ABCB

PRELIMINARY IMPACT ANALYSIS

PROPOSAL: This proposal seeks to review Australian Standard and New Zealand Standard (AS/NZS) 3500 Plumbing and Drainage Part 3 Stormwater Drainage Systems, to update the rainfall intensity data provided for Australia and New Zealand based on 2019 data and improve consistency in terminology.

Standard Committee Responsible Technical committee:	WS-014, Plumbing and Drainage

NCC REFERENCE: For revisions or amendments to existing National Construction Code (NCC) referenced documents, provide additional information	**BCA Volume One:**	F1.1
	BCA Volume Two:	3.1.3.0, 3.1.3.4, 3.5.3.0, 3.5.3.3, 3.5.3.5
	PCA Volume Three:	N/A (Note: Referenced in Schedule 1 State and Territory Variations and Additions).

PROPONENT:	Nominating organisation:	Australian Building Codes Board
	Nominating individual:	Tom Roberts
	Position:	Director - Plumbing
	Contact email:	Tom.Roberts@abcb.gov.au

DATE OF PIA: To differentiate between versions include the document date and/or version number	Date:	March 2020
	Version:	1.5
	Status:	DRAFT

NATURE AND EXTENT OF THE PROBLEM:

There are two main problems that the proposal seeks to address, out of date rainfall intensity data and terminology.

Rainfall intensity data

Rainfall intensity data is used by AS/NZS 3500.3 to the expected amount of rainfall in a location to accurately design and size roof drainage and stormwater drainage systems.

The method of referencing rainfall intensity data is in itself can presents an issue, as the data is continually updated through the relevant government agencies within Australia and New Zealand, however AS/NZS 3500 (and the Building Code of Australia) are only revised every three years (minimum). The nature of the problem is this leads to system designs based on outdated data which decreases stormwater system design accuracy. This can make it difficult for designers to determine if the Deemed-to-Satisfy (DtS) information provided continues to be appropriate to ensure system failure is avoided.

Whilst a review of the current (late 2019) data in comparison with the data contained with AS/NZS 3500.3:2018 indicates that only minimal change in some locations, with no change in others (see Attachment 3), it is considered that not keeping the rainfall intensity data updated increases the risk of practitioners losing confidence that the DtS pathway will result in correct component sizing and designs.

In some rare instances, the site conditions such as catchment area size and type may be such that a rainfall intensity decreased or increased would trigger the requirement for an amendment in the size and/or design of components and pipework. Whilst this would be an extremely rare scenario as demonstrated in Attachment 5, to not amend the Deemed-to-Satisfy provisions used to design and size roof and stormwater drainage systems could result in a system not fit for purpose and could fail.

Note: The history of rainfall intensities provided as a DtS Solution in the current and previous revisions of AS/NZS 3500.3 has been provided in Attachment 2.

<u>Terminology</u>

It is also important for AS/NZS 3500.3 to be kept up to date with the terminology used in regards to rainfall intensity data. The terminology used should be updated to reflect that used in industry.

The definitions provided by the Australian Government Bureau of Meteorology, outlined below should be inserted to provide users with a clarification of the change in terminology.

- Annual exceedance probability (AEP) - The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.
- Average recurrence interval (ARI) - The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random.

<u>NCC and Referenced Document Alignment</u>

The National Construction Code (NCC) also provides practitioners with rainfall intensity data in Volume Two for use in Class 1 and Class 10 Buildings when using an Acceptable Construction Practice (ACP). However this is only used when designing and installing stormwater drainage systems in accordance with the ACP. When using the Acceptable Construction Manual (ACM) method of Volume Two, or Volume One (for Class 2 to Class 9 buildings), AS/NZS 3500.3:2018 is used (based on 2014 data).

The data within the Building Code if Australia (BCA) is being updated with data obtained in late 2019 for inclusion in the NCC 2022 public consultation draft. This update has been included thorough the ABCB's ACP review project. Standards Australia's WS-014 committee considers that not having alignment between the BCA would risk causing confusion within industry through the use of different data for different buildings classes (through use within both Volume One and Volume Two of the NCC) as well as different designs between the use of the ACP and the ACM (AS/NZS 3500.3), both acceptable under Volume Two of the NCC.

As the AS/NZS 3500 series has adopted a three year amendment cycle to align with the NCC, it is proposed that should AS/NZS 3500.3:2021 be amended to include updated rainfall intensity data, to align with that of Volume 2 of the NCC (ACP) to achieve consistency in stormwater drainage system design.

A search for insurance claims specifically recoded as a result of undersized gutters, downpipes and stormwater systems was requested, however information this specific was not able to be obtained.

OBJECTIVES:

The objective of this proposed amendment is to ensure that stormwater drainage systems are adequately designed to the current climatic conditions.

OPTIONS:

There is considered to be three main options available to address the issues outlined above, being:

- **Status Quo – No change option**

  This option would see no change occur to AS/NZS 3500.3.

- **Non-regulatory option**

  This option would seek to remove the rainfall intensity data from the standard and provide non-regulatory guidance to plumbing practitioners, primarily designers of stormwater drainage systems on how to obtain and utilise the most up to date rainfall intensity data through a Performance Solution.

- **Regulatory option**

  This option would amend the rainfall intensity data from AS/NZS 3500.3 to the most up to date data available (late 2019) from the relevant government organisations in Australia and New Zealand and utilise the appropriate terminology.

  NOTE: Updates to the rainfall intensity data can only be undertaken every three years in alignment with the NCC amendment cycle. This option does not consider any ongoing updates as a new project would be required for each update and the impacts of this change would be required to be analysed at the time of each amendment.

IMPACT ANALYSIS (OF ALL OPTIONS):

Analysis of these three options is as follows:

- Status Quo – No change option

This option would see no change occur to AS/NZS 3500.3. This option would not only continue the risk that stormwater drainage systems are not designed and sized appropriately but would see this risk become greater as the data becomes progressively outdated.

The 2016 design rainfalls are based on a more extensive database, with more than 30 years of additional rainfall records and inclusion of data from an extra 2300 rainfall stations across Australia. By combining contemporary statistical analysis and techniques with this expanded rainfall database, the 2016 design rainfalls provide more accurate estimates for Australia. In addition, the 2016 design rainfalls provide better estimates of the 2% and 1% annual exceedance probability (AEP) design rainfalls than the interim 2013 design rainfalls.

- Non-regulatory option

This option would seek to remove the rainfall intensity data from the standard and provide non-regulatory guidance to plumbing practitioners, primarily designers of stormwater drainage systems on how to obtain and utilise the most up to date rainfall intensity data.

Whilst under this option, plumbing practitioners would be utilising the most up to date rainfall intensity data, there is a significant cost increase associated with moving from what would currently be considered a Deemed-to-Satisfy solution, to a Performance Solution for every new stormwater drainage system design and installation.

Whilst costs would vary across the country, an example of the implication of this option would see all new buildings have an additional cost of $800 which is the application fee associated with submitting a Performance Solution. For this example, there are approximately 22,833 new buildings constructed in Western Australia each year, with this change resulting in an approximate additional cost of $20,666,400 to industry within this jurisdiction alone.

Note: Taking a 5 year average, the total number of dwellings completed each year in WA is 22,833. This includes houses and other residential buildings (SOUs) only. There is less certainly around the number of new commercial buildings constructed each year, however as an estimate have around 3,000 a year is suggested in the absence of further analysis.

