MUSIC Guidelines

Recommended input parameters and modelling approaches for MUSIC users
Draft January 2016 update

State Government Victoria

Melbourne Water

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1. Introduction

MUSIC is software that simulates rainfall, stormwater runoff and pollution. It also simulates pollution removal and flow reduction through stormwater management systems such as sediment ponds, wetlands, bioretention and harvesting.

Stormwater management minimum requirements are set by the Victorian Environmental Protection Agency (EPA) through the Best Practice Environmental Management Guidelines (BPEMG). The latest BPEMG information is available via the EPA Victoria website:

http://www.epa.vic.gov.au/business-and-industry/guidelines/water-guidance/urban-stormwater-bpemg

Melbourne Water, Councils and EPA may require different stormwater management levels depending on the receiving environment.

The design intent for any treatment system must be clearly documented and discussed with Melbourne Water early in the conceptual design stage. Melbourne Water uses MUSIC to assess the impacts of proposed development against performance targets. If methods or models other than MUSIC are used, the designer must demonstrate to Melbourne Water's satisfaction that performance targets can be achieved.

2. Purpose of document

This document provides guidance on modelling approaches and input parameters for MUSIC that are recommended by Melbourne Water. The MUSIC User Manual is also useful for building a model.

These guidelines support people submitting MUSIC models to Melbourne Water. The objectives are to:

- Ensure a consistent, fair and evidence based approach is applied to MUSIC models.
- Be specific to the climate and geology of the Melbourne region
- Reduce the time taken by Melbourne Water in assessing models.

Users are expected to have an understanding of water sensitive urban design principles and approaches and have knowledge and training in the use of the MUSIC software.

This document is a modelling guideline, and should be read in conjunction with appropriate design guidelines such as:

- WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005) and
- Melbourne Water Constructed Wetlands Design Manual (Melbourne Water, 2014)

MUSIC can help validate a design, but is not the only validation. Many other requirements are outlined in the above documents. Other referral authorities, including Local Government, may have their own requirements for MUSIC modelling.

3. Climate data

Rainfall period

Climate data including rainfall and evapotranspiration are essential inputs to MUSIC. MUSIC is a continuous simulation model and requires an input time series of rainfall data. Data is available from the Bureau of Meteorology at a 6 minute timestep for a number of gauges across Melbourne Water's service area. The selection of a rainfall gauge and period should consider:

- local rainfall patterns for the site of interest
- completeness of record
- representation of a range of conditions including wet and dry periods and a variety of storm events of varying size and antecedent dry periods
- purpose of the model

The choice of meteorological data is a balance between the level of accuracy required and the time and effort required for modelling. The following levels are recommended:

- **1 year MW reference period**: Simple concept designs and preliminary modelling of stormwater treatment systems for urban areas with an impervious fraction of at least 40% with no harvesting of rainwater or stormwater.
- **10 year period**: A minimum period of 10 years for:
  - functional and detailed designs
  - all wetland design
  - modelling of stormwater treatment trains including rainwater tanks or stormwater reuse
  - modelling of areas including significant areas of pre-development, rural or pervious land.
  - Analysis of flow frequency objectives such as number of flow days, stream erosion index and flow frequency curves
- **20+ year period**: Municipal and larger integrated water management strategies, waterway flow analyses, analysis of large pervious catchments (> 100 ha).

Melbourne Water has developed reference rainfall templates for 1 and 10 year periods. The templates have been selected to reflect the rainfall gradient across metropolitan Melbourne.

All models must use either Melbourne Water's recommended rainfall templates or appropriate local rainfall. Use of alternative rainfall data is permitted if it can be demonstrated that the selected rainfall data is of a high quality and representative of the area to which it is being applied.

The rainfall distribution map below can be used to find the best weather station for a site; [a large-scale version of the map]() and the rainfall templates are available on the Melbourne Water [guidelines webpage](). Rainfall data is available from the Bureau of Meteorology www.bom.gov.au.

