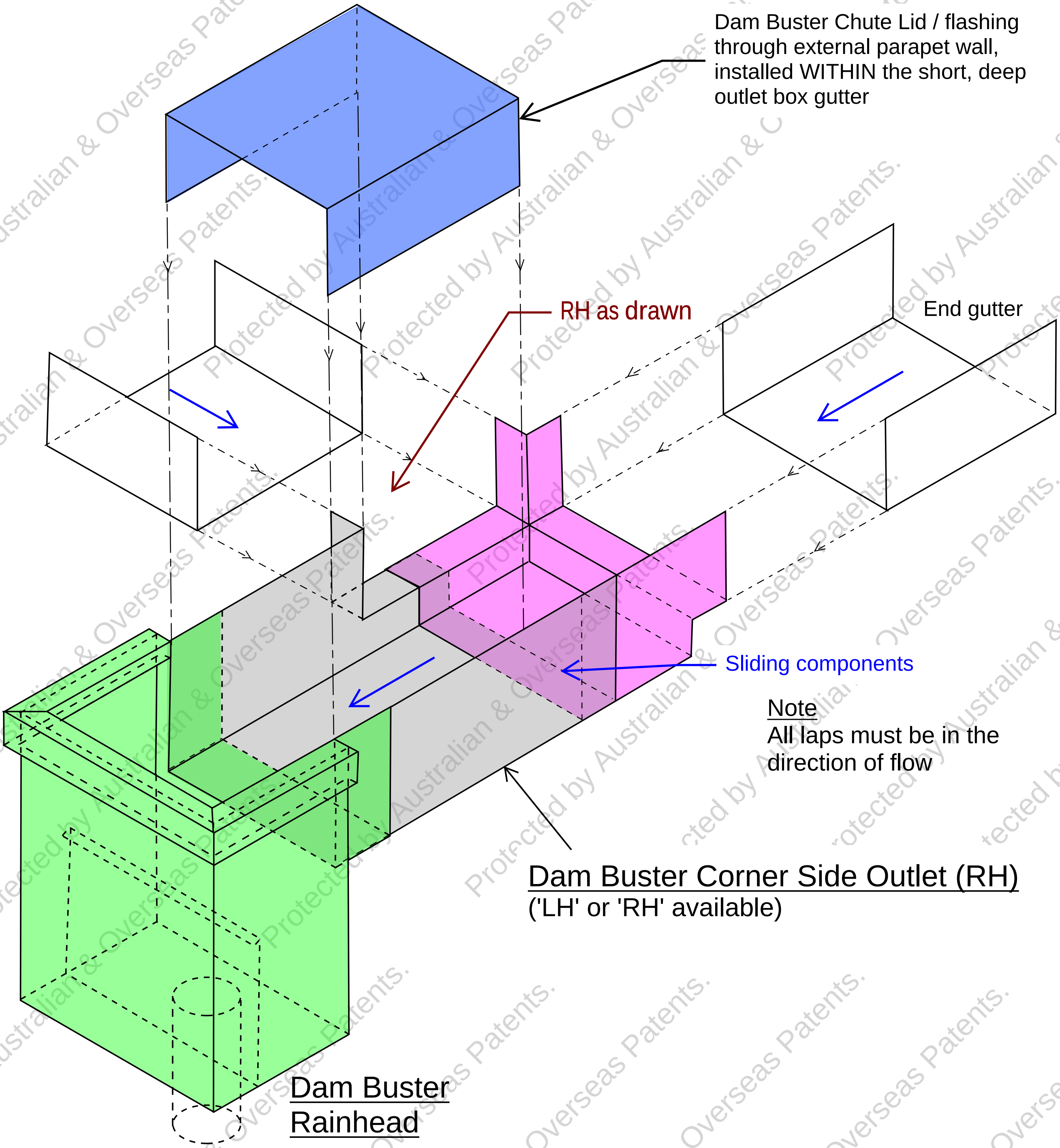
SD006 - Dam Buster End Side Outlet & Rainhead combination (NTS)

NOTES

1. Refer to the current Dam Buster manual for installation details

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets	DESIGNED	DRAWN	
	CHECKED		
	SCALE NTS @A4	REVISION 4	
	DATE 01.02.2023		
	JOB No.	SHEET No. SD006	



Corner Side Outlet Size	Side Outlet Width	Rainhead size	Side Outlet Expansion range	End Box Gutter Width
CSO-200-(L or R)	200 mm	R-200 or CR-200	200 to 350 mm	200 mm
CSO-300-(L or R)	300 mm	R-300 or CR-300	300 to 450 mm	300 mm
CSO-400-(L or R)	400 mm	R-400 or CR-400	400 to 600 mm	400 mm

SD007 - Dam Buster Corner Side Outlet & Rainhead combination (NTS)

NOTES

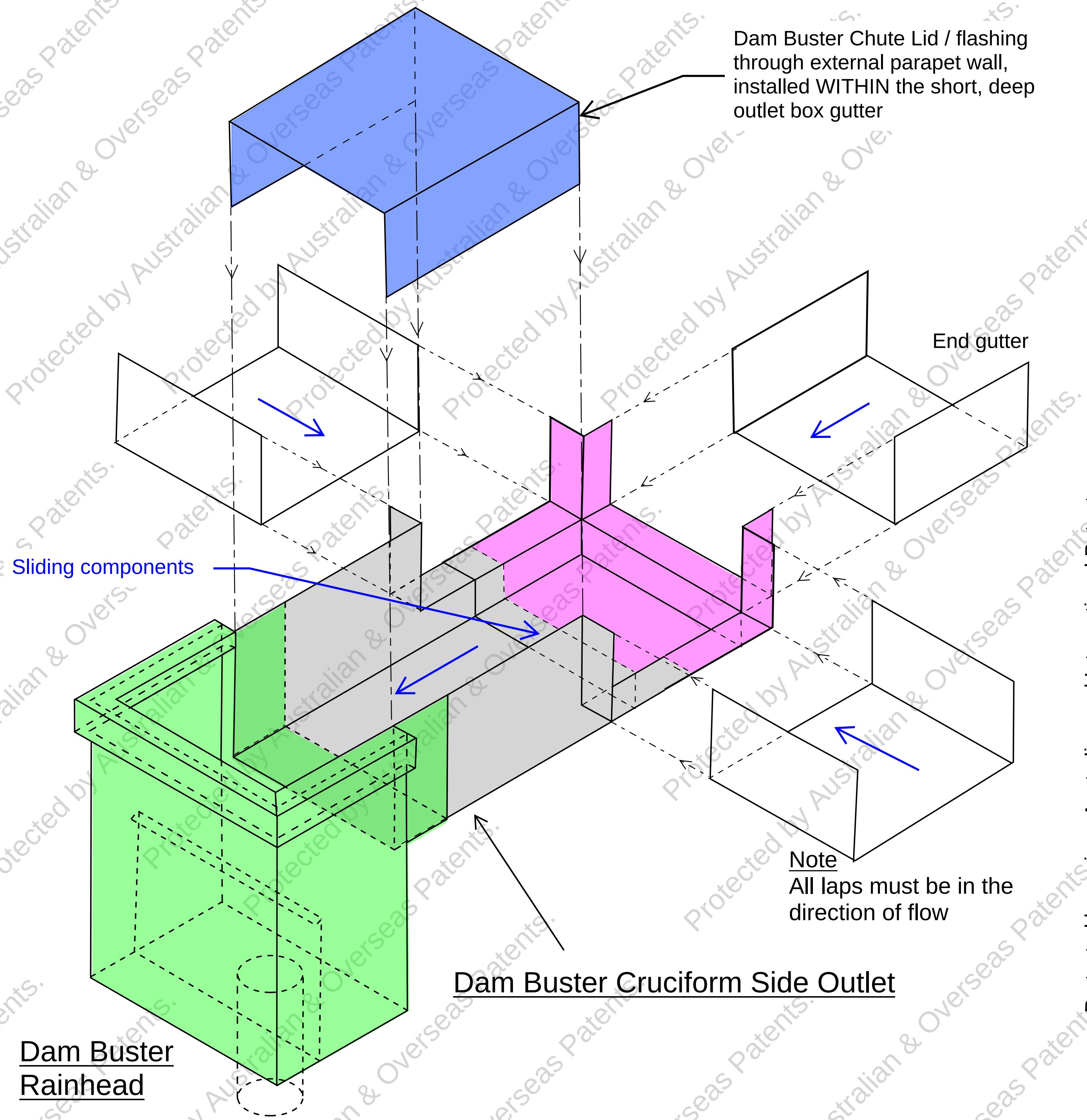
1. Refer to the current Dam Buster manual for installation details

DAM BUSTER®

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

DESIGNED		DRAWN	
CHECKED			
SCALE NTS @A4		REVISION 4	
DATE 01.02.2023			
JOB No.		SHEET No. SD007	

TITLE: Standard Details Sheets



Cruciform Side Outlet Size	Side Outlet Width	Rainhead size	Side Outlet Expansion range	End Box Gutter Width
XSO-200	200 mm	R-200 or CR-200	200 to 350 mm	200 mm
XSO-300	300 mm	R-300 or CR-300	300 to 450 mm	300 mm
XSO-400	400 mm	R-400 or CR-400	400 to 600 mm	400 mm

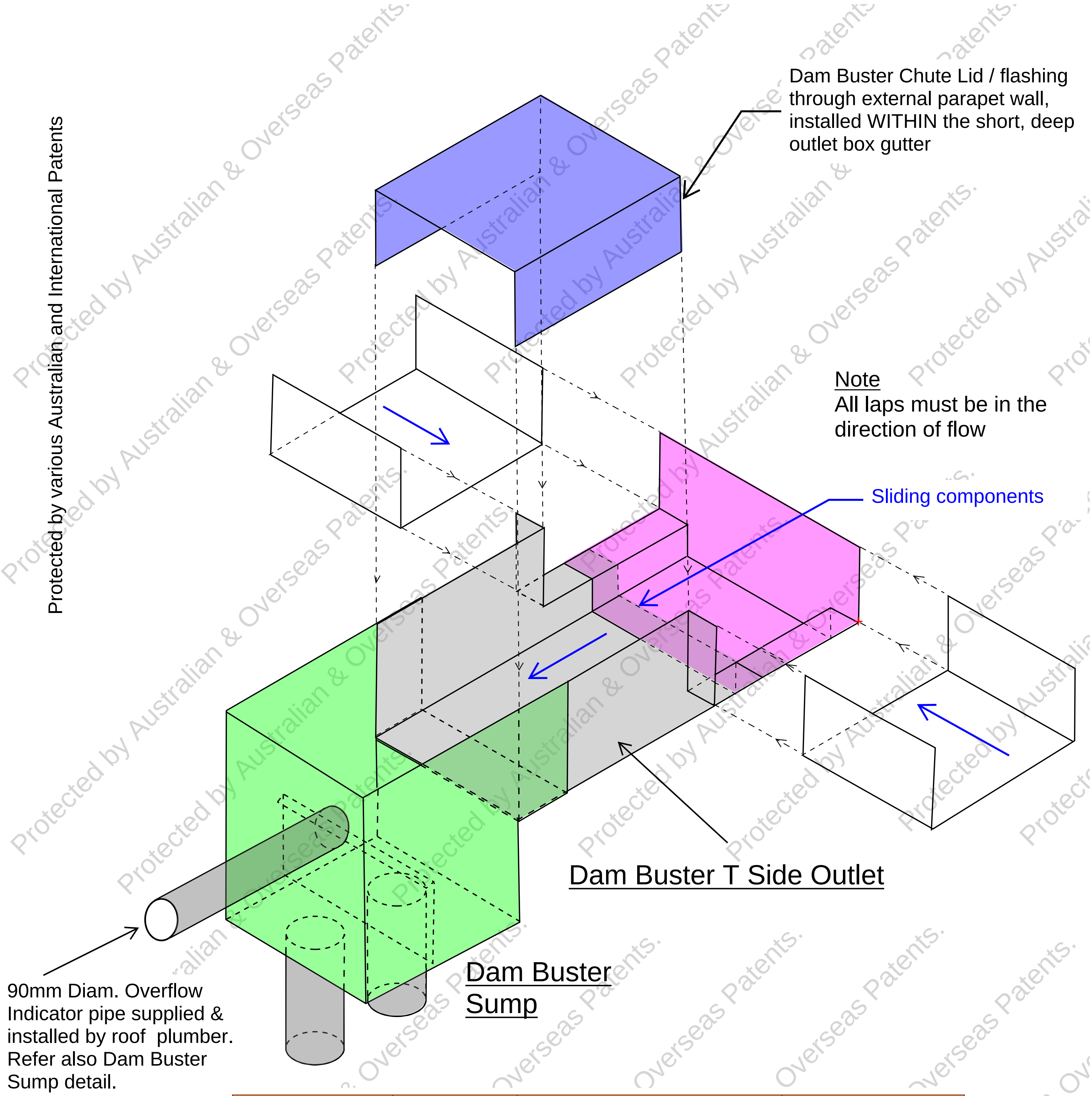
SD008 - Dam Buster Cruciform Side Outlet & Rainhead combination (NTS)

NOTES

1. Refer to the current Dam Buster manual for installation details

DAM BUSTER®
Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets	DESIGNED		DRAWN
	CHECKED		
	SCALE NTS @A4		REVISION 4
	DATE 01.02.2023		
	JOB No.	SHEET No. SD008	

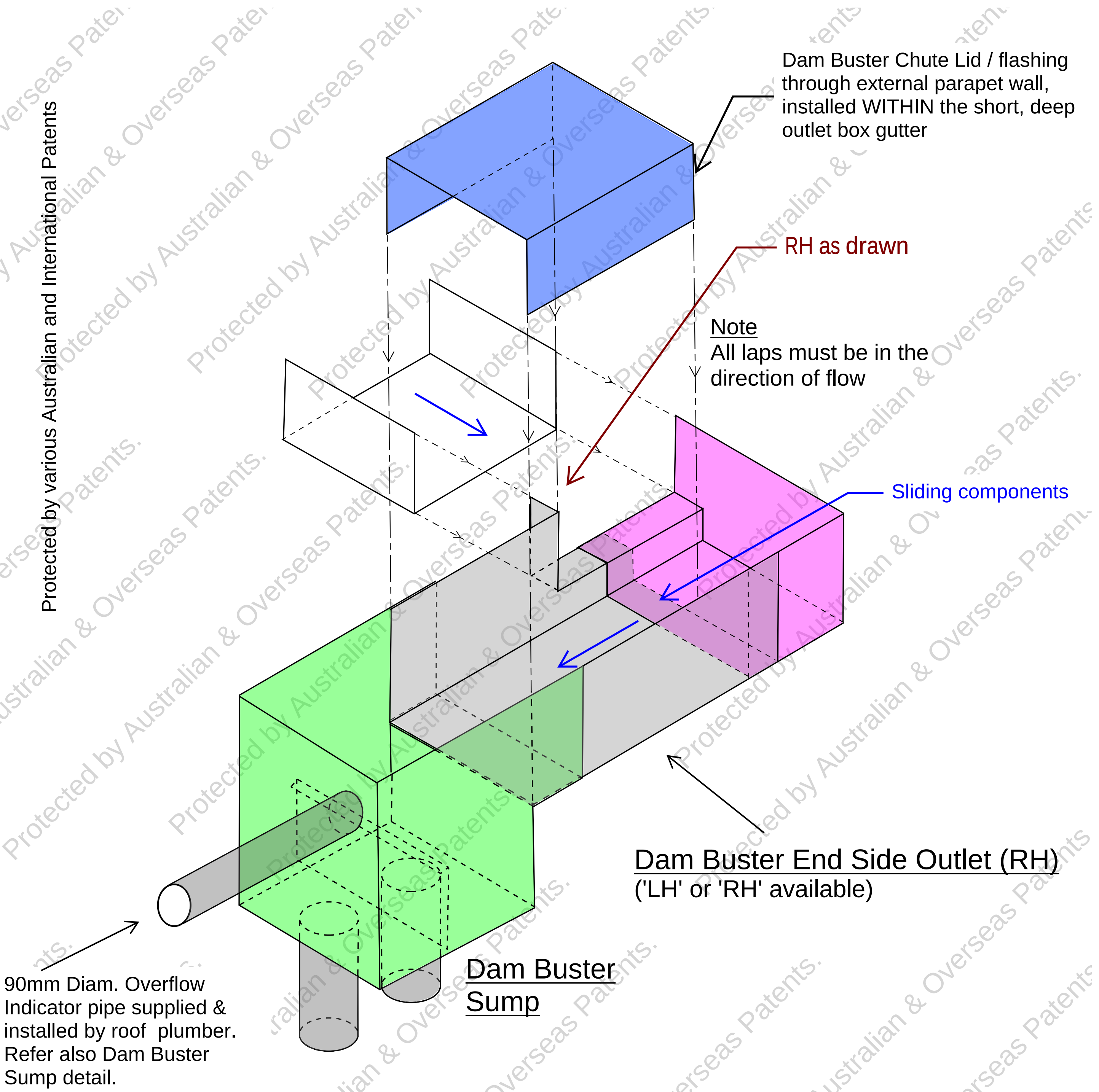


T Side Outlet Size	Side Outlet Width	Sump size	Side Outlet Expansion range
TSO-200	200 mm	SU-200-100 or SU-200-150	200 to 350 mm
TSO-300	300 mm	SU-300-125 or SU-300-200	300 to 450 mm
TSO-400	400 mm	SU-400-150 or SU-400-200	400 to 600 mm

