Amended

Stormwater Study

&

Management Plan

Residential Rezoning

Lot 82 DP263591

Riverview Place

South West Rocks

Final - April 2012

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1.0 INTRODUCTION

This amended Stormwater Study & Management Plan (the Plan) has been prepared as a requirement of NSW Planning and in consultation with Kempsey Shire Council. The information contained in this report is in support of the proposed residential rezoning of Lot 82 DP 263591 Riverview Place, South West Rocks. ***Figure 1***.

The Plan provides the principles for stormwater in accordance with Water Sensitive Urban Design using current specifications for the subject site. A more detailed design will be required as part of any future Development/Construction Application in agreement with the principles.

2.0 BACKGROUND

As background, the proposal initially offered dedication of the Environmental Lands (proposed 7(d) zone land) to Council for its long term protection. Council's report of 17 May 2011 under paragraph titled Ownership of remaining 7(d) - Scenic Protection Land recommends that Council not accept maintenance of land that could be attached to lot(s) in any future subdivision. As a result of Council's decision, the proposal will now incorporate the 7(d) zoned component of the land into the rear of private allotments while retaining the protection of the environmental zoning.

The Council report of 17 May 2011 also does not accept the locating of any water quality treatment measures in land zoned 7(d) even though much of it is not vegetated and there is potential to enhance the native plantings in that zoned area complementary to ensuring water quality protection for the downstream areas.

The other directive from Council staff is that they do not want a specific & final stormwater solution or subdivision layout proposed at rezoning.

These three directives from Council staff have been taken into account in the amended stormwater plan.

3.0 PURPOSE

The purpose of this Stormwater Study & Management Plan is to demonstrate that sensitive downstream environments can be protected in terms of water quality and quantity.

The future development of the site following rezoning must include submission of a comprehensive development application addressing all relevant matters including stormwater management. As such, this Plan is required to set forth the principles for water management within and from the site in a post development scenario.

The applicant wishes to create a development that promotes sustainable and integrated management of land and water resources, and incorporates best stormwater management, water conservation/reuse and environmental protection.

The Stormwater Study & Management Plan conceived for Lot 82 Riverview Place is the response the physical and biological attributes of the site and the requirements of aquatic ecosystems that exist adjacent and downstream of the site.
In summary, the Plan for this site is to :

- Treat urban stormwater to meet best practice water quality objectives for discharge to receiving environments; and

- Integration of water management measures into the landscape to reduce reliance on end of line mechanisms.

Figure 1 - Locality Map (Source: Google Maps)

4.0 DESCRIPTION OF CATCHMENT

The unique character of the topography and existing upstream stormwater controls is such that the site is essentially its own catchment. Lot 82 is 2.02 ha in area and the proposed residential zone component of Lot 82 encompasses approximately 1.47 ha of the site with the remaining area under an environmental protection zoning.

4.1 TOPOGRAPHY

Lot 82 is characterised by east to west sloping topography with the western most edge comprising steep lands. The residential rezoning is restricted to the gentler graded areas in the middle and east of the site. The steeper land at the western end is to be protected under an environmental protection zone.

Downstream of Lot 82 is an adjacent gravel track and public reserve, fringing the confluence of Macleay River and Spencers Creek.

The site slopes from the eastern boundary at about RL 28m AHD to its western boundary at about RL 5.0m AHD.

The area for inclusion in the residential zoning is well above the 1 in 100 year flood level of RL 2.55m AHD. An additional rise in sea level due to climate change has been estimated by the between 0.18 to 0.91m by between 2090 and 2100 according to the Floodplain Risk Management Guideline prepared by the NSW Government Department of Environment & Climate Change. Modelling undertaken by WMA Water in 2008 has predicted the flood level for the 1 in 100 year level, inclusive of climate change, to be RL 3.08m AHD adjacent to the subject site location. This level is still significantly lower than any future residential land on Lot 82 being RL 12m AHD.

Upstream flows are currently diverted along the eastern boundary at the top of the site by way of the Riverview Place roadside drains. Pre developed flows comprise water that falls directly on the site only.

Flows off the site are primarily over the western boundary to the crown reserve lands adjacent the Macleay River – the bottom of the catchment.

Midway down the north boundary the topography does provide potential for stormwater flow from Lot 82 to cross the north boundary into adjacent land at its western extent.

Clearly any future development would need to ensure that stormwater generated from the development is captured and directed to the west. This is typically achieved with interallotment drainage at the boundary of the site.

A similar scenario occurs at the western most extent of the south boundary of Lot 82 and would also require capture of any developed site stormwater at the boundary, to redirect flows to the west.

4.2 WATERWAYS

The Macleay River and confluence with Spencers Creek are located downstream to the west and south west. Designated SEPP 14 Wetlands and Mangrove areas are also in the downstream environs.

A small drainage line within the south west end of the site is currently vegetated with a mix of weeds and low level scrub.

To achieve capture of potential urban contaminants from the development suitable water quality devices will be required

As the site is at the bottom of its catchment there is no necessity for detention of stormwater flows to pre-developed levels, apart from the retention requirements for water quality, as there are no downstream properties that will be impacted.

4.3 CLIMATE & HYDROLOGY

The climate of the region is considered to be sub-tropical having warm summers and mild winters.

Rainfall is typically around 1300 mm/yr per year. However, recent seasons have resulted in higher than average rainfall events in the region.