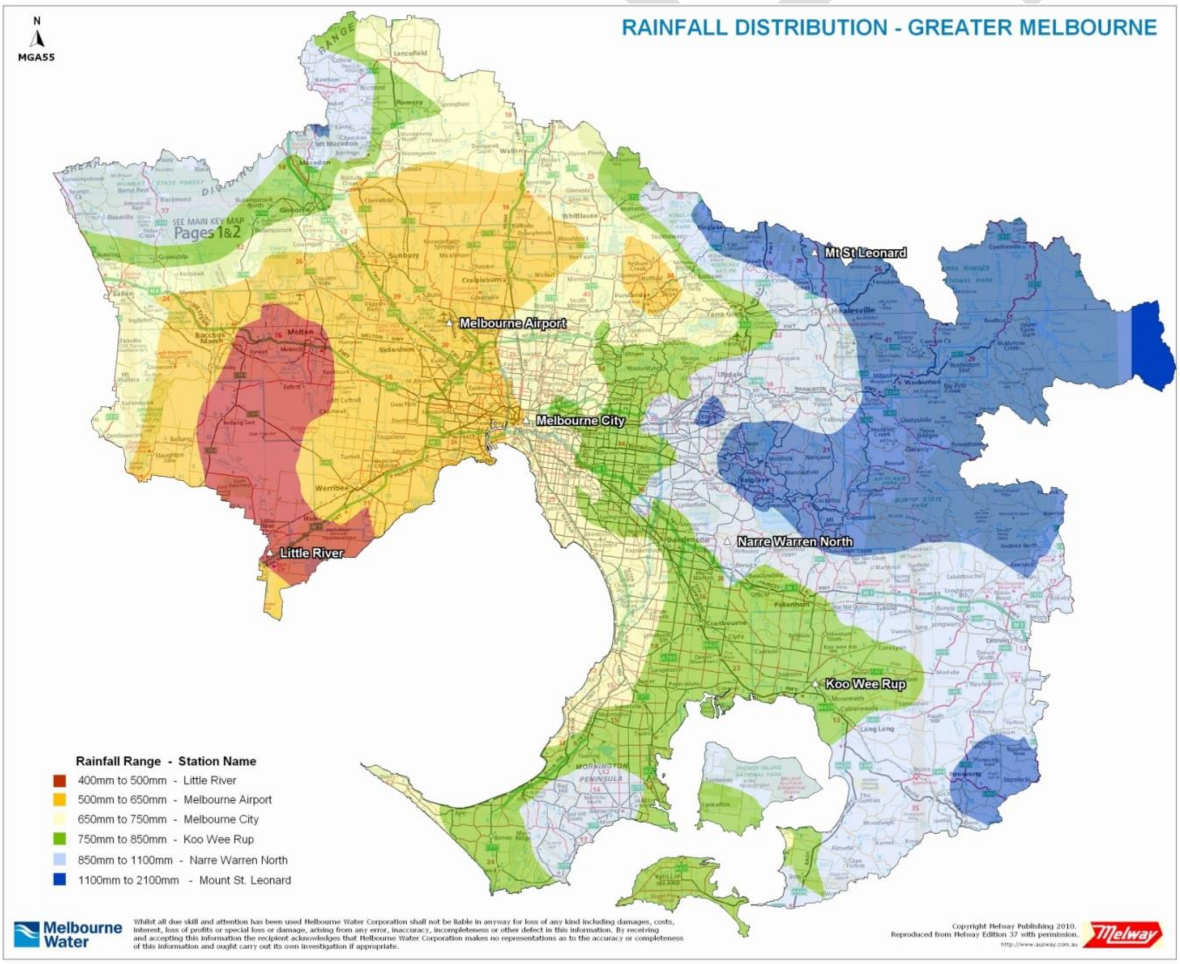


Figure 1. Greater Melbourne Rainfall Distribution

Timestep

All models must be run at a 6 minute timestep where this is possible. The use of longer timesteps can result in significant errors and increase the variability of results. Where a different timestep is adopted it must comply with the following:

The timestep must be equal to or less than:
1. the Time of Concentration of the smallest Sub-Catchment, and
2. the shortest detention time (under design flows) of the treatment measures being modelled.

Circumstances where a different modelling timestep may be appropriate include:
1. concept level modelling of systems that have long times of concentration and detention times, such as rivers or lakes, where no representative 6 minute data is available
2. where a larger timestep is required to interface with another model and allow consistent rainfall to be used. Depending on the outputs required, it may be possible to run MUSIC at a 6 minute time step and export results at a longer time step.

4. Hydrologic routing

Hydrologic routing should be used where appropriate to reflect the Time of Concentration of the Catchment as calculated using a recognised procedure. Routing can be ignored to reduce the complexity of the model. Not using routing will usually result in the performance of treatment systems being underestimated. Routing should be applied (or not applied) consistently across a model; otherwise timing of peak flows (and possible coincident peaks) will not be modelled correctly.

5. Source nodes

Source node selection (urban, forest, agricultural etc)

Urban nodes are recommended for most modelling purposes to represent existing urban, new development and parkland areas. Forest nodes are only recommended for use when representing old growth or well established forested areas. The agricultural node has elevated nutrient concentrations and can be used to represent actively farmed areas.

Source nodes can be split by surface type (e.g. roads, roofs). Input parameters for stormwater pollutant concentrations (other than default values) are listed in Table 3 on page 9. Other parameters may be accepted if there is suitable published data to support this - subject to prior agreement by Melbourne Water.

Impervious fraction

The "effective impervious" percentage (portion of impervious area that drains directly to the receiving waterway via a constructed drainage system) must be used. Ideally, the effective imperviousness fraction would be calibrated using local rainfall and stream flow data, but in most cases this is not possible. The preferred method for catchments smaller than around 10 hectares is to physically measure the proportion of impervious surfaces that are effectively connected to the drainage system. An example of physical measurement of effective imperviousness is provided below:

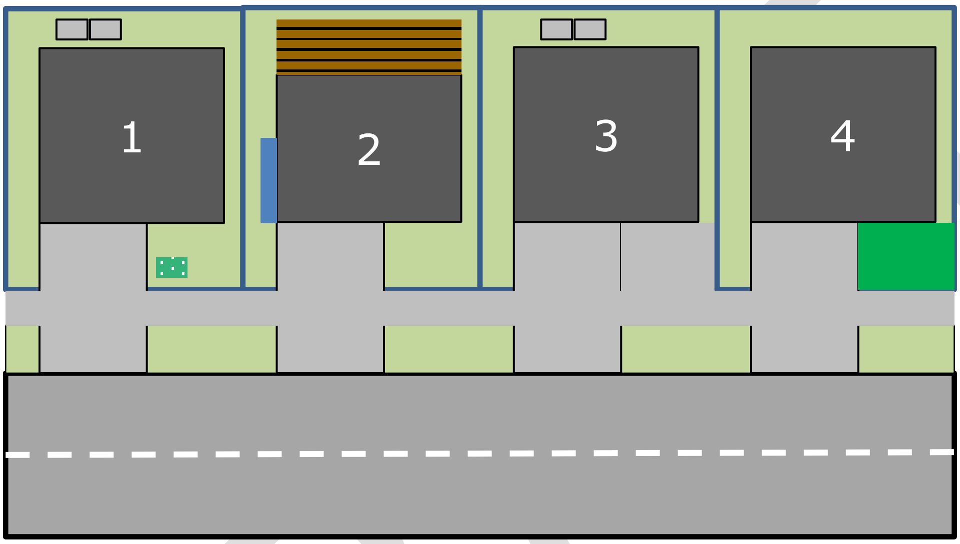


Figure 2- Impervious fraction calculation example

Property 1 has all downpipes charged (as in Figure 1 of Technical Solution Sheet 4.05: Drainage (Below Ground Stormwater) – VBA 2014) to an aboveground planter box raingarden in the front yard. The roof connected to the raingarden must still be counted as "directly connected". It also has a 15m^2 paved area in the backyard that drains to an equivalent area of surrounding grass, not connected to the drainage system.

Property 2 has 30% of the roof draining to a rainwater tank that is connected to a toilet for flushing. The roof connected to the tank must still be counted as "directly connected". The back yard has an uncovered wooden deck that allows rainwater to fall through to the ground below. This deck is not counted as an impervious surface.

Property 3 has additional paved area in the front yard connected to the drainage system and a 15m^2 paved area in the backyard that drains to an equivalent area of surrounding grass, not connected to the drainage system.

Property 4 has synthetic grass in the front yard that connects to the drainage system.

