STORMWATER MANAGEMENT REPORT

for

PROPOSED CARAVAN PARK DEVELOPMENT

247 MUNGO BRUSH ROAD
HAWKS NEST

LOT 105 IN DP 260058

Prepared by
TATTERSALL LANDER PTY LTD
Development Consultants
October 2024

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report has been prepared to support a Development Application for a caravan park development proposed for Lot 105 in DP 260058, located at 247 Mungo Brush Rd, Hawks Nest. This October 2024 report is a revision of our previous reports, updated to reflect design changes to reduce the development density by reducing the number of sites and introducing a central north-south landscaped corridor.

Figure 1: Locality Diagram

2.0 BACKGROUND INFORMATION

Historically the site has been used for mineral sand mining. The portion of the site proposed for development is vacant and generally cleared.

3.0 SITE CONTEXT

The portion of the site proposed for development is zoned RU2 Rural Landscape under *Great Lakes Local Environmental Plan 2014*. A significant portion of the remainder of the site is zoned E2 Environmental Conservation, and is also constrained by ecological and flooding issues.

The topography within the development footprint is best described as gently sloping and undulating, comprising primarily of a single sand ridge, consistent with much of the Hawks Nest / Mungo Brush area. Levels generally range from 1.0m-6.0m AHD. The development area is mostly cleared, but the proposed development will require some areas of clearing in the south-east corner and also for the main entranceway.

Figure 2: Existing Site

4.0 PROPOSED DEVELOPMENT

The development application proposes caravan park primarily on the cleared portion of the site. The caravan park will include: -

1. Bulk earthworks,
2. 175 long term sites (27 with caravans, 148 with moveable dwellings),
3. Community Facilities,
4. Roads and drainage,
5. Other associated infrastructure.

A proposed layout plan can be seen below.

Figure 3: Proposed Development

5.0 WATER QUALITY TARGETS

The Water Sensitive Design section of the Great Lakes Council Development Control Plan states that a water quality treatment train for this development should meet the pollution reduction targets in Table 1 below:

Table 1: Stormwater Quality Targets

Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	Neutral or Beneficial Effect
Total Phosphorus (TP)	Neutral or Beneficial Effect
Total Nitrogen (TN)	Neutral or Beneficial Effect

6.0 CONSTRAINTS AND OPPORTUNITIES / BEST PLANNING PRACTICES

Best-planning practices have been considered throughout the planning process, with significant biofiltration areas (Council's preferred device) included through the concept design process.

The sandy nature of the existing site presents significant challenges to WSUD implementation. High infiltration sand sites result in low existing pollutant levels, but those same sandy soils, combined with a vacant greenfield site and elevated terrain present opportunities for large scale regrading to effect proper and efficient WSUD and drainage design.

The depth to groundwater at the perimeter of the site will also be a constraint affecting the design of the biofilters.

Council has previously advised the 1% AEP 2100 Flood Level at the site is 2.3m AHD, and the resulting Flood Planning Level is 2.8m AHD. Lower areas of the site will need to be filled sufficiently to provide for future flood free dwelling installation. Details provided on the Tattersall Lander DA Road and Drainage plans show the minimum fill level on the dwelling sites is 3.3m AHD, clear of the FPL.

7.0 SOIL AND WATER MANAGEMENT

A critical time for increase pollutant loads is during construction, and with this in mind, current practice recommends guidelines from Landcom's "Blue Book". Erosion and sediment control measures should be designed and specified in accordance with the "Blue Book" guidelines, and to Council's satisfaction, and be inspected and maintained during the construction phase. This will assist in ensuring adherence to pollutant prevention measures, particularly the removal of suspended solids (sediment).

As the construction footprint will be in excess of 2,500sq.m, typically it would be expected that a detailed Soil and Water Management Plan would need to be prepared for construction stage prior to release of the Construction Certificate. This would normally include calculations of likely soil loss during construction, instructions on preferred construction sequence and limiting land disturbance, and calculations for the provision and sizing of any temporary sedimentation basin to cover the period of civil works.

As a general comment on this site, the combination of flat grades and high permeability sandy soils are likely to limit any significant risk of erosion and sedimentation issues. The following RUSLE calculation illustrates this (references are to "The Blue Book" – Managing Urban Stormwater, Landcom, 2004);

2-year 6hour Intensity = 11.5mm/hr	(former GLC Engineering Dept)
R = 2860	(Eq 2 App A)
K = 0.005	(Tab 14 App C)
LS = 0.19 (1% Slope for 80m)	(Tab A1 App A)
P = 1.3	(Tab A2 App A)
C = 1.0 (bare earth during construction)	

The resulting computed soil loss is therefore calculated as 2.72m^3/ha/yr, or 29.2m^3/yr on this site. As this is far less than 150 m^3/yr trigger in The Blue Book, no sedimentation basin would be required (S6.3.2 (d)), and the erosion risk should be able to be adequately addressed with standard construction erosion control measures such as silt fencing and sandbagging.

8.0 INTEGRATED WATER CYCLE MANAGEMENT

All created sites will be serviced with reticulated water and sewer from the MidCoast Water Services network. MidCoast Water Services have previously investigated recycled water reticulation and determined it was not feasible in the Hawks Nest / Tea Gardens area.

BASIX does not strictly apply to moveable dwellings on long term sites in a caravan park. However, to decrease the development's demand on potable water and also in line with WSUD principles, runoff from roof areas of community structures and any future dwelling installations is to be directed into rainwater tanks for reuse within the dwelling (toilet & laundry), and external use.

