A part of BMT in Energy and Environment

98 Coachwood Drive, Medowie Water Cycle Management Plan

R.N20085.001.00.docx

16 July 2013

98 Coachwood Drive, Medowie Water Cycle Management Plan

Prepared For:	Paxria Pty Ltd
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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BMT WBM Pty Ltd BMT WBM Pty Ltd 126 Belford Street BROADMEADOW NSW 2292 Australia PO Box 266 Broadmeadow NSW 2292 Tel: +61 2 4940 8882 Fax: +61 2 4940 8887 ABN 54 010 830 421 www.bmtwbm.com.au	***Document :*** R.N20085.001.00.docx ***Project Manager :*** Mark Wainwright ***Client :*** Paxria Pty Ltd ***Client Contact:*** Jean Carman (Carman Surveyors) ***Client Reference***

Title :	98 Coachwood Drive, Medowie - Water Cycle Management Plan
Author :	Mark Wainwright
Synopsis :	*This report outlines a preliminary Water Cycle Management Plan (WCMP) for 98 Coachwood Drive, Medowie (Lot 1 DP 1019113). The WCMP is provided to inform an application to rezone part of the existing property to enable residential development.*

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	16/07/13	MEW		MEW	

DISTRIBUTION

DESTINATION	REVISION			
	0	1	2	3
Carman Surveyors	1			
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1 INTRODUCTION

Paxria Pty Ltd is requesting a Gateway Determination under section 56 of the Environmental Planning and Assessment Act 1979 in respect of a planning proposal to amend the Port Stephens LEP 2000 to rezone land at Lot 1 DP 1019113 (98 Coachwood Drive, Medowie) “the site”. The site is currently zoned E3 Environmental Management and the proposal is to rezone a portion of the site to R2 Low Density Residential. The remaining portion of the site would be rezoned for environmental conservation. The site adjoins the existing Coachwood Drive Estate.

The site comprises approximately 71 hectares of partially cleared bushland and wetland areas that are currently used informally by local residents for recreational activities. Existing infrastructure within the site includes an existing sewer pumping station owned by Hunter Water, an existing sediment retention basin and a large water quality control pond. High ecological value wetlands are located within the site and these wetlands would receive stormwater runoff from future development within the site. Management of the stormwater runoff from the future development site will be critical for protecting the existing wetlands.

In an urban context, water cycle management refers to a range of water cycle systems which are an integral component of urban development. It includes the provision of water supply, wastewater and stormwater systems. Under present institutional arrangements the major capital infrastructure requirements for the provision or procurement of water supply and wastewater systems falls upon the Hunter Water Corporation. The remaining aspect of water cycle management relates to the management of stormwater quantity and quality which falls within the jurisdiction of Council. This WCMP focuses on the management of stormwater within the site.

Future development within the site will adopt a Water Sensitive Urban Design (WSUD) approach to the management of stormwater quality and quantity. The WSUD approach involves distributing stormwater quality and quantity measures across the lot, street and subdivision scales in a treatment series. This approach ensures that potential risks to the receiving environments are mitigated by a series of barriers that each has the potential to intercept pollutants.

The central water cycle management objective for the development is to provide measures in the public domain that will achieve environmental protection of the sensitive downstream wetlands. It is important that any future development in the site establishes a sustainable balance between current uses, new development and the environment. WSUD measures will be required to ensure that the quality and quantity of water leaving the site achieves Council’s water cycle management objectives and targets.

This report outlines a preliminary water cycle management plan (WCMP) for the site to support the gateway submission.

2 OBJECTIVES AND TARGETS

2.1 Port Stephens LEP and DCP

The Port Stephens Local Environment Plan (LEP) 2000 outlines provisions for development of land within the Port Stephens local government area. The LEP is in place to encourage conservation and proper management of such areas to ensure the environmental value of the land is not compromised. Specific objectives of the LEP include to:

- Protect areas of environmental significance and biodiversity;
- Regulate development to avoid inappropriate uses of land which could destroy or damage an ecosystem; and
- Encourage ecologically sustainable development.

The development proposal involves an application to rezone a portion on Lot 1 DP 1019113 from the current E3 Environmental Management to R2 Low Density Residential. The application also aims to rezone the remaining portion of the site for environmental conservation.

The Port Stephens Development Control Plan (DCP) 2007 requires that all development must comply with the water quality management provisions of Port Stephens Council's Urban Stormwater and Rural Water Quality Management Plan.

2.2 Urban Stormwater and Rural Water Quality Management Plan

Port Stephens Council's Urban Stormwater and Rural Water Quality Management Plan (2003) outlines stormwater quality performance targets for developments in the Local Government Area.

The performance targets for small development (<10ha) are load-based targets requiring it to be demonstrated that a particular development with treatment measures in place would achieve the targeted reductions when compared to the proposed development without treatment. For large developments (>10ha) or development within a sensitive catchment, the development proponent is required to assess the magnitude of any change in stormwater pollution loads caused by the development (with treatment measures in place) and the likely impact of any increase in pollutant levels.

2.3 SEPP BASIX

State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 (BASIX) is the overriding and mandatory instrument for water efficiency targets for 'BASIX affected development' which includes the type of residential development planned for the site.

The current residential water efficiency target relevant for BASIX affected development in Medowie is a 40% reduction compared to 2004 residential water use. Residential development applications must be accompanied by a BASIX Certificate which indicates compliance with the prescribed water efficiency targets before development consent can be granted.

For this preliminary WCMP, it is assumed that future dwellings in the proposed development would be constructed with a rainwater tanks to achieve the BASIX targets.

2.4 Summary

The site is located within the catchment of Moffats Swamp. Moffats Swamp is classified as a SEPP 14 Coastal Wetland and is therefore considered to have a high ecological value. For this reason, the site is considered to be located within a sensitive catchment. The development site also exceeds 10ha. Therefore, the sensitivity of the receiving environment and size of the future development warrants consideration of the magnitude of the change in pollutants loads and likely impacts on the receiving environment.

3 EXISTING SITE CHARACTERISTICS

The site is located on the north-eastern extents of the existing Medowie township adjacent to the existing Coachwood Drive subdivision. The site topography is undulating with typical gradients of 2% to 4%. The site topography generally falls in an easterly direction towards Moffats Swamp. The site is forested and is currently in a relatively natural state. Informal tracks where forested land has been cleared traverse the site. A sewer pumping station is located centrally within the site and an existing easement along a cleared track provides access for Hunter Water to maintain the pumping station.

The site currently incorporates a sediment basin in the northern part of the site to manage runoff from the northern part of the adjacent Coachwood Drive subdivision. Surface runoff from that existing development drains along an open channel within the site to the sediment basin. A large water quality control pond is located within the southern part of the site. The water quality pond was constructed within the site as a component of the adjacent Coachwood Drive subdivision. This pond currently accepts piped discharges of runoff generated within the broader existing urban catchment west of the site. The land title for the site currently incorporates easements for these structures and the drainage channels / overland flow paths that direct runoff onto the site from upstream properties.

The Soil Landscapes of the Newcastle 1:100,000 Sheet (Matthei, 1995) indicate that the main soil landscape likely to occur across the site is Medowie (me). The Medowie soil landscape is a residual landscape where deep soils have generally being formed through insitu weathering of the underlying rock. The upper soil layer is typically a moderately permeable (although seasonally hardsetting) sandy clay loam with typical thickness of 0.3m to 0.6m. The upper soil layer typically overlies a moderate to slowly permeable silty to medium clay with a thickness of 0.8 to >1m. This layer is typically underlain by a deep weathered clay layer. The soils are typically considered to form a low constraint for future urban development.