Total Area	3000 m^2
Impervious Area Directly Connected	
All Roofs	744 m^2
Road	933 m^2
Driveways	387 m^2
Footpath	104 m^2
House 4 synthetic turf	38 m^2
House 3 additional front yard paving	38 m^2
Impervious Area Not Directly Connected	
House 1 & 3 backyard paving	30 m^2
Total Impervious Fraction = (744+933+387+104+38+38+30)/3000	76%
Effective Impervious Fraction (**to be used in MUSIC**) = (744+933+387+104+38+38)/3000	**75%**

Table 1 - Effective Impervious calculation example

Note – All impervious areas that drain to WSUD features, such as the raingarden and rainwater tank in this example, must be counted in the effective impervious fraction.

For larger catchments, the following table indicating the fraction effective impervious for different land uses can be used as a guide. Any significant deviation from the figures in the table below must be supported by relevant information (i.e. long term flow data that enables calibration of the model).

Zone	Zone Code	Brief Description / Examples	Normal Range	Typical Value
Residential Zones:				
Residential Growth Zone, General Residential Zone and Neighbourhood Residential Zone	RGZ, GRZ & NRZ	Large Residential. (Allotment size 601m^2 – 1000m^2)	0.50 – 0.80	0.60
		Standard densities. (Allotment size 300m^2 – 600m^2)	0.70 – 0.80	0.75
		High densities. (Allotment size $<300m^2$)	0.80 – 0.95	0.85
Low Density Residential Zone	LDRZ	Allotment size $>1001m^2$	0.10 – 0.30	0.20
Mixed Use Zone	MUZ	Mix of residential, commercial, industrial and hospitals.	0.6 – 0.90	0.75
Township Zone	TZ	Small townships with no specific zoning structures	0.40 – 0.70	0.55
Industrial Zones				
Industrial 1 Zone	IN1Z	Main zone to be applied in most industrial areas	0.70 – 0.95	0.90
Industrial 2 Zone	IN2Z	Large industrial zones away from residential areas	0.70 – 0.95	0.90
Industrial 3 Zone	IN3Z	Buffer between Zone 1 and Zone 3	0.70 – 0.95	0.90
		- for garden suppliers/nurseries	0.30 – 0.60	0.50
		- for quarries	0.10 – 0.30	0.20
Commercial Zones				
Commercial 1 Zone	C1Z	Main zone to be applied in most commercial areas	0.70 – 0.95	0.90
Commercial 2 Zone	C2Z	Offices, manufacturing industries and associated uses	0.70 – 0.95	0.90
Rural Zones				
Rural Zone	RUZ	Main zone to be applied in most rural areas	0.05 – 0.20	0.10
Rural Living Zone	RLZ	Predominantly residential use in rural areas	0.10 – 0.30	0.20
Public Land Zones:				
Public Use Zone				
- Education	PU2Z	- schools and universities	0.60 – 0.80	0.70

Zone	Zone Code	Brief Description / Examples	Normal Range	Typical Value
- Service and Utility	PU1Z	power lines, pipe tracks and retarding basins	0.00 – 0.10	0.05
		- reservoirs	0.40 – 0.60	0.50
- Health and community	PU3Z	- hospitals	0.80 – 0.90	0.85
- Transport	PU4Z	- railways and tramways	0.60 – 0.80	0.70
- Cemetery/ Crematorium	PU5Z	- cemeteries and crematoriums	0.50 – 0.70	0.60
Local Government	PU6Z	- Libraries, sports complexes and offices/depots.	0.50 – 0.90	0.70
- Other Public Use	PU7Z	- Museums	0.50 – 0.80	0.60
Public Park and Recreation Zone	PPRZ	Main zone for public open space, incl golf courses.	0.00 – 0.20	0.10
Public Conservation and Resource Zone	PCRZ	Protection of natural environment or resources	0.00 – 0.05	0.00
Road Zone – Category 1	RDZ1	Major roads and freeways	0.60 – 0.90	0.70
Road Zone – Category 2	RDZ2	Secondary and local roads	0.50 – 0.80	0.60
Special Purpose Zones				
Special Use Zone	SUZn	Development for specific purposes	0.50 – 0.80	0.60
Comprehensive Development Zone	CDZn	Large and complex developments – residential	0.40 – 0.80	0.50
Urban Floodway Zone	UFZ	Land identified as part of an active floodway	0.00 – 0.05	0.00
Capital City Zone	CCZn	Special use Zone for land in Melbourne's central city	0.70 – 0.90	0.80
Docklands Zone	DZn	Special use Zone for land in Docklands area	0.70 – 0.90	0.80
Commonwealth Land	CA	Army Barracks, CSIRO	0.50 – 0.80	0.60

Table 2 - Effective Impervious values for source nodes

Note: Values included in this table are not runoff coefficients and should not be used as runoff coefficients for flood modelling.

Soil parameters

In MUSIC the pervious area properties default to Brisbane properties. These will need to be altered to reflect Melbourne properties. Any deviation from the Melbourne parameters listed here should be described in the report provided with the model. Supporting evidence should also be provided.

The soil input parameters recommended here are based on a review of twelve catchment calibrations undertaken for Melbourne catchments in recent years.

Soil Store Capacity = 120mm   Field Capacity = 50mm

Pollutant concentration data

The default values provided for TSS, TP and TN should generally be used, unless additional data is available. Any new data must be published and demonstrate that there is a significance difference between the new data and the default data. In models where roofs, paved areas and the remaining vegetated areas of urban areas are split into separate source nodes, the following guideline values will be accepted:

Pollutant	Surface Type	Wet Weather		Dry Weather	
		Mean (log mg/L)	SD (log mg/L)	Mean (log mg/L)	SD (log mg/L)
SS	Roof	1.301	0.333	n/a	n/a
	Road and paved areas	2.431	0.333	n/a	n/a
	Urban area not covered by roof, road or paved areas	1.900	0.333	0.96	0.401
TP	Roof	-0.886	0.242	n/a	n/a
	Road and paved areas	-0.301	0.242	n/a	n/a
	Urban area not covered by roof, road or paved areas	-0.700	0.242	-0.731	0.360
TN	Roof	0.301	0.205	n/a	n/a
	Road and paved areas	0.342	0.205	n/a	n/a
	Urban area not covered by roof, road or paved areas	0.243	0.182	0.455	0.363

Table 3 - Pollutant concentration data for source nodes

Any changes to default or guideline pollutant concentrations for the modelling of development or Melbourne Water works must be agreed by Melbourne Water in writing.