Under both the status quo and regulatory options, the use of a Performance Solution is an option which can be utilised by practitioners at their discretion.

- <u>Regulatory option</u>

This option primarily relates to an update in the terminology used within the standard and an amendment of Appendix E to include the latest rainfall intensity data provided by the Australian Government - Bureau of Meteorology. Attachment 3 indicates the changes as a result of this option.

Under this option, in some locations the data is still accurate and no change is proposed, however in some locations the data is proposed to be amended to increase or decide by 1mm/h. There is one instance of the data being proposed to increase by 2 mm/h in Newman, Western Australia. Example calculations have been undertaken in three locations to identify the potential impacts of the proposed changes of this option (see Attachment 4). Note: This option does not seek to reference the Bureau of Meteorology website as a solution as this would be subject to change and would not meet Protocol for NCC referenced documents.

In updating the rainfall intensity data, the terminology used to describe rainfall intensities will also be updated.

Under this option, the most significantly affected area is identified to be in Newman, Western Australia, with an increase in intensity of 2mm/h. It is considered that this area will be the most impacted by the proposed change, however this change is proposed for the 1% AEP (100 year ARI) which is used primarily for the design of box gutters and overflow measures. To determine the impacts of this change, an example case study on the required overflow capacities has been undertaken for the existing and proposed rainfall intensities (see Attachment 4).

Under this option rainfall intensity averages for a 5% AEP (20 year ARI) would result in some increases by a maximum of 1mm/h and some decrease by a maximum of -1mm/h. As mentioned above, the most significant change proposed is an increase of 2mm/h in one location.

It is important to note that a change in rainfall intensity in most instances will not equate to a change in the design of gutters, downpipes, overflow measures and stormwater drainage systems.

e.g. When sizing stormwater drainage systems in accordance with AS/NZS 3500.3:2018 as a general indication, 90mm PVC can cater for a flowrate range of between approx. 6 L/s and 8L/s and 100mm PVC pipe can cater for a flowrate range between approx. 8 L/s and 17 L/s.

Whilst there are a number of changes proposed to the rainfall intensity data, these changes would not very rarely result in changes to sizing on the stormwater system components. Other factors such as catchment area size and type (roofed, pervious and impervious areas) also need to be taken into consideration to determine if a change is design or size would be required as a result of the proposed changes being considered under this option. This is demonstrated by a number of case studies identifying the average impacts for these proposed amendments (see Attachment 4).

In any instances where the changes proposed under this option would result in variances to design and sizing, only minimal cost variations are considered to be the result in changes to sizes of gutters, downpipes and stormwater drainage and no change to installation practice would be considered necessary.

In the rare event of the rainfall intensity changes proposed resulting in a change to the design and sizing of the components of a stormwater drainage system, an approximate cost outline for pipework and guttering has been estimated within Attachment 5. The primary benefits of this option to the plumbing and building practitioners and homeowners remains that the stormwater drainage systems designed as a Deemed-to-Satisfy Solution have been designed accurately for the rainfall intensity of that particular location.

Through consultation with members of Standards Australia's WS-014 committee, there is considered to be a level of reassurance provided to stormwater designers as the up to date rainfall intensity data will ensure that stormwater and roof drainage systems will be appropriately sized to cater for the anticipated rainfall events, thus removing the risk of incorrectly sized systems. In some cases incorrectly, especially undersized system may lead to an increased risk of damage to buildings caused by rain water ingress creating unsafe situations such as ceiling collapse.

TRANSITIONAL MEASURES

Transitional measures are not considered necessary as industry will not need time to adjust to the new standard. The time period between the publication of this standard and the adoption of the NCC into legislation in 2022 is regarded to be suitable to allow industry to become familiar with these changes.

CONSULTATION:

Consultation on this proposed change has occurred through the circulation of Standards Australia's proposal form with numerous stakeholders across both the building and plumbing sectors through the ABCB's Building Codes Committee (BCC) and Plumbing Code Committee in January 2019. Both committees provided support for the proposal.

This proposal has also been the topic of discussion from the BCC's Acceptable Construction Practices (ACP) review steering committee who has reviewed the proposed update to Volume Two of the NCC and recommended this change be included in the public comment draft for NCC 2022. This position was taken to the BCC who at their 2020-1 meeting endorsed the update of the rainfall insanity data and terminology update to Volume Two of the National Construction Code.

Standards Australia's WS-014 committee have also provided support for this project forming a working group from both members of WS-014 and other industry experts.

It is intended that the draft changes will be released for public consultation in the first half of 2020.

CONCLUSION AND RECOMMENDED OPTION:

Based on this analysis the recommended option for resolving the issues described is the Option 3 - Regulatory option.

IMPLEMENTATION AND REVIEW:

This proposed revision is intended to be implemented into the National Construction Code (NCC) in 2022.

LIST OF ATTACHMENTS:

- Attachment 1 – Schedule of Major Changes
- Attachment 2 - History of Rainfall intensities provided in AS/NZS 3500.3
- Attachment 3 - Adjustments to rainfall intensity data
- Attachment 4 – Case studies
- Attachment 5 – Cost adjustments

Attachment 1 – Schedule of Major Changes

Changes to rainfall intensity data and terminology changes

Design rainfall intensities are now expressed in terms of the Annual Exceedance Probability (AEP) values to reflect the practice of the Australian Bureau of Meteorology (BOM) and the performance requirements of New Zealand Building Code Clause E1 Surface Water. The definition of Annual Exceedance Probability (AEP) has been included in Part 0 as the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

There has been no change in the requirements or the calculations. The 5 min duration rainfall intensities for representative places in Australia given in Table D.1 have been updated to show the latest values from the BOM.

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

Major clauses affected by the change from ARI to AEP.

Clause	Change	Notes
Throughout the document	Single references to ARI have been changed to AEP. Where there is a numerical value associated with the ARI e.g. 20 the equivalent AEP value has been inserted and the ARI value added parenthetically. For example : “an ARI of 20” becomes “an AEP of 5% (20 year ARI)” since the numerical values of the equivalent AEP and ARI are the same there has been no changes to the associated text. The symbol for rainfall intensity *I* had a superscript of referring to the relevant ARI value in years. This superscript has now been changed to show the equivalent AEP value For example $^{20}I_5$ becomes $^{5\%}I_5$. This occurs throughout the document and in Figures 3.5.4 (A) and (B).	
3.3.1 General	Roof drainage systems shall be designed for the average exceedance probability (AEP) …	