9.0 STORMWATER MANAGEMENT - HYDROLOGY

The nature of urban development is that it significantly increases the amount of impervious surface in a catchment, which in turn can decrease runoff times and create higher peak flow rates. It is important with new developments that measures are put in place to prevent increases in runoff from the site that may impact on surrounding properties.

Stormwater runoff generated by the proposed development will be treated and discharged from the site via infiltration. In this current revision of the design, high-flow infiltration areas have been established in the wildlife corridor to the north of the site, and the cleared portion of wetlands proximity area to the west of the development footprint. With the high infiltration rates available onsite, these will be sufficient to capture and discharge rainfall up to the 1% AEP event, and thus preventing any surface discharge into the retained vegetation on the lower lying portion of the site to the west of the development footprint.

While the property has frontage to the Myall River, this lies between 350-600m to the west of the proposed development extent, and is not expected to be impacted in any way by the proposal.

Flood levels in this section of the Myall River are governed by ocean events in Port Stephens or long duration flood events in Myall Lake 20km upstream. Local storm events do not coincide with the critical flood peaks and, as such, on-site detention is not required in this location. The proposed development should have no impact on flooding on any adjacent properties.

10.0 STORMWATER MANAGEMENT – WATER QUALITY MODEL

10.1 BACKGROUND

The quality of runoff generated by the site is important to ensure the preservation of the downstream environments as an increased proportion of impervious area can lead to a subsequent increase in the quantities of suspended solids, phosphorus and nitrogen exiting the site in stormwater runoff. The aim of this section of the study is to determine what measures need to be undertaken as part of this development to meet the water quality objectives set out in Table 1 in Section 5 of this report.

10.2 MUSIC MODELLING

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC provides the ability to model both quality and quantity of runoff generated by catchments, allowing simulation of expected annual pollutant loadings from a site.

MUSIC is designed to model stormwater runoff systems in urban catchments. It is used to simulate a range of temporal and spatial scales. Catchment modelling can be performed for areas up to 100 km^2, with times steps from 6 minutes to 24 hours to match the range of spatial scale. This enables long term modelling of continuous historical rainfall data from pluviograph sources, and reflects the ability to account for temporal variation in data for an annual rainfall series directly.

MUSIC also has the ability to model a number of treatment devices, and measure their effectiveness in terms of the quantity and quality of runoff downstream. This allows determination of the degree of reduction in annual pollutant loadings.

It is noted that the MUSIC simulation relies heavily on input variables and MUSIC models can be calibrated to local conditions. However, for the scale of most urban development projects, it is generally considered unreasonable to perform a

calibration and input parameters can be sourced from various guidelines, such as Council's WSD Guideline or the current NSW MUSIC Modelling Guidelines.

10.2.1 CLIMATE / RAINFALL

To accurately model a site of this size, a continuous rainfall record spanning at least five years with a six minute timestep is required. MidCoast Council have prepared a template for use across the LGA and this template has been utilised to create the model for this report.

The rainfall record in the template is ten years of data between the dates of 1/1/1969 and 31/12/1978. This data produced a mean annual rainfall of 1234mm. It is noted that the long term average rainfall (obtained from the Bureau of Meteorology) for Nelson Bay (approximately 13km from the site) is 1348mm.

10.2.2 EVAPORATION

To accurately model the outcome of water quality treatment measures, potential evapotranspiration (PET) data is required. Again, this data has been taken from the MidCoast Council template which has a mean annual value of 1367mm.

It is noted that the previous approach of determining monthly average areal potential evapotranspiration values from maps in the 'Climate Atlas of Australia, Evapotranspiration' (BoM, 2001) resulted in an annual average of 1335mm.

10.2.3 NODE PARAMETERS

The MUSIC model was used to simulate the pollutant export generated during a ten-year period of average rainfall. Rainfall-runoff parameters for Sand soils were adopted from the Midcoast Council Guidelines for Water Sensitive Design Strategies (2019). Typical pollutant concentrations were derived from the NSW

MUSIC Modelling Guidelines (2015). The adopted parameters can be seen in Figure 4 and Table 2 below.

Note that a Rainfall Threshold of 1.5mm/day was adopted for the “Sealed Road” node and 0.3mm/day was adopted for the “Roof” node per Table 5-4 in the NSW MUSIC Modelling Guidelines (2015). A Rainfall Threshold of 1.0mm/day adopted for all other nodes.

