FAQ

MUSIC Guideline update – Release A

Purpose of the update

This update has been developed to address:

- industry feedback since the last update 2018
- identified information gaps and needs
- advancements in science and industry.

What is new

New guidance

- **modelling high flow bypasses and overflows:** guidance on different high flow bypass and overflow configurations and when to use them
- **modelling wetlands with multiple inlets:** guidance on how to configure these in MUSIC

Updated guidance

- rainfall templates
- source nodes including pollutant concentration data
- stand-alone sediment pond (basin) treatment
- modelling sedimentation basins connected to wetlands
- wetlands online or in series
- defining custom outflow and storage properties for wetlands
- hydrologic routing and drainage links
- proprietary stormwater treatment devices

VICTORIA State Government

Melbourne Water is owned by the Victorian Government. We manage Melbourne's water supply catchments, remove and treat most of Melbourne's sewage, and manage rivers and creeks and major drainage systems throughout the Port Phillip and Westernport region.

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Further information on the updates

Modelling high flow bypasses and overflows

To address a need for further information, new guidance is provided explaining how to model high flow bypasses and overflows.

Modelling wetlands with multiple inlets

To address an information gap not covered by standard MUSIC guidance, new guidance is provided explaining how to model high flow bypasses and overflows.

Rainfall templates

In response to an industry request, the rainfall templates were reviewed and this review was peer reviewed to ensure robustness of the process and results.

As a result of the review, the following changes from six to seven rainfall templates as illustrated in Figure 1 were made:

Melbourne Airport	1971-1980 is replaced with Melbourne Airport 1987-1996 infilled.
Koo Wee Rup	1971-1980 removed and replaced with two bands with new templates: Dandenong 1967-1976 for the 750-850 mm east band, with Koo Wee Rup PET Bullengarook East 1990-1999 for the 750-850 mm west band, with Melton PET.

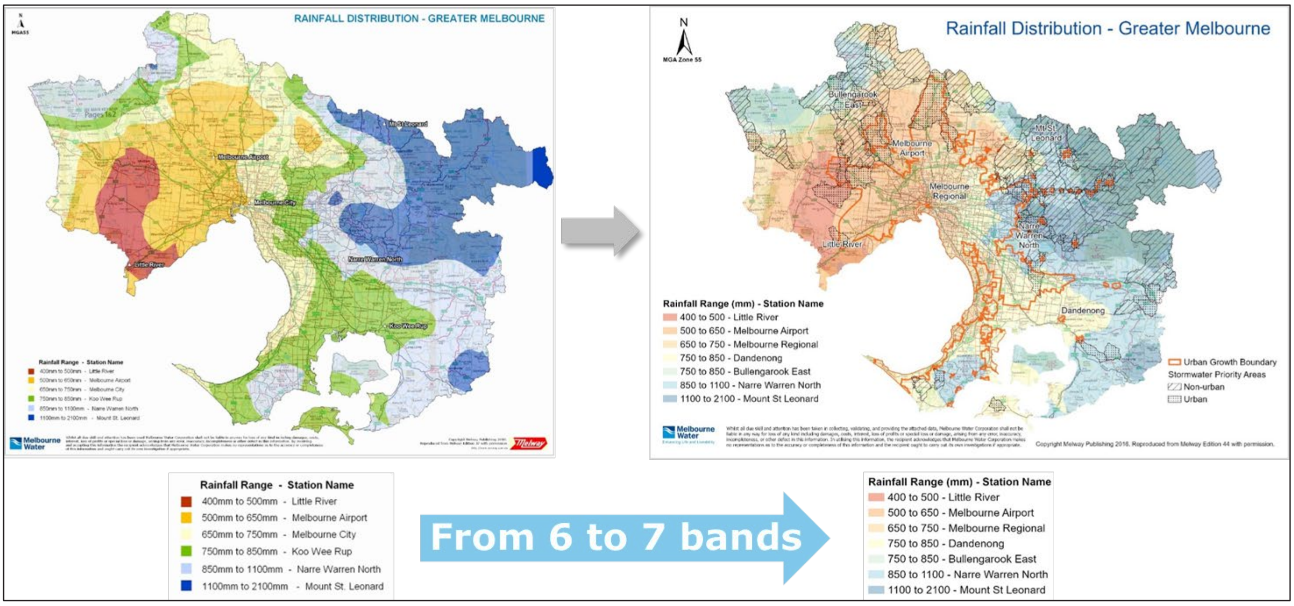

Figure 1 Change from six to seven rainfall templates

The review did not include new work on climate change considerations due to the following reasons:

- Limited change in stormwater treatment performance is anticipated in the short to medium term.
- Current approaches using current climate data are expected to meet objectives under a range of possible future climate scenarios making them an appropriate precautionary position.
- Sensitivity should be considered for long term harvesting yields on large projects.
- Current rainfall templates already include a range of climatic conditions.