SD009 - Dam Buster T Side Outlet & Sump combination (NTS)

NOTES

1. Refer to the current Dam Buster manual for installation details



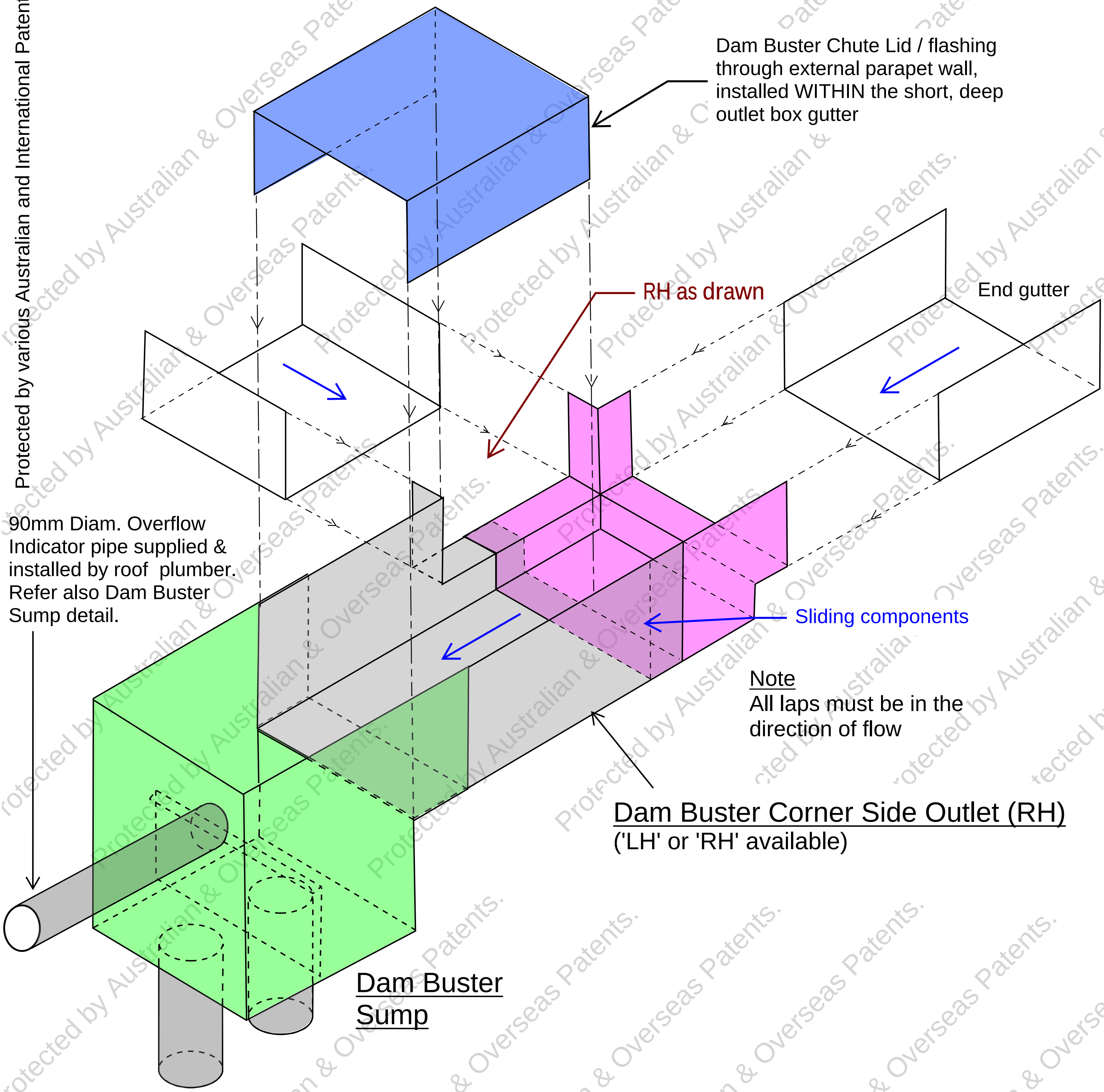
End Side Outlet Size	Side Outlet Width	Sump size	Side Outlet Expansion range
ESO-200-(L or R)	200 mm	SU-200-100 or SU-200-150	200 to 350 mm
ESO-300-(L or R)	300 mm	SU-300-125 or SU-300-200	300 to 450 mm
ESO-400-(L or R)	400 mm	SU-400-150 or SU-400-200	400 to 600 mm

SD010 - Dam Buster End Side Outlet & Sump combination (NTS)

NOTES

1. Refer to the current Dam Buster manual for installation details

DAM BUSTER®	Dam Buster Pty Ltd www.dambuster.com.au orders@dambuster.com.au	TITLE: Standard Details Sheets	DESIGNED	DRAWN
			CHECKED	
			SCALE NTS @A4	REVISION 4
			DATE 01.02.2023	
			JOB No.	SHEET No. SD010



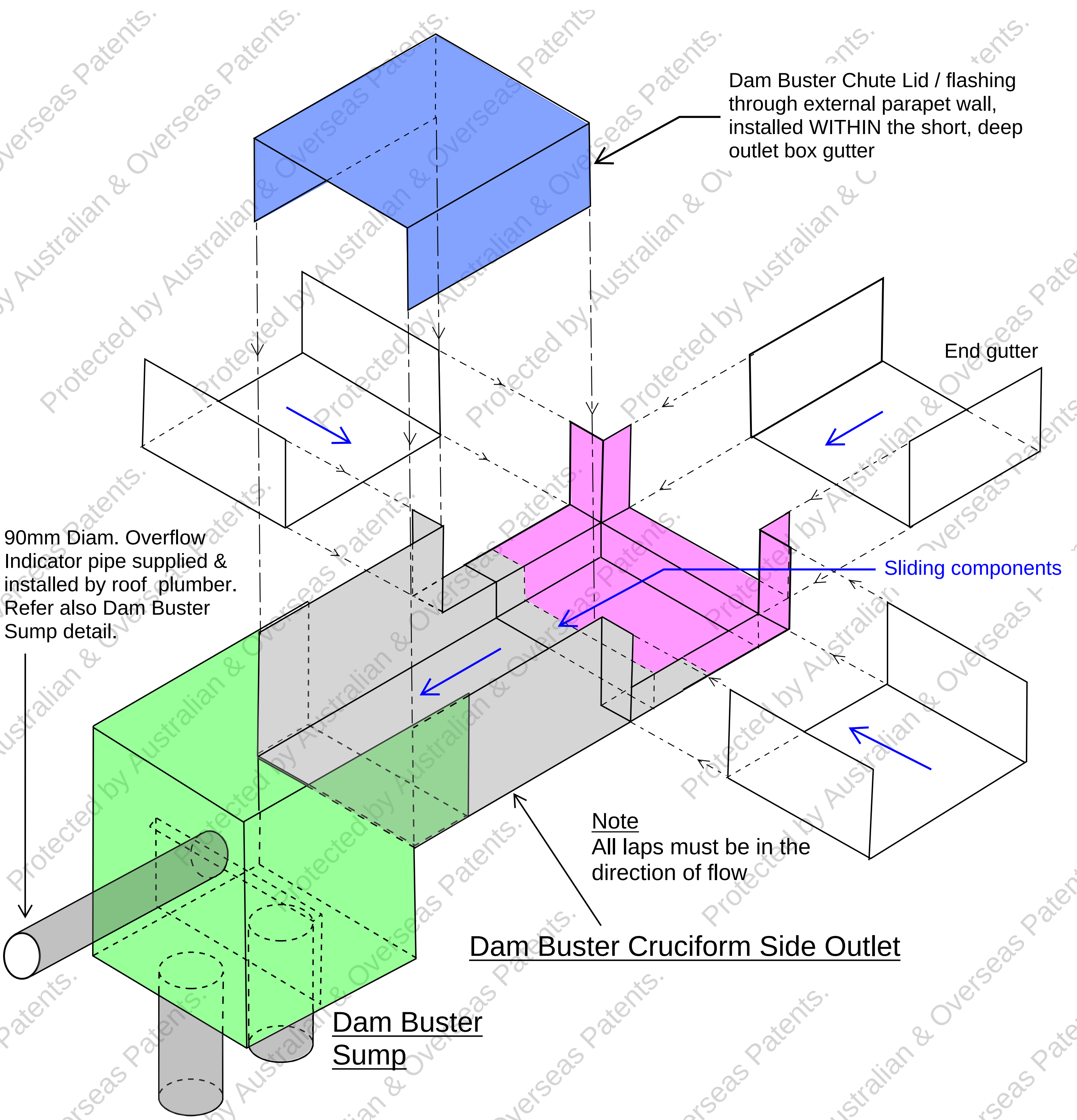
Corner Side Outlet Size	Side Outlet Width	Sump size	Side Outlet Expansion range	End Box Gutter Width
CSO-200-(L or R)	200 mm	SU-200-100 or SU-200-150	200 to 350 mm	200 mm
CSO-300-(L or R)	300 mm	SU-300-125 or SU-300-200	300 to 450 mm	300 mm
CSO-400-(L or R)	400 mm	SU-400-150 or SU-400-200	400 to 600 mm	400 mm

SD011 - Dam Buster Corner Side Outlet & Sump combination (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details

DAM BUSTER®
Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets	DESIGNED	DRAWN	
	CHECKED		
	SCALE NTS @A4	REVISION 4	
	DATE 01.02.2023		
	JOB No.	SHEET No. SD011	

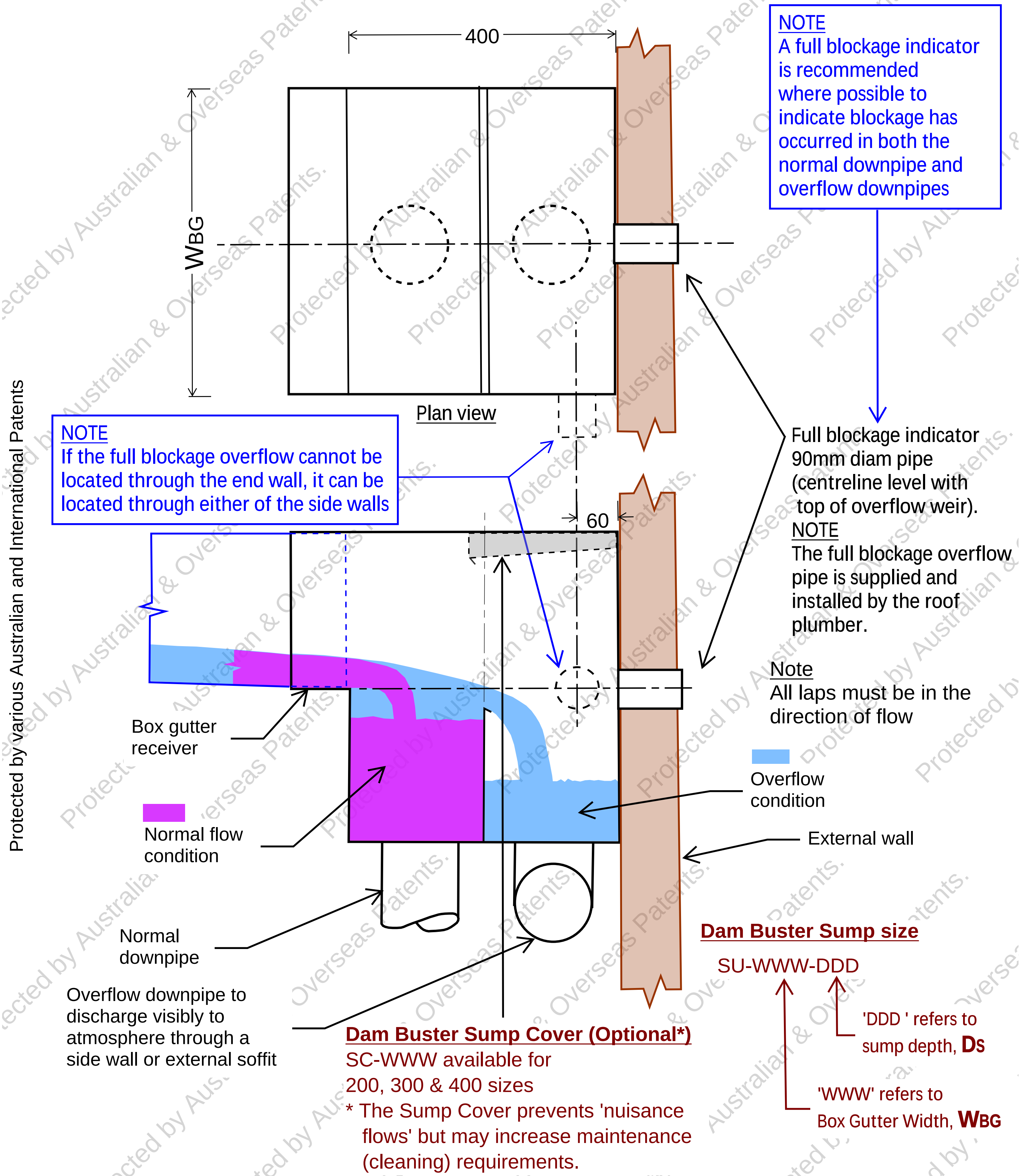


Cruciform Side Outlet Size	Side Outlet Width	Sump size	Side Outlet Expansion range	End Box Gutter Width
XSO-200	200 mm	SU-200-100 or SU-200-150	200 to 350 mm	200 mm
XSO-300	300 mm	SU-300-125 or SU-300-200	300 to 450 mm	300 mm
XSO-400	400 mm	SU-400-150 or SU-400-200	400 to 600 mm	400 mm

SD012 - Dam Buster Cruciform Side Outlet & Sump combination (NTS)