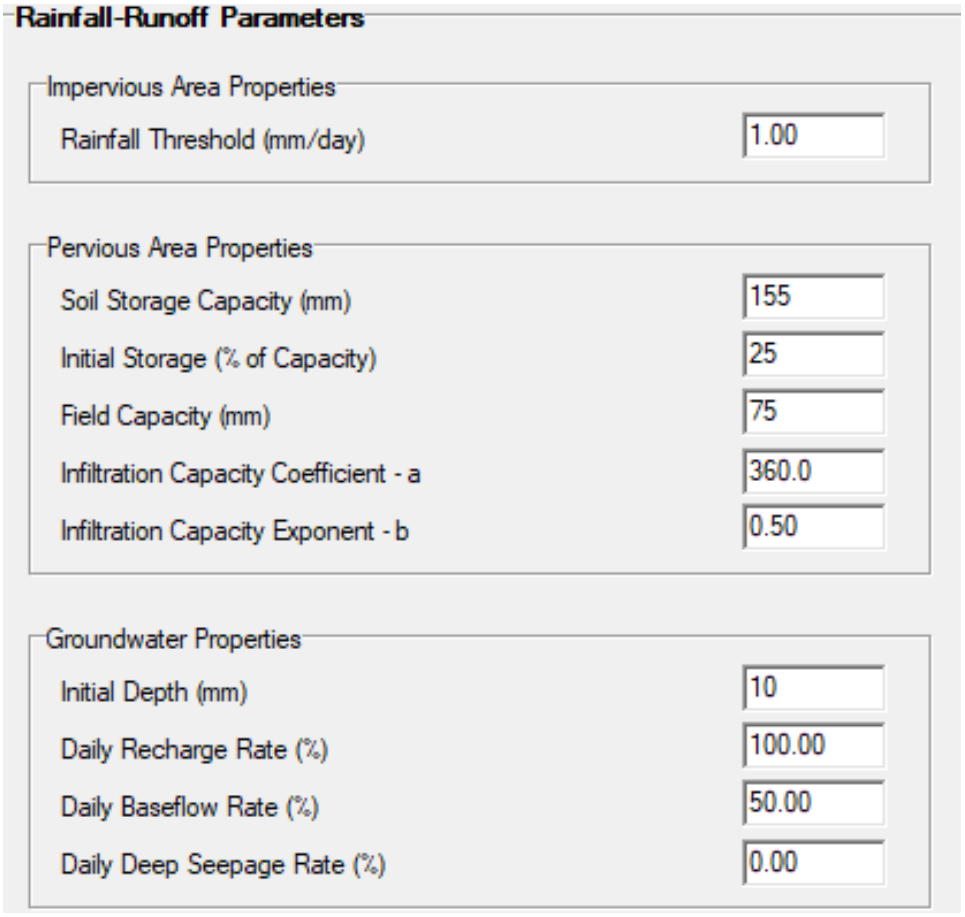

Figure 4: Adopted Rainfall-Runoff MUSIC Parameters

Table 2: Adopted MUSIC Pollutant Generation Parameters

	Rural	Forest	Urban	Roof	Road	Revegetated Land
Baseflow TSS Mean (mg/L)	14	6	16	-	16	14
Stormflow TSS Mean (mg/L)	89.1	40	140	20	270	89.1
Baseflow TP Mean (mg/L)	0.06	0.06	0.14	-	0.14	0.06
Stormflow TP Mean (mg/L)	0.22	0.08	0.25	0.13	0.5	0.22
Baseflow TN Mean (mg/L)	0.9	0.3	1.3	-	1.3	0.9
Stormflow TN Mean (mg/L)	2	0.9	2	2	2.2	2

10.2.4 EXISTING FLOW & POLLUTANT ANALYSIS

The existing site was modelled to simulate the current pollutant loads from the site. The cleared portion of the site has been modelled simply as vacant rural land, with the area to be cleared modelled as a Forest node.

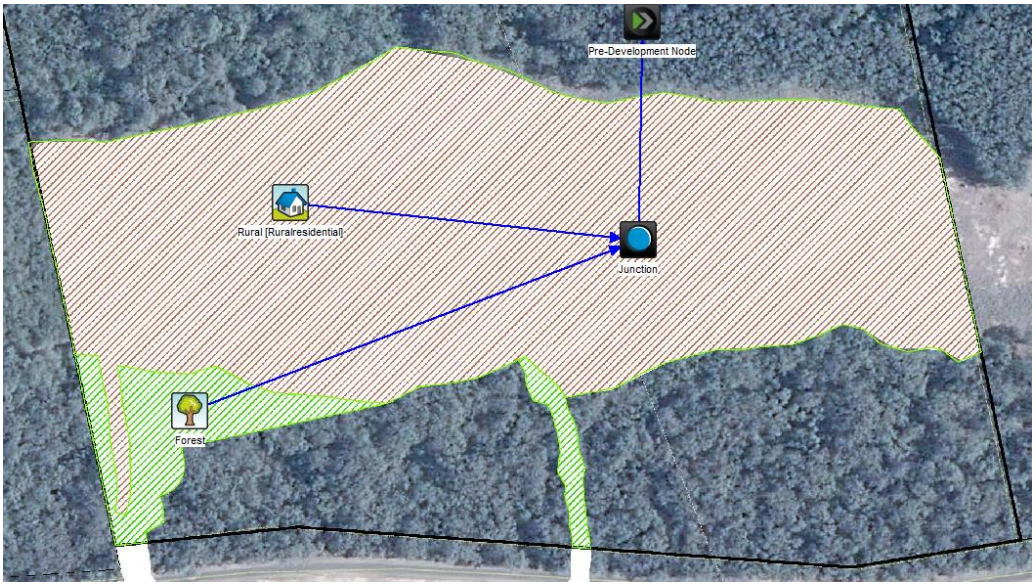

Figure 5: Existing State MUSIC Model

10.2.5 PROPOSED DEVELOPMENT FLOW & POLLUTANT ANALYSIS

The proposed development was modelled to determine expected pollutant loads and the effectiveness of the proposed water treatment measures. The catchment was broken up into different areas depending on the surface type, including;

- Roofs areas (assumed at 150sq.m per long term site, plus roof areas from the various community buildings measured directly off the plans), modelled as “Roof” nodes with 100% impervious area;

- All access road areas (measured directly off design plans) were modelled as “Urban” nodes with 100% impervious area;

- Due to the significant areas of biofiltration in the concept design, these areas (including the landscaped batters into the biofilters) have been included as a separate source node with a “forest” landuse as it is not accurate to include them as an urban landuse. These areas are 100% pervious, have complete native vegetation coverage, and would experience none of the pollutant generating activities typical of urban lands (lawn clippings, fertilisation, dog droppings, deciduous leaf-fall etc).

- Remaining urban pervious area were modelled as residential nodes with 10% DCIA to account for any additional sheds, paths, landscaping, paved courtyards etc that may be directly connected to site drainage. This area represents the long-term site areas not covered by a dwelling roof, open spaces around the various community facilities and maintained grassed areas in the bushfire APZ buffers.