Serial correlation

The Serial Correlation (R squared) must be zero for TSS, TP and TN for analysis of stormwater quality. This is especially important where a single reference rainfall year is used as it can otherwise result in significant fluctuations in predicted performance.

Stochastic versus mean generated data

Stochastically generated data is always to be used, except where there is a requirement to examine behaviour for a particular storm event or set of operating conditions.

6. General guidelines for treatment nodes

K, C*, C**

Melbourne Water must approve any changes to these parameters in writing. Any data used to modify these parameters must be published data, and be appropriate for the circumstances being modelled.

Number of CSTR cells

The CSTR input parameter in MUSIC represents the mixing behaviour of treatment nodes. The default number of CSTR cells for a treatment node can be changed through the "More" button. The number of CSTR cells for sedimentation basins can also be changed through the "Estimate Parameters" button.

The length to width ratios for the shapes used to estimate the number of CSTR cells is listed in the figure below.

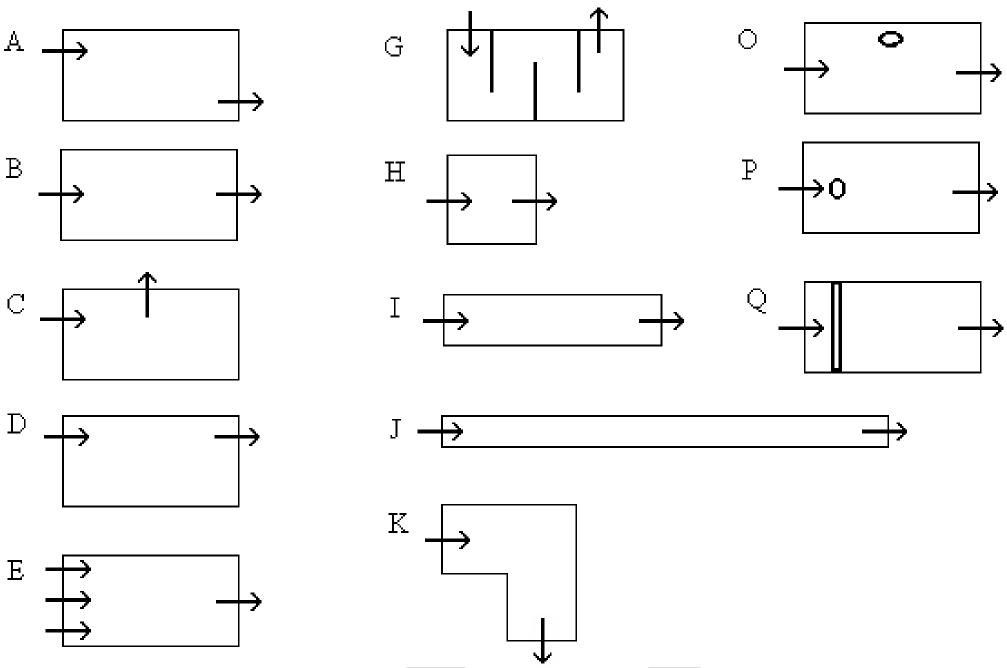


Figure 3 - Treatment node shape to determine the number of CSTR cells (Persson, 2000). **Length to width ratio: A, B, C, D, E, G, O, P, Q – 2:1; H – 1:1; I – 4:1; J – 12:1; K – 3:1; P contains an island blocking the central flow path and Q contains a structure to distribute the flows evenly**.

Treatment trains

Treatment nodes within a MUSIC model must be linked in an appropriate order, with primary treatment devices first and tertiary treatment devices last (if present).

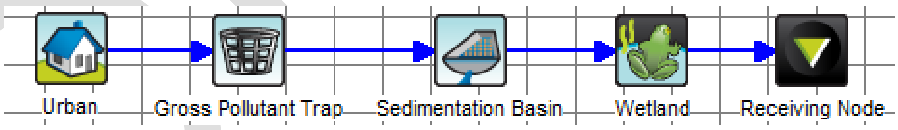


Figure 4 - example treatment train

Exfiltration

The exfiltration rate relates to the seepage rate (in mm/hr) of the soil surrounding and underlying a treatment system and is used to represented losses from a treatment system into the surrounding soils. Exfiltration does not refer to the hydraulic conductivity of the soils contained within the treatment system.

For all nodes, adoption of an exfiltration rate greater than 0 mm/hr must be supported by geotechnical information, and, for Melbourne Water assets, prior agreement by Melbourne Water is needed. Exfiltration is encouraged where practical.

Instream works and waterways

Do not include constructed or natural waterways, or grassed retarding basins as treatment nodes.

Stormwater harvesting (labelled "reuse" in MUSIC)

Details on Melbourne Water's processes for stormwater harvesting can be found here:

http://www.melbournewater.com.au/planning-and-building/stormwater-management/stormwater-harvesting/pages/stormwater-harvesting-licence.aspx

For large scale stormwater harvesting, a reuse master plan must be provided which is to be signed off by all relevant authorities (Local Government, Retail Water Company, Melbourne Water). Calculations should be provided to support volumes of harvested stormwater. All harvested stormwater should be treated to a fit-for-purpose standard that also supports the long term sustainability of the reuse infrastructure (including irrigation infrastructure). Guidelines on quality of harvested stormwater are here:

http://www.environment.gov.au/water/quality/publications/nwqms-australian-guidelines-water-recycling-managing-health-phase2-stormwater

Stormwater harvesting can contribute to treatment train performance if the demands are reliable (e.g. toilet flushing – 20 litres per person per day; laundry – 80 litres per household per day). Irrigation of residential blocks is encouraged, however will not be accepted as a demand for reuse in a model due to the high variability of this demand.

For stormwater harvesting to be accepted as part of a MUSIC model there needs to be a suitable agreement between the relevant stakeholders.

A minimum of ten years of six minute rainfall data must be used to model all stages of a design that includes stormwater harvesting.

7. Swales

Suggested vegetation heights:

- **Grass swale** (mowed) height range: 10 – 100mm
- **Vegetation** (not mowed): 100 – 400mm

In the case where unmown vegetation is being used, the proponent should identify what type of vegetation is proposed, and how it will be managed within the landscape and maintenance requirements of the development. Waterways within developments cannot be deemed as swales and shall not be included in the treatment train model.