NOTES

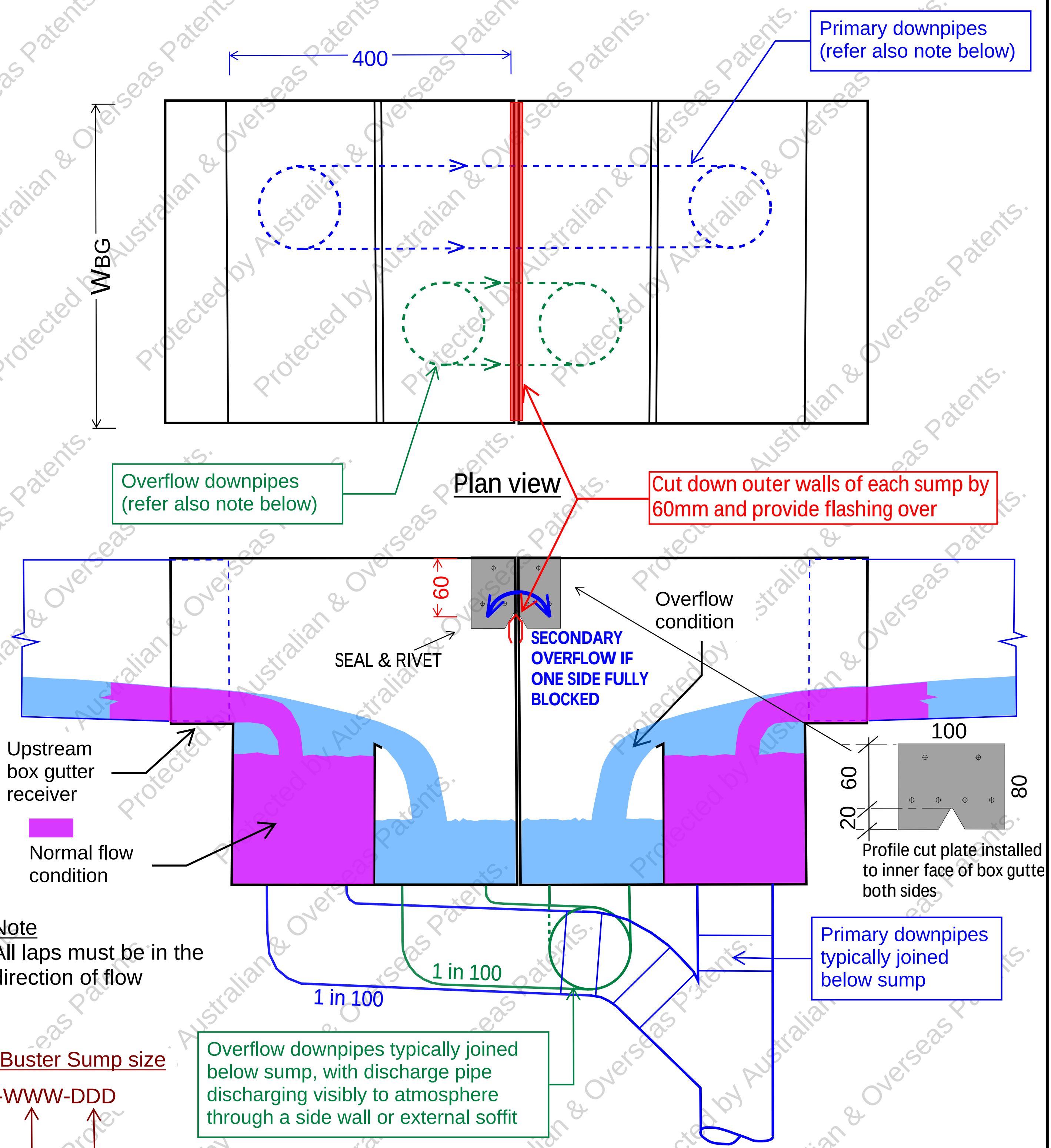
1. Refer to the current Dam Buster manual for installation details



SD013 - Typical Dam Buster Sump detail (NTS)

NOTES

1. Refer to the current Dam Buster P/L technical manual for installation details



Dam Buster Sump size

SU-WWW-DDD

'DDD ' refers to sump depth, **DS**

'WWW' refers to Box Gutter Width, **WBG**

SD014 - Typical Dam Buster Back-to-Back Sump detail (NTS)

NOTES

1. Refer to the current Dam Buster P/L technical manual for installation details
2. The hydraulic capacity of the Dam Buster Back-to-Back Sump is double that of a single Dam Buster Sump, however, the aerial overflow pipe must be sized for the total design flow in both box gutters / sumps.

DAM BUSTER®

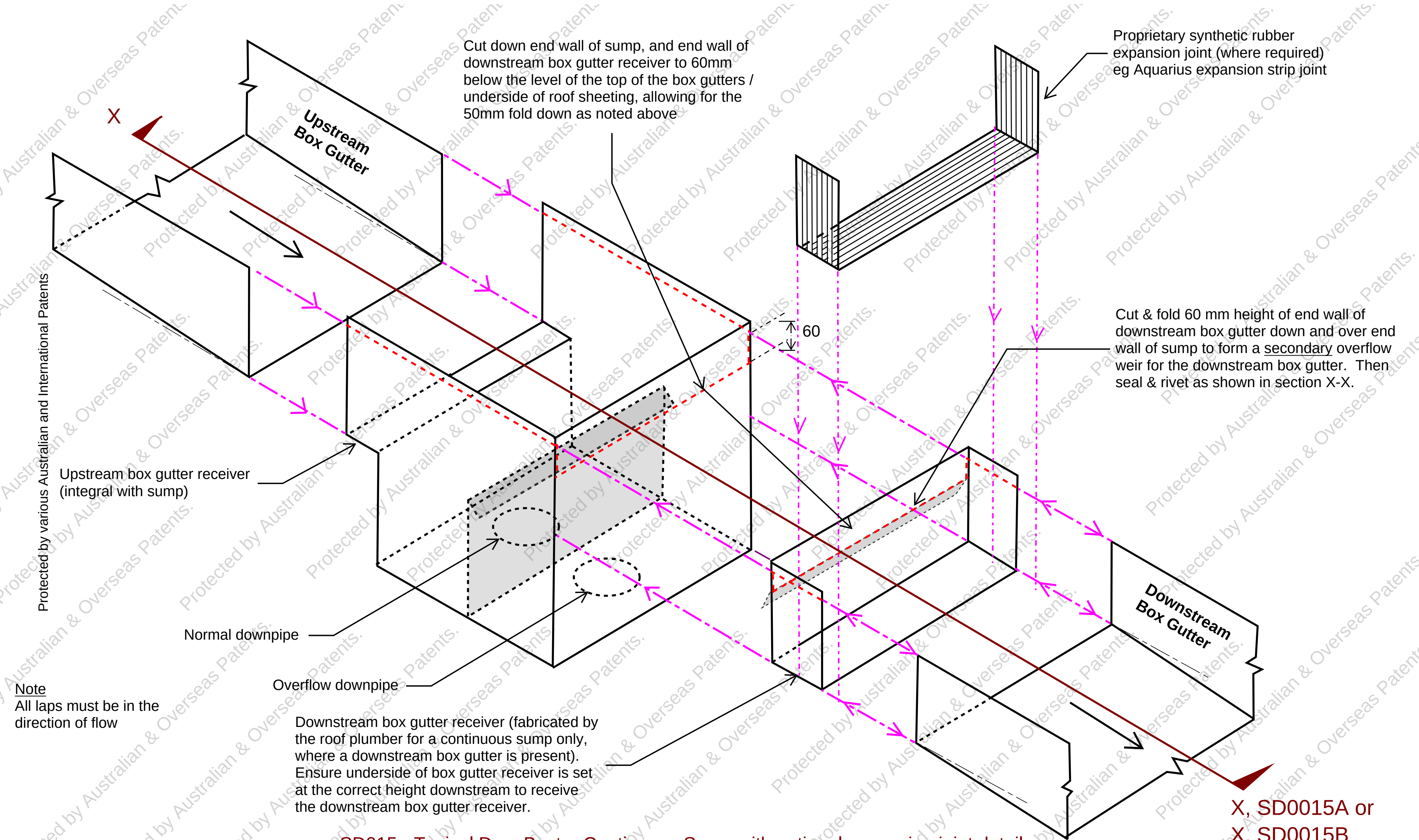
Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

DESIGNED		DRAWN
CHECKED		
SCALE NTS @A4		REVISION 4
DATE 01.02.2023		
JOB No.		SHEET No. SD014

TITLE: Standard Details Sheets

DAM BUSTER®

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au



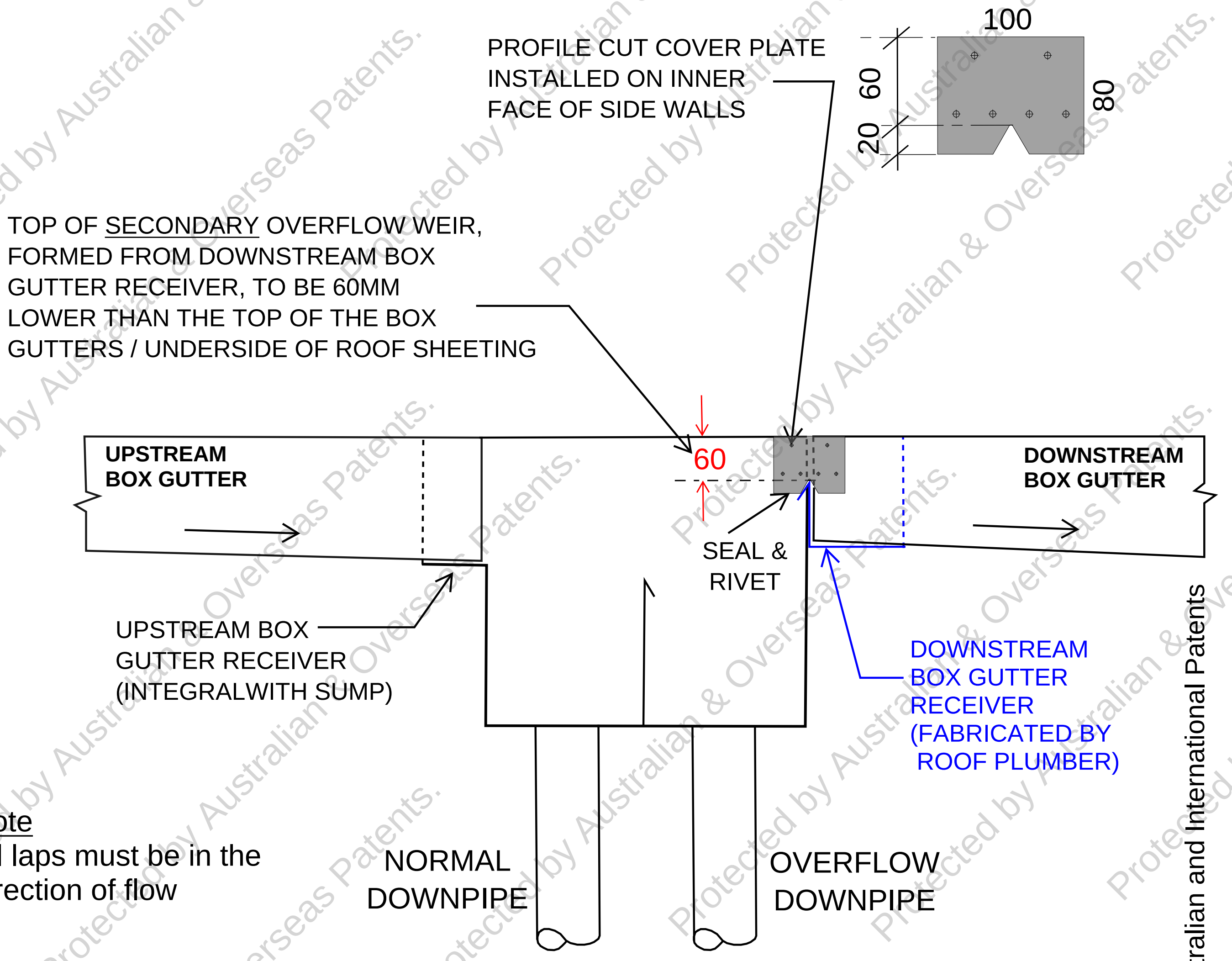
SD015 - Typical Dam Buster Continuous Sump with optional expansion joint detail (NTS)

NOTES

1. Refer to the current Dam Buster P/L technical manual for installation details
2. Refer to detail SD0015A for Continuous Sump, WITHOUT an expansion joint
3. Refer to detail SD0015B for Continuous Sump, WITH an expansion joint

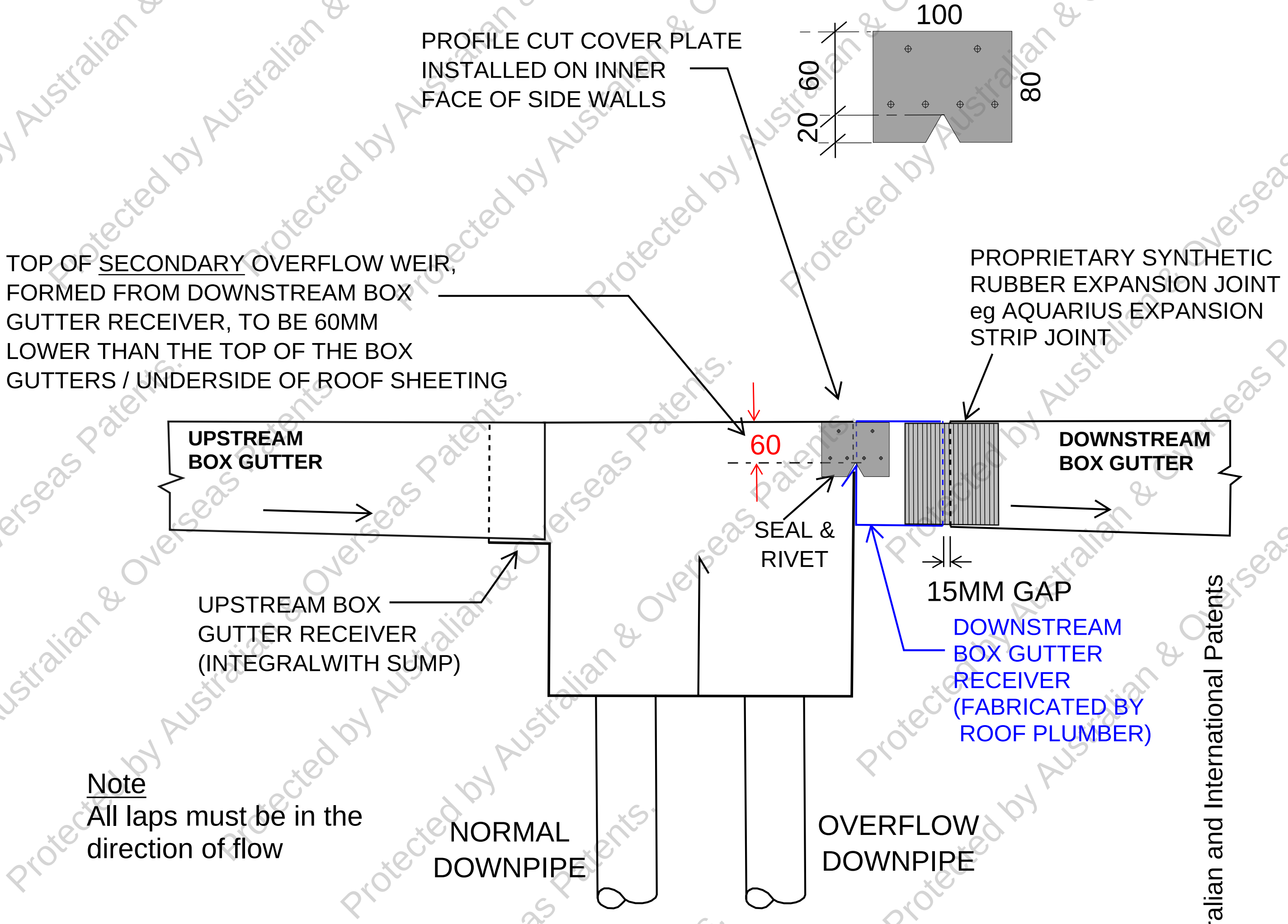
TITLE: Standard Details Sheets

DESIGNED	DRAWN
CHECKED	
SCALE NTS @A4	REVISION 4
DATE 01.02.2023	
JOB No.	SHEET No. SD015



Note
All laps must be in the direction of flow

SD0015A - Section X-X, SD0015 (Dam Buster Continuous Sump, as installed WITHOUT expansion joint)