Modelled treatment nodes include;

- Rainwater tanks - 3kl per long term site, on the conservative assumption that all sites will end up with dwellings installed, pus 3kl tank on each Community building. Modelled for reuse in toilet, laundry and external uses only. Tank water reuse rates were adopted for a dwelling with 2 occupants from Table 6-1 in the 2015 NSW Music Modelling Guidelines - an internal water reuse rate of

0.115kL/day/dwelling and external reuse rate of 55kL/yr/dwelling (distributed by PET minus Rain). It has been assumed that 100% of the roof areas will be connected to the tanks;

- Biofiltration systems - have been designed adjacent to the perimeter road in the north and west of the site, and through the newly included central landscaping corridor. Features include sediment forebays, 0.3m detention depth, variable base width (generally 1.0m-6.0m) and a 0.6m filter depth. The orthophosphate content of the filter media has been modelled at 40mg/kg.

  Filter bases will be unlined to allow treated water to infiltrate, mimicking existing hydrological processes onsite. There is approximately 1m clearance between the base of the biofilters and the groundwater level measured during the site survey on the 24/1/19. Details are shown on the DA Engineering design plans.

  The original application lodged to Council had biofilter media area equivalent to 4.4% of the development footprint, derived from a sensitivity analysis that was shared and discussed with Council at that time. In a subsequent formal review of the application, Council has indicated it considered this to be oversized, and have suggested the biofilter area be reduced to an apparently arbitrary 3% of the development footprint. It is noted that there is no reference for a 3% target (or any other target) in Council's recent WSD Guidelines, or any other locally adopted WSD guidelines for that matter. With the original application falling short of Council's NorBE water quality targets, Council's direction to reduce the size of the treatment devices results in an increase of this shortfall. In this current revision of the application, 2,710sq.m total filter area has been modelled.

- High flow event infiltration discharge areas – Irregular major storm events will generate more runoff than the biofiltration systems are sized to contain. In these large events, overflow discharge from the development area will occur along the western and northern edges of development. This overflow discharge is not via pit inlets and pipes, but via overflow across the adjacent pathway, which will act as a weir to distribute flows into the two designated infiltration areas, in the adjacent revegetation corridor in the north, and in the currently cleared section of the wetlands proximity area in the south-west. These areas are currently

cleared, and will simply be shaped via earthworks and a low perimeter bund to capture and infiltrate high flow event runoff. Ecological regeneration will then occur in accordance with the Vegetation Management Plan. Further details addressing locating the infiltration area within the wetlands proximity area can be found in the Updated Biodiversity Development Assessment Report (October 2024) prepared for the project by Wildthing Environmental Consultants.

Review of MUSIC flow summaries shows that these areas will only receive runoff water up to two times per year on average, storage depths would be limited to 300mm and this water will dissipate in a matter of hours. A preliminary DRAINS model was also prepared that suggests the current configuration of raingardens and storages will contain the 1EY event but anything larger will see overflows to these high-flow infiltration areas. Refinement of this DRAINS model will come at future detail design stage.

Notes:

1. The proposed grassed swale adjacent to Road 1 (Ch30-Ch265) has not been included in the modelling due to uncertainty about Council's position on modelling requirements (requirement to maintain >100mm grass length, some sections <2% slope).
2. Permeable paving was investigated for use in parking areas, but it was determined that this was not of benefit as the area is comparatively small, and its use actually allowed untreated urban runoff to discharge to groundwater, rather than allowing its collection and treatment.
3. Similarly, roadside 'evapotranspiration swales' were trialled and then discounted as they introduced more untreated nutrient-rich flows into the groundwater.