Issues with current rainfall templates

The Melbourne Airport station has a gap with no rainfall of about four months which can affect stormwater harvesting and spells assessments.

The Koo Wee Rup rainfall station represents the 750-850 mm rainfall band in Melbourne, which applies across a wide region extending from the coastal town of Koo Wee Rup near Westernport Bay in Melbourne's south-east to the Macedon Ranges north-west of Melbourne. There are concerns the rainfall at Koo Wee Rup may not represent rainfall patterns across this region. In particular, WSUD assets designed using the Koo Wee Rup rainfall station perform significantly better than both the adjacent rainfall regions, Melbourne

Regional and Narre Warren North. While this may reflect specific coastal rainfall patterns in the Koo Wee Rup area (higher frequency and lower intensity), it is unlikely this reflects conditions across the region.

Addressing issues with the Melbourne Airport rainfall template

The Melbourne Airport rainfall station was infilled and a new period selected. A period of 1987-1996 with a mean annual rainfall of 574 mm/year (target for region is 576 mm/year) was adopted.

Addressing issues with the Koo Wee Rup rainfall template

The 750-850 mm rainfall band was split into two rainfall regions with new associated rainfall stations, Bullengarook East and Dandenong. The rainfall data for these stations was infilled and a suitable period was chosen to represent each of the regions.

Revisions in response to peer review

Peer review recommended that any remaining significant periods with zero rainfall be further infilled.

These are periods that have zero rainfall, but have not been flagged with quality codes by the BoM as known or suspected periods with missing or accumulated data. It was necessary to consider whether the data was likely to be accurate or erroneous and needing infilling. On one hand, it is apparent that there are periods with erroneous zero rainfall data not been identified by the BoM (for example a period of 54 days with zero rainfall for 086224 Dandenong is obviously erroneous data given its length and rainfall occurring at corresponding gauges). On the other hand, extended periods with no rainfall do occur and these need to be retained to avoid misrepresenting dry spells and overstating the frequency of rainfall.

All periods with zero rainfall for 14 days or more were reviewed. Each reference station was compared with data for the corresponding daily rainfall station and nearby pluviographs with which the station was most highly correlated.

Where daily rainfall occurred at the nearby gauge during a zero-rainfall period for the pluviograph, it was assumed this indicates a gap in data where rainfall should have occurred. In this case, the data was infilled.

Where the nearby daily gauge also had zero rainfall, this may indicate either that there was no rainfall or that both gauges were not working. The length of the spell was considered and comparison was made with other gauges to see whether significant rainfall had occurred at highly correlated gauges. A long spell of no rainfall with significant rainfall at the most closely correlated gauge or multiple gauges was taken as indicative of a likely gap. If there was little or no rainfall at other gauges then it is likely the record accurately represents a period of no rainfall and the data was not infilled.

Most of the longest gaps were infilled (the longest for Dandenong being 54 and two periods of 33 days and for Bullengarook East being 43 and 19 days). For Melbourne Airport, the longest two gaps of 24 and 23 days were found to be reasonable data while a further five gaps from 17-20 days were infilled. Most of the apparent gaps and most of the shorter gaps were considered reasonable, taking into consideration the highly correlated gauges. Less than a third of all zero rainfall periods warranted infilling. This highlights the importance of not infilling apparent zero rainfall periods without due consideration of other evidence. The only substantial rainfall volume infilled was for Bullengarook East for the period October-December 1999 for which 23.5 mm of rainfall was infilled. All other rainfall depths were relatively small and the overall impact on volumes minimal.

The number of gaps for each station is summarised in Table 1 along with the change in mean annual rainfall.

Table 1 Rainfall templates with mean annual rainfall and quality

Rainfall band (mm)	Rainfall station	Period	Gaps ≥ 14 days	Gaps infilled	Mean annual rainfall before	Mean annual rainfall after	Cumulative error before	Cumulative error after
500-650	86282 Melbourne Airport infilled	1987-1996	16	5	573	574	4.5%	2.5%
750-850 west	87075 Bullengarook East	1990-1999	3	2	770	779	3.6%	2.5.%
750-850 east	86224 Dandenong	1967-1976	12	3	773	777	2.1%	0.8%

Reviewing results

A double mass curve was used to compare the pluviograph data before and after manual gap filling with the corresponding daily data. The cumulative error was already relatively small (<5%) and further improved through the gap-filling with the largest remaining cumulative error being just 2.5%. This provides good confidence the pluviograph data is quite closely representative of the daily data.