<table>
<tr>
<td>3.3.4 Design probabilities</td>
<td>The average exceedance probability (AEP) shall be as given in Table 3.3.4.</td>
<td>
Table 3.3.4 — Average ~~recurrence interval (ARI~~exceedance probability (AEP)
<table>
<tr><th colspan="2" rowspan="2">Effect of overtopping</th><th colspan="2">~~ARI, years~~AEP %</th></tr>
<tr><th>Australia</th><th>New Zealand</th></tr>
<tr><td>(a)</td><td>Eaves gutters, external</td><td>≥ ~~20~~5</td><td>≥ 10</td></tr>
<tr><td>(b)</td><td>Box gutters and valley gutters</td><td>≥ ~~100~~1</td><td>≥ ~~50~~2</td></tr>
<tr><td colspan="4">NOTE 1: For Australia, this Table should be used in conjunction with the NCC, which includes requirements to prevent rain and stormwater from roof drainage from entering certain buildings.</td></tr>
<tr><td colspan="4">NOTE 2:
1 % AEP is equivalent to 100 years ARI ~~and~~;
2 % AEP is equivalent to 50 years ARI;
5 % AEP is equivalent to 20 years ARI; and
10 % AEP is equivalent to 10 years ARI.</td></tr>
</table>
</td>
</tr>
<tr>
<td>3.3.5 Rainfall intensity
3.3.5.1 Australia</td>
<td>Five minutes duration rainfall intensity (in mm/h) for any place in Australia shall be determined for —
(a) an AEP of 5% (20 years ARI) and 1% (100 years ARI), from Appendix D; and
(b) an AEP of 0.2% (500 years ARI), assumed to be 1.5 times the 1% AEP (100 years ARI) intensity at the same place.
NOTE 1: Guidelines for the determination of rainfall intensity are given in Appendix C.
NOTE 2: Intensities for specific locations throughout Australia can be obtained using the Bureau of Meteorology rainfall intensities described in Appendix D.</td>
<td></td>
</tr>
<tr>
<td>3.3.5.2 New Zealand</td>
<td>Ten minutes duration rainfall intensity (in mm/h) for any place in New Zealand shall be determined for AEPs of 10% (10 years ARI) and 2% (50 years ARI), from Appendix E.
NOTE: Guidelines for the determination of rainfall intensity are given in Appendix C.</td>
<td></td>
</tr>
<tr>
<td>Flow charts in Figures 3.5.2 and 3.7.4</td>
<td>ARI replaced with AEP and, where mentioned the corresponding ARI value changed to the equivalent AEP i.e. 100 year ARI replaced with 1% AEP.</td>
<td></td>
</tr>
</table>

3.8 Balcony and terrace areas	Systems for draining balconies and terraces shall be designed for — (a) In Australia: (i) a 5 % AEP (20 years ARI) rainfall intensity; and (ii) a 1 % AEP (100 years ARI) rainfall intensity for overflow. (b) In New Zealand: (i) a 10 % AEP (10 years ARI) rainfall intensity; and (ii) a 2 % AEP (50 years ARI) rainfall intensity for overflow	
5.2.3 Design rainfall intensity	Where a box gutter system is directly connected to downpipe systems or surface water drains (upstream of a surcharge outlet as specified in Clause 5.4.12.1), these conduits shall be sized for a 1 % AEP (100 years ARI) storm event. Pipes downstream of the designated surcharge point shall be designed for AEPs set out in Table 5.4.3. NOTE: Surface water drainage systems should be designed to ensure overflows, in storm events with an AEP of 1 % (ARI of 100 years) in Australia or an AEP of 2 % (ARI of 50 years) in New Zealand, do not present a hazard to people or cause damage to property.	

5.4.3 Average exceedance probability (AEP)

The values of AEP for design vary according to the importance of the property, consequences of failure and local practice.

The AEP shall be as given in Table 5.4.3.

Table 5.4.3 — Average ~~recurrence intervals (ARIs~~ exceedance probability (AEPs)

Effect of surcharge — Overland flow	~~ARI*, years~~ AEP*, percentage	
	Australia	New Zealand
Small impact, in low density areas	≥ ~~1~~ 99.75	≥ ~~1~~ 63.3
Normal impacts	≥ ~~2~~ 50	≥ ~~2~~ 50
Ponding in flat topography; or flooding of parking lots to depths greater than 150 mm	≥ 10	≥ 10
Impeded access to commercial and industrial buildings	≥ 10	≥ 10
Ponding against adjoining buildings; or impeded access to institutional or important buildings (e.g. hospitals, town halls and school entrances)	≥ ~~20~~ 5	≥ 10

* A higher ~~ARI~~ AEP should be used where there is only limited access for maintenance.

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

NOTE 2: For Australia,

AEP of 99.75% is equivalent to 1 year ARI;

AEP of 50% is equivalent to 2 years ARI;

AEP of 10% is equivalent to 10 years ARI; and

AEP of 5% is equivalent to 20 years ARI.

NOTE 3: For New Zealand

AEP of 63.3% is equivalent to 1.58 year ARI;

AEP of 50% is equivalent to 2 years ARI; and

<table>
<tr>
<td>Table 5.4.6(A) — Multipliers for run-off coefficients (m)</td>
<td></td>
<td>
<table>
<tr><th>AEP Percentage (ARI ~~Years~~years)</th><th>m</th></tr>
<tr><td>63 (1)</td><td>0.8</td></tr>
<tr><td>39 (2)</td><td>0.85</td></tr>
<tr><td>34 (3)</td><td>0.95</td></tr>
<tr><td>10 (10)</td><td>1.0</td></tr>
<tr><td>~~20~~5 (5)</td><td>1.05</td></tr>
<tr><td>~~50~~2 (2)</td><td>1.15</td></tr>
<tr><td>~~100~~1 (1)</td><td>1.2</td></tr>
<tr><td>> ~~100~~1 (1)</td><td>1.25</td></tr>
<tr><td colspan="2">Source: Australian Rainfall and Runoff: A Guide to Flood Estimation.</td></tr>
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</tr>
<tr>
<td>Appendix C Guidelines for determining rainfall intensities
C1 Scope</td>
<td>This Appendix sets out guidelines for determining for any site in —
(a) Australia, rainfall intensities for 5 min duration and AEP's of 5 % and 1 % (ARIs of 20 and 100 years); and
(b) New Zealand, rainfall intensities for 10 min duration and AEP's of 10 % and 2 % (ARIs of 10 and 50 years).</td>
<td></td>
</tr>
<tr>
<td>E D.2 Selected place references</td>
<td>For selected places in Australia, the latitude and longitude and 5 % AEP (20 years ARI) and 1 % AEP (100 years ARI) rainfall intensities are given in Table D.1.</td>
<td>Table D1 simply lists the current values directly from the Bureau of Meteorology's web site under the headings:
Australian location Latitude Longitude 5 % AEP (20 years ARI) intensity 1 % AEP (100 years ARI) intensity</td>
</tr>
</table>

Attachment 2 - History of Rainfall intensities provided in AS/NZS 3500.3

AS 3500.3:1990 referenced rainfall intensity data from 1987 within Clause 3.4.2, which stated:

Rainfall intensities shall comply with Australian Rainfall and Runoff, 1987 for average recurrence intervals of not less than 5 years for Classes 1, 2, 3, and 4 buildings and 20 years for other buildings. Longer average recurrence intervals shall be adopted where surcharge from a stormwater installation could cause danger to persons or property, building, etc. Note: the appropriate rainfall intensities may be obtained from the Regulatory Authority.

AS/NZS 3500.3:2003 introduced rainfall intensity data within Appendix E Rainfall intensities for Australia – 5 Min duration and included figures prepared by Hydrometeorological Advisory Service, Melbourne and the Commonwealth of Australia – Bureau of Meteorology 1991. Appendix F contained the rainfall intensities for New Zealand – 10 Min duration with figures prepared by National Institute of Water and Atmospheric Research Ltd.

AS/NZS 3500.3:2015 continued to utilise the rainfall intensity data provided by the Hydrometeorological Advisory Service, Melbourne and the Commonwealth of Australia – Bureau of Meteorology 1991.