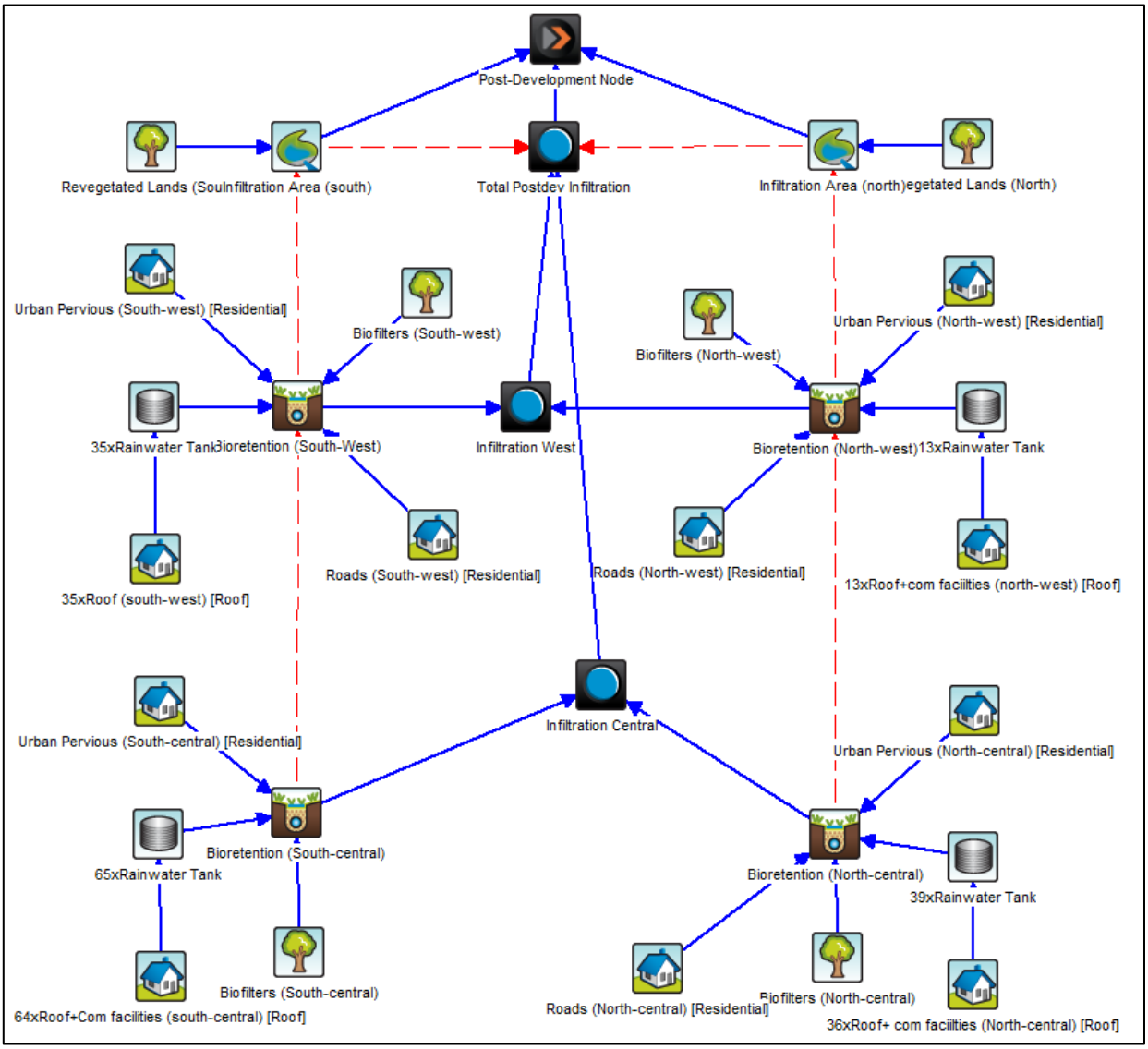

Figure 6: Proposed Development MUSIC Model

10.2.6 COMPARISON OF POLLUTANT RESULTS

Pre and post development pollutant loads are compared in the table below, to compare results to the required targets.

Table 3: Comparison of Pre and Post-Development Pollutant Loads

	Pre-Developed	Post-Developed	Percentage Reduction	NorBE Compliant
TSS (kg/yr)	1250	383	94.0%	Yes
TP (kg/yr)	4.24	4.57	71.3%	No
TN (kg/yr)	51.0	48.3	68.4%	Yes
GP (kg/yr)	0	0	100%	-

* NorBE = Neutral or Beneficial Effect

It can be seen that the NorBE target is not met for Total Phosphorus, due primarily to the very low existing targets modelled from the existing site. As mentioned above, a sensitivity analysis of biofiltration sizing was originally undertaken and provided to Council, who subsequently directed the biofilters be capped in size at 3% of the development footprint and that they consider the treatment train design to be the most appropriately sized system for the development.

The modelled TP exceedance is 0.33kg/yr, or approximately 7.8% increase on existing levels. Council staff have advised they consider the downstream environment a Nitrogen limited system which therefore is not particularly sensitive to this degree of change in phosphorus exposure.

For reference, a summary of the revised sensitivity analysis for treatment device sizing can be seen in Appendix D.

10.2.7 COMMENT: FILTER MEDIA ORTHOPHOSPHATE CONTENT

MUSIC results can be sensitive to the Filter Media Orthophosphate Content parameter, and as a result Council conservatively requires a minimum of 40mg/kg be included in the modelling. This parameter is a measure of the phosphorus nutrient level in the installed filter media – if plants have ready access to Phosphorus in the soil profile, they are less likely to absorb it from stormwater during runoff events.

Filter media is a manufactured product for which suppliers provide Quality Assurance documentation, including laboratory testing results for orthophosphate content.

Council's 40mg/kg minimum is generally consistent with other NSW based guidelines (understood to originate from the 2015 **NSW MUSIC Modelling Guidelines** produced by BMT WBM). In contrast;

- The most recent **Water By Design MUSIC Modelling Guidelines** published in 2018 requires adoption of the larger of 30mg/kg or the actual supplier certified value.
- The 2024 **Melbourne Water MUSIC Modelling Guideline** allows values as low as 20mg/kg as long as certification is provided in the construction documentation.
- The 2023 **Using MUSIC in the Sydney Drinking Water Catchment** states to use 40mg/kg when values are unknown, but that *"accurate figures based on locally-sourced filter media should be used where available and justification provided in the report* ".

Certified testing of commercially available filter media shows that locally available product is typically around 10mg/kg, meaning a 400% factor of safety is being applied by Council. This is considerably more conservative compared to other stormwater engineering material specifications that can be tested and certified before installation (concrete strength, pipe diameters, grate areas, pipe classes etc). While this level of conservativeness may be appropriate in scenarios where small-scale raingarden installations have their soils prepared by mixing onsite, material supply for large scale installations such as proposed in this development will be from large scale commercial suppliers who supply laboratory testing and certification of their product mixes.

Sensitivity runs of the current model indicate that modelling with 38mg/kg rather than 40mg/kg would achieve compliance with Council's requirements. In effect, the contention about changes in nutrient levels as a result of the proposed development, and non-compliance with NorBE targets is based on a single

assumption on a single modelling parameter that other contemporary guidelines would consider too conservative.

