WSUD for WSU Indigenous Centre for Excellence

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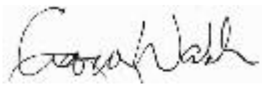
Signed	
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Revision	Date	Approved	Details of Revision
01			
Draft 03	12 September		Updated roof areas and wetland size
Draft 05	4 November		Revised with updated roof, catchment, tank and drainage arrangements
Draft 07	8 November	Gary Walsh	Performance for runoff volume reduction
Draft 08	14 November 2024		Updated southern car park area and gravel path
Final	3 March 2025	Gary Walsh	Reflects final Civil and landscape plans
Version 10	13 August 2025	Gary Walsh	Reports implications of temporary carpark: Issued for review
Version 11	13 August 2025	Gary Walsh	Incorporates feedback from EU

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CONTENTS

1. Purpose of report

This report is prepared for Jackson Clements Burrows to support the development of the Indigenous Centre of Excellence at the Western Sydney University - Parramatta South Campus. It:

- Sets out a configuration of WSUD elements for this project to support nominated objectives and performance targets
- Presents a MUSIC modelling approach for assessing the performance of the WSUD strategy.
- Reports performance with reference to relevant requirements.
- Describes steps towards the performance of the site’s ultimate development form.

2. Site WSUD Objectives

The proposed WSUD elements aim to meet the following multiple objectives:

- **Stormwater Pollutant Reduction:**

  Best Practice Environmental Management Practice (BPEM) targets for New South Wales nominate post-development pollutant reduction targets (percentage of the post-development average annual load) for New South Wales. These same targets are also specified in the Development Control Plan of Parramatta City Council (2023), and are as follows:

  - Total suspended solids (TSS): 85%
  - Total phosphorous (TP): 65%
  - Total nitrogen (TN): 45%

- **Annual Runoff Volume Reduction:** Annual outflow at least 10% less than pre-development outflow where practicable, specified in the Development Control Plan of Parramatta City Council (2023).
- **Cooling and Greening:** Integration with landscape to enhance urban cooling and increase green spaces.
- **Reducing Potable Water Usage:** Aligning with building sustainability standards to minimize reliance on potable water.

Urban Water Cycle mitigation requirements

The project results in substantial re-naturalisation of the site. Large areas of currently impervious car parking will be restored to natural landscapes (refer Table 2-1). The impervious character of typical urban development creates an excessive volume of stormwater runoff, which is polluted and also has a detrimental hydrologic impact on downstream waterway ecosystems, mostly due to changes to the patterns of the small and frequent flows. A primary objective for the new Indigenous Centre for Excellence, is to promote connection to Country, with the site design intended to maximise the extent to which the building surrounds can re-connect with Country. Returning the building surrounds to Country is a more appropriate performance target than applying targets associated with mitigating urban development.

The balance of the site areas should be regarded as urban development (buildings, car parks, paths) (Table 2-1). It is proposed to provide mitigation for these developed areas to address their detrimental impacts including stormwater runoff volumes and pollutants. In order to quantify the extent of mitigation required, these areas have been modelled in MUSIC to identify the pollutants generated by these catchments, and to calculate the pollutant reductions that would be required to meet the applicable targets (Table 2-2).

Requirements for the site's interim car park development

An extension to the development site area is proposed within the Submissions & Amendment Report to accommodate the relocation of the existing carpark within the development footprint.

The Indigenous Centre of Excellence project will be constructed on the existing P1 carpark that will result in the loss of 284 carparking spaces. The revised project, the subject of consideration by the Department of Planning, Housing and Infrastructure (DPHI) includes the provision of a temporary carpark proposal to mitigate the traffic and parking impacts of the Indigenous Centre of Excellence by providing a total of 288 temporary carparking spaces until such time that the Parramatta South Place Strategy has been implemented. This timeframe is currently estimated to be five (5) years, at which time it is anticipated the temporary carpark will be removed and the landscape reinstated.

This extension to the development site area is expected to be returned to its existing form at project completion and will therefore be 'undeveloped' as part of the ultimate development. The interim development form and associated mitigation initiatives (WSUD elements described in Section 3) are part of the trajectory of the site's conversion from existing impactful urban development into an exemplar of water sensitive urban development. As such, it is proposed that there be no specific performance requirements for this interim development site form.

The temporary carpark and associated temporary WSUD elements have therefore not been included in reporting the site's performance against 'BPEM' (stormwater quality) and 'Annual Runoff Volume Reduction' targets.