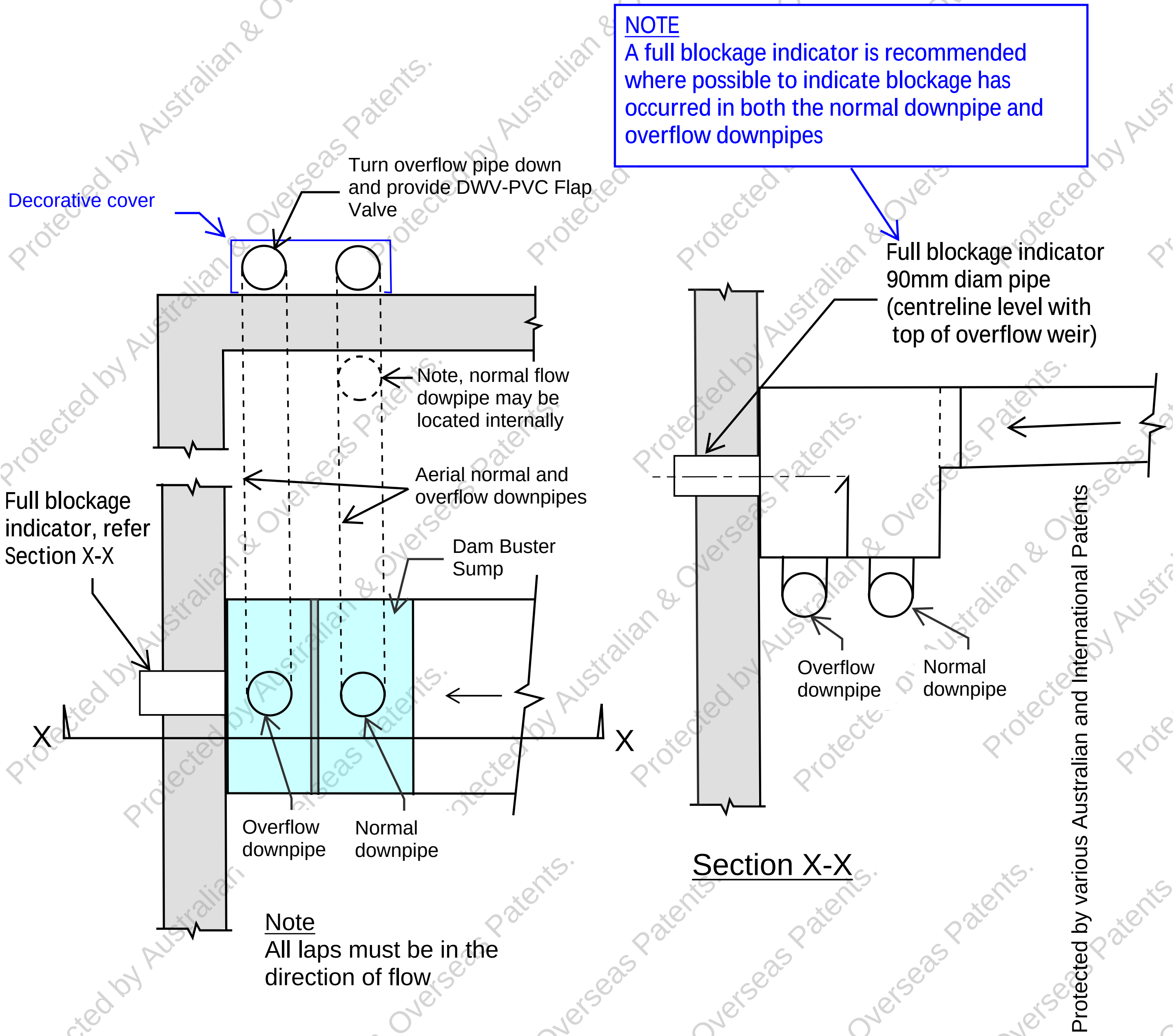
SD0015B - Section X-X, SD0015

(Dam Buster Continuous Sump, as installed WITH expansion joint)

DAM BUSTER®

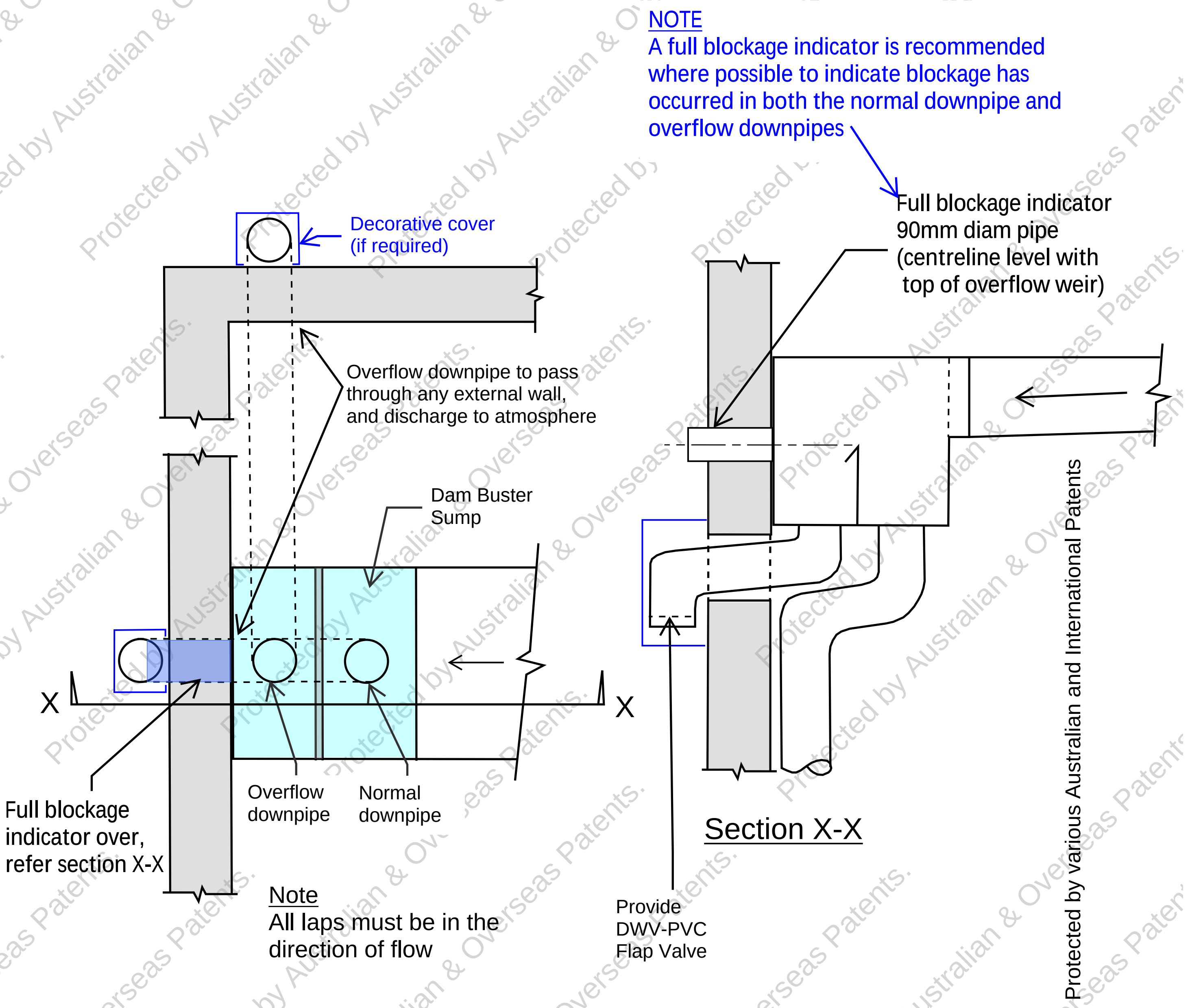
Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets	DESIGNED		DRAWN
	CHECKED		
	SCALE NTS @A4		REVISION 4
	DATE 01.02.2023		
	JOB No.	SHEET No. SD015B	



SD016 - Dam Buster Sump used in lieu of rainhead - Option A (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details
2. This arrangement may be required where a rainhead cannot be installed at the external wall (for example, the box gutter is located above a window or door opening)
3. Refer also SD017 for an alternative arrangement



SD017 - Dam Buster Sump used in lieu of rainhead - Option B (NTS)

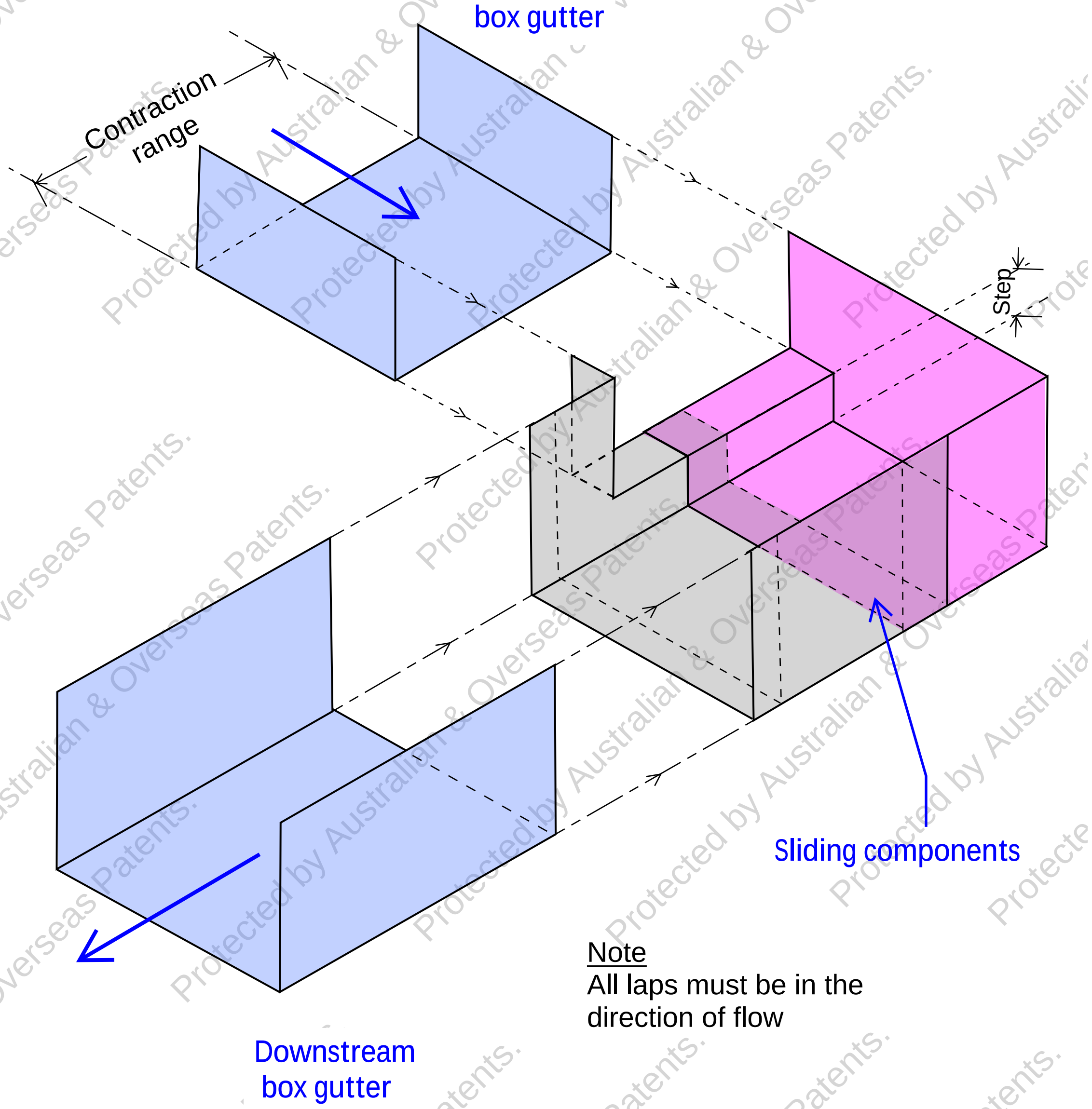
NOTES

1. Refer to the current Dam Buster manual for installation details
2. This arrangement may be required where a rainhead cannot be installed at the external wall (for example, the box gutter is located above a window or door opening)
3. Refer also SD0016 for an alternative arrangement

Dam Buster Pty Ltd
www.dambuster.com.au
orders@dambuster.com.au

TITLE: Standard Details Sheets

DESIGNED		DRAWN	
CHECKED			
SCALE	NTS @A4	REVISION	4
DATE	01.02.2023		
JOB No.		SHEET No.	SD017



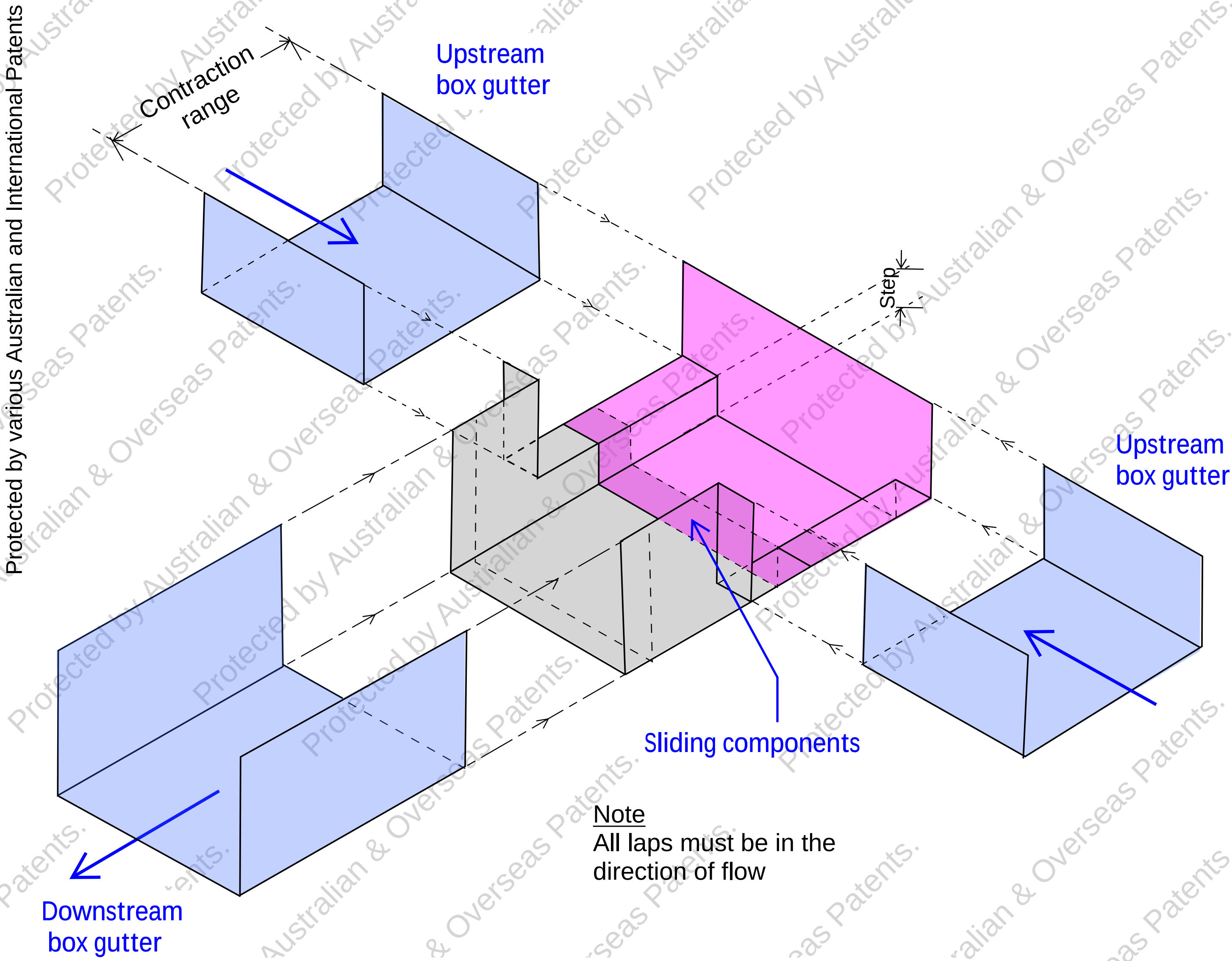
Note
All laps must be in the direction of flow

Dam Buster Elbow

Dam Buster Elbow size	Upstream Contraction range (mm)	Downstream box gutter width	Step
ELB-200-(L or R)	200 (fixed) mm	200 mm	50 mm
ELB-300-(L or R)	200 to 300 mm	300 mm	60 mm
ELB-400-(L or R)	300 to 400 mm	400 mm	70 mm
ELB-500-(L or R)	400 to 500 mm	500 mm	70 mm
ELB-600-(L or R)	400 to 600 mm	600 mm	70 mm

SD018 - Dam Buster Elbow (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details