10.2.8 COMMENT: OFFSITE OFFSET WORKS

Council staff have previously advised in writing that they would support the proposed development with the inclusion of off-site offset works to make up any on-site modelled shortfalls to the NorBE pollutant targets. To this end, Tattersall Lander and Council had discussed the best available local sites, and a report was prepared assessing and ranking these sites. Council confirmed a preferred option of a raingarden retrofit into the Myall Park carpark adjacent to the tennis courts and child care site in Hawks Nest. Further site survey, engineering design and MUSIC modelling was undertaken to demonstrate viability and presented to Council for approval. Following the initiation of Land and Environment Court proceedings, Council have advised that they no longer agree to this approach.

11.0 WATER BALANCE ASSESSMENT

A water balance for the site can be generally summarised as having the following components;

- Direct rainfall onto the site – no external catchments flow into the proposed development area,
- Evapotranspiration – direct from the site surfaces, and from proposed treatment devices,
- Infiltration to groundwater – pre-development this will be dispersed across the site. Post-development this will be from pervious surface areas and from treated flows through the bioretention areas, plus irregular infiltration in the overflow disposal areas,
- Surface runoff – nil in the pre-developed scenario and nil in the post-developed scenario,
- Proposed capture and reuse of runoff from roof areas into water tanks (tank overflows will still pipe downstream and contribute to bioretention infiltration / overflows).

Generally speaking, the proposed development will reduce evaporation and dispersed infiltration, and increase 'concentrated' infiltration from the bioretention areas.

To give an indication of the longer-term site water balances and the possible number and quantity of site discharges, the MUSIC model detailed in Section 10 of this report has been utilised to undertake a Water Balance Assessment of the proposed development. Flow details have been extracted from the summary MRT file produced by MUSIC, as detailed below.

MUSIC offers a continuous simulation approach using real world rainfall inputs over an extended period, to more realistically model long-term conditions (which include extended wet and dry periods). The conceptual hydrological model utilised in the MUSIC model is shown below.

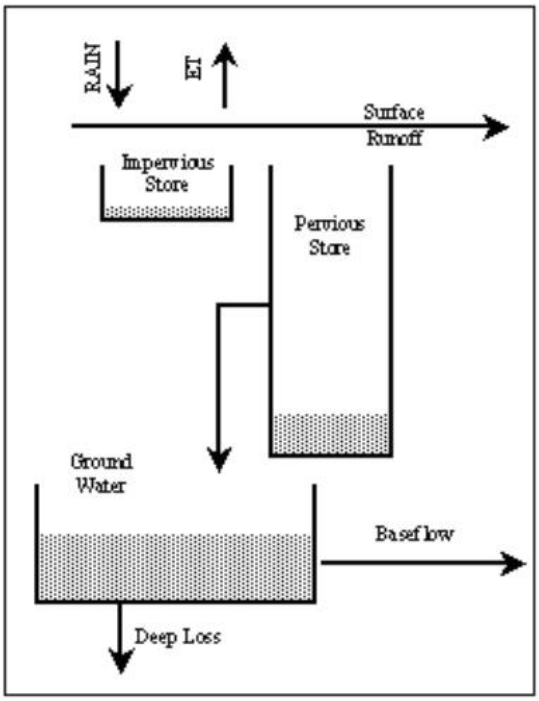

Figure 7: Conceptual Rainfall-Runoff Model adopted for MUSIC

The MUSIC model inputs include ten years of real-world rainfall data (in six-minute timesteps) and monthly average Potential Evapotranspiration data. These inputs have previously been provided by MidCoast Council as the most appropriate data for use in the LGA. A time series plot of the model inputs can be seen below;

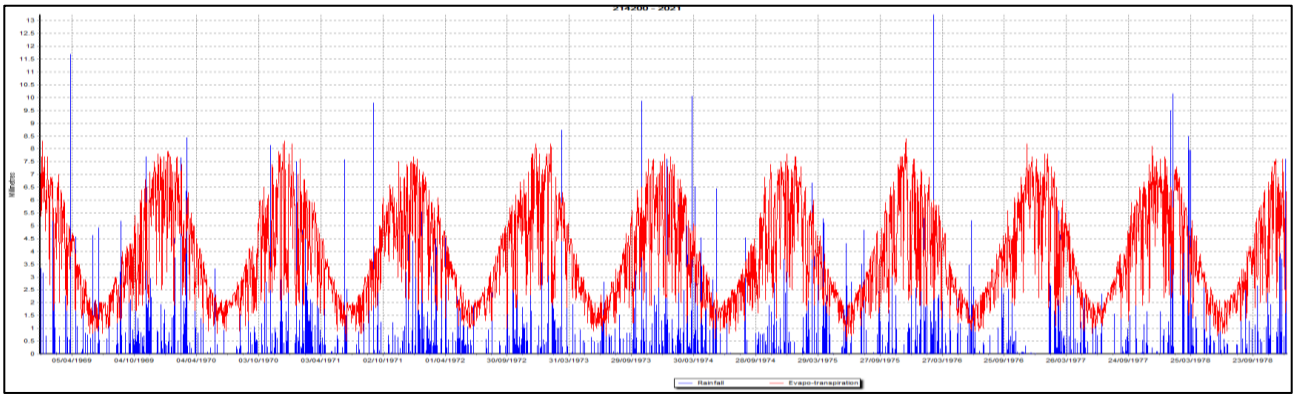

Figure 8: Rainfall and PET Model Inputs

A full summary of the model setup is explained above in Section 10 of this report.

As shown in Figure 7, the key outlets from the MUSIC model are Evapotranspiration, Surface Runoff, Baseflow and Deep Seepage. With the water table in relative proximity to the surface, a deep seepage rate of zero has been adopted, and as such no infiltrated water is lost from the model as seepage but instead is modelled as baseflow.