The site includes large areas of identified endangered ecological communities (EECs). The ecological characteristics are described within the flora and fauna assessment prepared by RPS for the site (RPS, 2013).

The site is located within the Moffats Swamp catchment. Moffats Swamp has formed within a natural depression just east of the area planned for residential development and is a designated SEPP 14 Coastal Wetland. The eastern portion of the site is located within the mapped extents of the wetland.

4 DEVELOPMENT IMPACTS

The site development would comprise construction of residential lots, roads, services, landscaping and stormwater quality improvement devices (SQIDs). The planned development occupies the western portion of the site. The eastern proportion of the site would remain undeveloped in response to the ecological significant of this area.

Residential development within the site has the potential to significantly alter the natural hydrology and water quality characteristics of catchment runoff. In addition, water will be imported for human uses and discharged back to the environment following this use. The key changes in catchments that occur following development (without mitigation) that are relevant to water cycle management include:

- Evapotranspiration and infiltration is lowered due to increased impervious surfaces;
- Groundwater recharge is lowered due to reduced infiltration;
- Surface runoff is increased due to clearing of natural vegetation, soil compaction and construction of impervious surfaces;
- Surface runoff quality is lowered due to increased sources of pollutants;
- Rainfall is effectively increased through irrigation of pervious areas with imported water; and
- Imported water is used and discharged into sewerage systems.

The proposed development will require the clearing of existing forested areas to enable the construction of allotments, roads and SQIDs, and to satisfy bushfire management criteria. Low level vegetation will be incorporated into the development within landscaped areas.

The existing soils and topography will primarily be modified in areas within and adjacent to road reserves. Site regrading would be completed to minimise disturbance to the existing site topography. Additional excavation will be required to construct the proposed SQIDs. Regrading to form the roads and SQIDs will expose existing soils to potential erosion during construction.

The majority of additional surface runoff would be generated from roof and road pavement surfaces connected through a series of impervious surfaces to the receiving environment. To manage the quantities of diffuse stormwater pollutants discharging to the wetland areas, the WCMP focuses on managing runoff from these surfaces which have the potential to contribute elevated stormwater volumes and pollutant loads to Moffats Swamp.

Regular diffuse source pollution results from runoff flowing across the impervious surfaces entraining pollutants deposited on these surfaces into the flow. Some pollutants such as light litter can be entrained relatively easily by low flows, whilst other pollutants including large organic debris and coarse sediment may require higher flows to generate enough energy to transport the matter from catchment surfaces. Other finer and dissolved pollutants can be generated in high concentrations during all events.

Increased runoff volumes from the development have the potential to impact adversely on the hydrologic regime and ecology of Moffats Swamp. The hydrological regime of a wetland determines the depth, frequency, duration and temporal pattern of flooding and drying and therefore influences the physical, chemical and biological characteristics of the wetland substratum. Typically urbanisation will increase the frequency and volume of stormwater discharged to wetlands. Following development, it is likely that runoff would occur (without mitigation) on average up to approximately 80 days/yr. Therefore under developed conditions, wetlands that naturally dry would be less likely to dry, and when drying occurs, the period of drying is likely to reduce. This limits opportunities for new plant growth and can lead to drowning of existing wetland vegetation. Changes to wetland vegetation impact on habitat for fauna living in the wetland. The changes can often favour introduced fauna species that outcompete the native species.

5 STORMWATER MANAGEMENT STRATEGY

Water Sensitive Urban Design (WSUD) is a philosophy that incorporates urban water cycle management into the urban design process. WSUD considers options to integrate urban water management infrastructure within the natural environment. WSUD aims to protect the health of aquatic ecosystems by minimising negative impacts on the natural water cycle. Stormwater quality and quantity management are particularly important for protecting aquatic ecosystems. WSUD principles will be applied within the proposed development to mitigate development impacts on Moffats Swamp that forms the key receiving environment for this development.

We understand that Port Stephens Council is seeking to improve the management of stormwater runoff quality and quantity from new developments, whilst also ensuring that the systems implemented are financially sustainable to maintain. Stormwater Quality Improvement Devices (SQIDs) assist to manage stormwater quality and quantity from development. SQIDs function by detaining, retaining, harvesting, screening, filtering, infiltrating and/or biologically treating stormwater runoff to reduce the concentrations and loads of pollutants discharged to the receiving environments. SQIDs can also assist with reducing stormwater runoff volumes to reduce impacts on the wetting and drying cycles of natural wetlands. SQIDs are proposed throughout the development to intercept and treat stormwater runoff prior to discharge into the receiving environment.

SQIDs can be configured to enable distributed infiltration of stormwater across the proposed development to offset the reduction in groundwater recharge that will occur in areas covered by impervious roof and road surfaces. At this stage the WCMP has been prepared assuming that infiltration of high volumes of stormwater is not feasible within the site due to the potential impacts on future infrastructure. If subsequent geotechnical investigations confirm infiltration is feasible, SQIDs will be designed to encourage infiltration. Infiltration would further enhance the treatment performance of the proposed SQIDs outlined in this WCMP.

Riparian zones will be protected by excluding SQIDs from these areas and a large proportion of the site is proposed to be rezoned for environmental protection. SQIDs provided to manage stormwater quality will be located outside riparian zones and endangered ecological communities.

SQIDs incorporating retention will be provided to control runoff volumes from the development. BASIX targets are likely to require the provision of rainwater tanks within many residential lots as a component of building works. It is envisaged that most residential lots will incorporate rainwater tanks to achieve BASIX targets.

To mitigate potential impacts on natural wetlands, it will be critical that runoff volumes are reduced. This can be achieved by harvesting stormwater, distributed infiltration of stormwater, increasing evapotranspiration or diverting flows away from the wetland. For this development, the strategy will be to harvest roof runoff within residential areas, distribute infiltration and enhance evapotranspiration within the proposed SQIDs. Whilst the volume of runoff will increase following development, it is envisaged that the impacts of this increased runoff can be mitigated by discharging the increased volume over a large area at the perimeter of the development outside designated EEC areas.

Specific details of the individual SQIDs proposed for the site are provided in Section 6. The treatment series is outlined in the WCMP in Section 7.

6 WSUD MEASURES

6.1 Rainwater Tanks

The requirement for rainwater tanks to be installed in individual residential lots within the development will be confirmed during the dwelling construction phase where lot owners are required to obtain a BASIX certificate. It is envisaged that achievement of the BASIX water conservation target of 40% will require most lot owners within the development to install a rainwater tank. Provision of an alternative reticulated recycled water supply is not planned for this development.

Rainwater tanks sizes for individual residential lots would be determined at the construction certificate stage for each dwelling. For preparation of this WCMS, it was assumed that rainwater tanks with an average volume of 3 kL would be provided within each lot to achieve BASIX objectives. This is slightly smaller than the median tank size installed in regional NSW under BASIX (refer Figure 6-1) and therefore the modelling completed for the WCMS provides a conservative estimate of the volume of additional stormwater generated by the development that would potentially be diverted away from Moffats Swamp.