In AS/NZS 3500.3:2018 Appendix E Rainfall Intensities for Australia was updated which removed the figures utilized in the previous edition and listed locations within a Table. The intensities in this table were obtained from the Bureau of Meteorology (BOM) website in December 2014. An informative note provided with this table states that the intensities provided may change with time, and updated intensities can be obtained from the Bureau of Meteorology. The use of this updated rainfall intensity data would be utilised through a performance solution through the Building Code of Australia.

Attachment 3 – Adjustments to rainfall intensity data

Australian location	AS/NZS 3500.3:2018		Proposed amendment (AS/NZS 3500.3:2021)		Adjustment	
	20 years ARI (5 % AEP) intensity mm/h	100 years ARI (1 % AEP) intensity mm/h	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h	5 % AEP (20 years ARI) intensity mm/h	1 % AEP (100 years ARI) intensity mm/h
AUSTRALIAN CAPITAL TERRITORY						
Canberra	143	192	143	192	0	0
Conder	149	215	149	214	0	1
Gungahlin	137	179	136	179	1	0
NEW SOUTH WALES						
Adaminaby	115	156	115	156	0	0
Albury	138	180	139	180	1	0
Appin	197	275	197	274	0	-1
Armidale	179	238	178	238	-1	0
Ballina	216	278	216	278	0	0
Balranald	142	212	141	212	-1	0
Bangalow	220	286	220	285	0	-1
Batemans Bay	192	266	192	267	0	1
Bathurst	125	163	124	164	-1	1
Bega	176	244	176	244	0	0
Bellingen	251	340	250	339	-1	-1
Bermagui	176	240	176	240	0	0
Berridale	133	186	134	186	1	0
Berrigan	152	208	152	207	0	-1
Berry	205	289	205	289	0	0
Bingara	182	242	183	242	1	0
Braidwood	132	168	131	168	-1	0
Brewarrina	217	302	217	303	0	1
Bodalla	176	239	176	239	0	0
Bombala	166	232	166	232	0	0
Bourke	199	277	199	278	0	1
Broken Hill	142	217	142	217	0	0
Bulahdelah	221	311	221	311	0	0
Bundarra	170	224	170	225	0	1
Bungendore	136	178	136	178	0	0
Byron Bay	218	282	219	282	1	0
Casino	214	277	213	278	-1	1
Cessnock	182	253	182	254	0	1
Cobar	178	248	178	248	0	0
Cobargo	172	234	171	233	-1	-1
Coffs Harbour	277	384	277	384	0	0
Condobolin	158	216	158	216	0	0
Cooma	127	172	127	172	0	0
Coonabarabran	186	251	187	251	1	0
Coonamble	187	251	187	251	0	0
Cootamundra	134	180	134	181	0	1
Copacabana	223	316	223	316	0	0
Corowa	133	173	133	173	0	0
Cowra	140	190	140	190	0	0
Crookwell	102	130	102	129	0	-1
Culburra Beach	200	280	200	280	0	0
Delegate	155	216	155	216	0	0
Dorrigo	209	271	209	271	0	0
Dubbo	167	222	166	221	-1	-1
Dungog	187	259	187	260	0	1
Eden	178	244	178	244	0	0
Evans Head	210	271	210	272	0	1
Forbes	151	205	151	206	0	1
Forster-Tuncurry	232	319	232	319	0	0
Gilgandra	172	230	172	230	0	0
Glen Innes	167	218	167	218	0	0
Gloucester	192	263	192	262	0	-1
Gosford	216	307	216	307	0	0
Goulburn	120	155	120	154	0	-1
Grafton	203	268	202	267	-1	-1
Grenfell	140	190	141	190	1	0
Griffith	130	178	129	178	-1	0
Gulgong	150	197	150	197	0	0

Gundagai	137	187	137	187	0	0
Gunnedah	157	211	157	211	0	0
Hay	120	166	120	166	0	0
Helensburgh	218	296	218	297	0	1
Hillston	143	198	143	198	0	0
Inverell	180	236	179	237	-1	1
Ivanhoe	145	204	146	204	1	0
Jerilderie	145	199	145	199	0	0
Jindabyne	136	190	136	190	0	0
Junee	140	191	141	190	1	-1
Kangaroo Valley	185	259	185	259	0	0
Katoomba	151	193	151	193	0	0
Kempsey	216	288	216	288	0	0
Kiama	226	319	225	320	-1	1
Kyogle	206	274	207	274	1	0
Leeton	128	174	128	175	0	1
Lake Cargelligo	151	208	151	207	0	-1
Lightning Ridge	206	281	207	281	1	0
Lismore	208	271	208	271	0	0
Lithgow	148	194	148	194	0	0
Lockhart	142	190	142	190	0	0
Maclean	212	277	212	278	0	1
Maitland	191	265	191	266	0	1
Manilla	160	211	159	211	-1	0
Marulan	139	185	140	184	1	-1
Menindie	151	232	151	231	0	-1
Merimbula	181	248	181	248	0	0
Merriwa	145	191	145	190	0	-1
Milparinka	136	206	135	206	-1	0
Mittagong	167	229	167	229	0	0
Moree	182	241	182	241	0	0
Moruya	184	252	183	252	-1	0
Moss Vale	156	212	155	213	-1	1
Mount Victoria	151	196	151	196	0	0
Mudgee	146	193	147	193	1	0
Mullumbimby	227	298	227	298	0	0
Murwillumbah	235	313	235	313	0	0
Muswellbrook	144	193	144	194	0	1
Nambucca	253	343	253	343	0	0
Narooma	176	240	177	240	1	0
Narrandera	125	169	125	169	0	0
Narrabri	178	238	178	237	0	-1
Nelson Bay	240	340	240	340	0	0
Newcastle:						
Charlestown	221	312	221	311	0	-1
Newcastle City	226	316	225	316	-1	0
West Wallsend	209	293	208	293	-1	0
Nimbin	214	284	214	284	0	0
Nowra	181	252	182	253	1	1
Nyngan	193	263	193	263	0	0
Oberon	134	179	134	178	0	-1
Orange	142	186	141	186	-1	0
Parkes	156	211	156	212	0	1
Picton	170	236	170	236	0	0
Port Macquarie	233	313	233	313	0	0
Queanbeyan	143	189	142	190	-1	1
Quirindi	160	212	159	212	-1	0
Raymond Terrace	214	300	213	299	-1	-1
Scone	140	187	141	187	1	0
Shoalhaven Heads	203	284	202	284	-1	0
Singleton	157	216	158	216	1	0
Springwood	186	256	186	255	0	-1
Sussex Inlet	209	301	209	301	0	0
Swansea	221	313	220	314	-1	1
Sydney:						
Avalon	210	287	210	287	0	0
Bankstown	162	204	162	204	0	0
Camden	161	218	161	219	0	1
Campbelltown	167	223	166	223	-1	0
Cronulla	188	241	189	241	1	0
Hornsby	200	274	201	274	1	0