11.1 SURFACE SITE DISCHARGES

The site generally falls from east to west. Pre-development, the combination of sandy soils and lack of defined flow paths means that there is likely to be minimal surface discharges into the existing vegetation to the west of the footprint. It is noted that MUSIC is somewhat simplistic for this sort of assessment - while it considers landuse, imperviousness and soil type, it does not consider landform and assumes uniform 'average' catchment slopes – i.e. a steep hillside would have the same runoff rates as a completely flat site. The actual results extracted from the MUSIC model show approximately 4% of the rainfall on the pre-development site would flow off as surface runoff, but given the sand soils and lack of defined flow paths, it would be more realistic to assume the existing site surface discharge to be zero. As such, the results displayed below in Table 4 have been manually edited to show zero surface discharge and instead direct that volume to infiltration.

Post-development, stormwater is directed to the raingardens designed into the landscape corridor in the middle of the site and along the western edge of the development footprint. Most regular runoff will be captured, detained treated and ultimately infiltrated from the base of the bioretention systems – in this regard, the natural groundwater flows into the adjacent vegetation will be maintained. However, in a limited number of large events, the storage capacity of the bioretention is exceeded and surface overflow will occur from the raingardens. In the original design concepts, this was released into the adjacent forest via distributed sheet flow with the perimeter pathway acting as a level weir to avoid any concentrated flow points. In the current iteration of the design, these infrequent overflows are now directed to purpose-built infiltration areas, which are sufficiently sized to ensure there should not be any surface discharges into the adjacent vegetation (this discharge mechanism over the pathway would still exist as an emergency overflow path);

- In the northern half of the site – overflow will be directed into a purpose-built infiltration zone within the proposed wildlife corridor,
- In the southern half of the site - overflow will be directed into a purpose-built infiltration zone within a portion of currently cleared lands between the perimeter pathway and the existing vegetation.

A Water Balance summary at the outlet node is summarised in the table below.

Table 4: Site Water Balance

	Existing Site	Proposed Development
Total Rainfall Inflow (ML/yr)	131.3	131.3
Total Evapotranspiration Loss (ML/yr)	79.6	54.5
Total Infiltration (ML/yr)	51.2	67.0
Change in Soil Storage (ML/yr)	0.5	0.3
Total Rainwater Tank Reuse (ML/yr)	N/A	9.5
Stormflow (surface discharge) (ML/yr)	0.0	0.0

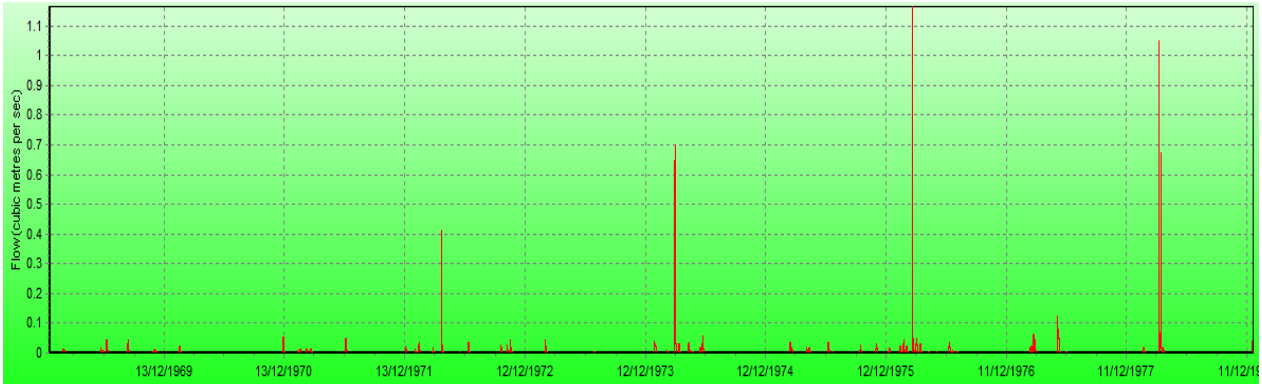

Figure 9: Pre-Development site discharge via infiltration

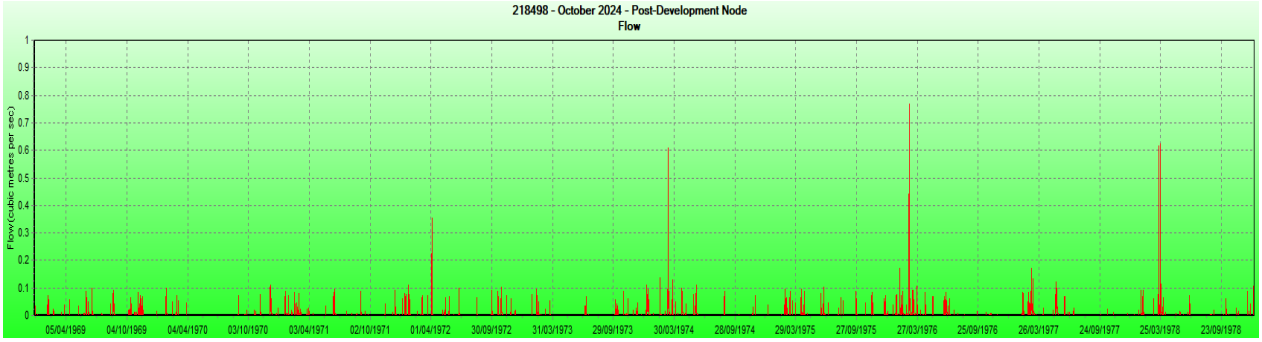

Figure 10: Post-Development site discharge via infiltration

The modelling results in Table 4 and Figures 9 and 10 show that;

- Total Evapotranspiration is reduced post-development,
- Total Infiltration is increased post-development (mostly from more regular infiltration events rather than increased peak discharge rates),

- Onsite capture and reuse are introduced (partly offsetting the reduction in Evapotranspiration),
- There are not expected to be any surface water discharges from the development footprint into the retained vegetated lands.