Although we have not assembled a model of the interim development form, the performance of these temporary WSUD elements ('Atlantis' turf cells in place of impervious surfaces within carparking bays, combined with Gross Pollutant Traps) is likely to:

- achieve close to the Stormwater Pollutant reduction targets
- not achieve the Annual Runoff Volume reduction target (but will be significantly reduced compared with a conventional carpark).
- be a compromised 'Cooling and Greening' outcome (but will be significantly better than a conventional carpark).

Table 2-1 Natural and urban catchments within the project site

	Area (ha)	Impervious	Mitigation
Area of site returned from urban to natural	0.287	0 %	No Mitigation required
Developed area of site	0.590	100 %	Pollutant reduction targets apply

Table 2-2 Pollutant reduction requirements applicable to urban catchments

	Unit	TSS	TP	TN
Annual pollutant load generated by developed area of site	kg/y	953.8	2.0	13.5
Annual pollutant reduction requirement	%	85 %	65 %	45 %
Annual pollutant load reduction required for developed area of site	kg/y	810.7	1.3	6.1

3. Proposed configuration of WSUD elements

We have used the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) model in an iterative design process to optimise the proposed WSUD response for the site. Through optimization, we considered wetland sizes ranging from 100 to 400 m^2, bioretention areas between 1 and 20 m^2, and rainwater tanks with capacities of up to 100kL. This process led to the following proposed configuration:

- 15 m^2 bioretention at the north car park
- 10 m^2 bioretention at the south car park
- 100 kL of rainwater tank

- 84 m of swale
- 180 m² of constructed wetland

Figure 1 below shows the layout of these elements within the site and the stormwater catchments which connect to these elements.