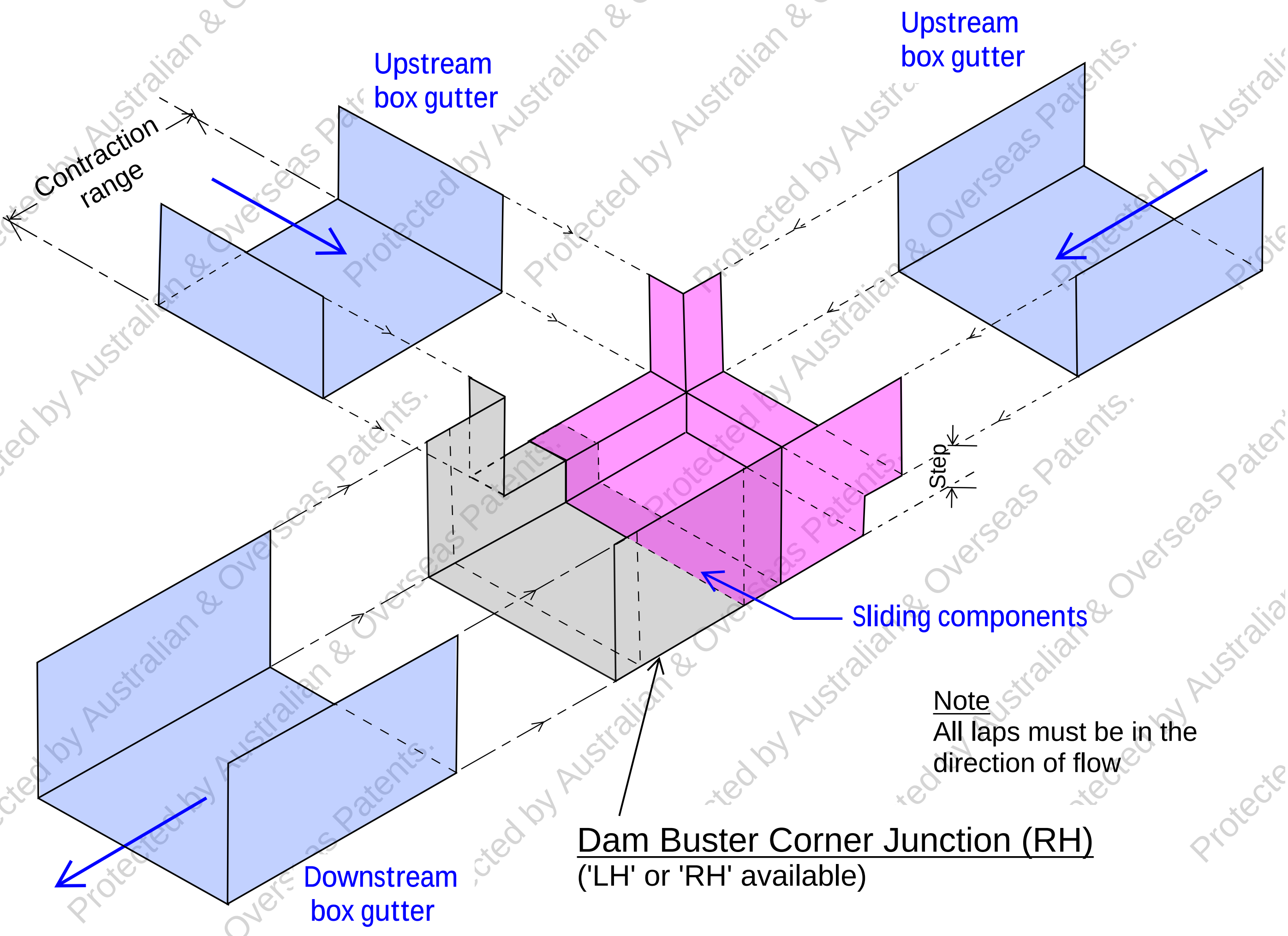
Note
All laps must be in the direction of flow

Dam Buster Tee Junction

Junction size	Upstream Contraction range	Downstream width	Step
TJN-200	200 (fixed) mm	200 mm	50 mm
TJN-300	200 to 300 mm	300 mm	60 mm
TJN-400	300 to 400 mm	400 mm	70 mm

SD019 - Dam Buster Tee Junction (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details



Note
All laps must be in the direction of flow

Dam Buster Corner Junction (RH)
('LH' or 'RH' available)

Dam Buster Corner Junction

Junction size	Upstream Contraction range	Downstream width	Step
CJN-200 (L or R)	200 (fixed) mm	200 mm	50 mm
CJN-300 (L or R)	200 to 300 mm	300 mm	60 mm
CJN-400 (L or R)	300 to 400 mm	400 mm	70 mm

SD020 - Dam Buster Corner Junction (NTS)

NOTES
1. Refer to the current Dam Buster manual for installation details

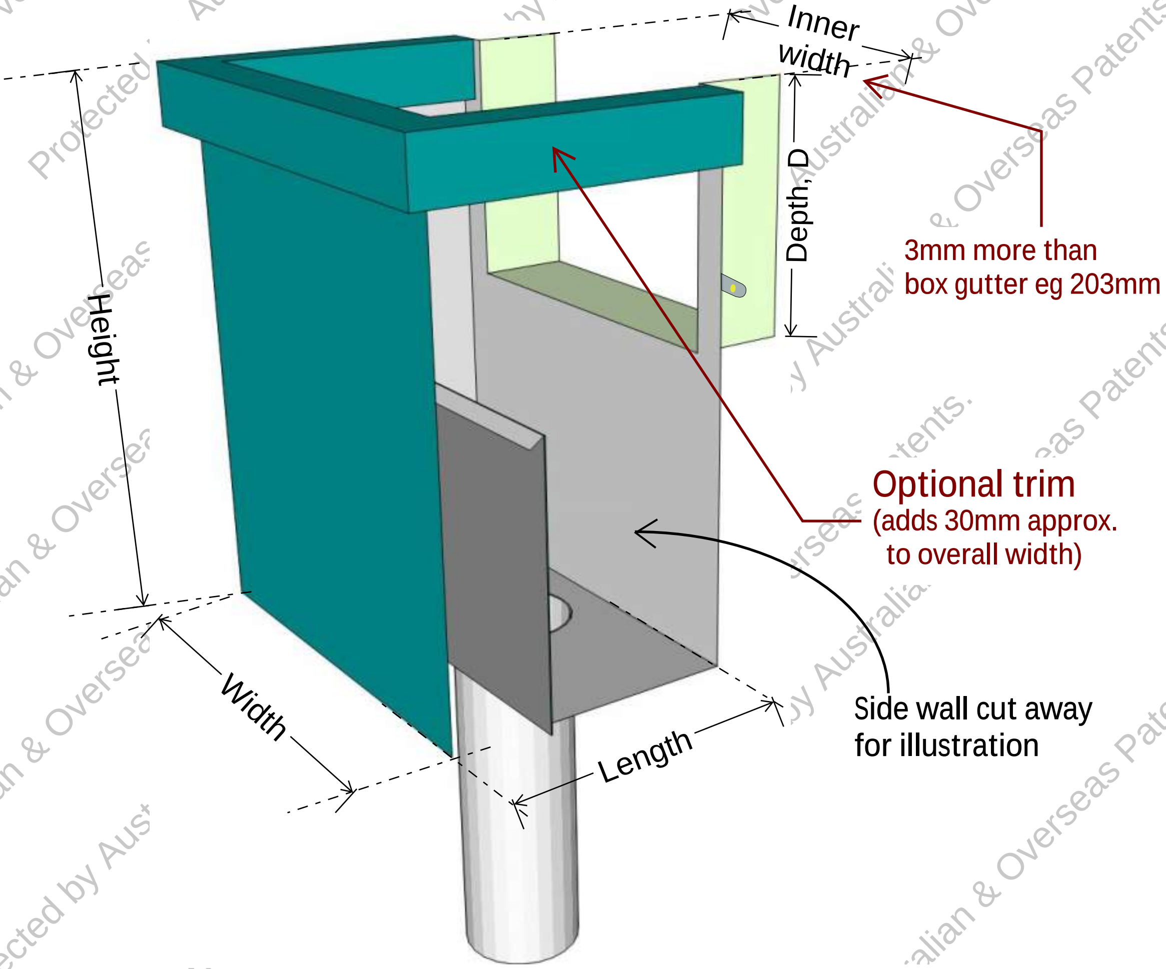
Appendix D

Dam Buster Product Data Sheets

Product Data Sheet Rainhead R-www & R-www-F

Standard sizes to suit 200mm, 300mm, 400mm, 500mm and 600mm wide box gutters. Refer to the table below for available Non-Standard sizes.

-F refers to the Flat Back version of the rainhead (i.e no box gutter receiver)



STANDARD RAINHEAD DIMENSIONS – R series

Rainhead size	Width (mm)	Height (mm)	Length (mm)	Box gutter Width (mm)	Box g. receiver Depth 'D' (mm)
R-200	265	350	205	200	200
R-300	365	450	245	300	200
R-400	465	600	325	400	250
R-500	565	650	325	500	275
R-600	665	700	325	600	300

NON-STANDARD RAINHEAD DIMENSIONS for R-200-xxx & R-300-xxx series

Rainhead size	Width (mm)	Height (mm)	Length (mm)	Box gutter Width (mm)	Box g. receiver Depth 'D' (mm)
R-**200**-300	365	350	205	300	200
R-**300**-350	415	450	245	350	200
R-**300**-380	445	450	245	380	200
R-**300**-400	465	450	245	400	200
R-**300**-450	515	450	245	450	200
R-**300**-500	565	450	245	500	200

CERTIFIED PRODUCT (DAM BUSTER RAINHEAD OVERFLOW PERFORMANCE)

HARDWARE AND BUILDING PRODUCT DESIGN

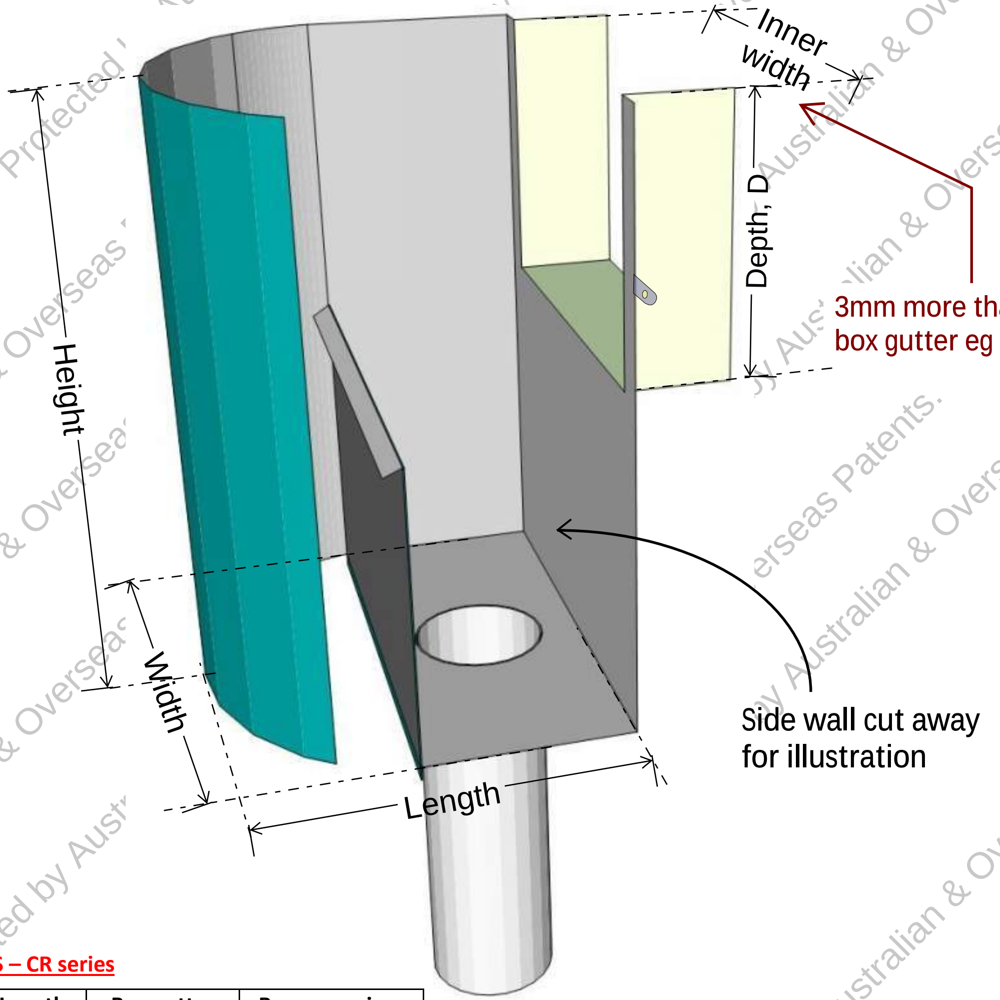
GOOD DESIGN AWARD® WINNER

DAM BUSTER RAIN HEAD

Product Data Sheet Curved Rainhead CR-www & CR-www-F

Standard sizes to suit 200mm, 300mm, 400mm 500mm & 600mm wide box gutters.

-F refers to the Flat Back version of the rainhead (i.e no box gutter receiver)



CURVED RAINHEAD DIMENSIONS – CR series

Rainhead size	Width (mm)	Height (mm)	Length (mm)	Box gutter Width (mm)	Box g. receiver Depth 'D' (mm)
CR-200	265	350	240	200	200
CR-300	365	450	290	300	200
CR-400	465	600	375	400	250
CR-500	565	650	375	500	275
CR-600	665	700	375	600	300

CERTIFIED PRODUCT
(DAM BUSTER RAINHEAD)

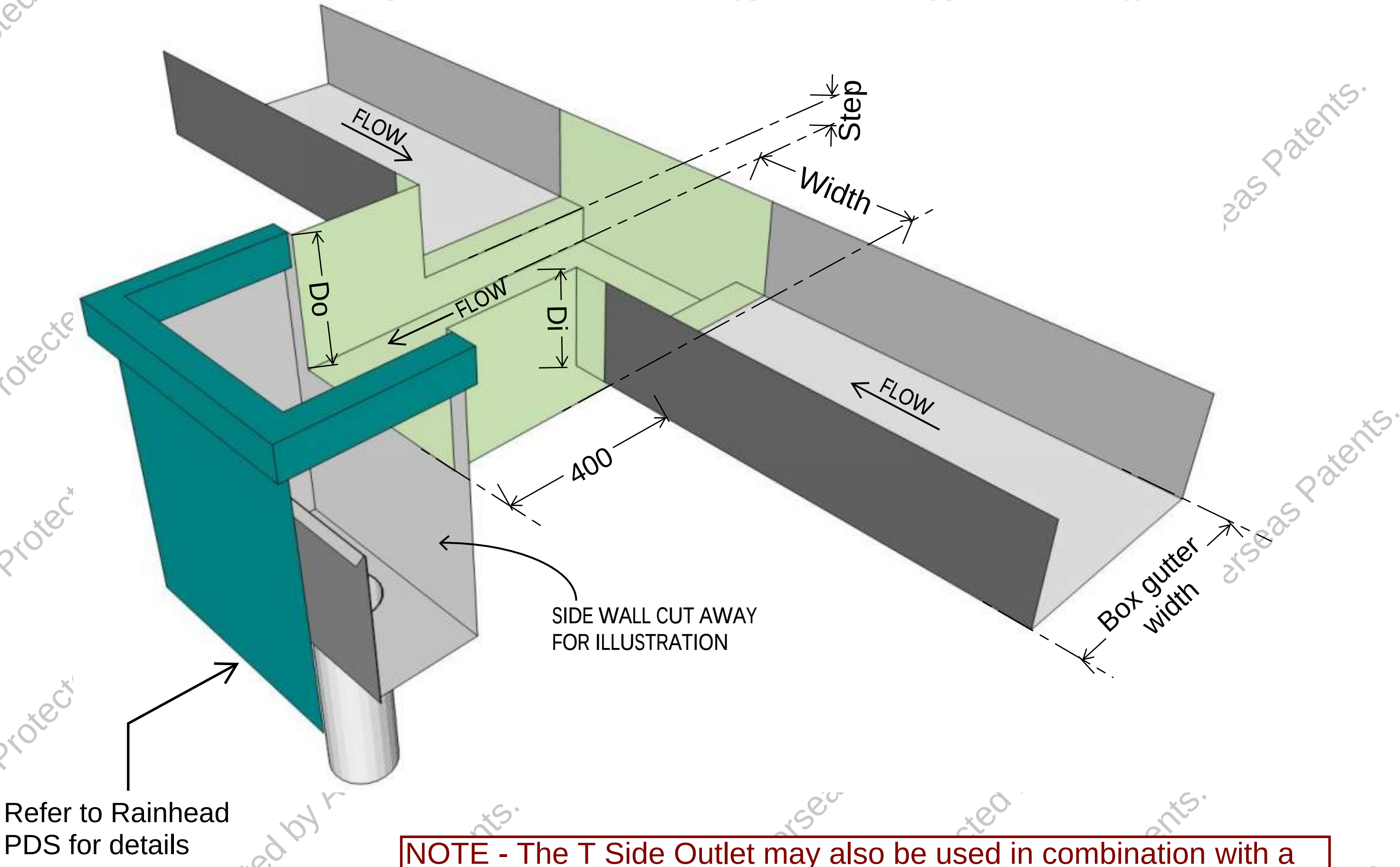
GOOD DESIGN AWARD WINNER

PRODUCT DESIGN
HARDWARE AND BUILDING

DAM BUSTER
RAIN HEAD

Product Data Sheet
'T' Side Outlets TSO-www

Standard sizes to suit any box gutter width between 200mm to 600mm.
Must only be used in combination with a Dam Buster Rainhead