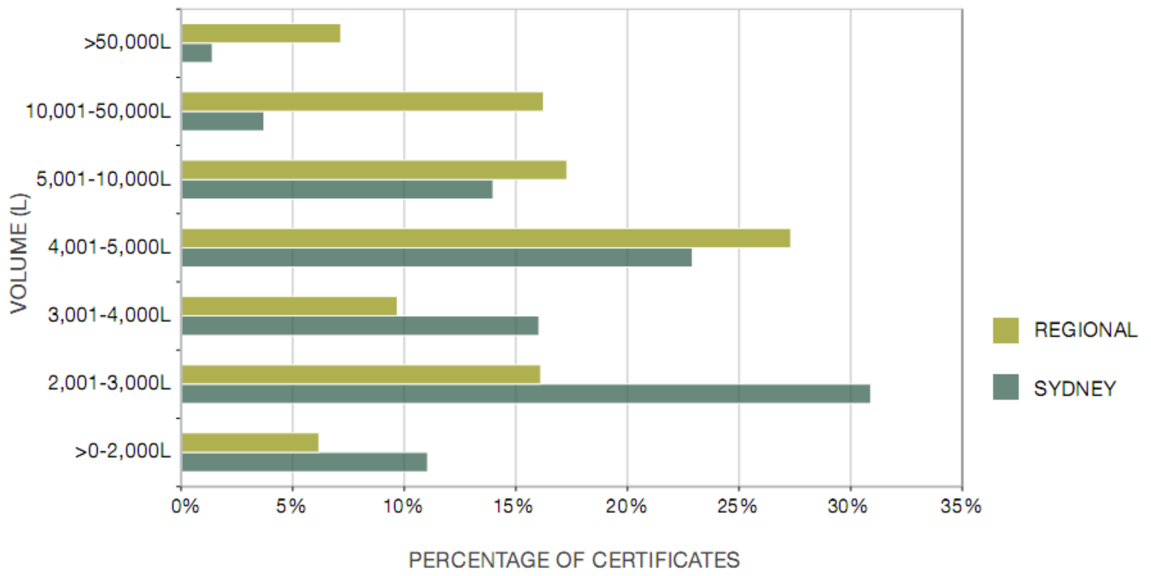

Figure 6-1 Installed BASIX Rainwater Tank Sizes 2005-2008 (NSW DoP, 2009)

6.2 Raingardens

Raingardens would be provided to enhance the streetscape and treat runoff in areas where road pavement runoff is likely to be concentrated. It is envisaged that raingardens in the streetscape would provide an opportunity for resident education and create an awareness of the similar function of the larger wetland treatment zones.

Raingardens are proposed for consideration at intersections of minor streets within the development. Whilst these SQIDs are proposed, MUSIC modelling undertaken to assess the performance of the WCMP has conservatively not included consideration of these SQIDs. The performance of the WCMP is therefore likely to exceed the modelled outcomes. Further design development is required to determine the specific locations where these SQIDs can be installed.

Figure 6-2 Example Street Scale Raingarden

A typical section of a raingarden is shown in Figure 6-3 and the function of these measures is described below.

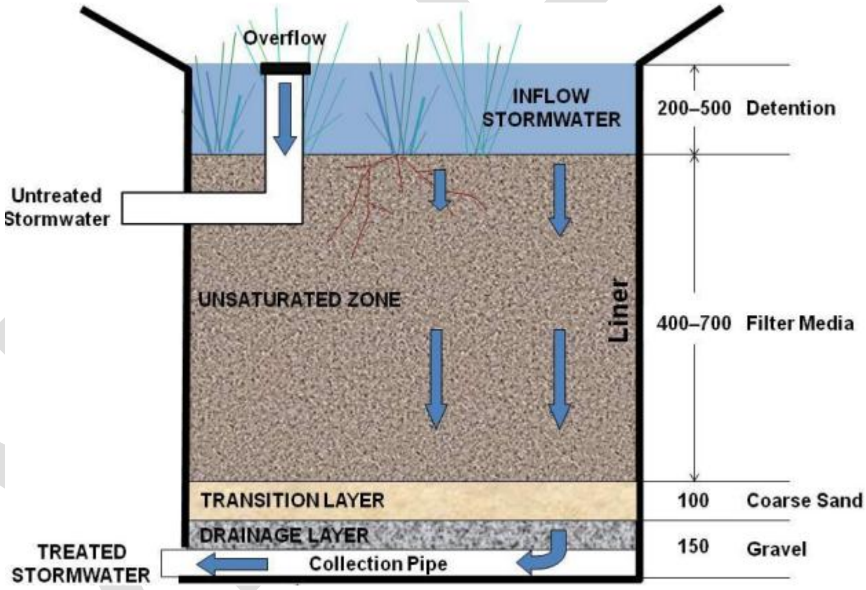

Figure 6-3 Typical Biofiltration Arrangement (FAWB, 2009)

Raingardens assist with achieving stormwater quality and stormwater retention objectives. Raingardens include extended detention storage and below ground filter media. The extended detention storage enables settling of sediment and other particles. The below ground filter intercepts finer particles including heavy metals. Nutrients are removed through uptake by appropriate vegetation planted within the measure. Raingardens assist with disconnecting impervious areas (particularly road pavement) from receiving environments by retaining stormwater for an extended period.

The extended detention is typically trapezoidal shaped with a slightly grading base and 1(v):4 to 6(h) side slopes for access. The extended detention temporarily stores runoff prior to filtration through the media filter. During events that exceed the available volume in the extended detention storage, excess runoff typically overflows into a minor drainage system through structures positioned within the measure.

The filter media will comprise a biofilter layer, transition layer and drainage layer. The biofilter layer is the upper layer and incorporates soil with a water holding capacity sufficient for sustaining vegetation growth. The biofilter layer will have an appropriate saturated hydraulic conductivity to enable steady percolation of runoff when the soil water holding capacity is exceeded. A transition layer of coarse sand will be provided between the biofilter and drainage layers to intercept fine to medium size soil particles that may otherwise be conveyed into the drainage layer and potentially block the underdrains. The drainage layer will comprise fine gravel surrounding slotted agricultural drainage pipe (no filter sock) for capturing the filtered stormwater before directing it to the drainage outlet from the basin.

It is likely that the surrounding natural soils will have a saturated hydraulic conductivity at least an order of magnitude lower than the biofilter and will form a natural barrier to exfiltration. Soil investigations to confirm this assumption would be completed during detailed design to confirm this assumption. If natural soils are found to have a higher potential for infiltration, vertical lining of the sides of the media filter layers with a geotextile membrane may be undertaken to prevent untreated stormwater bypassing the biofilter.

For the raingardens to be effective it will be important that the biofilter media grading, characteristics and preparation is closely considered. Biofilter media would be graded in accordance with Appendix C of the Facility for Advancing Water Biofiltration (FAWB) "Adoption Guidelines for Stormwater Biofiltration Systems" (FAWB, 2009).

A key component of the raingardens is vegetation planted into the biofilter layer. Appropriate species will be selected during design considering the biofilter soil characteristics and local climatic conditions. Species will be capable of withstanding dry periods in addition to periods of frequent wetting.

There are two alternative approaches proposed for constructing and protecting these SQIDs from damage during the dwelling construction stage. These approaches are discussed below.

One construction approach would involve the raingardens being constructed in two stages, a functional stage and a final stage. The functional stage raingardens would involve constructing the biofilter and drainage system. During dwelling construction, the biofilter would be covered by a sacrificial geofilter fabric, a shallow topsoil layer and turf. When 80% of dwellings have been constructed and occupied within the subdivision, the turf, shallow topsoil layer and membrane will be removed and the biofilter planted out with appropriate vegetation species.

The second approach would involve constructing the raingardens in their final form as part of the subdivision construction works, but excluding stormwater inflows and access through the provision of a continuous kerb and bollards during construction. At a stage when 80% of dwellings have been constructed, sections of the kerb would be removed to enable inflows from the road pavement into the raingarden. The advantage of this approach is that the biofilter plants could be established following completion of subdivision construction, rather than at the 80% dwelling construction phase. This would also assist in improving the aesthetics of the development earlier on but protect the raingarden from being overloaded with sediment from construction.