8. Gross pollutant traps (GPTs)

No treatment should be attributed to a GPT unless it is supported by reliable studies. Where reliable and locally representative data is available, gross pollutant and sediment treatment may be attributed to a GPT. In the absence of specific data, the default treatment performance for sediment removal provided in the MUSIC Manual can be applied (70% removal for concentrations greater than 75mg/L).

Nitrogen and phosphorus reductions from GPT's must be set to zero.

9. Sediment ponds (labelled "sedimentation basin" in MUSIC)

Concept Design

For the concept design stage, the sediment pond can be assumed to be 10% of the macrophyte zone area and have an average depth of 1.5 metres.

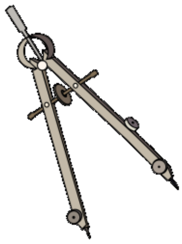
Use of separate 'sedimentation pond' and 'wetland' nodes

Where there is a difference in water level between the sediment pond and wetland macrophyte zone (at top of extended detention), the sediment pond and wetland macrophyte zone should be modelled using separate nodes in MUSIC (i.e. a "sedimentation basin" node and a "wetland" node). When separate nodes are used, the wetland node's "Inlet Pond Volume" should be set to zero. The sedimentation basin node's equivalent pipe diameter must reflect the hydraulic control between the sediment pond and macrophyte zone (this is likely to need to be defined using the custom outflow function). The surface area and extended detention depth should match the dimensions shown on the functional design plans.
Where the sediment pond and macrophyte zones have a common water level at (at top of extended detention), a single "wetland" node should be used to represent the system in MUSIC with the sediment pond represented by input parameters of the Inlet Pond Volume of the wetland node (see below for more detail).

Functional and Detailed Design

Do not design the size of the sediment pond with MUSIC alone. Sediment ponds must be designed to meet the sediment pond requirements of Melbourne Water's Constructed Wetland Design Manual. To demonstrate water quality objectives, the

MUSIC model sediment pond area can unrepresentatively be set to 10% of the macrophyte zone area, rather than the size calculated to the Constructed Wetland Design Manual requirements.

	Actual design to meet the sediment pond requirements of Melbourne Water's Constructed Wetland Design Manual.
	MUSIC model sediment pond area can unrepresentatively be set to 10% of the designed wetland macrophyte zone area to demonstrate water quality objectives.

10. Wetlands

Constructed wetland systems must be designed in accordance with Melbourne Water's Design, Construction and Establishment of Constructed Wetlands: Design Manual (Melbourne Water). This document is available from Melbourne Water's web page. MUSIC can verify the pollutant removal results of a design.

The recommendations for modelling with an inlet pond or separate sedimentation basin node are in section 9.

For Functional and Detailed Design stages, the stage storage discharge relationships of the wetland extended detention must be represented using MUSIC's Custom Outflow and Storage Relationship function. Further information on this is in section 19. Where the wetland is within a retarding basin, the MUSIC model must also reflect the stage/storage/discharge relationship of the retarding basin (i.e. when the water level exceeds TED).

In MUSIC the area and volume of the wetland is entered. The volume divided by the area must be no more than 400mm.

Wetland user defined outlet

Stage storage discharge relationship

By default MUSIC automatically estimates the stage-storage-discharge relationship for a wetland or pond. It does this with the user defined dimensions including the permanent pool volume, surface area, extended detention depth, outlet pipe diameter and weir length.

- Stage (m) – height or depth of water in the wetland
- Storage (m^3) – water storage volume for a given stage
- Discharge (m^3/s) – Outflow rate (for outflow pipe or weir and for overflow pipe or weir)

The default approach is adequate for concept level design, but not for functional or detailed design. Melbourne Water's Constructed Wetlands Design Manual recommends that, for functional and detailed design, the stage storage discharge relationships are defined by the user to provide greater accuracy. This is especially important for understanding the inundation frequency and duration patterns of the wetland.

MUSIC requires three relationships to be defined:

- Stage – storage
- Stage – discharge for outlet
- Stage – discharge for overflow

Stage – storage relationship

The stage-storage relationship describes how the water storage volume of the wetland changes as depth increases. These can be obtained from a 3D model or estimated based on the base wetland area and batter slopes.

Stage-discharge relationship

The stage-discharge relationship equation in Melbourne Water's Constructed Wetland Design Manual should be used for the outlet weir for a range of water levels. It is important that the relationships are extended across a broad range of depths, storage volumes and discharges, even beyond what is physically realistic, to ensure the model is always able to find a valid numerical solution. By default, MUSIC creates the stage-storage-discharge relationship to a depth of 2 m above the extended detention depth.

Entering data in the Custom Outflow and Storage Properties

MUSIC by default assumes a low flow orifice outlet (**Pipe Flow**). In most cases the design will have a narrow slot weir plate, and this needs to be defined using the custom outflow properties.

MUSIC by default adds in a high flow weir outlet at the extended detention depth (**Weir Flow**). Overflow weirs included in the design to discharge flows above the extended detention depth can be defined using the standard outflow properties box.

MUSIC by default assumes the wetland or other treatment has vertical sides. If that is not a reasonable assumption for your design it can be changed using the custom **storage** properties.

The figure below indicates the location of each of these input parameters within the Custom Outflow and Storage Properties when defined by the user.