Liverpool	158	205	159	205	1	0
Manly	203	264	202	264	-1	0
Maroubra	199	257	200	257	1	0
Parramatta	163	209	163	209	0	0
Penrith	178	240	178	240	0	0
Sutherland	179	228	179	228	0	0
Sydney City	200	262	201	262	1	0
Windsor	175	234	175	234	0	0
Tamworth	160	211	160	212	0	1
Taree	222	300	222	301	0	1
Temora	133	179	133	179	0	0
Tenterfield	182	241	182	242	0	1
The Entrance	224	324	225	324	1	0
Thredbo	126	174	126	174	0	0
Tibooburra	143	218	143	219	0	1
Tocumwal	143	196	143	195	0	-1
Toronto	214	302	214	303	0	1
Tumut	137	187	136	188	-1	1
Tweed Heads	252	332	252	332	0	0
Ulladulla	212	306	212	306	0	0
Vincentia	204	289	204	289	0	0
Wagga Wagga	154	208	154	208	0	0
Walgett	191	258	191	258	0	0
Wanaaring	192	280	192	280	0	0
Warialda	187	250	188	250	1	0
Warren	181	245	181	245	0	0
Wellington	157	206	157	206	0	0
Wentworth	142	218	142	218	0	0
West Wyalong	140	188	140	189	0	1
Wilcannia	151	232	151	232	0	0
Wollongong:						
Bulli	218	313	218	313	0	0
Dapto	210	295	210	295	0	0
Kembla Heights	252	376	252	375	0	-1
Port Kembla	218	308	218	308	0	0
Shellharbour	222	314	222	314	0	0
Wollongong City	217	311	218	311	1	0
Woolgoolga	272	377	273	377	1	0
Woy Woy	211	296	211	296	0	0
Wyong	221	319	221	320	0	1
Yamba	220	289	220	289	0	0
Yass	136	179	136	178	0	-1
Young	132	178	132	178	0	0
NORTHERN TERRITORY						
Alice Springs	166	239	165	239	-1	0
Daly Waters	192	236	192	236	0	0
Darwin	234	274	233	274	-1	0
Jabiru	227	266	227	266	0	0
Kaltukatjara	175	258	175	258	0	0
Katherine	216	250	216	250	0	0
Mataranka	220	259	220	259	0	0
Nhulunbuy	227	271	226	271	-1	0
Palmerston	232	270	231	270	-1	0
Tennant Creek	173	223	173	223	0	0
Yulara	214	322	214	322	0	0
QUEENSLAND						
Alpha	196	263	196	263	0	0
Barcaldine	194	260	194	260	0	0
Beaudesert	203	266	203	266	0	0
Bedourie	180	264	180	264	0	0
Biloela	204	259	204	259	0	0
Birdsville	138	211	137	212	-1	1
Blackall	188	253	189	253	1	0
Blackwater	203	264	202	265	-1	1
Boulia	176	247	176	247	0	0
Bowen	229	284	229	285	0	1
Brisbane:						
Beenleigh	232	305	232	305	0	0
Brisbane City	235	306	236	306	1	0
Manly	244	318	244	318	0	0
Redland Bay	246	323	245	322	-1	-1

Sandgate	241	313	241	313	0	0
Springfield Central	221	289	220	290	-1	1
Bundaberg	266	340	266	339	0	-1
Burketown	246	306	246	306	0	0
Caboolture	242	316	242	316	0	0
Cairns	229	278	230	279	1	1
Caloundra	262	341	261	341	-1	0
Camooweal	178	232	177	232	-1	0
Canungra	212	277	213	278	1	1
Cape York	269	316	269	316	0	0
Charleville	176	236	177	237	1	1
Charters Towers	199	250	199	249	0	-1
Chinchilla	228	301	228	302	0	1
Clermont	200	257	200	257	0	0
Cloncurry	218	278	218	278	0	0
Cooktown	228	277	227	277	-1	0
Crows Nest	204	264	204	264	0	0
Cunnamulla	197	277	197	278	0	1
Currumbin	251	331	251	331	0	0
Dalby	211	280	212	280	1	0
Dirranbandi	217	295	217	295	0	0
Eidsvold	216	281	216	281	0	0
Emerald	215	282	214	282	-1	0
Gatton	211	281	212	281	1	0
Gladstone	215	271	214	271	-1	0
Goondiwindi	193	257	193	257	0	0
Gympie	218	278	218	278	0	0
Hervey Bay	244	314	243	314	-1	0
Hughenden	206	265	206	265	0	0
Hungerford	180	274	179	274	-1	0
Ipswich	211	277	212	277	1	0
Ingham	245	307	245	308	0	1
Innisfail	248	301	248	302	0	1
Kilcoy	214	272	214	272	0	0
Kingaroy	220	284	220	284	0	0
Longreach	192	251	193	250	1	-1
Mackay	250	314	250	315	0	1
Mareeba	197	245	197	245	0	0
Maroochydore	259	337	260	337	1	0
Mission Beach	241	293	241	293	0	0
Mission River (Weipa)	238	281	238	281	0	0
Mitchell	168	227	169	227	1	0
Moonie	209	281	208	280	-1	-1
Mount Isa	200	262	201	262	1	0
Mundubbera	232	301	232	301	0	0
Nambour	250	324	250	324	0	0
Nerang	242	319	242	319	0	0
Noosa Heads	258	331	258	332	0	1
Normanton	228	283	227	283	-1	0
Port Douglas	250	304	250	304	0	0
Proserpine	232	290	232	290	0	0
Quilpie	191	287	190	287	-1	0
Ravenshoe	170	212	170	212	0	0
Richmond	215	275	215	275	0	0
Roma	212	286	213	286	1	0
Rockhampton	230	301	230	301	0	0
St. George	222	300	222	299	0	-1
Southport	256	337	255	337	-1	0
Springsure	210	281	211	281	1	0
Stanthorpe	184	244	183	244	-1	0
Tambo	185	250	185	250	0	0
Tamborine Mountain	223	293	223	293	0	0
Texas	185	241	184	241	-1	0
Thargomindah	180	277	180	277	0	0
Toowoomba	202	266	202	267	0	1
Townsville	235	300	235	300	0	0
Warwick	191	253	191	253	0	0
Windorah	174	265	173	265	-1	0
Winton	216	299	216	299	0	0
Yarraman	214	274	213	274	-1	0