6.3 Construction Stage Sediment Management

6.3.1 Subdivision and Dwelling Construction

For the subdivision construction phase, sediment basins would be constructed to intercept and manage sediment laden runoff from areas disturbed by earthworks during site clearing, site regrading and construction of roads and drainage systems. The construction stage sediment basins would be formed at locations where pre-treatment basins will be formed as a component of the ultimate post development strategy.

Earthworks that are necessary to form the base, embankments and bunds of the pre-treatment basins would be completed at the subdivision stage. At a stage when subdivision works are complete and 80% of dwellings have been constructed and occupied within the development, the sediment basins will be converted to the final pre-treatment basin form at these locations.

6.3.2 Lot Erosion and Sediment Control

Whilst the sediment basins formed during the subdivision construction phase are proposed to remain in place until 80% of dwellings have been constructed and occupied, provision of functioning erosion and sediment controls within lots will be important for reducing sediment close to the source during building works and preventing drainage systems from being blocked by excessive loads of sediment.

Preparation of an erosion and sediment control plans (ESCP) for the dwelling construction phase will be a condition of consent for dwelling construction. For the purposes of this WCMP, it is assumed that dwelling construction would only commence after appropriate sediment and erosion controls are in place and have been approved by an accredited certifier. In addition, it is assumed that accredited certifiers or Council compliance officers will have an ongoing role to inspect erosion and sediment controls installed for individual dwellings.

6.4 Pre-treatment Basins

Sediment basins provided for the subdivision and dwelling construction phases would be maintained until a stage when 80% of dwellings have been constructed and occupied within the subdivision. At that stage, the construction stage basins will be converted to the post development pre-treatment basins.

For the post development phase, the pre-treatment basins will target the capture of medium to coarse sediment, organic debris and litter. Finer sediments that are targeted by the construction stage sediment basins will be captured by filtering through bunded wetland treatment zones. The pre-treatment basins will therefore typically be smaller than the construction stage sediment basins at the same location.

6.5 Wetland Treatment Zones

Wetland treatment zones are proposed adjacent to the proposed perimeter road. These wetland treatment zones would be positioned between the development and the identified areas of endangered ecological communities (EECs) that surround Moffats Swamp downslope of the site.

The wetland treatment zones would be formed by bunding areas of existing vegetation adjacent to the development site to form enclosed areas that stormwater runoff from the development areas would discharge into after initially passing through the pre-treatment basins to remove litter, organic debris and coarse sediment. The wetland treatment zones would only be formed in areas outside of mapped EEC extents. The typical existing condition of these areas is shown in Figure 6-4.

Figure 6-4 Existing Vegetation in Wetland Treatment Zones

The wetland treatment areas would essentially form an additional filter between the development and the EEC area. The bunded areas would retain the stormwater for extended period of time, enabling finer sediments to settle and provide opportunities for nutrients to be taken up by the existing plants that exist in these areas. Removal of existing weeds and enhanced planting in currently bare/degraded areas would also form a component of this measure.

The bunded areas would enable an additional average 0.3m temporary depth of extended detention volume to occur to cater for the increased volume of stormwater following development. To ensure that the ephemeral nature of these areas is maintained, outlets will be located within these zones to enable water levels to be slowly drawn down to the typical existing levels at the conclusion of a wet weather period. Discharges from these areas will be released over a period of days following conclusion of a wet period as distributed flow into the downslope EEC areas.

Currently existing residential development to the east of the site discharges into the EEC areas through the site as concentrated flow along a channel (refer Figure 6-5). The proposed development will intercept these channel flows, treat the runoff to a higher level than currently occurs and discharge it as distributed flow into the EEC. It is considered that this approach would improve the environmental outcomes when compared to the existing conditions.

Figure 6-5 Existing Drainage Channel

A key component of the implementation of these measures will be to undertake ecological monitoring of the health of the existing vegetation within the bunded wetland treatment zones following development to ensure that the additional stormwater runoff does not impact on the health of the vegetation. Infrastructure that enables the water levels in these bunded areas to be controlled will be designed to ensure that the wetland hydrology can be adapted based on the monitoring outcomes.

6.6 Existing Pond Modification

A nutrient control pond was constructed in the southern part of the site as a component of earlier subdivision works. The pond was constructed off-line of a drainage channel formed to convey major flows from upslope development through to Moffats Swamp. The existing pond is shown in Figure 6-6.

Figure 6-6 Existing Nutrient Pond

Inflow to the existing pond is controlled by the flow capacity of a 1050mm diameter piped drainage system that was designed to direct flow up to the 2 year ARI design flow from the upstream catchment into the pond. Runoff in excess of the 2 year ARI flow was designed to either surcharge at a drainage structure positioned just downstream of Coachwood Drive (refer Figure 6-7) or flow overland along a drainage channel that crosses Coachwood Drive and bypasses the existing pond before discharging into Moffats Swamp.

Figure 6-7 Existing Surcharge Structure Downstream of Coachwood Drive

The existing pond receives inflows from the 1050mm diameter drainage system only. Available data indicates that the invert of the pipe outlet into the pond is set above the permanent water level of approximately RL 9.6 in the pond. The current maximum water depth in the pond is unknown, although design drawings indicate that the maximum water depth should be approximately 1.5m. The limited fringing vegetation within the pond suggests that water depths increase relatively rapidly from the pond edges to depths in excess of 1m.

Outflows from the pond are currently controlled by the crest height of a weir positioned within the northern wall of the pond at approximately RL 9.6. Flow through this weir is directed back to the drainage channel discharging into Moffats Swamp. Site observations indicate that there is currently no functioning low level outlet structure from the pond.

It is estimated that the 'nutrient' pond is currently providing limited benefit in terms of nutrient removal due to the lack of vegetation that would be necessary to intercept dissolved nutrients within the pond. Although no monitoring data is available, it is envisaged that over time the pond has intercepted an increasing amount of nutrients from the catchment. It is considered that during summer months, these nutrients are likely to be taken up by algae and aquatic weeds that undergo a growth and death cycle, resulting in nutrients cycling through the pond bed, water column and aquatic plants. It is likely that over time the concentration of nutrients in the pond has increased, resulting in increasing aquatic plant growth and death, leading to increasing impacts on water quality. To improve the water quality conditions in the pond, it is proposed to modify the pond to increase the coverage of aquatic plants and regulate the water levels.

To improve safety for the community, wide shallow benches would be formed around the perimeter of the pond to reduce community access to the deeper pond areas. These benches would be graded at approximately 1(v):8-10(h) and planted out with a range of aquatic plants appropriate for the range of inundation depths (refer example planting in Figure 6-8).