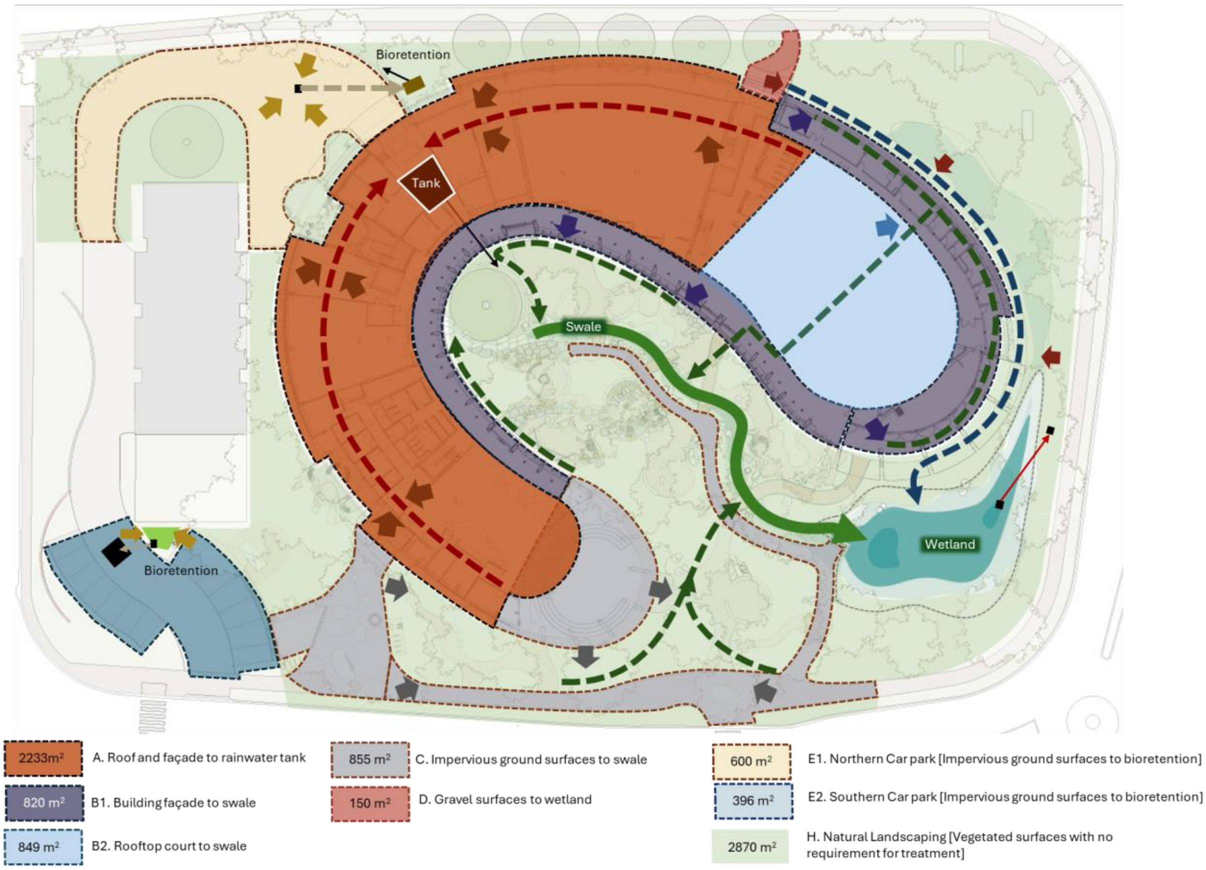

Figure 1 Schematic plan of the proposed WSUD elements (not to scale). Arrows show indicative stormwater flow paths and drainage connections.

Design details of proposed stormwater treatment devices

Rainwater tanks:

- Total storage: 100 kL
- Demands:
  - Toilet flushing
  - Wash down
  - irrigation demand for the small atrium landscape (optional).

Adopting irrigation as a demand is not critical for the attainment of performance targets.

Bioretention system in the northern car park:

- Extended detention: 0.2 m

- Filter area: 15 m^2
- Submerged zone: 300 mm depth.

Bioretention system in the southern car park:

- Extended detention: 0.2 m
- Filter area: 10 m^2
- Submerged zone: 300 mm depth.

Swale:

- Length: 84 m
- Width: 1 m base width, 5 m top width
- Batter slope: Typical 1:4 but variance in slope would have insignificant influence on performance results.

Constructed wetlands:

- Total Wetland area 180 m^2 (macrophyte zone 150 m^2 minimum wetted area at normal water surface level plus sediment basin / inlet zone: 30m^2)
- Extended detention: 0.35 m
- Average water depth at normal water level: 0.15 to 0.3 m
- Macrophyte cover: 80% (non-variable model input parameter)
- Wetland batter slopes: Typical 1:4 but variance in slope would have insignificant influence on performance results
- Notional detention time: 3 days

4. Assessment of performance of proposed WSUD elements

The proposed WSUD elements were modelled using MUSIC v6.3 to assess the potential reductions in flow and pollutant load. The key information of the meteorological data are as follows:

- Rainfall station: PARRAMATTA NORTH MASONS DR (66124)
- Time period: 1/1/1988 - 1/1/1998 11:54:00 PM
- Time step: 6 minutes
- Mean Annual Rainfall: 900mm
- Evapotranspiration: 1171mm

Rainwater tank Reuse demand estimation

Rainwater was assumed for toilet flushing within the building. The following parameters were considered in the rainwater reuse estimation:

- Toilet flushing (Estimation: 28.5 kL/day):
  - Daily flush volume: 4.5 L per full flush (Source: Sydney water[1])
  - Usage: 4 flushes per person per day (Source: Energy.gov.au[2])
  - Building occupancy: 1583 person (Source: provided by the client)
- Wash down (Estimation: 0.7 kL/day):
  - Taps for wash down: 3
  - Average flowrate: 12 L/min
  - Wash down frequency: 20min/day

In total, the overall site design is based on the total reuse demand of 29.2 kL/day for the rainwater tank.

MUSIC Model configuration

The configuration of the MUSIC model is shown in Figure 2. The input parameters for each of the nodes are shown in Table 4-1.

1 https://www.sydneywater.com.au/education/drinking-water/water-use-conservation.html
2 https://www.energy.gov.au/households/water-efficiency