The most significant improvement in the data due to the further infilling is in the representation of dry spell lengths which are of interest for dry spells for wetlands, bioretention and tree pits. The impacts on treatment performance are relatively minimal given the very small changes in mean annual rainfall volumes.

A summary of the changes is provided in Table 2.

Table 2: Summary of changes

Issues with current templates	Updates	Implications
Melbourne Airport station: 4-month gap in rainfall	New period selected: 1987-1996 Remaining data gaps infilled	Minimal changes to wetland treatment system areas (performance slightly improved with infilled data)
Concerns **Koo Wee Rup** rainfall station is not a reflection of the rainfall patterns across the 750-850mm rainfall band	Band has been split into two new rainfall regions: Bullengarook East (Macedon Ranges area) and Dandenong	Dandenong: 0.6% increase in wetland treatment system area Bullengarook East: 1.2% increase in wetland treatment system area

The final templates are summarised in Table 3.

Table 3 New rainfall templates with mean annual rainfall and evapotranspiration

Rainfall band (mm)	Rainfall station	Period	Period mean annual rainfall	Evapo-transpiration
400-500	87033 Little River	1992-2001	473	1067
500-650	86282 Melbourne Airport infilled	1987-1996	574	1047
650-750	86071 Melbourne Regional	1952-1961	707	995
750-850 West	87075 Bullengarook East	1990-1999	779	1043
750-850 East	86224 Dandenong	1967-1976	777	1027
850-1,100	86085 Narre Warren North	1984-1993	933	985
1,100-2,100	86142 Toolangi (Mount St Leonard DPI)	1995-2004	1,221	962

Source nodes including pollutant concentration data

The guideline was revised to more clearly communicate the distinction between total and directly connected impervious fractions, when and why these should be used.

The pollutant concentrations for different surface types such as roofs, roads and other impervious surfaces are provided based on University of Melbourne and Melbourne Water Melbourne data for modelling stormwater treatment and harvesting assets where water is collected from different types of surfaces (as an alternative to mixed urban node which just provides an average). Minor revisions were made to correct rounding errors and improve accuracy.
A limited literature review was undertaken of pollutant concentrations to consider whether changes were needed. The review found that the outcomes

of monitoring studies are mixed. In general, the more recent studies suggest that total suspended solids (TSS) concentrations may be lower than the values currently used in the guideline, although total nitrogen (TN) concentrations are not likely to vary significantly. However, the reasons for lower TSS results are less clear. These may in part reflect differences in the context, character, surface types and scale of study catchments. This may be a result of some of the recent studies focussing at the development scale or smaller urban catchments rather than the catchment scale which may pick up additional processes such as occasional construction sites and channel erosion. Local (Victorian) monitored data for urban stormwater drains is still quite limited and there continues to be a need to draw on data from a broad database of national and international data to achieve concentration breakdowns for land uses or surface types beyond simply urban pollutant concentrations.

In conclusion:

1. It is recognised the existing concentrations are mostly based on a dated but extensive study of concentrations (Duncan, 1999) with minor additions (Fletcher 2006).

2. Revising concentrations based on a limited data set could diminish rather than improve accuracy. An extensive and ideally national study to collate and assess all relevant data is the preferred pathway to provide justification to make revisions to the existing concentrations.

3. The understanding that there are clear differences between surface types but not necessarily urban landuses (such as residential, commercial and industrial) proposed by Duncan (1999) was re-affirmed based on consideration of several other studies. Therefore, there is limited justification for differentiating the standard pollutants between these landuses. On the other hand, it was noted that freeways, parks and non-urban landuses may have significantly different concentrations. Furthermore, other pollutants of concern (not represented by MUSIC at this time) may also show clearer differences with landuse. At this time, the guideline supports broad modelling using general landuse classifications (urban, agricultural, forest) or split surface types which primarily recognise the significant differences in TSS concentrations across surface types.

Standalone sediment pond (basin) treatment

In response to industry requests, clearer guidance is provided on how standalone sediment ponds, without any further secondary or tertiary treatment, should be accounted for in treatment performance reporting with respect to nitrogen.

As there is insufficient evidence to confirm that permanent nitrogen removal is facilitated by sediment ponds, Melbourne Water cannot accept nitrogen removal modelled for stand-alone sediment ponds when these are not part of a treatment train, including subsequent secondary or tertiary treatment.