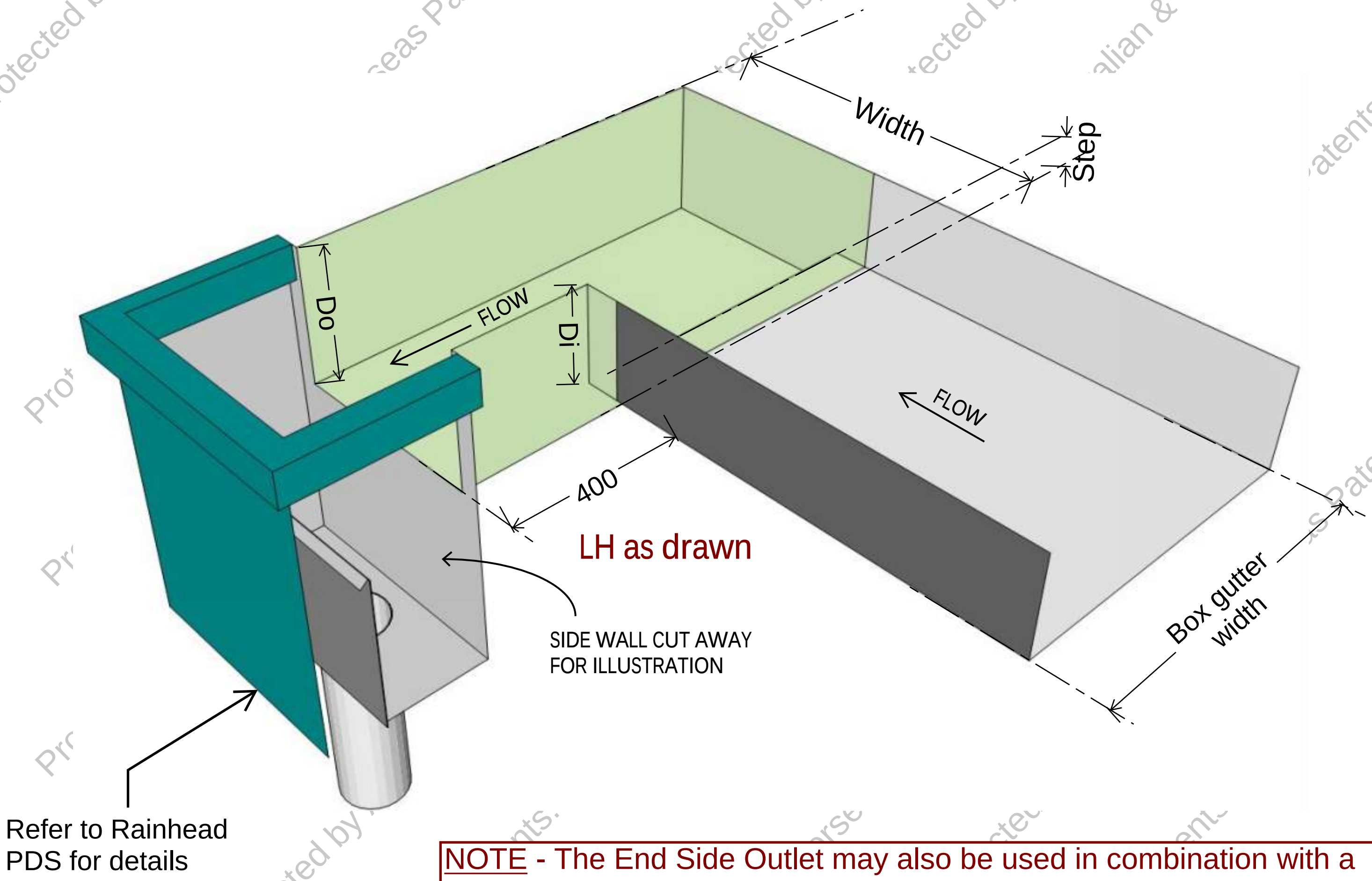
NOTE - The T Side Outlet may also be used in combination with a Dam Buster Sump - refer to the Standard Details drawings

'T' Side Outlet dimensions

Side Outlet size	Rainhead size	Width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)	Box gutter width range (mm)
TSO-200	R-200 or CR-200	200	50	150	200	200 to 350
TSO-300	R-300 or CR-300	300	60	140	200	300 to 450
TSO-400	R-400 or CR-400	400	70	180	250	400 to 600

Product Data Sheet
'End' Side Outlets ESO-www-(L or R)

Standard sizes to suit any box gutter width between 200mm to 600mm.
Must only be used in combination with a Dam Buster Rainhead



NOTE - The End Side Outlet may also be used in combination with a Dam Buster Sump - refer to the Standard Details drawings

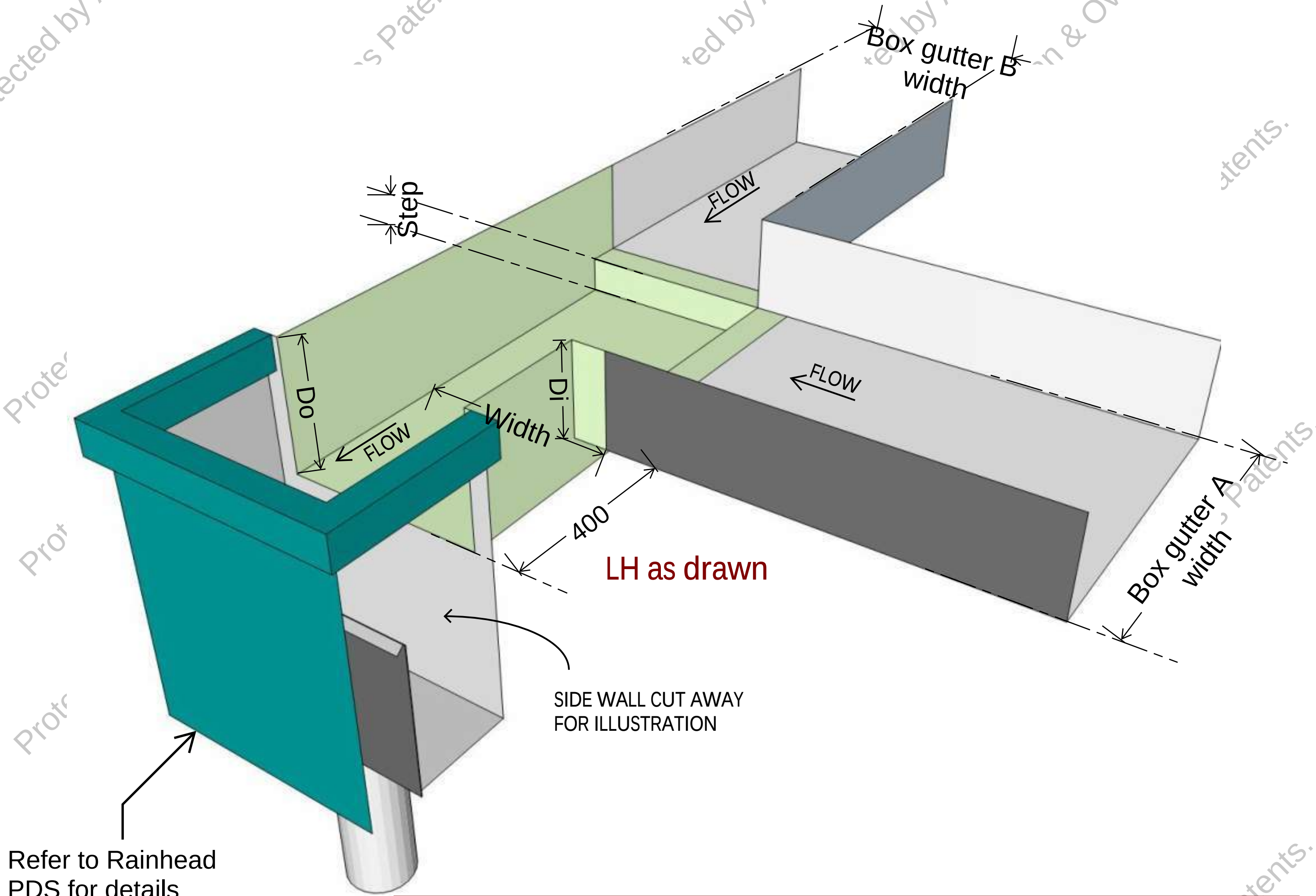
'End' Side Outlet dimensions

Side Outlet size	Rainhead size	Width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)	Box gutter width range (mm)
ESO-200-L or R	R-200 or CR-200	200	50	150	200	200 to 350
ESO-300-L or R	R-300 or CR-300	300	60	140	200	300 to 450
ESO-400-L or R	R-400 or CR-400	400	70	180	250	400 to 600

Product Data Sheet

'Corner' Side Outlets CSO-www-(L or R)

Standard sizes to suit any box gutter width between 200mm to 600mm.
Must only be used in combination with a Dam Buster Rainhead



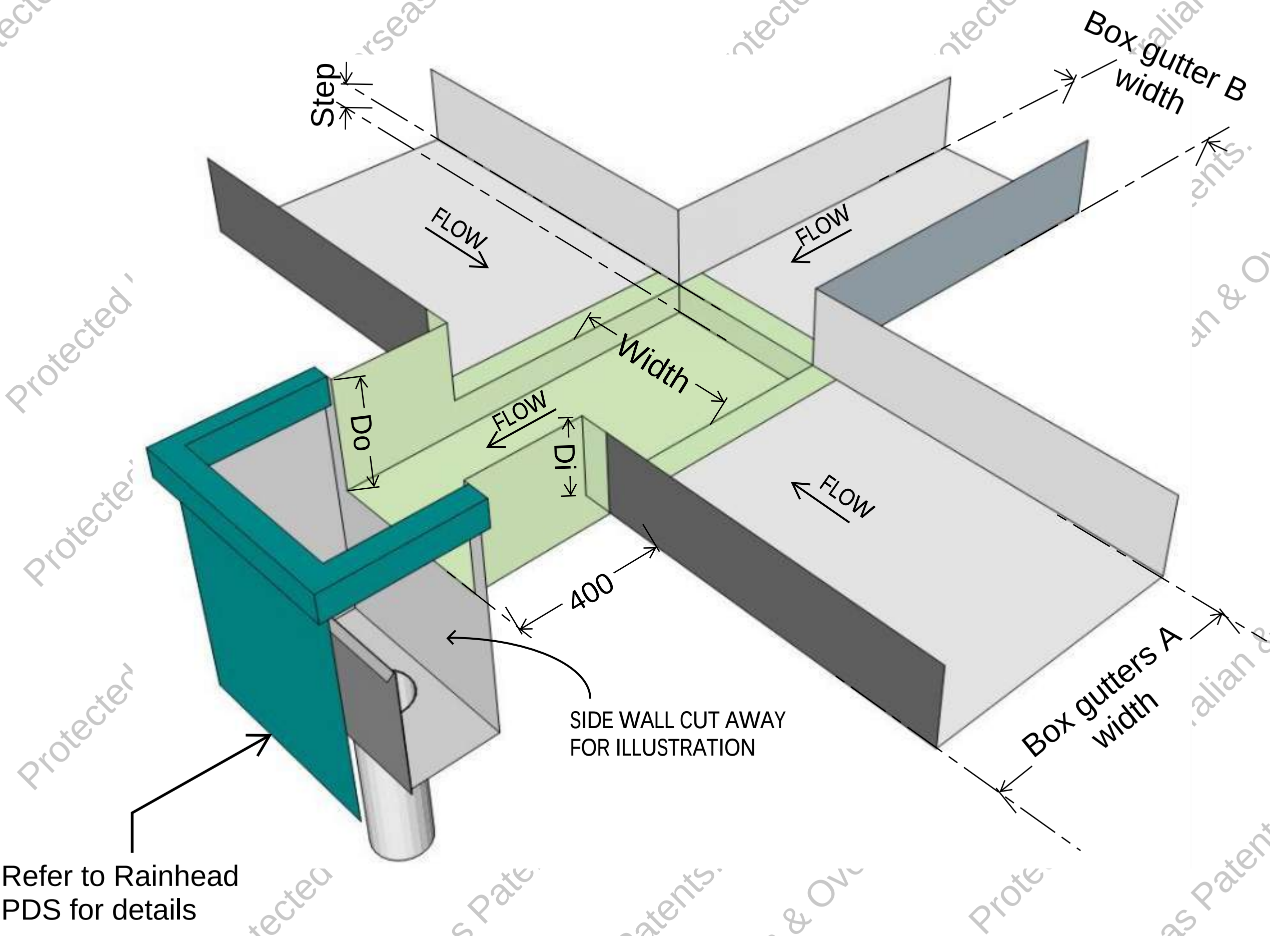
NOTE - The Corner Side Outlet may also be used in combination with a Dam Buster Sump - refer to the Standard Details drawings

'Corner' Side Outlet dimensions

Side Outlet Size	Rainhead size	Width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)	Box gutter A width range (mm)	Box gutter B width (mm)
CSO-200-L or R	R-200 or CR-200	200	50	150	200	200 to 350	200
CSO-300-L or R	R-300 or CR-300	300	60	140	200	300 to 450	300
CSO-400-L or R	R-400 or CR-400	400	70	180	250	400 to 600	400

Product Data Sheet
'Cruciform' Side Outlets XSO-www

Standard sizes to suit any box gutter width between 200mm to 600mm.
Must only be used in combination with a Dam Buster Rainhead



NOTE - The Cruciform Side Outlet may also be used in combination with a Dam Buster Sump - refer to the Standard Details drawings

'Cruciform' Side Outlet dimensions

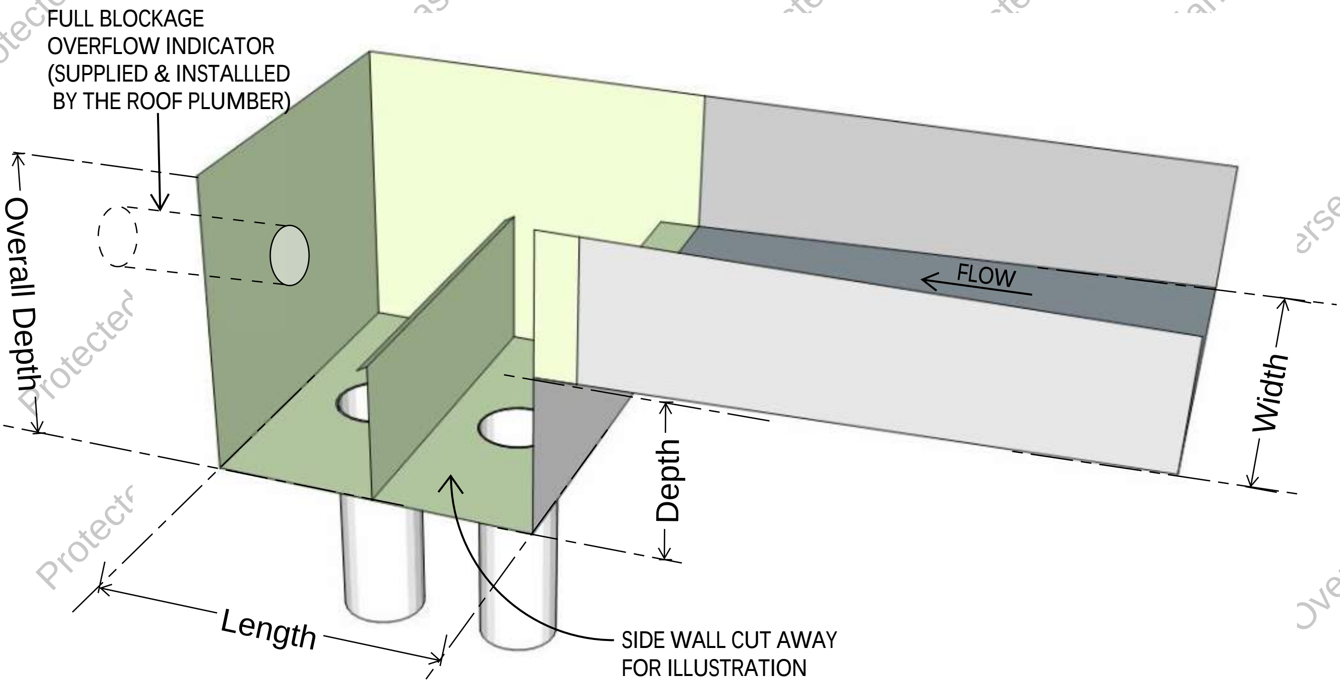
Side Outlet Size	Rainhead size	Width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)	Box gutters A width range (mm)	Box gutters B width range (mm)
XSO-200	R-200 or CR-200	200	50	150	200	200 to 350	200
XSO-300	R-300 or CR-300	300	60	140	200	300 to 450	300
XSO-400	R-400 or CR-400	400	70	180	250	400 to 600	400