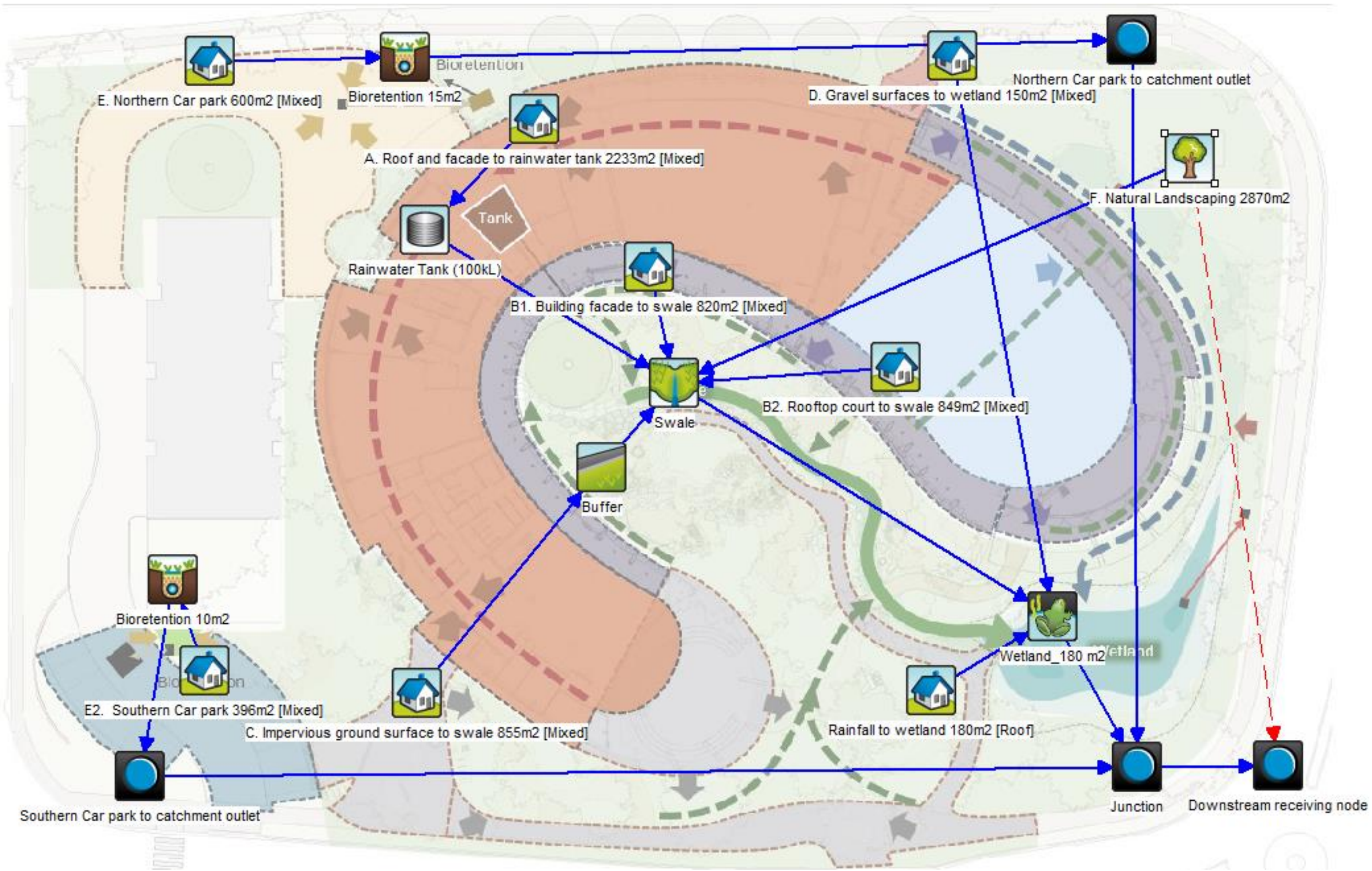

Figure 2 MUSIC Model Set-up

Catchment node

Table 4-1 - Catchment node input parameters

Source node	Total area (ha)	Imperviousness	Surface type in MUSIC model
Roof and facade to rainwater tank	0.223	100 %	Urban - Mixed
Building facade to swale	0.082	100 %	Urban - Mixed
Rooftop court to swale	0.085	100 %	Urban - Mixed
Impervious ground surface to swale	0.086	100 %	Urban - Mixed
Gravel surface to wetland	0.015	0%	Urban - Mixed
Northern Car park	0.060	100 %	Urban - Mixed
Southern Car park	0.040	100 %	Urban - Mixed
Natural landscaping	0.287	0 %	Forest
Rainfall to the wetland	0.018	100%	Roof
Total Site Area	**0.877**	-	-
Total Urbanised Catchments	**0.590**	-	-

Treatment nodes

Modelling properties of the rainwater tank (Figure 3), swale (Figure 4), bioretention in the northern car park (Figure 5), bioretention in the southern car park (Figure 6), and wetland (Figure 7) are presented below.