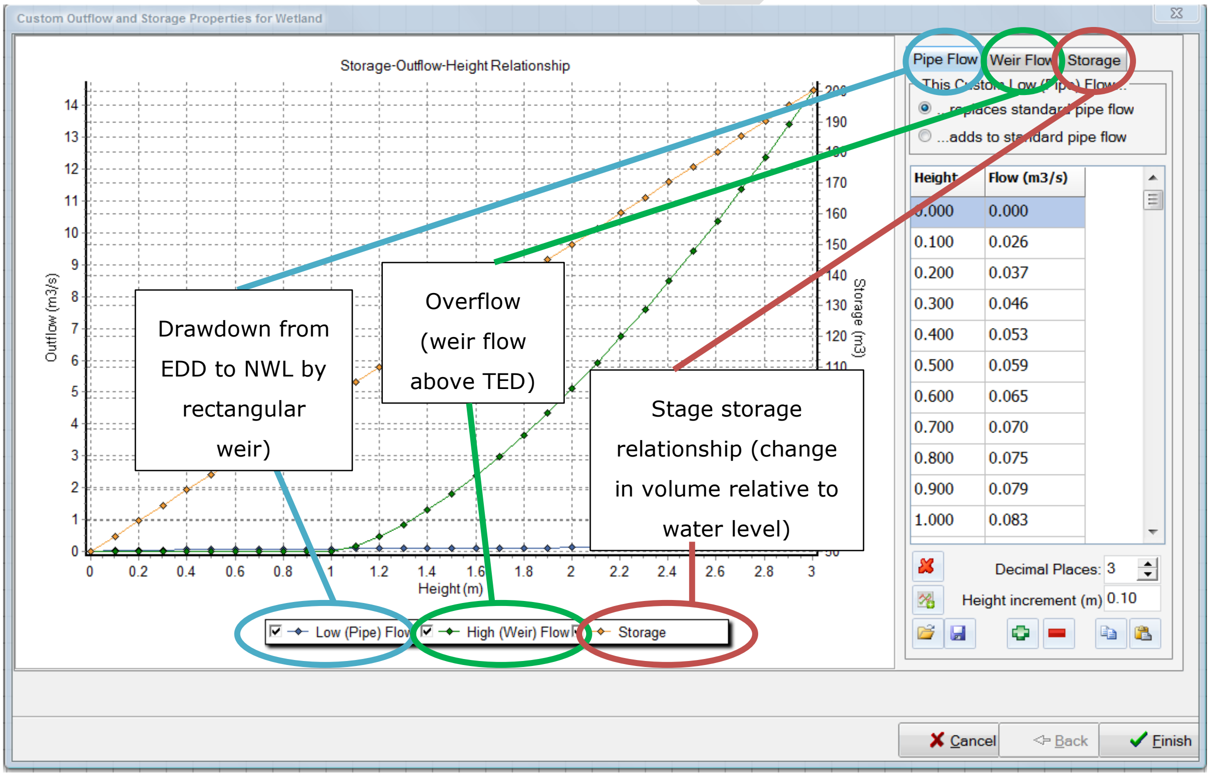


Figure 4 - Description of input parameters for Custom Outflow Storage Properties

11. Lakes

MUSIC is not a suitable model for in-lake processes, other than water balance assessments. Guidance on this topic can be found in the Melbourne Water publication

"Constructed Shallow Lake Systems for Developers". This document is available as a PDF download from Melbourne Water's web page.

12. Bioretention systems

Sediment removal

Bioretention systems with catchments greater than 5 Ha must have a sediment pond upstream. Bioretention systems with catchments less than 5 Ha must have a vegetated swale, coarse sediment forebay, inlet pond or gross pollutant trap on the inlet.

Filter media

In the model, the hydraulic conductivity of the filter media should match the specification or be a conservatively lower figure (as recommended in the Adoption Guidelines for Stormwater Biofiltration Systems 2015). An acceptable range for the hydraulic conductivity of a bioretention system is 100mm/hr – 300mm/hr.

Submerged zones, or systems without an underdrain, are generally recommended if site conditions permit. If a submerged zone is not used, the filter media depth field in MUSIC must not include the transition or drainage layers. Drainage and transition layers can be included as part of the submerged zone depth.

Plant species selection

The Adoption Guidelines for Stormwater Biofiltration Systems 2015 recommend some specific plant species as well as recommending typical characteristics of plants that provide effective nutrient removal. If effective nutrient removal plants are selected under 'Vegetation Properties' (recommended), the planting specification must support this.

The design must provide adequate soil moisture to sustain plants. This can be achieved through:

- minimum filter media depth of 400mm (500mm preferred),
- a submerged zone
- no underdrain
- a large enough size catchment (generally 50-100 times the area of the bioretention system)
- a reliable source of irrigation.

Extended detention depth

Consideration should be given to the extended detention depth selected for bioretention systems. The depth should be safe for construction, operation and maintenance of the system. If the system has a longitudinal slope, it will not have a uniform extended detention depth, and therefore an average should be selected.

13. Permeable pavement

Permeable pavement should be modelled as per the manufacturer's guidelines. Documentation supporting the modelling must be submitted for review.

14. Imported data nodes

Supporting documentation will be required to demonstrate the use of any imported data nodes in models.

15. Generic treatment nodes

Generic nodes should not be used for modelling treatment systems unless supported by supplementary models or if modelling as per a treatment manufacturer's guidelines with supporting documentation. Such models are subject to prior agreement by Melbourne Water.

A generic treatment node may be used to simulate a pump, by setting the flow rate passing through the node to the maximum pump flow rate. Flows in excess of the pump flow rate may need to be accounted for using a duplicate catchment.

Generic nodes may be used to simulate the splitting of flows, where a flow rate based diversion is used. Appropriate documentation and calculations must be provided to justify the split of flows, if used to simulate splitting flows. Most flow splits can be more easily modelled using a secondary link to split flows from a catchment or treatment outlet.

For generic nodes, within a transfer curve, the outflows, or pollutant concentrations out, must not exceed the inflows, or pollutant concentrations in. A pollutant balance should be done to check that pollutants are not created or lost, as generic treatment node outputs can easily be misinterpreted.

16. Use of secondary links

Secondary links can be used to direct surface flows and baseflows through different routes. For example, surface flows may be directed through treatment systems while baseflows pass through groundwater and discharge directly into the receiving water.

This can be modelled by adding a secondary link to a catchment and routing it around the treatment to the receiving node.
Secondary links are particularly useful for controlling outflows from treatment nodes. For example, they can be used top model piped flows from a treatment system entering a downstream treatment while overflows or bypass flows are routed around it. This is especially useful when modelling stormwater reuse systems where only treated flows are likely to be captured for reuse, while overflows are likely to bypass the reuse system.
Another scenario where secondary links are particularly useful is when directing pumped flows from one treatment to another treatment/storage from which reuse is extracted.