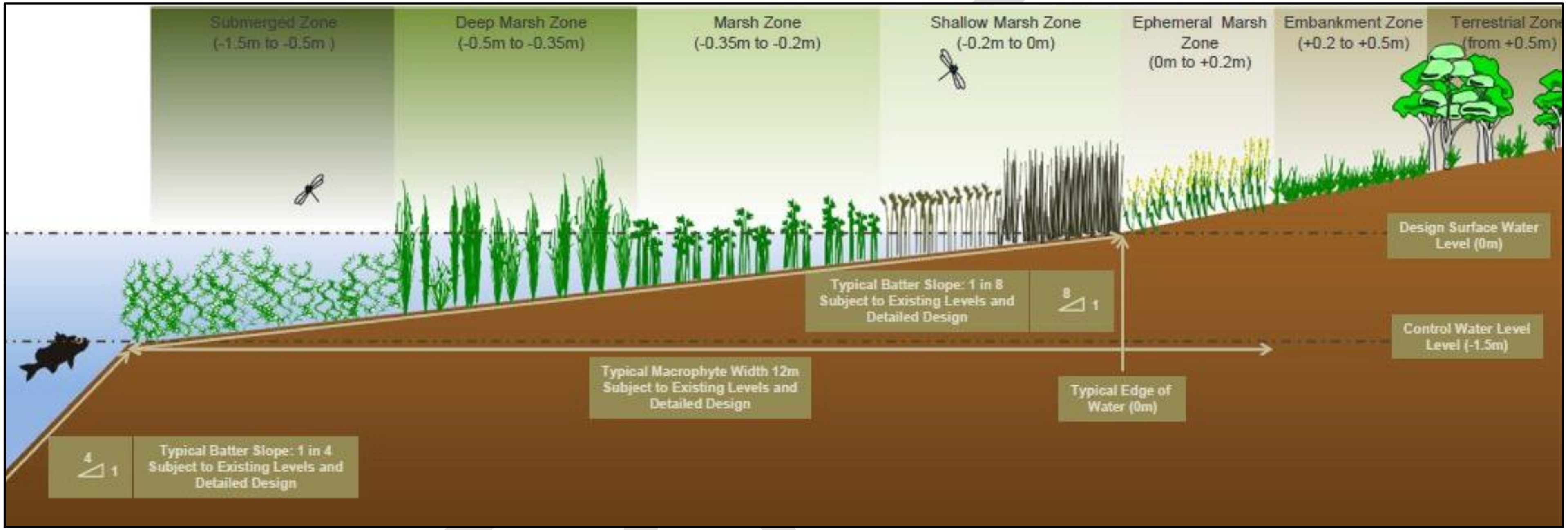

Figure 6-8 Example Benching and Planting in Modified Pond

A new low level discharge structure would be incorporated into the planted bench to enable water levels to be controlled. This structure could be utilised to slowly draw down the pond water level from the maximum weir level to the edge of the planted bench to mimic ephemeral conditions that would occur in a natural wetland.

The existing pond does not currently incorporate any pre-treatment measures to prevent organic debris, litter and coarse sediment from the upslope catchment discharging into the pond. It is proposed that a pre-treatment measure would be constructed along the existing upstream drainage system to capture these pollutants and minimise the volume of these pollutants discharging into the pond. The recommended pre-treatment measure along with other drainage improvements to the existing public drainage system are summarised in Section 6.7.

6.7 Drainage System Improvements

It is considered that improvements to the existing piped drainage system that conveys flow into the pond are necessary to improve the function of the pond. In particular, it is considered that the inlet capacity of the drainage line into the pond may currently be insufficient for the design 2 year ARI flow, and this may be leading to the erosion observed near the drainage structures adjacent to Coachwood Drive just upstream of the pond. In addition, incorporation of a dry sediment retention basin / GPT is considered warranted to capture organic debris, litter and coarse sediment.

An existing in-line minor storage is located downstream of Kindlebark Oval and this storage is currently mapped in Council's database. This storage includes the main inlet to the piped drainage system discharging into the existing nutrient pond. The estimated 2 year ARI flow at this location from the earlier design is approximately 2.5m^3/s (Paul Clarke and Associates, 1994). Although the existing structure was not observed on site due to the existing height and density of vegetation in the storage, it is considered likely that the inlet capacity of the drainage structure at this location is significantly less than 2.5m^3/s. Consequently, it is likely that a significantly lower flow would be entering the drainage system at this location. This would limit the volume of stormwater currently discharging into the current pond. It is considered that the limited inlet capacity at this location is likely to be a key contributor to the erosion near Coachwood Drive and the regular observed overtopping of the road (refer Figure 6-9).

Figure 6-9 Erosion at Drainage Inlet Upstream of Coachwood Drive

To increase the volume of flow entering the piped drainage system, it is proposed that the inlet capacity be increased at this location by augmenting the drainage structure. To increase the capture of organic debris, litter and coarse sediment it is also proposed that the size of the existing storage at this location be increased and a dry sediment basin formed. This would also enable organic debris, litter and coarse sediment to be captured at this location. Maintenance access to the upgraded basin could be achieved from Rosewood Drive or Ingla Close.

7 CONCEPTUAL STORMWATER MANAGEMENT PLAN

The conceptual stormwater management plan is shown on Figure 7-1 and the concept design details for these SQIDs are summarised in Table 7-1. The size of the SQIDs was estimated based on the outcomes of MUSIC modelling that are summarised in Section 8.

Table 7-1 Modelled SQID Dimensions

Location	SQID Type	Extended Detention (m)	Permanent Storage (m^3)	Planted Area (m^2)	Surface Area (m^2)	Estimated Footprint (m^2)
1	Sediment Basin	0.6	0	0	225	350
1	Wetland	0.3	0	450	900	1200
2	Sediment Basin	0.6	0	0	775	1150
2	Wetland	0.3	0	1550	3100	4050
3	Sediment Basin	0.6	0	0	150	225
3	Wetland	0.3	0	300	600	800
4	Sediment Basin	1.0	0	0	600	900
5	Modified Pond	0.4	3600	1300	2650	4250
6	Raingardens	to be confirmed				

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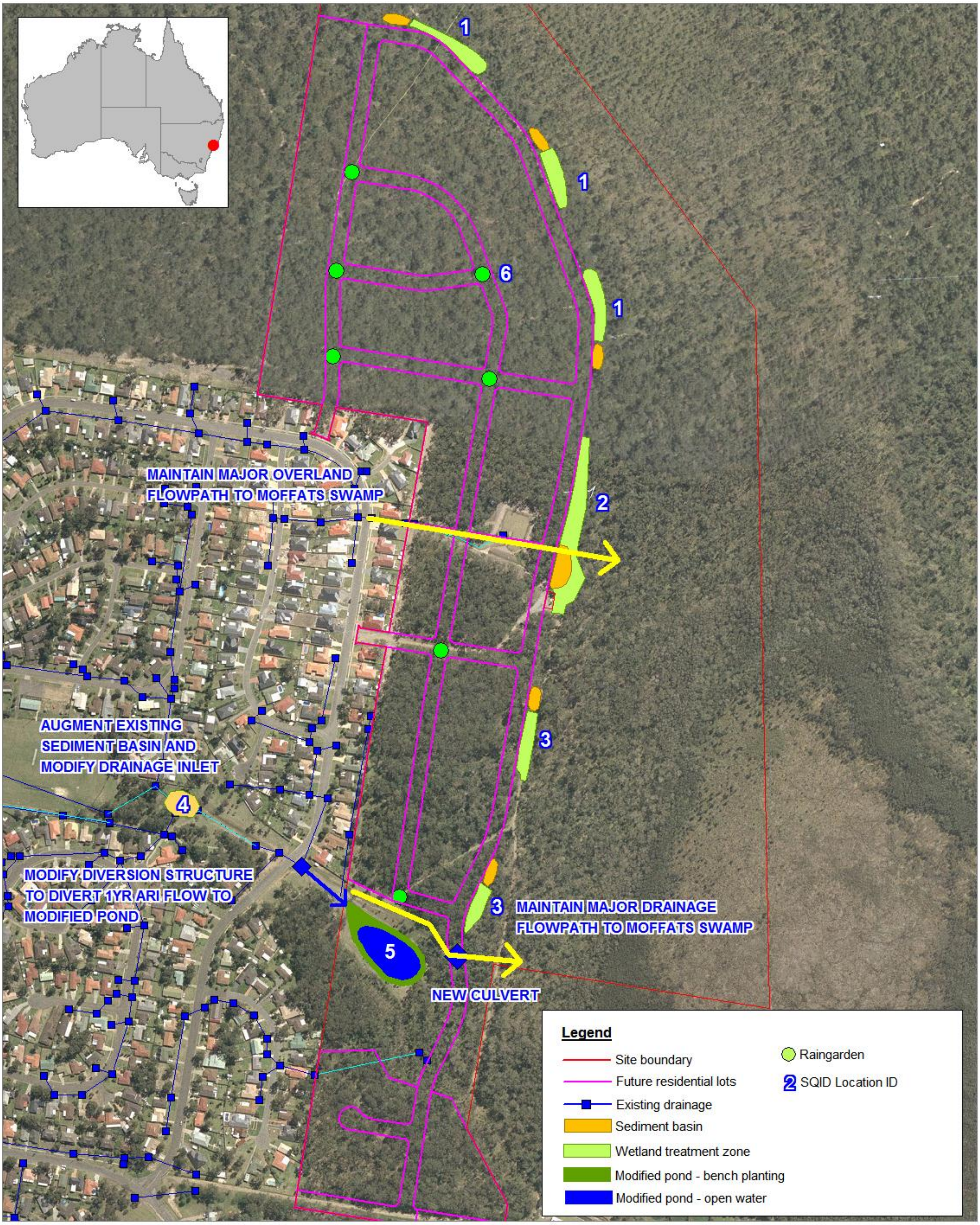