Yeppoon	244	319	244	319	0	0
SOUTH AUSTRALIA						
Adelaide:						
Adelaide City	120	174	120	174	0	0
Christies Beach	118	169	118	169	0	0
Fairview Park	119	170	119	170	0	0
Gawler	110	158	111	158	1	0
Glenelg	120	175	120	175	0	0
Port Adelaide	124	185	124	184	0	-1
Ardrossan	112	160	112	160	0	0
Balaklava	114	166	114	165	0	-1
Berri	125	185	124	185	-1	0
Blinman	151	226	151	226	0	0
Bordertown	115	164	115	165	0	1
Burra	115	167	115	167	0	0
Cape Jervis	120	170	120	170	0	0
Ceduna	114	167	114	167	0	0
Clare	113	162	113	162	0	0
Coober Pedy	115	174	115	174	0	0
Cowell	116	169	116	169	0	0
Delamere	130	184	129	184	-1	0
Edithburgh	116	168	116	168	0	0
Goolwa	109	156	109	156	0	0
Hahndorf	114	157	114	157	0	0
Hawker	144	216	144	216	0	0
Iron Knob	127	191	128	191	1	0
Jamestown	109	158	110	159	1	1
Kadina	118	170	118	170	0	0
Keith	110	157	111	157	1	0
Kimba	109	158	109	158	0	0
Kingscote	112	158	112	159	0	1
Kingston SE	106	149	106	149	0	0
Leigh Creek	131	197	131	197	0	0
Loxton	124	185	124	184	0	-1
Mannum	125	185	125	184	0	-1
Marree	138	211	138	211	0	0
Meningie	110	160	111	160	1	0
Millicent	98	136	98.3	135	0.3	-1
Morgan	122	182	123	182	1	0
Mount Gambier	103	144	103	144	0	0
Murray Bridge	120	176	120	177	0	1
Murray Town	118	172	118	172	0	0
Naracoorte	109	156	109	155	0	-1
Normanville	120	170	120	171	0	1
Nuriootpa	110	156	110	156	0	0
Orroroo	122	181	123	182	1	1
Peterborough	120	178	120	177	0	-1
Pinnaroo	121	178	122	178	1	0
Penola	104	146	104	146	0	0
Port Augusta	133	199	133	199	0	0
Port Broughton	122	180	122	180	0	0
Port Lincoln	98	138	98.7	138	0.7	0
Port Pirie	124	182	123	183	-1	1
Port Wakefield	113	163	113	164	0	1
Renmark	127	190	127	190	0	0
Robe	106	148	105	147	-1	-1
Roxby Downs	143	217	143	217	0	0
Snowtown	115	168	115	168	0	0
Strathalbyn	113	163	113	163	0	0
Tailem Bend	116	170	116	170	0	0
Victor Harbour	110	156	110	156	0	0
Waikerie	128	192	129	192	1	0
Whyalla	130	193	130	194	0	1
Wudinna	104	152	104	153	0	1
Yalata	106	156	106	155	0	-1
Yorketown	115	166	115	166	0	0
TASMANIA						
Brighton	83	114	83.2	114	0.2	0
Burnie	128	178	128	178	0	0
Campbell Town	82	110	82	111	0	1
Deloraine	108	145	108	145	0	0

Devonport	119	162	118	162	-1	0
Flinders Island	124	168	124	167	0	-1
George Town	107	144	107	144	0	0
Hobart	86	120	86.9	120	0.9	0
Huonville	88	120	87.2	121	-0.8	1
Launceston	91	122	91	123	0	1
New Norfolk	79	108	78.8	108	-0.2	0
Oatlands	83	114	83.1	114	0.1	0
Port Arthur	84	114	84.5	114	0.5	0
Port Sorell	113	154	113	153	0	-1
Queenstown	94	120	93.5	120	-0.5	0
St. Helens	133	182	134	183	1	1
St. Marys	150	206	150	207	0	1
Smithton	107	143	107	143	0	0
Sorrell	86	119	86.9	119	0.9	0
Southport	82	109	81.1	110	-0.9	1
Strahan	83	106	82.7	105	-0.3	-1
Swansea	108	146	108	147	0	1
Zeehan	91	116	91	116	0	0
VICTORIA						
Apollo Bay	101	134	101	135	0	1
Avalon	106	148	106	148	0	0
Bacchus Marsh	108	149	108	149	0	0
Bairnsdale	143	197	143	197	0	0
Ballarat	134	192	134	192	0	0
Benalla	146	193	146	194	0	1
Bendigo	145	215	145	214	0	-1
Bright	146	190	146	189	0	-1
Camperdown	104	143	104	143	0	0
Cape Otway	101	136	101	135	0	-1
Casterton	110	156	110	157	0	1
Castlemaine	136	198	136	198	0	0
Colac	94	127	93.9	127	-0.1	0
Echuca	130	186	130	186	0	0
Edenhope	113	160	112	160	-1	0
Foster	112	152	112	152	0	0
Geelong	103	143	103	143	0	0
Hamilton	115	164	115	164	0	0
Heathcote	144	208	144	208	0	0
Horsham	121	174	121	173	0	-1
Hopetoun	140	208	140	207	0	-1
Johanna	96	128	95.5	129	-0.5	1
Kerang	139	205	139	205	0	0
Kinglake	134	187	134	187	0	0
Kyneton	139	200	139	201	0	1
Lakes Entrance	145	199	145	199	0	0
Leongatha	108	143	108	143	0	0
Macarthur	119	168	119	168	0	0
Mallacoota	172	236	171	237	-1	1
Mansfield	133	174	133	174	0	0
Maryborough	125	180	124	180	-1	0
Melbourne:						
Craigieburn	128	186	128	186	0	0
Dandenong	133	181	133	181	0	0
Frankston	124	166	123	165	-1	-1
Hastings	112	144	112	145	0	1
Melbourne City	132	187	132	187	0	0
Oakleigh	132	182	132	182	0	0
Portsea	106	140	106	140	0	0
Sunbury	121	172	122	171	1	-1
Sunshine	131	186	131	186	0	0
Warrandyte	126	172	126	172	0	0
Meredith	116	167	117	167	1	0
Mildura	143	220	142	219	-1	-1
Morwell	124	173	123	172	-1	-1
Mount Macedon	131	178	130	177	-1	-1
Nelson	104	145	105	145	1	0
Nhill	125	180	125	180	0	0
Omeo	118	161	117	160	-1	-1
Orbost	148	198	147	198	-1	0
Ouyen	134	202	135	202	1	0

Packenham	126	168	126	168	0	0
Phillip Island	107	136	106	135	-1	-1
Port Campbell	97	130	97.2	130	0.2	0
Port Fairy	125	180	125	180	0	0
Portland	116	161	116	161	0	0
Queenscliff	107	144	107	144	0	0
Robinvale	142	215	142	215	0	0
Rutherglen	134	174	135	175	1	1
Sale	136	198	136	198	0	0
St. Arnaud	133	197	133	197	0	0
Shepparton	131	175	130	175	-1	0
Seymour	132	184	132	183	0	-1
Stawell	130	187	130	187	0	0
Sunbury	121	172	122	171	1	-1
Swan Hill	144	218	144	218	0	0
Venus Bay	110	145	110	145	0	0
Wangaratta	138	179	138	179	0	0
Warracknabeal	134	196	134	196	0	0
Warragul	112	146	111	147	-1	1
Warrnambool	120	169	119	169	-1	0
Wedderburn	142	212	142	212	0	0
Werribee	122	173	122	173	0	0
Winchelsea	97	134	96.9	134	-0.1	0
Wodonga	139	180	139	180	0	0
Wonthaggi	119	156	119	157	0	1
Wycheproof	148	222	147	222	-1	0
Yarram	132	185	132	185	0	0
Yarrawonga	134	176	134	177	0	1
WESTERN AUSTRALIA						
Albany	127	179	127	179	0	0
Augusta	149	199	149	200	0	1
Bremer Bay	131	185	131	185	0	0
Bridgetown	121	169	121	169	0	0
Brookton	119	173	119	173	0	0
Broome	232	287	232	287	0	0
Bunbury	148	198	147	198	-1	0
Busselton	169	223	169	223	0	0
Canarvon	136	200	136	201	0	1
Carnarmah	119	168	119	168	0	0
Cervantes	128	176	129	177	1	1
Collie	125	166	125	165	0	-1
Dalwallinu	122	176	123	176	1	0
Denham	137	203	137	203	0	0
Denmark	116	163	117	163	1	0
Derby	211	257	211	256	0	-1
Dongara	127	174	127	174	0	0
Dumbleyung	116	169	116	169	0	0
Eneabba	118	163	118	163	0	0
Esperance	115	162	115	162	0	0
Eucla	156	234	156	234	0	0
Fitzroy Crossing	208	250	207	250	-1	0
Geraldton	138	194	138	194	0	0
Halls Creek	202	251	202	251	0	0
Harvey	138	184	138	184	0	0
Hopetoun	118	166	118	166	0	0
Jurien Bay	128	175	128	176	0	1
Kalbarri	130	182	129	183	-1	1
Kalgoorlie	136	204	136	204	0	0
Karratha	142	194	141	194	-1	0
Katanning	125	181	125	181	0	0
Kununurra	202	244	202	244	0	0
Lake Grace	121	175	121	175	0	0
Lake King	115	166	116	166	1	0
Lancelin	134	186	134	186	0	0
Leinster	138	214	138	214	0	0
Leonora	136	210	136	210	0	0
Madura	132	198	132	198	0	0
Mandurah	133	169	134	169	1	0
Marble Bar	173	232	173	231	0	-1
Margaret River	161	210	161	210	0	0
Meekatharra	143	221	143	221	0	0