A range of nitrogen and other pollutant removal processes are facilitated by stormwater control measures (SCMs), depending on their design. Since nitrogen is present in stormwater in both particulate and dissolved form, it is necessary to consider the processes that can act on both nitrogen and sediment in SCMs:

- **sedimentation** – removal of sediment and associated pollutants via settling; particles may gradually become buried within the sediment or remobilised by re-suspension or decomposition processes
- **re-suspension** – disturbance and resuspension of sediment and associated pollutants by high velocity flows, wave action or bottom-dwelling organisms
- **decomposition and mineralisation** – conversion of organic nitrogen to simpler and eventually inorganic components
- **nitrification** – bacterial conversion of ammonium to nitrate
- **biological assimilation** – uptake and retention of inorganic nitrogen in the tissues of plants or microbes
- **denitrification** – bacterial conversion of nitrate to N_2 gas
- **sorption/adsorption** – a reversible process of attachment of ammonium to the surface of negatively charged particles
- **ammonia volatilisation** – conversion of aqueous ammonia to gaseous ammonia followed by loss to the atmosphere

Nitrogen is very active and readily transforms between forms. The transformation processes that can occur in water-plant-soil SCMs are complex but, as they are aerobic environments, the overall direction of transformation is from particulate organic nitrogen to dissolved organic and, ultimately, dissolved inorganic form. In addition, the majority of nitrogen (>75%) in stormwater is present in dissolved form. As a result, the SCMs that deliver the most reliable, long-term removal are those that facilitate the removal of dissolved inorganic nitrogen, particularly nitrate.

Denitrification has previously been assumed to be an important nitrogen removal process in SCMs but recent studies have shown that, not only is denitrification less important than previously assumed, but that nitrogen fixation (the reverse of denitrification) can exceed denitrification in some open-water SCM sediments. Long-term nitrogen removal by sediment ponds is therefore solely reliant on the burial of incoming organic matter before it is transformed to soluble forms via decomposition and mineralisation. The ultimate fate of most of the nitrogen that enters a sediment pond is thus release via the pond outlet. It is for this reason that Melbourne Water does not accept sediment ponds on their own as a viable system for long-term nitrogen removal.

The much higher proportion of water covered by dense vegetation in constructed stormwater wetlands facilitates a greater range and extent of removal processes, including vegetation-related filtration, biological assimilation and coupled nitrification-denitrification. The addition of a pre-treatment sediment pond to a constructed wetland increases the overall volume of the system, meaning it can detain a greater volume of water per event. Some nitrogen will be temporarily removed from incoming stormwater through the settling of particulate organic matter in the sediment pond. However, as noted above, settling is largely only a temporary store of nitrogen because most of the nitrogen that enters the system as particulate organic matter will eventually be converted to dissolved (and thus mobile) form. When this eventually moves from the sediment pond to the macrophyte zone of the wetland, it can be locked up in longer term stores (for example recalcitrant biomass) or even permanently removed from the system via denitrification. Melbourne Water therefore accepts the contribution of sediment ponds when they are part of a constructed wetland system because, while they do not directly contribute to net removal of nitrogen, they allow the system to detain a larger volume of water and thus increase the opportunity for eventual removal within the macrophyte zone.

Modelling sediment ponds connected to wetlands

To address a need for further information, clearer guidance is provided on how sediment ponds connected to wetlands should be modelled.

Online wetlands or wetlands in series

In response to industry requests, additional guidance is provided confirming and further specifying Melbourne Water’s approach to online wetlands.

Defining custom outflow and storage properties for wetlands

To address a need for further information, additional procedural guidance is provided on how to define custom stage-storage relationships, such as by using a 3D earthworks model.

Application of hydrologic routing and drainage links

To address a need for further information, additional guidance is provided on using secondary drainage links.

Proprietary stormwater treatment devices

In response to industry requests, clearer guidance is provided on Melbourne Water's approach to proprietary stormwater treatment devices.

It is acknowledged that proprietary devices play an important role and form part of the solutions for stormwater management. However, proprietary stormwater treatment devices may not be a replacement of nature-based solutions in Development Services Schemes.

Melbourne Water supports a national approach to proprietary stormwater treatment device validation and is looking toward accepting a national approach that meets Melbourne Water requirements.

Estimating design flows

In response to industry requests for clarity on calculation methods for the very frequent flows that are used for designing SCMs, new guidance was planned to be included in Release A however due to additional work being undertaken, this update will likely be provided outside of the MUSIC Guideline.