Title:
98 Coachwood Drive, Medowie
Stormwater Management Plan

Figure: 7-1

Rev: A

N

0 125 250m
Approx. Scale

BMT WBM
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8 MUSIC MODELLING

8.1 Modelling Approach

The performance of the proposed WCMP was assessed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) (Version 5.1) developed by eWater. The software was designed to enable comparisons to be made between different stormwater management systems and thereby function as a decision support tool. The key model inputs and MUSIC modelling approach are described in the following sections.

The WCMP comprises a treatment series of SQIDs that will retain and/or filter stormwater runoff. Bypass, overflow or filtered flow from these measures would be discharged as distributed flow into the downstream receiving environment. The SQIDs will be provided in series to add redundancy to assist with minimising potential risks to the environment resulting from any one particular SQID failing.

8.2 Meteorological Template

The meteorological template includes the rainfall and areal potential evapotranspiration data. It forms the basis for the hydrologic calculations within MUSIC.

Rainfall input to MUSIC is typically sourced from a nearby long-term pluviograph type rainfall station. The nearest Bureau of Meteorology (BoM) continuously recording rainfall station is located at the Williamtown RAAF Base (Station 61078) approximately 8.0km from the site. Pluviograph data is available from that station for the 1952 to 2011 period. The mean annual rainfall for Williamtown is 1125mm.

Interpolated average annual rainfall grids based on data gathered from 1950 are available from the Bureau of Meteorology covering all of Australia. The average annual rainfall for the site based on these grids is 1153mm which is similar to the long term average for Williamtown.

The Williamtown record is fairly complete without a significant number of missing or accumulated data periods. Pluviograph rainfall data were sourced for Williamtown and reviewed for the 1952 to 2011 period to identify a continuous period of good quality data with an average annual rainfall similar to long term conditions. Review of the Williamtown rainfall data indicated that the 1997 to 2007 period was relatively free of data gaps and accumulated rainfall data. The mean annual rainfall for this period is 1116mm which is similar to the long term mean annual rainfall for the site. Rainfall data from Station 61078 Williamtown RAAF for the 1997 to 2007 period were adopted for MUSIC modelling at the site.

Average monthly areal potential evapotranspiration (PET) rates adopted for the MUSIC modelling are summarised in Table 8-1. These values were obtained from BOM gridded data. A 6-minute time step was adopted for the MUSIC modelling.

Table 8-1 Adopted Average Monthly Areal PET Rates

Month	Mean monthly areal PET (mm)
January	186
February	148
March	147
April	95
May	66
June	54
July	56
August	72
September	100
October	139
November	160
December	180

8.3 Rainfall-Runoff Parameters

Modelling of the rainfall-runoff process in MUSIC requires the definition of one impervious surface parameter and nine pervious surface parameters. The parameters can be estimated through a calibration and validation exercise for a particular catchment. The impervious surface parameter (rainfall threshold) was adopted considering industry accepted defaults. Preliminary modelling was undertaken to confirm appropriate pervious surface parameters based on the soil types and hydrological conditions typical of catchments similar to site.

The average annual rainfall fraction (ARF) was estimated for the proposed development applying methods derived by Fletcher et al. (2005) for NSW catchments. The work by Fletcher et al. (2005) assists with estimating the surface runoff proportion for 100% pervious NSW catchments/sites based upon the local mean annual rainfall. It represents the proportion of rainfall that is typically converted to runoff for a particular catchment/site and is useful when estimating appropriate hydrologic conditions for ungauged catchments similar to this site. Based on a mean annual rainfall (MAR) of 1153mm, it is estimated that the ARF would be approximately 27% for the site.

Runoff modelled within MUSIC includes surface runoff and base flow components. For this study, a base flow index (BFI) of 0.3 was adopted as being representative of the existing catchment conditions. This assumes that 70% of runoff discharging to the watercourses/receiving environments is typically sourced from surface runoff, with the remaining 30% contributed by base flow during dry weather periods. The MUSIC hydrologic parameters estimated based on these assumptions are summarised in Table 8-2.

Table 8-2 Adopted MUSIC Rainfall-Runoff Parameters

Impervious Area Parameters	Value
Rainfall Threshold (mm)	1.0
Pervious Area Parameters	
Soil Storage Capacity (mm)	120
Initial Storage (% of capacity)	30
Field Capacity (mm)	85
Infiltration Capacity Coefficient – a	150
Infiltration Capacity Exponent - b	3.5
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	10
Daily Deep Seepage Rate (%)	0

8.4 Runoff Quality Parameters

The MUSIC input stormwater constituent concentrations were adopted from those recommended for NSW in Fletcher et al. (2005). Mean values for each parameter were calculated from the 'typical' values presented in Fletcher et al. (2005). The normalised values presented within that report were converted to logarithmic values for input into MUSIC. The existing default standard deviation values in MUSIC were adopted. This approach was consistent with that adopted for scenario modelling in Fletcher et al. (2005). The adopted $\log_{10}$ values are summarised in Table 8-3 and Table 8-4.

Table 8-3 Storm flow concentrations for MUSIC modelling in NSW ($\log_{10}$)

	TSS		TP		TN	
	mean	std. dev	mean	std. dev	mean	std. dev
Urban	2.15	0.32	-0.60	0.25	0.30	0.19
Forest	1.60	0.20	-1.10	0.22	-0.05	0.24
Eroding Tracks	3.00	0.32	-0.30	0.25	0.34	0.19

Table 8-4 Base flow concentrations for NSW MUSIC modelling in NSW ($\log_{10}$)

	TSS		TP		TN	
	mean	std. dev	mean	std. dev	mean	std. dev
Urban	1.20	0.17	-0.85	0.19	0.11	0.12
Forest	0.78	0.13	-1.52	0.13	-0.52	0.13
Eroding Tracks	1.20	0.17	-0.85	0.19	0.11	0.12

8.5 Sub-catchments

In addition to managing stormwater from the development areas within the site, the planning proposal will also incorporate measures to improvement the treatment of stormwater from existing urban development that drains through the site.