Menzies	142	217	142	218	0	1
Merredin	126	184	127	184	1	0
Mingenew	116	166	117	166	1	0
Moora	104	146	105	147	1	1
Morawa	120	173	120	172	0	-1
Mount Barker	116	163	116	163	0	0
Mount Magnet	131	200	131	200	0	0
Mukinbudin	128	187	128	187	0	0
Mullewa	114	163	114	164	0	1
Mundaring	125	166	125	166	0	0
Narrogin	115	168	115	168	0	0
New Norcia	110	155	110	154	0	-1
Newman	158	211	158	213	0	2
Norseman	113	161	113	160	0	-1
Northam	109	157	110	158	1	1
Northampton	116	161	116	161	0	0
Ongerup	126	184	126	183	0	-1
Onslow	185	259	185	259	0	0
Pemberton	121	167	121	166	0	-1
Perenjori	118	169	118	169	0	0
Perth:						
Armadale	136	179	135	179	-1	0
City Beach	132	174	132	174	0	0
Freemantle	131	173	131	173	0	0
Joondalup	133	180	133	180	0	0
Midland	122	163	122	164	0	1
Perth City	130	172	129	172	-1	0
Rockingham	136	175	136	175	0	0
Upper Swan	114	156	114	156	0	0
Port Hedland	168	233	168	232	0	-1
Ravensthorpe	118	166	117	165	-1	-1
Southern Cross	127	186	127	186	0	0
Tom Price	138	182	138	182	0	0
Walpole	113	162	113	162	0	0
Warburton	154	232	153	231	-1	-1
Wiluna	150	232	150	231	0	-1
Wongan Hills	118	167	118	167	0	0
Woodridge	137	190	136	190	-1	0
Wyndham	210	253	210	253	0	0
Yanchep	140	193	140	194	0	1
York	110	158	110	159	0	1

Key	
Colour	Indicator
	No change proposed
	Minor amendment
	Increase of 1 mm/h
	Decrease of 1 mm/h
	Increase of 2mm/h

Attachment 4 – Case studies

Stormwater system design

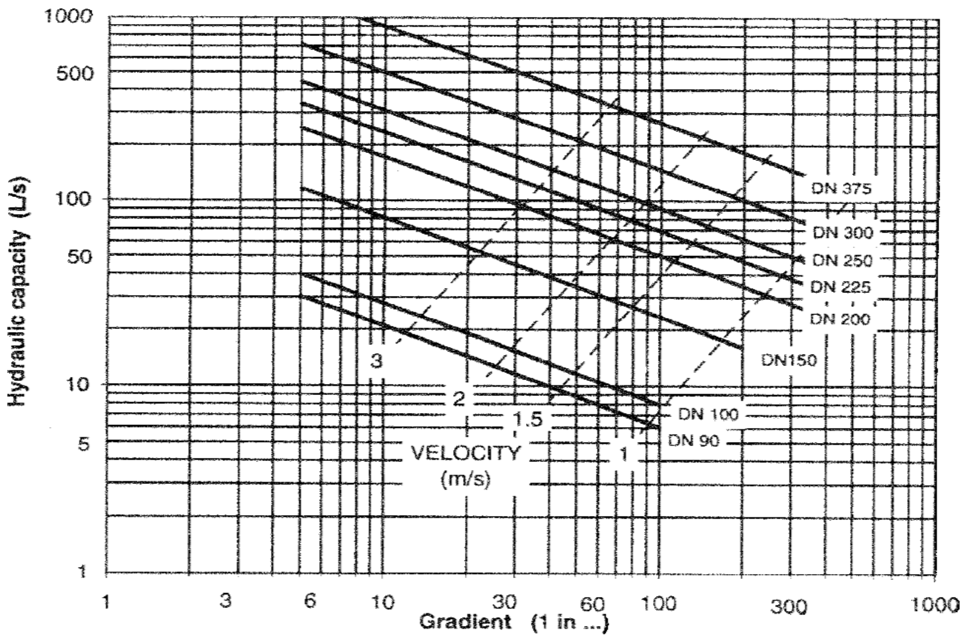
To better demonstrate why there is no requirement to make changes to the AS/NZS 3500.3:2021. The below are two case studies on pipe sizing with the changes in flow rates and one on overflow measures. Such a limited change case study, calculations for stormwater drainage systems for example locations where change is proposed.

Stormwater drainage systems are calculated using the following formula to determine the design flow.

$$Q = \frac{(C_r \; x \; A_r) \; x \; {}^{y}/_{t}}{3600}$$

- Q= design flow of stormwater in litres per second
- C_r = run-off coefficient for a roofed area – e.g. 1.0
- A_r = total roofed catchment area, in metres square – e.g. 200m^2
- y = rainfall intensity in mm/h
- t = rainfall intensity duration

The figure below show how pipe sizing is undertaken within the standard and the ranges of hydraulic capacity that each pipe size can cater for.



(a) *k* = 0.015 mm

AS/NZS 3500.3:2018 5.4.11.2 Diagram (a)

Two examples are for stormwater drainage systems design have been included below for Casino, NSW and Mt Isa, Qld. An example for Newman, WA has also been included for the proposed amendment as this area had the most significant amendment proposed to the data for a 1% AEP (100 year ARI).

Example Location 1: Casino, NSW

Rainfall intensity adjustments		5 % AEP (20 years ARI) intensity mm/h
Casino, NSW	-1mm/h	213

Existing: Rainfall intensity of 214mm/h

$$Q = \frac{(1.0\ x\ 200)\ x\ ^{214}/_{5}}{3600}$$

- Q= 2.378 design flow of stormwater in litres per second

Proposed: Rainfall intensity of 213mm/h

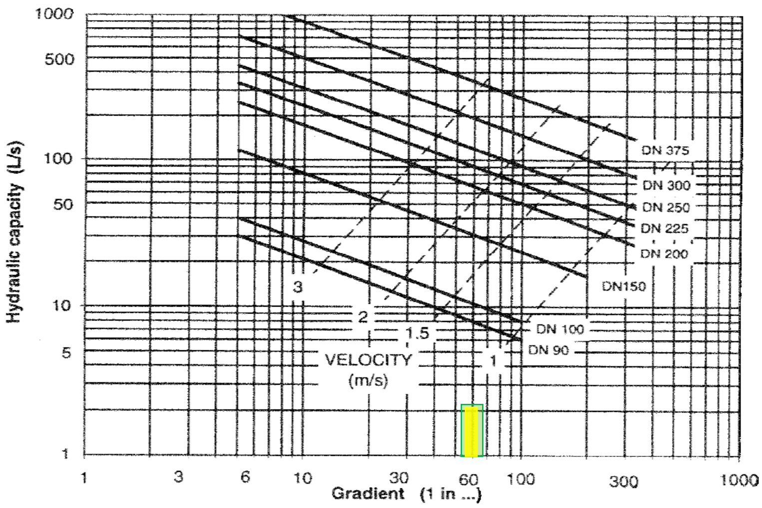
$$Q = \frac{(1.0\ x\ 200) x\ ^{213}/_{5}}{3600}$$

- Q = 2.367 design flow of stormwater in litres per second

This example there is a decrease in the design flow of stormwater of just -0.011L/s.