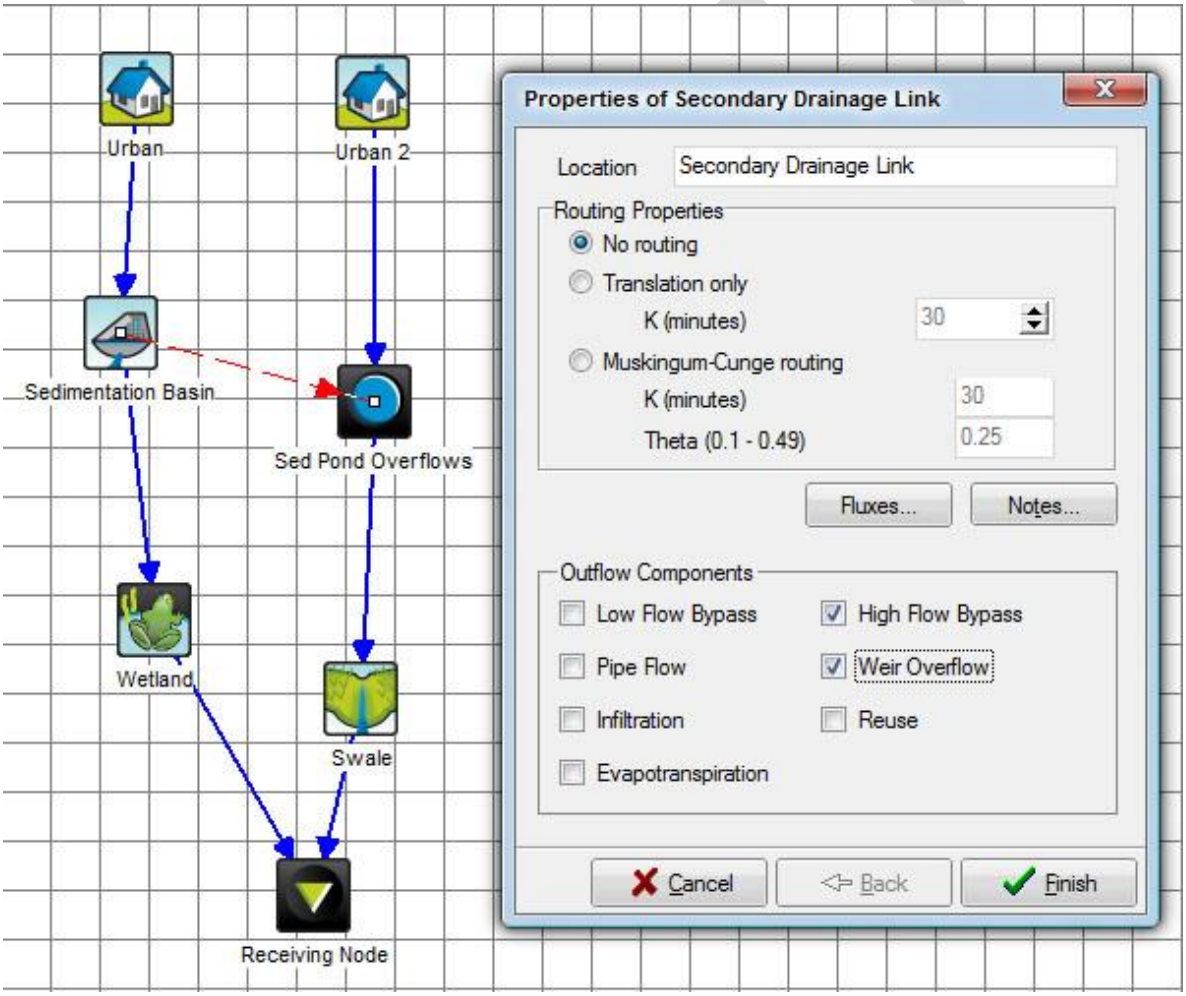


Figure 5 - A MUSIC model containing a secondary link

It is important when using secondary links to ensure that all flows are directed back into the final receiving node before reporting to ensure flows are not lost.

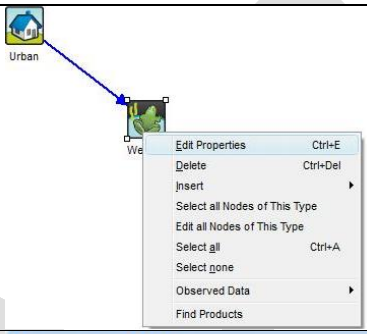
17. Exporting results

An inundation frequency curve illustrates the frequency with which certain depths are exceeded within a treatment system such as a wetland.

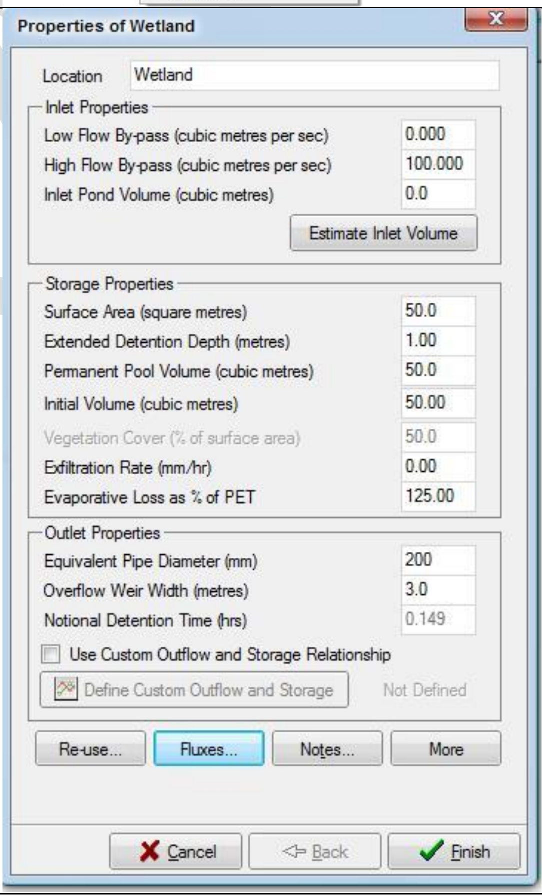
To undertake a frequency analysis, the treatment system depth data must be exported from MUSIC using the 'flux file'. Recent versions of MUSIC can export the data at a daily timestep that is easier to handle.