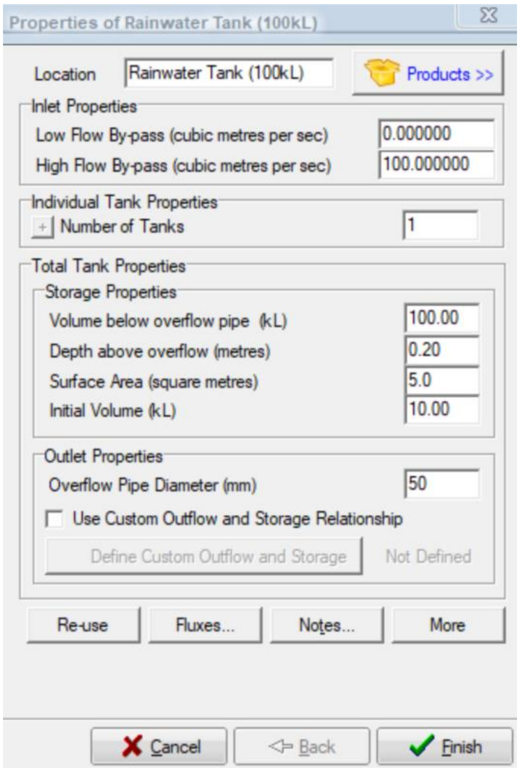

Figure 3 Design parameters used in modelling of rainwater tank

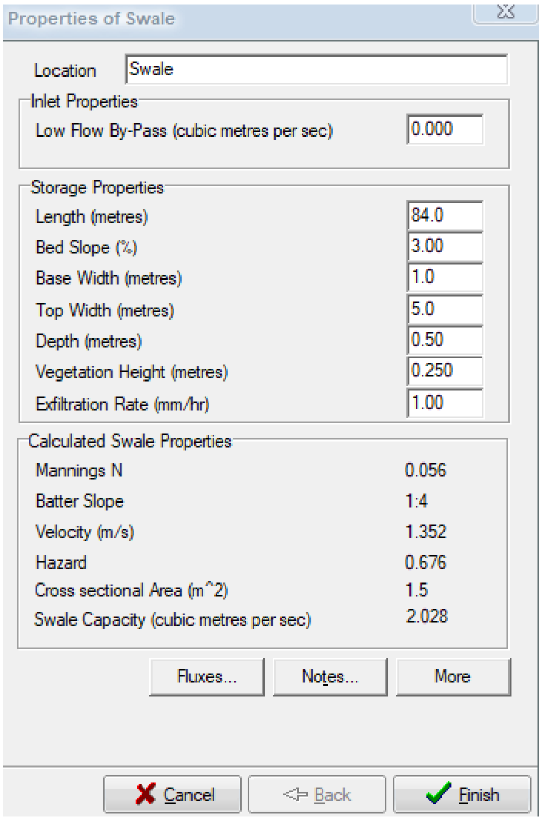

Figure 4 Design parameters used in modelling of swale

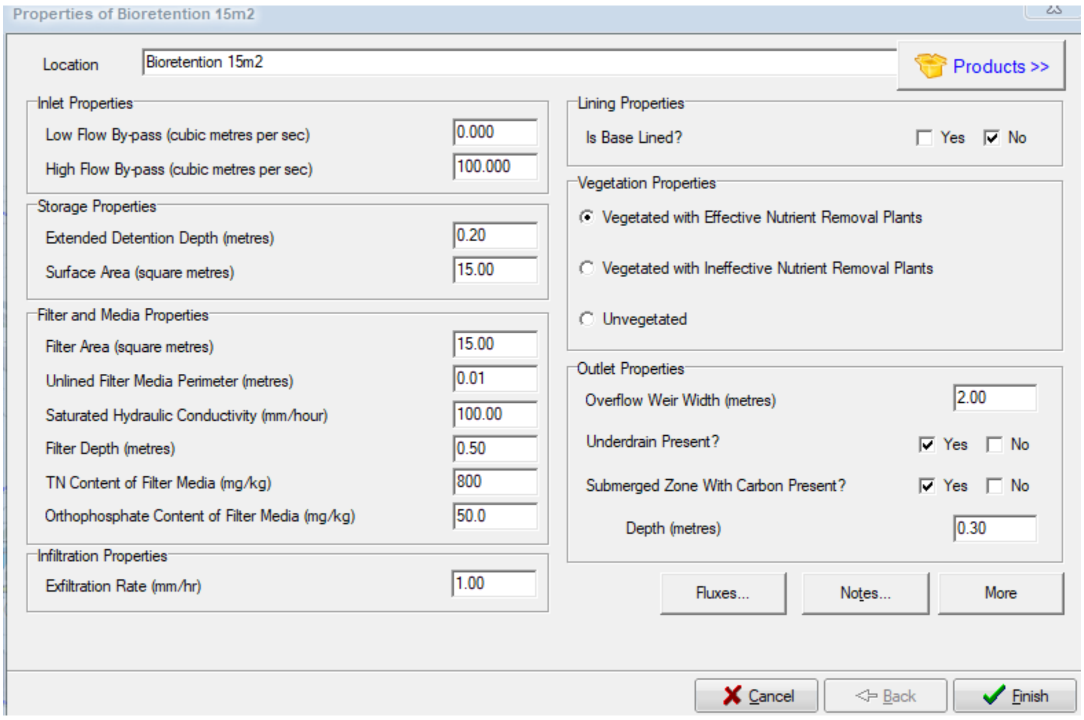