Implications of the updates for the industry

The updated guidance is aimed at improving clarity, consistency and accuracy.

The implications of the updates can be summarised as follows:

Modelling techniques – can be applied immediately

New rainfall templates – apply to new designs commencing after Release A publication

Wetlands online – protect waterways by locating wetlands offline

Sediment pond nitrogen removal – stand-alone sediment ponds are not preferred and no nitrogen removal should be modelled for stand-alone sediment ponds that are not part of a treatment train including downstream vegetated treatment assets

Proprietary stormwater treatment devices – may not be a replacement of nature-based solutions in Development Services Schemes

MUSICX – updated guidance applies to MUSICX as science between MUSIC Classic and MUSICX has not changed

Next steps

In addition to the MUSIC Guideline update Release A, subsequent industry guidance for stormwater infiltration and harvesting targets is coming. This guidance forms part of a broader planned program aimed at supporting industry capacity in achieving stormwater targets. This upcoming guidance includes:

- **Healthy Waterways Strategy Stormwater Targets - Practitioner's Note**
  update of the existing document to incorporate the new Release A rainfall data
- **new asset guidance**
  new asset specific guidance for four assets that encourage harvesting, evapotranspiration and infiltration across a range of scales
- **MUSIC Guideline update Release B**
  additional MUSIC modelling guidance added to Release A for modelling of stormwater volume reductions through harvesting, evapotranspiration and infiltration and the four asset types included in the new asset guidance.

Release B and the new asset guidance include interlinked content and will therefore be shared concurrently with industry.

The planned process for these document releases is illustrated in Figure 2.

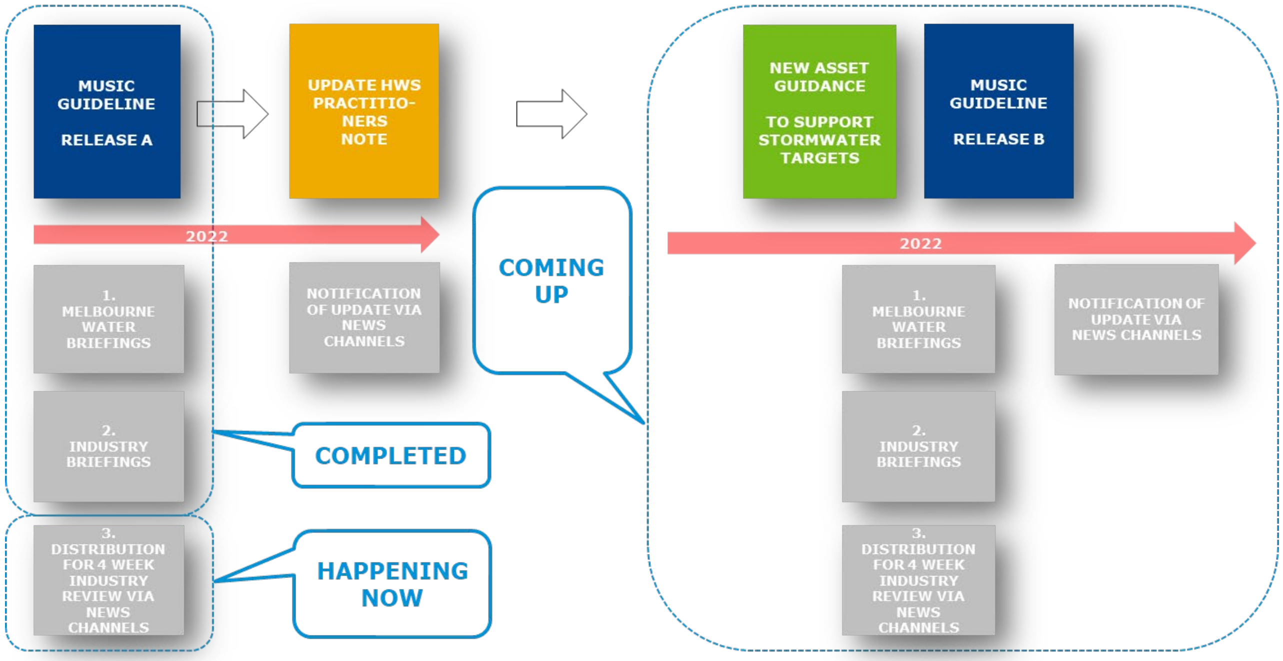

Figure 2 Planned process for MUSIC Guideline updates and stormwater targets asset guidance