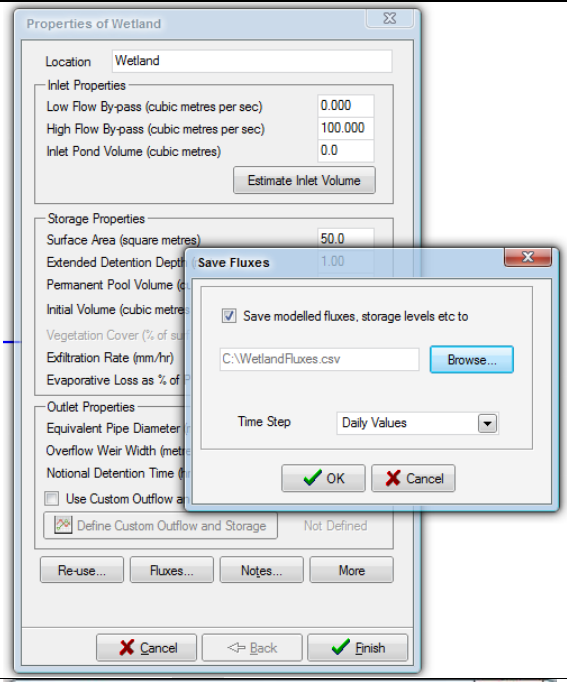
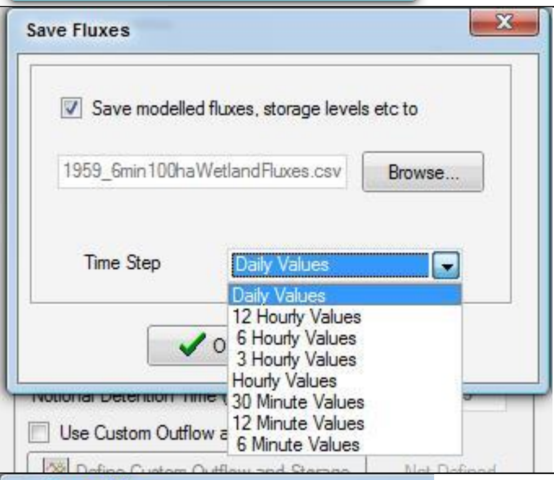
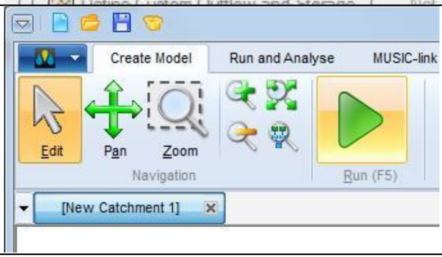
How to create a flux file

1. Right click on wetland and select 'Edit properties'



2. Click on 'Fluxes'



<table>
<tr>
<td>3. Tick ‘Save modelled fluxes’ and set a filename.</td>
<td>
</td>
</tr>
<tr>
<td>4. Change the Timestep to ‘Daily’ (Very important)</td>
<td>
</td>
</tr>
<tr>
<td>5. Run the MUSIC model</td>
<td>
</td>
</tr>
</table>

Once the flux file is created, an inundation frequency curve can be created automatically from a daily flux file using the Wetland Analysis Tool (on www.MUSICauditor.com.au) or manually in a spreadsheet following the guidance provided in the Constructed Wetlands Design Manual Part D.

Assessing flow rates for the 1.5 year ARI

The BPEM flows objective, or other flow objectives based on stream erosion potential, can be assessed in MUSIC. To make sure the 1.5 year flow rate in MUSIC is sensible, compare the partial series from MUSIC model (without any treatment/retardation) with peak 1 to 2 year flow estimates from rational method. Options for modelling are:

a) Manually create a rainfall file to use in MUSIC that contains a range of 1.5 year peak rainfall events (i.e. for a range of storm durations) and then run it through the MUSIC model and compare the maximum outflow rate with the pre development 1.5 year flow rate. This approach doesn't take into account antecedent conditions in storages (i.e. how full they are at the start of the event). To be conservative, assume rainwater tanks and extended detention storages are full at the start of the 1.5 year event.
b) Use 10 years of historical rainfall data. Open a flow timeseries plot for the downstream end of the developed catchment. Identify the flow rate of the 7th highest flow event (which should be the post development 1.5 year flow based on partial series plotting position) and compare to the pre-development peak 1.5 year flow rate.

18. Submission requirements for MUSIC modelling

Constructed wetlands

Melbourne Water's submission requirements for constructed wetlands are in Part B of the Constructed Wetlands Design Manual. An excerpt of the submission requirements that directly relate to MUSIC modelling are provided below.

Wetland concept design

1. 1. Summary of MUSIC modelling (or alternative method or models), including:
   a) version of MUSIC
   b) meteorological data used
   c) map outlining catchment areas and direction of flows
   d) justification for choice of source node impervious percentage
   e) any routing used
   f) treatment node parameters
   g) any modelling parameters that are not in accordance with Melbourne Water's MUSIC Modelling Guidelines (this document)
   h) pollutant removal results
2. A copy of the MUSIC model

Wetland functional design

1. A description of the updated MUSIC model (or alternative method or models), including matching:
   a) the inlet pond volume in MUSIC to the sediment pond volume shown on plans (excluding the sediment accumulation volume)
   b) the permanent pool volume to the proposed bathymetry (using the user defined stage-storage relationship)
   c) the high flow bypass configuration to the design
   d) the extended detention controlled outlet configuration to the design (using the user defined stage-storage relationship)
2. An inundation frequency analysis of water levels in the macrophyte zone
3. The 90th percentile residence time in the macrophyte zone
4. A report from MUSIC auditor tool (if available)

Other treatment devices

In general, the functional design report should incorporate the following information for systems (other than wetlands) modelled in MUSIC:

1. Description of the function and intent of the treatment system.
2. Description of how fraction impervious was calculated (what figures were used for different zonings).
3. Specification for the treatment system, including any soil or filter media.
4. Vegetation specification for bioretention systems.
5. Description of any updates to the MUSIC model at each stage of the design.
6. Summary of MUSIC modelling (or alternative method or models), including:
   a) version of MUSIC
   b) meteorological data used
   c) catchment areas with impervious percentage
   d) any routing used
   e) treatment node parameters
   f) any modelling parameters that are not in accordance with Melbourne Water's MUSIC Modelling Guidelines
   g) A copy of the MUSIC model
   h) A report from MUSIC auditor tool (if available)