DAM BUSTER®

AUSTRALIAN OWNED #00581 CERTIFIED

Product Data Sheet
Sumps SU-www-ddd

Standard sizes to suit box gutter widths of 200mm, 300mm, 400mm, 500mm & 600mm



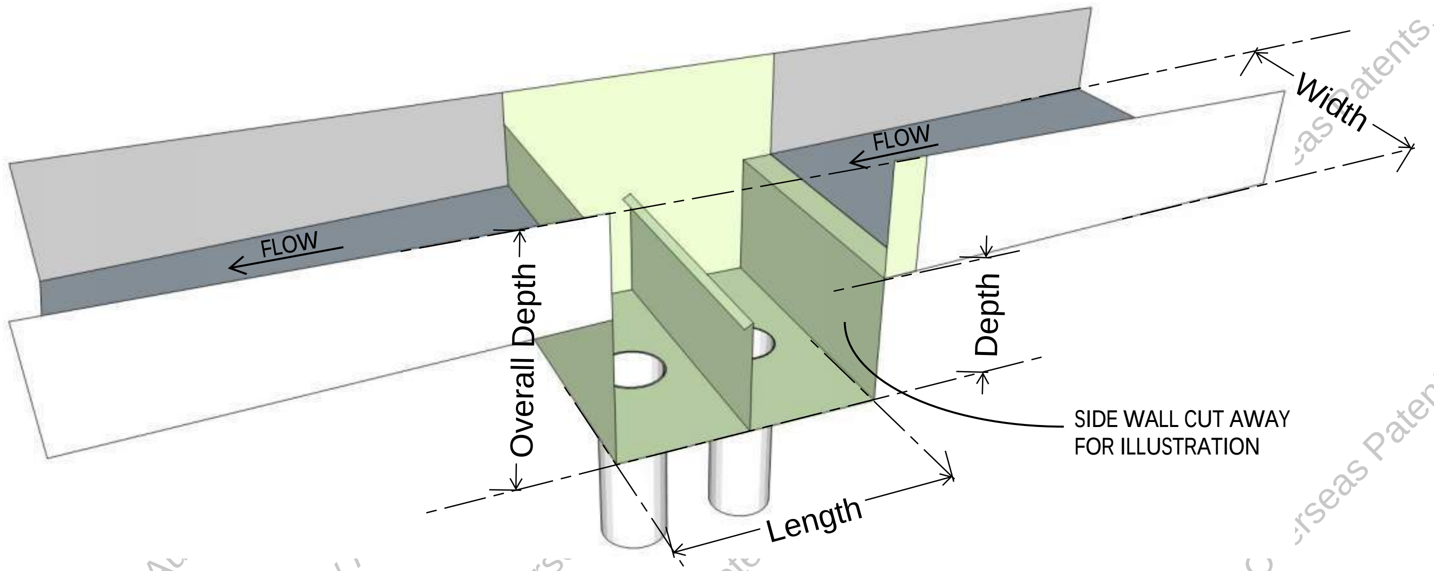
Sump dimensions

Sump size	Width (mm)	Depth (mm)	Length (mm)	Overall Depth (mm)
SU-200-100	205	100	400	300
SU-200-150	205	150	400	350
SU-300-125	305	125	400	330
SU-300-200	305	200	400	405
SU-400-150	405	150	400	400
SU-400-200	405	200	400	450
SU-500-150	505	150	400	300
SU-500-200	505	200	400	400
SU-600-150	605	150	400	300
SU-600-200	605	200	400	400

Product Data Sheet
Continuous Sumps SU-www-ddd*

* Ordered as a Dam Buster Sump

Standard sizes to suit box gutter widths of 200mm, 300mm, 400mm, 500mm & 600mm

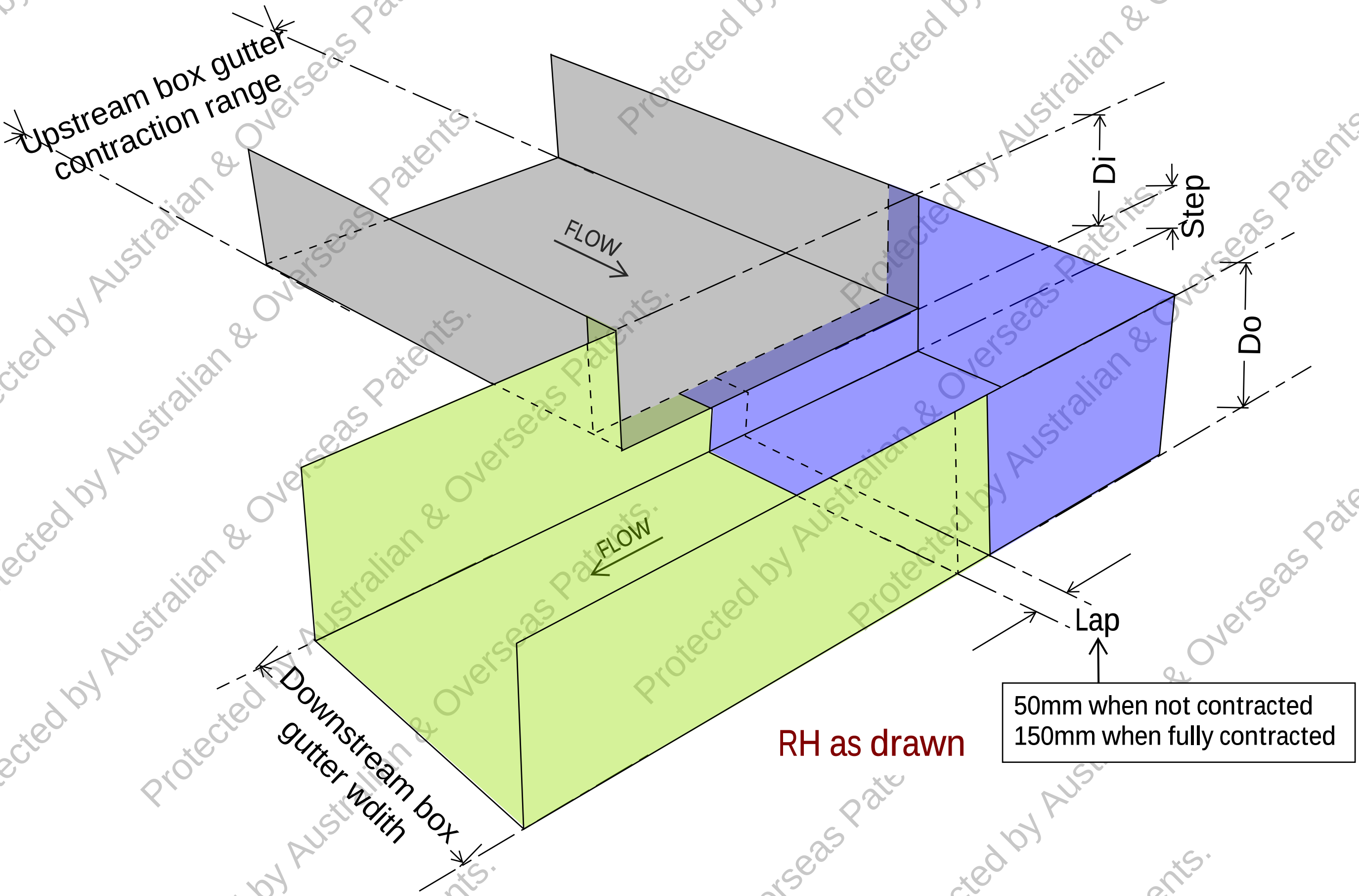


Continuous Sump dimensions

Sump size	Width (mm)	Depth (mm)	Length (mm)	Overall Depth (mm)
SU-200-100	205	100	400	300
SU-200-150	205	150	400	350
SU-300-125	305	125	400	330
SU-300-200	305	200	400	405
SU-400-150	405	150	400	400
SU-400-200	405	200	400	450
SU-500-150	505	150	400	300
SU-500-200	505	200	400	400
SU-600-150	605	150	400	300
SU-600-200	605	200	400	400

Product Data Sheet
Elbows - ELB-www- (L or R)

Standard sizes to suit any box gutter width between 200mm to 600mm.

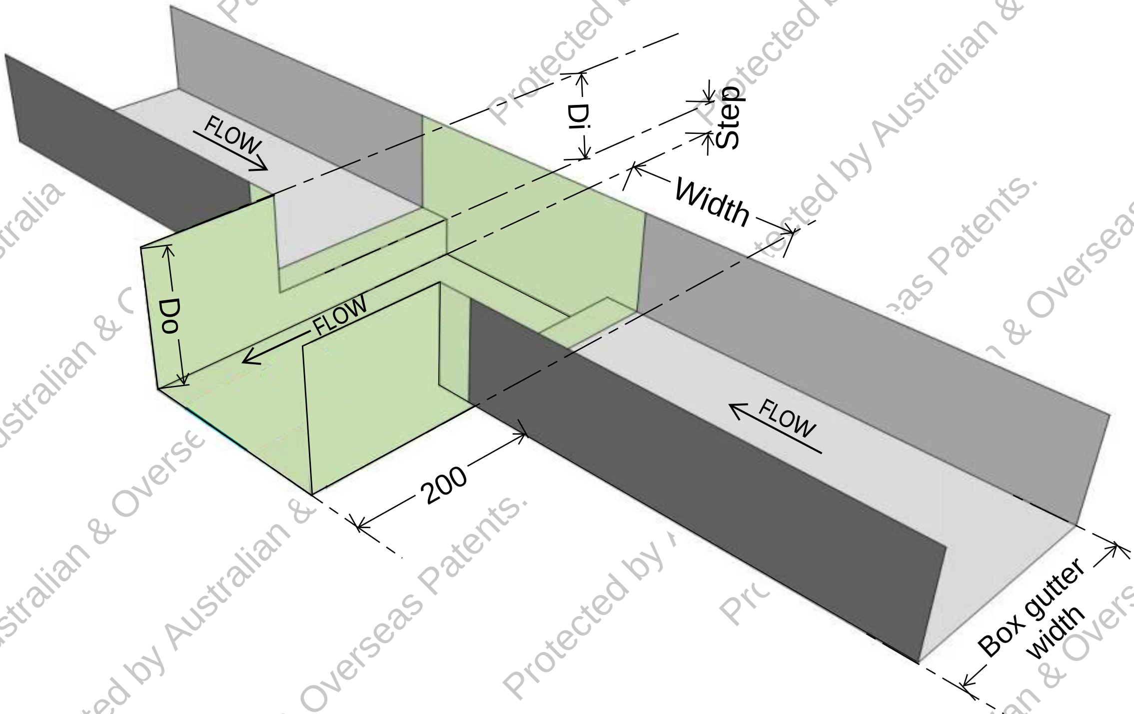


ELBOW dimensions

Elbow size	Upstream Contraction range (mm)	Downstream width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)
ELB-200- (L or R)	200 (fixed)	197	50	180	230
ELB-300- (L or R)	200 to 300	297	60	215	275
ELB-400- (L or R)	300 to 400	397	70	230	300
ELB-500- (L or R)	300 to 500	497	70	230	300
ELB-600- (L or R)	400 to 600	597	70	230	300

Product Data Sheet
Tee Junction TJN-www

Standard sizes to suit any box gutter width between 200mm to 400mm.



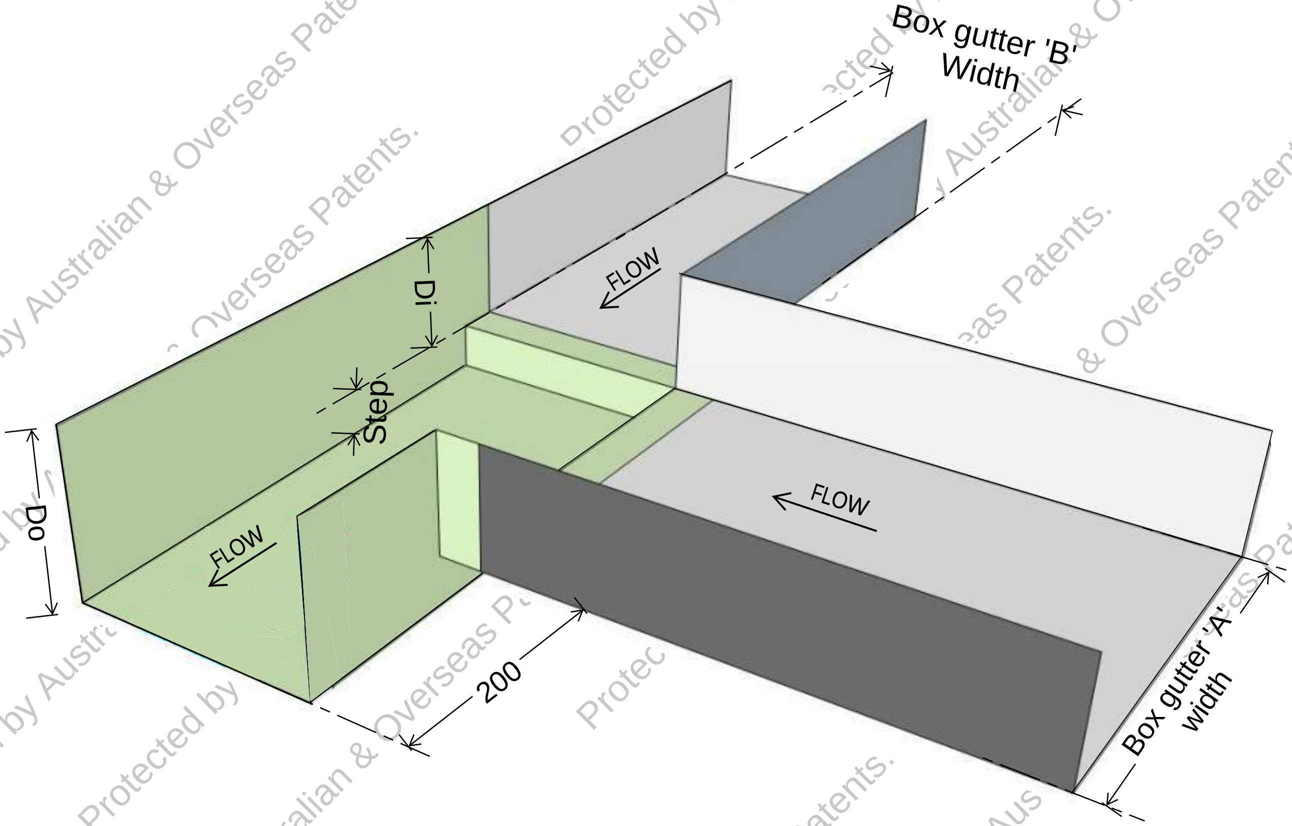
TEE JUNCTION dimensions

Tee Junction size	Upstream Contraction range (mm)	Downstream width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)
TJN-200	200 (fixed)	197	50	180	230
TJN-300	200 to 300	297	60	215	275
TJN-400	300 to 400	397	70	230	300

DAM BUSTER®

Product Data Sheet
Corner Junction CJN-www-(L or R)

Standard sizes to suit any box gutter width between 200mm to 400mm.