To allow for a comparison between the existing and proposed development scenarios, a MUSIC model was developed to represent existing conditions, with the upslope developed area included in the model.

The existing urban area and proposed site development were divided into Sub-catchments A and B respectively. The sub-catchments areas modelled in MUSIC are summarised in Table 8-5. The sub-catchments boundaries adopted for the MUSIC modelling are shown in Figure 8-1.

Table 8-5 MUSIC Sub-catchments

	Sub-catchment Area (ha)			
Sub-catchment ID	**Residential**	**Open Space**	**Natural Forest**	**Cleared Forest[1]**
A1	7.2	1.5	-	-
A2	19.4	2.4	0.9	-
A3	9.2	-	-	-
A4	8.0	-	-	-
A5	9.4	0.9	0.7	-
A6	4.2	-	-	-
A7	5.1	-	-	-
A8	7.4	-	-	-
B1	-	-	11.4	1.3
B2	-	-	6.5	0.7
B3	-	-	6.8	0.8
B4	-	-	3.8	0.4

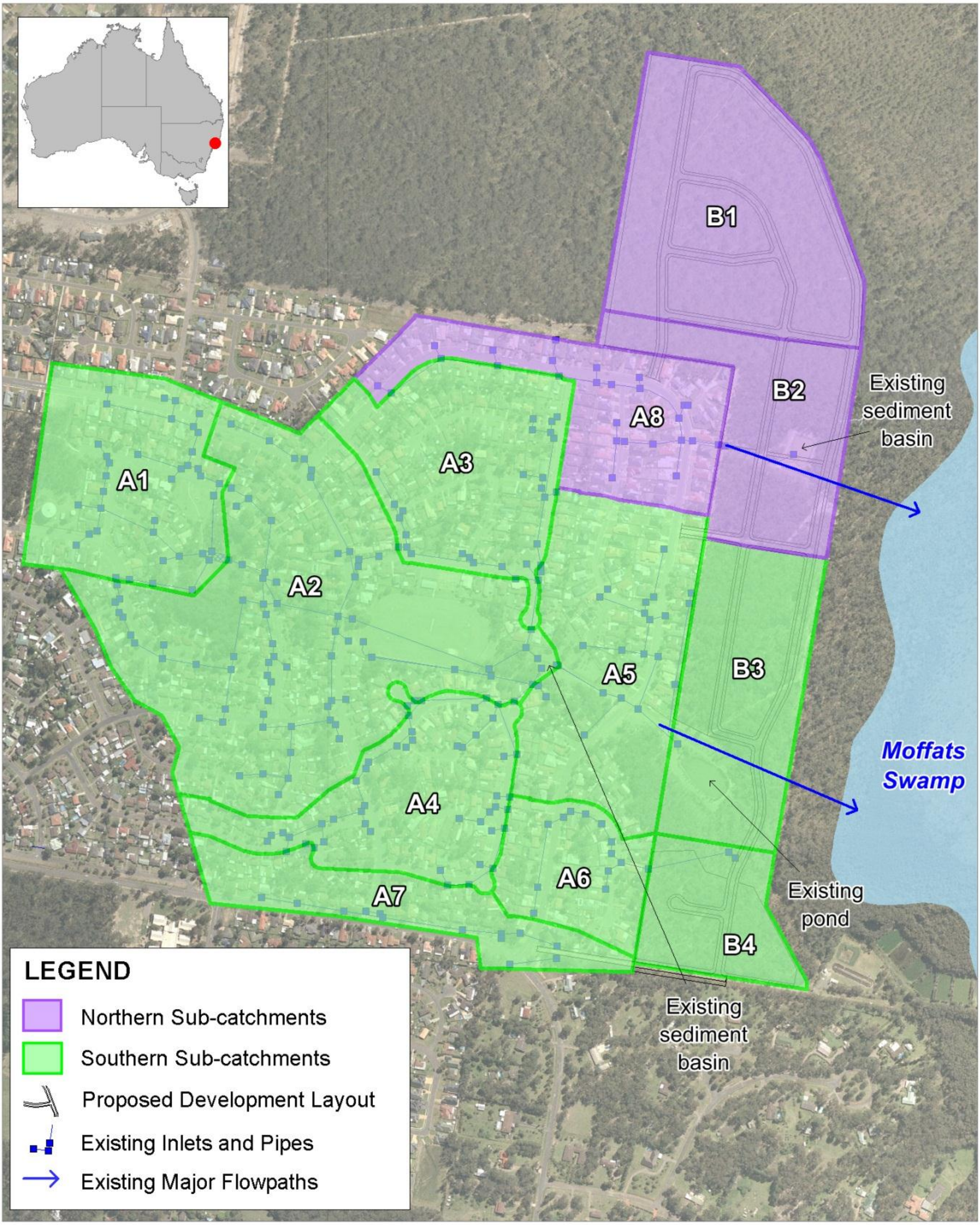
1. It was estimated that approximately 10% of the existing forested area within the development footprint has been cleared or otherwise disturbed by human activities.

8.6 Imperviousness

A key input to the MUSIC models is an estimate of the directly connected impervious area. The directly connected impervious area represents the area within a catchment that is linked through a continuous series of impervious surfaces to a particular location in the catchment. It effectively represents the areas that will result in runoff being discharged to a particular location in all but the smallest of rainfall events.

The imperviousness of the existing residential areas (excluding public open space areas and remnant bushland) adjacent to the site was estimated by digitising a sample of the residential areas. Based on the sampled area, it was estimated that the directly connected imperviousness of these areas is approximately 42%. The directly connected impervious estimate assumed that existing roof are 100% connected, roads are 100% connected, driveways are 50% connected, paved footpaths are 0% connected and paved landscaping areas are 0% connected.

The site development was assumed to have similar characteristics as the adjacent existing residential development. For the proposed development, roof areas were separated from other impervious areas in the development for modelling of rainwater tanks. It was assumed that dwellings would on average each have a roof area of 200m^2.



Title:
MUSIC Sub-catchments and Existing Drainage Layout

Figure: 8-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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0 200 400m
Approx. Scale

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8.7 Treatment Nodes

8.7.1 Overview

MUSIC enables the user to specify treatment nodes which represent the SQIDs proposed for improving the management of stormwater quality and quantity. MUSIC includes the capability to simulate the performance of a range of SQIDs including gross pollutant traps, ponds, constructed wetlands, swales, biofiltration systems, infiltration systems, sedimentation ponds and buffer strips. Each treatment node has a range of default parameters that may be altered by the user to allow the treatment node to be 'customised' to best represent the SQID proposed for the development. For the development scenario, stormwater quality is proposed to be managed primarily through rainwater tanks, raingardens, sediment basins and biofilter/wetland treatment zones. The modelling assumptions, dimensions and properties of these SQIDs are summarised below.

8.7.2 Rainwater Tanks

For modelling, it was assumed that rainwater tanks with an average volume of 3 kL would be provided in each future lot to achieve BASIX objectives. Average annual water use for residential properties in the Hunter Water Corporation service area was 175 kL in the 2010-2011 financial year (NoW, 2012). Based on the average residential water distribution shown in Figure 8-2 it is estimated that rainwater tanks can readily provide an alternative water source for up to 60% of water demands (i.e. toilet flushing, outdoor uses, washing machine and pool/spa). For MUSIC modelling it was therefore estimated that rainwater tanks would supply water to replace up to 105 kL/yr (290 L/day) of water demand per dwelling. For modelling, it was assumed that toilet flushing and washing machine uses would be constant throughout the year, and outdoor use would vary with weather and seasonal conditions.