11.2 GROUNDWATER MOUNDING

In reviewing the previous design iteration, Council staff raised some concern that the increased site discharges via infiltration may impact on the adjacent downstream ecology, primarily due to the fact that all infiltration was occurring in raingardens positioned along the western side of the development footprint. The suggestion was that this may locally raise (or 'mound') the groundwater under the existing vegetation during rainfall events, which might cause vegetation die-back.

The results in Table 4 of this report confirm that the modelled infiltration volumes are increased by the proposed development (generally due to reduced evaporation from the increased impervious surfaces). It is also true that the previous design concept focussed this infiltration to the western edge of the site (generally at an offset 6-10m away from the edge of the development footprint).

While it is beyond the capabilities of the modelling techniques used in this report to try to quantify this potential effect on groundwater, and generally beyond the scope of assessment required by Council for this scale of development, the following comments are relevant;

- From our experience working on numerous sites in the Hawks Nest area, the deep coarse sand soil profile and generally flat terrain between the tidal Myall River and the ocean means the water table is generally fairly flat, and so free-flowing that it experiences tidal effects well away from the river and ocean. The area also experiences regular heavy coastal rainfall events that at times result in significant natural variations in groundwater levels. It is expected that the existing vegetation would currently be regularly exposed to fluctuating groundwater levels.

- The adjacent vegetation is mapped either as;
    - Northern Paperbark-Swamp Mahogany Saw-sedge Forest (northern 200m of the developments western interface), or
    - Coastal Sands Apple-Blackbutt Forest (southern 80m of the developments western interface.

  Both these vegetations are currently growing in low-lying areas of former the sand-mining operation, and would already be subject to naturally changeable groundwater levels. The Swamp Sclerophyll Forest in particular grows in wet/dry conditions and would not be overly sensitive to any localised groundwater mounding.

  It is noted that the central 220m of the development's western frontage has a variable offset of up to 60m from the existing adjacent vegetation to the perimeter raingardens (i.e. infiltration points) due to the wetlands offset area, and so the possibility of groundwater mounding in this area is considered less of an issue.

- The current revision of the design plans has introduced a central landscaped corridor, which includes the relocation of some of the biofiltration to the middle of the development footprint. Runoff from the eastern half of the development will now be treated and discharged into this central corridor, which is located well away from the existing vegetation. While the quantum of any groundwater mounding has not been determined in this assessment, removal of half of the catchment from the perimeter infiltration areas would mean any potential issues with mounding have also been mitigated by half compared with the previous design iteration.

12.0 COSTS

All stormwater infrastructure in the proposed development site will be installed by the developer and will remain in private ownership for the life of the development. As no costs are to be incurred by Council for this private infrastructure, a detailed analysis has not been provided in this report.

13.0 OPERATION AND MAINTENANCE PLAN

Regular minor maintenance is required to ensure water treatment measures continue to operate in an effective way. These tasks should be performed every three months or after heavy storm events, but the flat nature of the site and sandy soil type means minimal sedimentation of the biofilter is expected once the site is finalised. Many of these tasks would be considered 'instinctive' every-day maintenance activities for park maintenance staff with minimal associated costs, such as watering the plants during dry periods, weeding and clearing blockages of inlet and outlet structures.

The maintenance schedule in Appendix B has been prepared as a typical template to direct grounds maintenance staff undertaking routine maintenance, and is based on Raingardens and Bioretention Tree Pits Maintenance Plan Example prepared by the Facility for Advancing Water Biofiltration, Monash University. Relevant sections have been reproduced and/or modified for the specific site conditions.

All biofilter maintenance activities will need to commence as soon as biofilters are planted and brought online and continue for the life of the development.

14.0 CONCLUSIONS

The proposed caravan park has been designed with flooding, drainage and water quality objectives in mind.

There will be no flooding impacts on the proposed development, with the lower parts of the site filled to be clear of the Flood Planning Level. Further, on-site detention will not be required due to the site's direct proximity to the Myall River and the behaviour of the critical regional flood event.

Stormwater runoff quality has been addressed on-site via a treatment train that includes;

- Construction of biofiltration raingardens adjacent to the perimeter road and community facilities, as shown on the DA engineering plans,
- Installation of a 3kL rainwater tanks with all future dwellings.

The results derived from modelling procedures indicate that long term water quality targets are met for Total Suspended Solids, Total Nitrogen and Gross Pollutants. There are minor exceedances of the Total Phosphorus targets as a result of the current development proposal. This should be acceptable as all practicable avenues have been explored to maximise treatment within the proposal, and these modelled exceedances are not likely to result in meaningful detrimental impacts on the adjoining wetlands and Myall River Estuary. Discussions with Council staff have indicated that they agree with this position, as they consider the downstream environment a Nitrogen limited system which therefore is not particularly sensitive to this degree of change in phosphorus exposure.

15.0 REFERENCES

NSW MUSIC Modelling Guidelines, 2015, BMT WBM

Music Version 6.0 User Manual, 2011, eWater

Policy 11: Land Development Guidelines, Section 13 Water Sensitive Urban Design, 2007, Gold Coast Council

Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, 2004, Fletcher et al

WSUD Engineering Procedures: Stormwater, 2005, Melbourne Water

APPENDIX A: PROPOSED LAYOUT & DETAIL PLANS