Figure 5 Design parameters used in modelling of bioretention in the northern car park

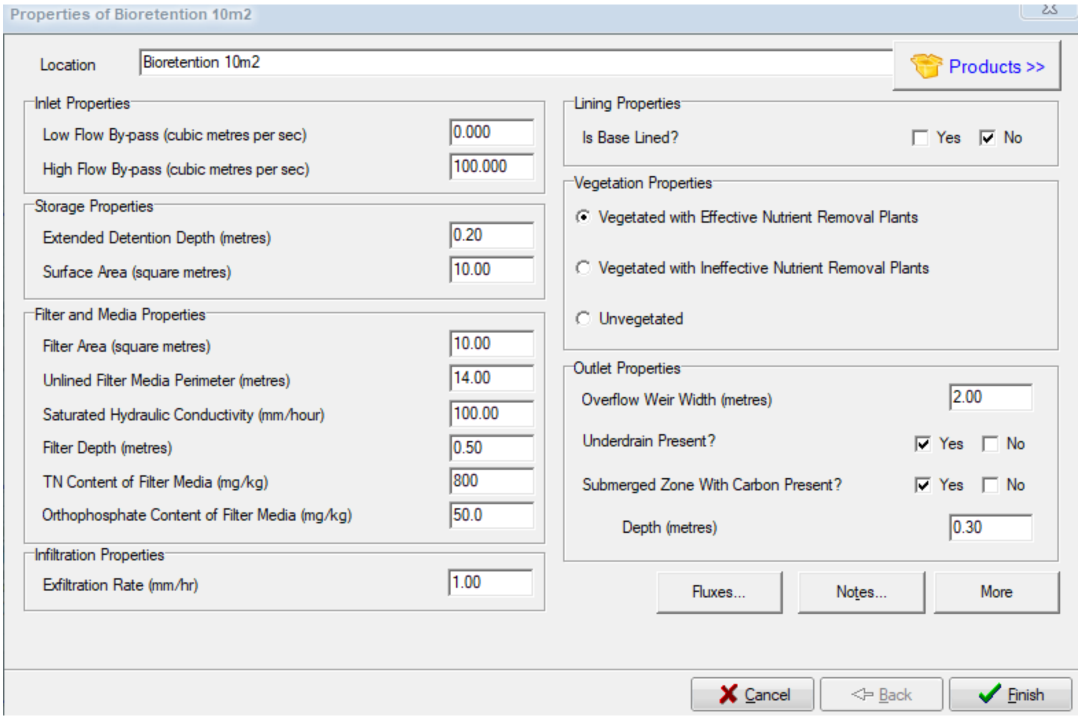

Figure 6 Design parameters used in modelling of bioretention in the southern car park