Summary:

Under this example, both the proposed and the existing would result in the use of 90mm pipework. As the minor decrease in flow there would be no requirement to adjust the current pipe sizing and would not result in any impacts or cost changes.



(a) k = 0.015 mm

The area highlighted above, represents the examples and demonstrate the minimal change with a gradient of 1:60. It is evident that the changes in rainfall intensity are still well within range of hydraulic capacity suitable for a pipe size of and with the objective of this proposal there is no need to change the pipe sizing requirements in the AS/NZS 3500.3:20xx.

Example Location 2: Mt Isa, QLD

Rainfall intensity adjustments		5 % AEP (20 years ARI) intensity mm/h
Mt Isa, QLD	+1mm/h	201

Existing: Rainfall intensity of 200mm/h

$$Q = \frac{(1.0\ x\ 200)x\ ^{200}/_{5}}{3600}$$

- Q= 2.222 L/S
- Pipe size = 90mm

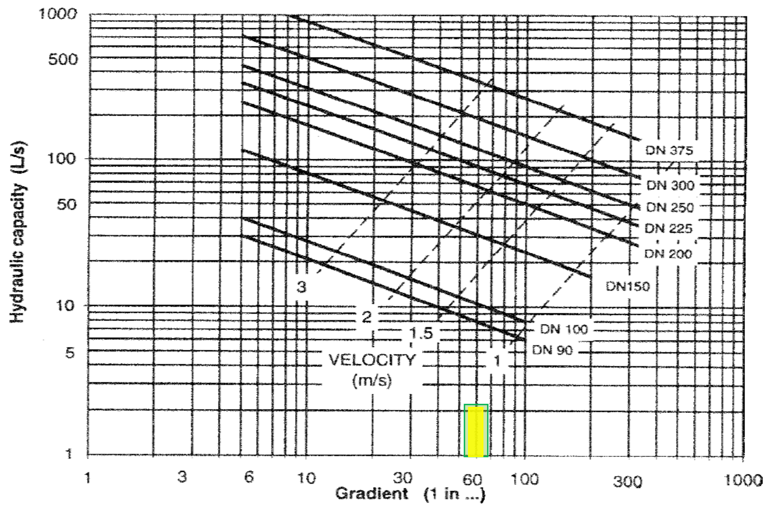
Proposed: Rainfall intensity of 201mm/h

$$Q = \frac{(1.0\ x\ 200)x\ ^{201}/_{5}}{3600}$$

- Q= 2.233 L/S
- Pipe size = 90mm

Summary:

This example, both the proposed and existing result in the continued use of 90mm pipework. There is no increase in pipe sizing and would not result in any impacts.



(a) *k* = 0.015 mm

The area highlighted above, represents the examples and demonstrate the minimal change with a gradient of 1:60. It is evident that the changes in rainfall intensity are still well within range of hydraulic capacity suitable for a pipe size of and with the objective of this proposal there is no need to change the pipe sizing requirements in the AS/NZS 3500.3:20xx.

Example Location 3: Newman, WA

Rainfall intensity adjustments		1 % AEP (100 years ARI) intensity mm/h
Newman, WA	+2mm/h	213

In this example, the increase if to a 1% AEP (100 year ARI) which is used to design overflow measures required. For this example, the Building Code of Australia has been used as a method of calculating the required overflow capacity for a catchment area of 50m^2.

Note: The BCA has been used as AS/NZS 3500.3 contains little guidance on the calculations of overflow capacity.

Existing:

- Rainfall intensity of 211mm/h

Proposed:

- Rainfall intensity of 213mm/h

Table 3.5.3.3b Overflow volume for dedicated measure (L/s)

Design 5 minute duration rainfall intensity (mm/h) (from Table 3.5.2.1a to Table 3.5.2.1h)	Roof catchment area — 30 m^2	Roof catchment area — 40 m^2	Roof catchment area — 50 m^2	Roof catchment area — 60 m^2	Roof catchment area — 70 m^2
150 mm/h	1.3 L/s	1.7 L/s	2.1 L/s	2.5 L/s	2.9 L/s
175 mm/h	1.5 L/s	1.9 L/s	2.4 L/s	2.9 L/s	3.4 L/s
200 mm/h	1.7 L/s	2.2 L/s	2.8 L/s	3.3 L/s	3.9 L/s
225 mm/h	1.9 L/s	2.5 L/s	3.1 L/s	3.8 L/s	4.4 L/s
250 mm/h	2.1 L/s	2.8 L/s	3.5 L/s	4.2 L/s	4.9 L/s
275 mm/h	2.3 L/s	3.1 L/s	3.8 L/s	4.6 L/s	5.3 L/s
300 mm/h	2.5 L/s	3.3 L/s	4.2 L/s	5.0 L/s	5.8 L/s
325 mm/h	2.7 L/s	3.6 L/s	4.5 L/s	5.4 L/s	6.3 L/s
350 mm/h	2.9 L/s	3.9 L/s	4.9 L/s	5.8 L/s	6.8 L/s
365 mm/h	3.1 L/s	4.2 L/s	5.2 L/s	6.3 L/s	7.3 L/s
400 mm/h	3.3 L/s	4.4 L/s	5.6 L/s	6.7 L/s	7.8 L/s

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Summary:

There is nil difference in required overflow capacity, under both examples the overflow capacity required = 3.1 L/s. This minor increase in rainfall intensity would not have any impact of overflow provisions, thus resulting in no impact on industry.

Attachment 5 – Cost Adjustments

The information provided below has been included to provide guidance on price changes should a component of a stormwater drainage system be required to reduce or increase in size based on the proposed changes of this option.

Pipe

Downpipes and Stormwater Drainage System

Size (PVC)	Price per 6m length	Price change
90	$17.83	
100	$37.63	+$19.80
150	$81.60	+$43.97
200	N/A	N/A
225 (250)	$243.27	
300 (315)	$358.47	+$115.20
375	$927.62	+ $569.15

Eaves gutters

Gutter type	Cross sectional area mm^2	Approx. price per 6m length (confirm gutter length)	Approx. price change
115mm D gutter	5225	$43.08	
Medium rectangular gutter	6244 (+1019mm^2)	$51.18	+$8.10
Large rectangular gutter	6273 (+29mm^2)	$64.62	+$13.44
125mm D gutter (Zinc)	6300 (+27mm^2)	(Zinc) - $113.10	+$48.48
150 D gutter	6700 (+400mm^2)	(C/B) – $61.66	-$51.44
		(Zinc) - $55.80	-$57.30