To model the tanks capturing rainfall off dwelling roofs, it was assumed each residential allotment had an average roof area of 200m², with each tank capturing runoff from up to 75% the roof (i.e. 25% of the roof area would not practicably be drained to the tank). The sub-catchment properties for the developed scenario were altered accordingly to replace the existing forested area with residential area.

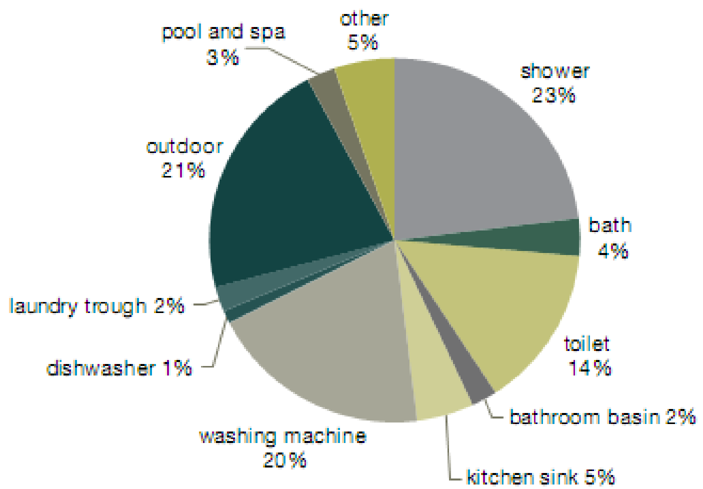

Figure 8-2 Residential Water Demand Distribution (NSW DoP, 2009)

8.7.3 Pre-treatment Sediment Basins

The sediment basins modelled within MUSIC as pre-treatment measures for the following biofiltration/wetland treatment zones. All sediment basins were modelled to have a short hydraulic residence time of one hour to achieve capture of coarse sediment, organic debris and litter, but minimise the potential for capturing fine and dissolved nutrients that could result in on-going water quality issues in the sediment basin. Fine and dissolved nutrients would be targeted for capture in the adjacent wetland systems. The basins were modelled to remain dry during periods of no rainfall.

8.7.4 Wetland Treatment Zones

The wetland treatment zones proposed along the northern extents of the development adjacent to the perimeter road are described in Section 6.5. The observed vegetation and expected sandy clay loam soils in these areas suggest that these natural areas function for water quality management in a similar manner as a combination of biofiltration and wetland measures. These natural areas were modelled in MUSIC as a combined 50% biofiltration and 50% constructed wetland measure.

The biofiltration and wetland nodes were both modelled to have zero permanent volume to reflect the intention that any additional ponding of water in these areas would be short-term (less than 1 day). A riser outlet/s would be provided in the wetland treatment zones to achieve this. The model assumes that a bund would be provided around each treatment zone to achieve an average extended detention depth of 0.3m above the existing surface levels. It was assumed that the ‘biofilter media’ is a sandy loam soil with a depth of 0.3m with an effective particle diameter of 0.5mm to represent the naturally occurring topsoil in the area. The ‘biofilter media’ was modelled assuming an effective saturated hydraulic conductivity of 100mm/hr.

It was assumed that species of existing vegetation within the wetland treatment zones will be effective nutrient removing plants. Selective planting of areas within the wetland treatment zones would be undertaken to enhance the treatment potential if necessary. Local indigenous plants that are effective for nutrient removal (e.g. Carex Apressa), would be considered for selective planting.

8.7.5 Existing Pond Modification

The constructed wetland treatment node was applied within MUSIC to model the modifications to the existing pond. The surface area and permanent pool volume were estimated based on the dimensions of the existing pond. The permanent depth of the pond was assumed to be 1.5m, with 0.4m of extended detention available up to the crest level of the pond wall.

The modelling assumed that the pond would be modified to form planted benches around the perimeter of a central open water body. The modelling assumes that a minimum of 50% of the total surface area within the pond would be planted out with aquatic wetland vegetation species.

The modified pond was modelled with a low level outlet comprising an inlet structure and vertical riser pipe to manage water levels in the extended detention zone.

8.7.6 Raingardens

At this stage, the street scale raingardens were conservatively not incorporated into the MUSIC models.

8.8 Results

MUSIC modelling results for the existing and developed scenarios are summarised in Table 8-6. The existing scenario represents the catchment in its current condition. The existing scenario results include allowance for treatment that would currently occur within the sediment basin and water quality pond constructed within the site. The developed scenario represents the proposed development with all SQIDs constructed (except street scale raingardens). The values shown in brackets in the table represent the percentage difference in modelled pollutant load difference achieved after treatment for each scenario. A negative percentage indicates a reduction in loads.

Table 8-6 MUSIC Modelling Results

		Stormwater Pollutant Loads			
		Existing	Developed		% change
	Parameter	Treated (1)	Untreated	Treated (2)	(2) – (1)
Northern Sub-catchments	Runoff (ML/yr)	121	170	150	+24%
	TSS (kg/yr)	13700	29500	2680	-80.4%
	TP (kg/yr)	17.9	48.2	16.7	-6.7%
	TN (kg/yr)	174	362	166	-4.6%
Southern Sub-catchments	Runoff (ML/yr)	385	401	395	+2.6%
	TSS (kg/yr)	45700	69100	28000	-38.7%
	TP (kg/yr)	85.2	114	64.7	-24.1%
	TN (kg/yr)	751	851	715	-4.8%
Total Catchment	Runoff (ML/yr)	507	571	545	+7.5%
	TSS (kg/yr)	59300	98600	30700	-48.2%
	TP (kg/yr)	103	163	81.4	-21.0%
	TN (kg/yr)	924	1210	881	-4.7%

The MUSIC modelling results indicate that the stormwater pollutant loads from the urban catchment draining to Moffats Swamp would increase substantially following development of the site without treatment. The MUSIC modelling results presented in Table 8-6 indicate that the TSS, TP and TN loads discharged to Moffats Swamp from the urban catchment comprising the site and existing external development can potentially be lowered when compared to existing conditions through the provision of improved stormwater quality treatment measures within the site. This exceeds Council's targets for this development and would potentially result in a net-benefit to Moffats Swamp.

The results also indicate there would be an increase in the runoff volume of 7.5% from the urban catchment as a result of the increased impervious area associated with additional development. The inclusion of rainwater tanks within the treatment series effectively reduces the increase down from 12.5% that would occur without the tanks. It is envisaged that harvesting of stormwater from the modified pond for open space irrigation could further reduce the increase.

9 SUMMARY AND CONCLUSIONS

- Site can be developed in a manner that would achieve a net-reduction in stormwater pollutant loads discharged to Moffats Swamp.
- Development would augment and upgrade existing treatment systems that are currently relatively ineffective at capturing pollutants.
- The treatment strategy comprises a series of treatment measures positioned in a distributed manner throughout the development site to mitigate risks to water quality of any particular measure failing.
- The SQIDs would be arranged and configured in a manner that will enable good access by Council for future maintenance.

BMT WBM Brisbane

Level 8, 200 Creek Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver

8200 S. Akron Street, Unit 120
Centennial Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com.au

BMT WBM Mackay

Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne

Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle

126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth

Suite 6, 29 Hood Street Subiaco 6008
Tel +61 8 9328 2029 Fax +61 8 9484 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney

Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver

401 611 Alexander Street Vancouver
British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com.au