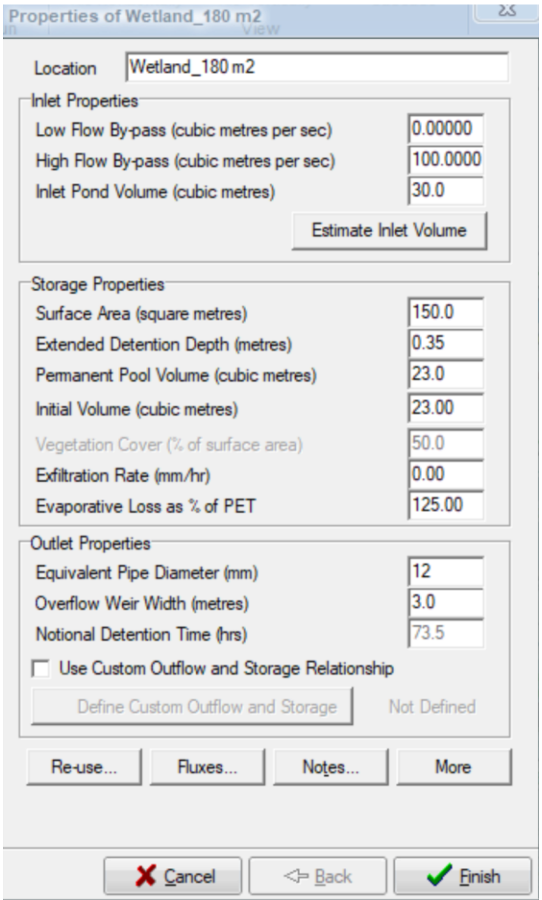

Figure 7 Design parameters used in modelling of wetland

5. Predicted performance

The following performance results from MUSIC modelling are presented and compared to targets and objectives for:

- Reduction in discharge of annual volume of runoff
- Reduction in discharge of stormwater pollutants
- Provision of alternate water to reduce the use of potable water

Reduction in discharge of annual runoff volume

The average annual runoff volume generated by the overall proposed site development, and the runoff volume removed by the proposed WSUD elements is shown in Table 5-1, indicating that the mitigation provided results in a decrease in runoff volume of 53 % compared to no WSUD. The baseflow from the natural landscapes was not included in the derivation of the post-development flow volume (Residual column in Table 5-1) because baseflow is not urban runoff and does not include any urban excess, and thus does not require mitigation. Mitigation was assessed at the node immediately downstream of the constructed wetland (refer Figure 2). The rationale for this configuration is based on the intent of the 10 % flow reduction target for the mitigating the urban excess runoff, to protect the stream from increased volumes of flow and flashy hydrology that is derived from urbanised impervious surfaces. The long attenuation of baseflows from natural landscapes supports rather than detrimentally impacts aquatic ecosystem health in the receiving environments.

Table 5-1 MUSIC model results for average annual runoff volumes

Treatment train at receiving node	Sources	Residual	% Reduction
Flow (ML/yr)	5.65	2.65	53%

This reduction is attained by various mitigation measures, but primarily by the rainwater tanks and associated re-use for non-potable demands. The runoff volume is also reduced by the evapotranspiration losses in the bioretention system and constructed wetlands. Infiltration losses are also modelled in the swale and bioretention by considering the exfiltration rate into the surrounding soil. The MUSIC modelling shows that the site's mean annual runoff volume can be reduced to 2.65 ML/yr.

Figure 8 Catchment of natural condition in the MUSIC set up

The total catchment in its undeveloped (i.e. natural) condition was modelled in MUSIC (Figure 9), using a forest node with 100% perviousness, with the soil parameters for a silty clay soil based on the NSW MUSIC Modelling guidelines (Sydney Local Land Services, 2015). The model of the natural catchment generated runoff of 2.67 ML/year.

In comparison, the proposed WSUD design has successfully reduced the excess runoff generated by the urban development, reducing runoff levels to 2.65 ML/year (Table 5-1), slightly less than those of the area in its natural state. This demonstrates the design's effectiveness in mitigating the impact of urbanization and restoring runoff to natural levels. It should be noted that connecting additional roof areas, such as building facades, to the rainwater tank could further support mitigation efforts to achieve the 10% reduction in flow, as specified in the Development Control Plan of Parramatta City Council (2023). However, to attain further flow reduction from the site would require a reduction in the size of the swale's upstream catchment, which could leave the swale with little water during dry seasons and would thus impact the amenity and character of this swale as a water-related feature.' Hence, further optimisation was not considered desirable for the natural character of the proposed landscape. Furthermore, allowing runoff to water the landscape assists with the reduction of urban heat through the retention of soil moisture, and thus contributes to one of the stated objectives of the DCP and the 'greening' the City of Parramatta (8.2.6.5.4 URBAN HEAT in the Parramatta_DCP_2023, Amendment 4).