CORNER JUNCTION dimensions

Corner Junction Size	Downstream width (mm)	Step (mm)	INLET Depth, Di (mm)	OUTLET Depth, Do (mm)	Box gutter A contraction range (mm)	Box gutter B width (mm)
CJN-200 (L or R)	197	50	180	230	200	200
CJN-300 (L or R)	297	60	215	275	200 to 300	300
CJN-400 (L or R)	397	70	230	300	300 to 400	400

DAM BUSTER®

Appendix E

Risk Management (Design) &

Maintenance of Box Gutter Systems

Risk Management (Design) &

Maintenance of Box Gutter Systems

E1 *Failure of box gutter installations*

Box gutter systems can and do fail - far more often than they should - and have consequently developed a 'bad reputation'. As a result, Architects and Building Designers often fear box gutters, but this fear is unfounded for a well-designed and constructed box gutter system, incorporating adequate and compliant overflow devices.
Failure predominately occurs due to one or more of the following factors:

- Inadequate / non-existent design and documentation, particularly concerning overflow provision and box gutter depths.
- Non-compliant / poor construction and installation
- Inadequate maintenance of box gutters*

* Regular inspection and maintenance is required to remove debris, which might otherwise result in failure of the box gutter system. Refer to section E6 for a more detailed discussion.

E2 *Current quality of design and documentation for roof drainage in Australia*

The level of design and documentation of box gutter systems in Australia is currently generally very poor. There are multiple reasons for this, including the following:

- Incorrect design on Architectural plans
- A lack of understanding, including by Building Certifiers, of the basic principles of roof drainage design
- Non-compliant / poor construction and installation
- AS/NZS 3500.3 is not an easy code to design to, and lacks flexibility in design, providing only three types of overflow devices
- Building Surveyors / Certifiers often do not require certification for roof drainage designs, particularly for residential and multi-unit residential type buildings. However, with introduction of new NCC Governing Provision A2.2(4) on 1 July 2021, Building Certifiers are increasingly requiring that the Performance Solution process be adhered to when the roof drainage is clearly not DtS (Deemed-to-Satisfy)

E3 *The Dam Buster Solution to Roof Drainage problems*

Dam Buster seeks to remedy many of the above problems by:

- Providing a simple design / selection process, based on the calculated design flow rate only
- Providing a rainhead which is fully compliant, aesthetically pleasing, has substantial overflow capacity and is also easy to install. Importantly the rainhead also has a novel box gutter receiver, allowing a good seal to be readily achieved between the box gutter and the rainhead. This is important because this junction is a very common point of water ingress into a building.
- Providing a range of innovative overflow devices which provide much greater flexibility for design, specifically:
  - the Dam Buster Side Outlet and Rainhead or Sump combination,
  - the Dam Buster Sump, Continuous Sump and Back-to-Back Sump
  - the Dam Buster Elbow & Junctions
- Adoption of a minimum depth of 150mm for the penetration for the box gutter in a parapet wall, where a straight box gutter discharges to a rainhead (even though the depth of the box gutter may be closer to 100mm in some cases). Note that the outlet box gutter for the Dam Buster Side Outlets is always a least 200mm deep (and hence the penetration in the parapet wall is a least 200mm deep).

When a box gutter system is designed and installed to comply with the relevant standards and Dam Buster's documentation, the risk of failure is significantly minimized, provided the property owner carries out normal and regular maintenance (refer E6).

E4 *Design considerations to mitigate against the risk of failure*

The following issues should be considered by designers of box gutter systems in order to minimize the risk of failure:

- A box gutter discharging directly to a Dam Buster Rainhead is the preferred method of discharging water from a box gutter as it places all of the overflow device outside of the building.
  <u>Note:</u> The 3500.3 standard Rainhead is only as a safe as the Dam Buster Rainhead if the box gutter is adequately sealed to the rainhead. However, without a box gutter receiver, it is much more difficult to get a good seal (and, very commonly, the seal is inadequate). Consequently the 3500.3 Rainhead is considered to be a less safe option than the Dam Buster Rainhead when the box gutter has not been adequately sealed to the rainhead. It is also very rare to see a rainhead installed in accordance with 3500.3, and typically installed rainheads also have inadequate overflow capacity and sizing.
- The next preferred box gutter overflow devices are:
  - The Dam Buster Side Outlet and Rainhead combination
  - The 3500.3 Sump and Side Outlet (when correctly designed and installed)
- The more complicated devices are:
  - The Dam Buster Sump / Continuous Sump / Back-to-Back Sump
  - The Dam Buster Side Outlet and Sump combination

  - The 3500.3 Sump / High-Capacity Overflow device
  - Note
    - The above devices have similar safety when installed 'internally' i.e. not immediately adjacent to a parapet wall
    - However, when the Dam Buster Sump is installed immediately adjacent to a parapet wall, the 90mm diameter Full Blockage Overflow Indicator should be installed whenever possible to increase the safety of this device, particularly if there are nearby trees which are expected to deposit organic material in the gutters (refer also to the note below). A common example of the usage of this device in lieu of a rainhead is where a rainhead cannot be installed due to a window or door opening being present below a box gutter which is perpendicular to the parapet wall.
- The usage of 200mm wide box gutters should be avoided wherever possible. Dam Buster recommends all new box gutters be 300mm minimum wide, and notes 3500.3, section 3.7.3, Note 3 states:
  "The minimum width of box gutters used for commercial construction is 300mm. Box gutters 200mm wide may be used for domestic construction, but they are more prone to blockages. Additional height is recommended where possible"
- When utilizing the Dam Buster Elbow to facilitate a 90 degree change in direction, it is important to consider that in the 200mm size in particular, this will slightly increase the risk of blockage, purely due to the reduced self-cleaning action as alerted to in section 3.7.3 of 3500.3 above. As a result, for roofs with nearby trees or the risk of other wind-blown debris, or any other conditions which may lead to potentially higher risk of box gutter obstruction, the 200mm Dam Buster Elbow is not recommended (300mm min is recommended).
  - Note that the Dam Buster Elbow has been hydraulically designed and tested to ensure the energy loss at the bend (change of direction) is less than the energy created by means of the Step built into the Elbow. This design ensures that backwatering in the 'Upper' box gutter cannot occur. Additionally, this device has more freeboard built into the design than other devices.

E5 *Summary – Risk Management*

In summary, there are various matters to consider when designing roof drainage, and also various strategies to minimize the risk of failure. A well-considered design in accordance with the relevant standards and also using the Dam Buster Roof Drainage System, carried out during the design process (i.e. as part of the Building Permit documentation) will, if correctly installed, ensure compliance and also minimize the risk of any potential failure of a box gutter system.

E6 *Cleaning / maintenance of box gutter systems*

AS/NZS 3500.3-2021, section M.5, states:

'Sizing of stormwater drainage installations assumes 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, builder's 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'

Whilst ideally all owners would carry out regular inspection and maintenance, this often does not happen, and consequently it is incumbent on the roof drainage designer to minimize the risk of failure in the first instance through good, compliant design.

Good design, where possible, should include the provision of safe access to allow regular inspection and maintenance to be carried out to the roof stormwater drainage system.

E7 *Limitations*

At all times, normal good practices and "common sense" must be observed when designing, specifying and installing roof drainage systems. It is also very important to consider that whilst the Dam Buster Roof Drainage System is thoroughly engineered and tested, if instructions and relevant codes are not followed, failure may still occur.

With the exception of a straight box gutter discharging to a Dam Buster rainhead, all Dam Buster solutions require a Performance Solutions. Performance Solutions should only be carried out by appropriately qualified professionals, who have a thorough knowledge of the appropriate standards (in particular, AS/NZS 3500.3).

It is important to remember that Deemed-to-Satisfy Solutions represent the minimum acceptable solutions to satisfy the relevant Performance Requirements. Whilst a properly prepared Performance Solution does not have to comply with the DtS provisions, the level of safety of a Performance Solution should logically not be of a lesser quality / safety than that for a Deemed-to-Satisfy Solution to the same situation. It therefore follows that Performance Solutions should never be used as a means by which to justify a non-compliant DtS Solution, nor any outcome which provides a lower level of quality / safety than a DtS solution.

Appendix F

Box gutter design charts

Design chart for box gutters discharging to Dam Buster devices

Design flow rate L/s	Box gutter width (mm)								
	200	250	Example 300	350	400	450	500	550	600
3.0	107	101	96	93	90	88	86	84	83
3.5	113	105	100	96	93	91	89	87	85
4.0	118	110	104	100	96	94	91	89	88
4.5	122	114	107	103	99	96	94	92	90
5.0	127	118	111	106	102	99	96	94	92
5.5	131	121	114	109	105	101	99	96	94
6.0	135	125	118	112	107	104	101	98	96
6.5	140	129	121	115	110	106	103	101	98
7.0	144	132	124	118	113	109	105	103	100
7.5	148	135	127	120	115	111	107	105	102
8.0	151	139	130	123	118	113	110	107	104
8.5	155	142	133	125	120	115	112	108	106
9.0	159	145	135	128	122	118	114	110	107
9.5	162	148	138	131	125	120	116	112	109
10.0	166	151	141	133	127	122	118	114	111
10.5	170	154	144	135	129	124	119	116	113
11.0		157	146	138	131	126	121	118	114
11.5		160	149	140	133	128	123	119	116
12.0		163	151	142	135	130	125	121	118
12.5		166	154	145	137	132	127	123	119
13.0		169	156	147	140	134	129	124	121
13.5			159	149	142	135	130	126	122
14.0			161	151	144	137	132	128	124
14.5			164	154	146	139	134	129	125
15.0			166	156	148	141	135	131	127
15.5			168	158	149	143	137	132	128
16.0				160	151	144	139	134	130

Minimum UPSTREAM box gutter depth (mm) for **1 in 200*** slope

* 1:200 slope equates to **5mm per m increasing depth** over the length of the gutter

Example
300mm wide box gutter
Flow rate = 6.0 L/s
=> Minimum UPSTREAM depth = 118mm
Recommend rounding up to nearest 5mm => Adopt 120mm UPSTEAM depth

Design chart for box gutters discharging to Dam Buster devices

Design flow rate L/s	Box gutter width (mm)		Example						
	200	250	300	350	400	450	500	550	600
3.0	104	98	94	90	88	86	84	82	81
3.5	109	102	97	94	91	88	87	85	83
4.0	113	106	101	97	94	91	89	87	86
4.5	118	110	104	100	96	94	91	89	88
5.0	122	113	107	103	99	96	94	92	90
5.5	126	117	110	105	102	98	96	94	92
6.0	130	120	113	108	104	101	98	96	94
6.5	134	124	116	111	106	103	100	98	95
7.0	138	127	119	113	109	105	102	99	97
7.5	141	130	122	116	111	107	104	101	99
8.0	145	133	125	118	113	109	106	103	101
8.5	148	136	127	121	116	111	108	105	102
9.0	152	139	130	123	118	113	110	107	104
9.5	155	142	133	125	120	115	112	108	106
10.0	158	145	135	128	122	117	113	110	107
10.5	162	148	138	130	124	119	115	112	109
11.0		150	140	132	126	121	117	113	110
11.5		153	142	134	128	123	119	115	112
12.0		156	145	136	130	125	120	117	113
12.5		158	147	139	132	126	122	118	115
13.0		161	149	141	134	128	124	120	116
13.5			152	143	136	130	125	121	118
14.0			154	145	138	132	127	123	119
14.5			156	147	139	133	128	124	121
15.0			158	149	141	135	130	126	122
15.5			161	151	143	137	132	127	123
16.0				153	145	138	133	129	125

Minimum UPSTREAM box gutter depth (mm) for **1 in 150*** slope

* 1:150 equates to **7mm approx. per m** increasing depth over the length of the gutter

Example
300mm wide box gutter
Flow rate = 6.0 L/s
=> Minimum UPSTREAM depth = 113mm
Recommend rounding up to nearest 5mm => Adopt 115mm UPSTEAM depth

DAM BUSTER®

Design chart for box gutters discharging to Dam Buster devices

Design flow rate L/s	Example Box gutter width (mm)								
	200	250	300	350	400	450	500	550	600
3.0	102	96	92	89	86	84	83	81	80
3.5	106	100	95	92	89	87	85	83	82
4.0	110	103	98	95	92	89	87	86	84
4.5	115	107	102	98	94	92	90	88	86
5.0	119	110	105	100	97	94	92	90	88
5.5	122	114	108	103	99	96	94	92	90
6.0	126	117	110	106	102	98	96	94	92
6.5	130	120	113	108	104	101	98	96	94
7.0	133	123	116	110	106	103	100	97	95
7.5	137	126	119	113	108	105	102	99	97
8.0	140	129	121	115	110	107	103	101	98
8.5	143	132	124	117	113	109	105	102	100
9.0	147	135	126	120	115	110	107	104	102
9.5	150	137	129	122	117	112	109	106	103
10.0	153	140	131	124	119	114	110	107	105
10.5	156	143	133	126	120	116	112	109	106
11.0		145	136	128	122	118	114	110	108
11.5		148	138	130	124	119	115	112	109
12.0		150	140	132	126	121	117	113	110
12.5		153	142	134	128	123	119	115	112
13.0		155	144	136	130	124	120	116	113
13.5			147	138	131	126	122	118	115
14.0			149	140	133	128	123	119	116
14.5			151	142	135	129	125	121	117
15.0			153	144	137	131	126	122	119
15.5			155	146	138	132	128	123	120
16.0				148	140	134	129	125	121

Minimum UPSTREAM box gutter depth (mm) for **1 in 100*** slope

* 1:100 slope equates to **10mm per m** increasing depth over the length of the gutter

Example
300mm wide box gutter
Flow rate = 6.0 L/s
=> Adopt 110mm UPSTEAM depth

DAM BUSTER ®

Design chart for box gutters discharging to Dam Buster devices

Design flow rate L/s	Example Box gutter width (mm)								
	200	250	300	350	400	450	500	550	600
3.0	93	88	85	83	81	79	78	77	76
3.5	96	91	88	85	83	81	80	78	77
4.0	100	94	90	87	85	83	82	80	79
4.5	103	97	93	90	87	85	83	82	81
5.0	106	100	95	92	89	87	85	83	82
5.5	109	102	97	94	91	89	87	85	84
6.0	112	105	100	96	93	90	88	86	85
6.5	115	107	102	98	95	92	90	88	86
7.0	118	110	104	100	96	94	91	89	88
7.5	120	112	106	102	98	95	93	91	89
8.0	123	114	108	103	100	97	94	92	90
8.5	126	117	110	105	101	98	96	93	92
9.0	128	119	112	107	103	100	97	95	93
9.5	131	121	114	109	105	101	98	96	94
10.0	133	123	116	110	106	103	100	97	95
10.5	136	125	118	112	108	104	101	98	96
11.0		127	119	114	109	105	102	100	97
11.5		129	121	115	111	107	104	101	99
12.0		131	123	117	112	108	105	102	100
12.5		133	125	118	113	109	106	103	101
13.0		135	126	120	115	111	107	104	102
13.5			128	122	116	112	108	105	103
14.0			130	123	118	113	110	107	104
14.5			131	125	119	115	111	108	105
15.0			133	126	120	116	112	109	106
15.5			135	127	122	117	113	110	107
16.0				129	123	118	114	111	108

Minimum UPSTREAM box gutter depth (mm) for **1 in 40*** slope

* 1:40 slope equates to **25mm per m** increasing depth over length of the gutter

Example
300mm wide box gutter
Flow rate = 6.0 L/s
=> Adopt 100mm UPSTEAM depth

Appendix G

Aerial downpipe design chart

Design chart for aerial downpipes

Slope	Pipe diameter			
	90mm	100mm	150mm	225mm
1 in 200	4.14	5.49	16.2	47.5
1 in 190	4.26	5.65	16.6	48.9
1 in 180	4.39	5.82	17.1	50.3
1 in 170	4.53	6.00	17.7	51.9
1 in 160	4.68	6.21	18.3	53.7
1 in 150	4.85	6.43	18.9	55.6
1 in 140	5.04	6.68	19.6	57.7
1 in 130	5.25	6.96	20.5	60.1
1 in 120	5.49	7.27	21.4	62.7
1 in 110	5.76	7.63	22.4	65.7
1 in 100	6.07	8.04	23.6	69.2
1 in 90	6.43	8.52	25.0	73.3
1 in 80	6.86	9.09	26.7	78.0
1 in 70	7.38	9.77	28.7	83.9
1 in 60	8.03	10.6	31.2	91.1
1 in 50	8.87	11.7	34.4	100.4

Maximum flow rates* (L/s)

* Based on a standard Colebrook-White calculator

Note

The table assumes there are no additional bends in the aerial downpipe other than the bend below the sump. Where there are additional bends, which will result in energy losses, advice should be obtained from a hydraulic engineer.