Reduction in discharge of stormwater pollutants

For the purposes of demonstrating compliance with the applicable 'best practice' targets for pollutant load reduction, the required pollutant load reduction targets applicable for the developed portion of the overall site (as derived in Table 2-1), were compared with the pollutant load reductions predicted by the MUSIC model of the proposed WSUD response. Table 5-2 shows that the required pollutant mass load reductions were achieved for TSS, TP and TN. This table also compares the percentage of pollutants removed by the proposed treatment train.

Table 5-2 Annual pollutant load reductions for the developed portion of the overall site.

		Pollutant Mass Loads		
		Total Suspended Solids	Total Phosphorus	Total Nitrogen
Load reduction	Annual pollutant load generated by the developed area (with no WSUD) (kg/yr)	953.8	2.0	13.5
	Annual pollutant load reduction target for the developed area (from Table 2-1) (kg/yr)	810.7	1.3	6.1
	Annual pollutant load reduction achieved for the developed area (with WSUD) (kg/yr)	842.7	1.6	10.4
	Compliance achieved	✓	✓	✓
Comparison based on percentage reduction				
Percentage reduction	'Best practice' annual pollutant load reduction (%)	85	65	45
	Annual pollutant load reduction achieved for the developed area (with WSUD) (%)	88	83	77
	Compliance achieved	✓	✓	✓

Provision of alternate water to reduce the use of potable water

The predicted water balance at the rainwater tank node is presented in Table 5-3. This water balance shows that most (87.71 %) of the rainwater flowing to the tank is used for non-potable demands. It should be noted that low percentage of the reuse demand met (13.26%) is due to high demands, with supply being constrained by the relatively small size of the roof area (0.223 ha).

Table 5-3 – Water balance at the rainwater tank

Modelled Parameter	Flow (ML/yr)
Flow In	1.79
Overflows	0.22
Reuse Requested	10.70
Reuse Supplied	1.42
Reuse Demand Met	13.26%
Proportion of inflows harvested	87.71%

6. Maintenance Considerations

WSUD elements requiring maintenance include the following assets:

- Rainwater tank – An underground rainwater storage tank is located beneath the building). Periodic maintenance may be required to remove any accumulated sediments. Maintenance of the tank for this purpose is to be undertaken through an access opening done without entering the tank, with the use of high-pressure washers and vacuum pumps. A second access opening is provided to facilitate venting in the circumstance where confined space entry may be required for repair work.
- Disinfection and water quality treatment for rainwater tank – enhanced filtering and Ultra Voilet disinfection plant and associated maintenance requirements are described in the building management plan.
- Pumps and rainwater tank – Pumps and associated plumbing including facility to switch-over to the potable water (and associated maintenance) supply these are described in the building management plan.
- Swale – accessible via paths and landscape areas. Maintenance tasks would require occasional weeding or trimming, and periodic infill planting.
- Constructed Wetland - accessible via paths and landscape areas. Maintenance tasks would require occasional desilting, weeding or trimming, and periodic infill planting. Desilting activities will not be frequent due to the nature of the upstream sub-catchments (roof and landscaped areas) and the existence of the rainwater tank and swale. The upstream end of the wetland is configured as a deeper pond which can act as a sediment trap but it is expected that cleanout frequency will be in the range of 20 - 30 years; and be undertaken as a complete re-set of the wetland vegetation at that time.
- Bioretention System. The bioretention systems is accessible via the proposed car parking areas. Maintenance tasks would require occasional litter collection, removal of sediments, weeding or trimming, and periodic infill planting. A re-set of the bioretention system may be required at 10 to 20 year intervals and would comprise removal and replacement of the top-most 100mm of bioretention media and vegetation.

7. Discussion and Conclusion

This WSUD concept design has been modelled in MUSIC to confirm compliance with City of Parramatta (New South Wales) best practice management standards for stormwater pollutant reduction. The design also offers multiple benefits, including runoff volume reduction (returning back to undeveloped catchment conditions), cooling and greening (through the provision of passively irrigated landscape in the form of swales and a wetland), and reducing the use of potable water. It recommended that this WSUD configuration (as per the design details in Section 3) be adopted and integrated into the detailed design of the project.

8. References

Greater Sydney Local Land Services, 2015. NSW MUSIC Modelling Guidelines. Available at: https://www.cityofparramatta.nsw.gov.au/sites/council/files/2021-04/nsw-music-modelling-guidelines-august-2015.pdf