In typical years the evapo-transpiration information infers that the natural aquatic ecosystems adjacent to the site (i.e. wetlands, streams) experience drying conditions (evapo-transpiration greater than rainfall) through Spring and most of Summer.

4.4 LAND USE

Land use upstream to the east and north east is residential. Adjacent to the north and south are large lot residential holdings, some with housing and some vacant.
Adjacent uses downstream (west and south west) are vacant crown land and the Macleay River.

4.5 EXISTING STORMWATER INFRASTRUCTURE

Existing stormwater infrastructure serving the established residential areas comprises typical urban interallotment piped drainage to street pits, supported by down stream water quality and retention basins.

The stormwater infrastructure adjacent the eastern frontage of Lot 82 includes a roadside dish drains in the vicinity of the gravel accesses leading to street pit & pipe drainage down to the existing basin at the corner of Riverview Place & New Entrance Road.

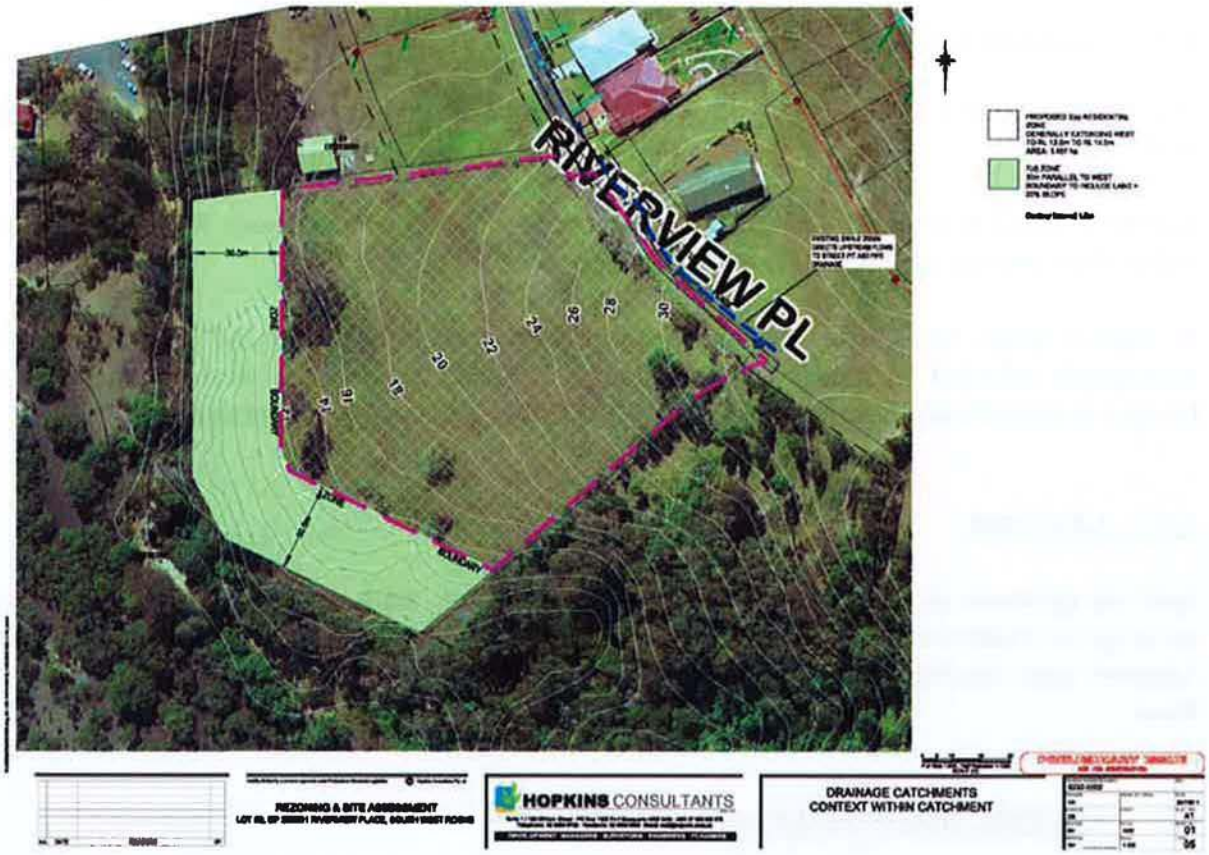
4.6 SITE DRAINAGE & RUNOFF WATER QUALITY

The site is located on the western side of a crest, along which the existing Riverview Place and private access roads are generally aligned. Upstream stormwater flows are directed by the existing road formation and street drainage system away from the site and down the street.

The site vegetation is primarily mown grass with trees & thicker vegetation along the western boundary of the lot. There are no uses on the site.

The future post development stormwater to be dealt with through on-site treatment train is limited to only that area pertaining to a potential residential subdivision.

The future engineering design for the internal road intersection with Riverview Place should be required to ensure the upstream drainage continues along the Riverview Place alignment.



5.0 STORMWATER MANAGEMENT OBJECTIVES

Objectives can represent a variety of overall design intents and policy directions, and ideally there will be consistency between objectives across various agencies at Local, State and National levels. The Figure below represents the groups of objective that are most commonly applied, though locally specific objectives (e.g. road design elements, maintenance pathways etc) may also be required.

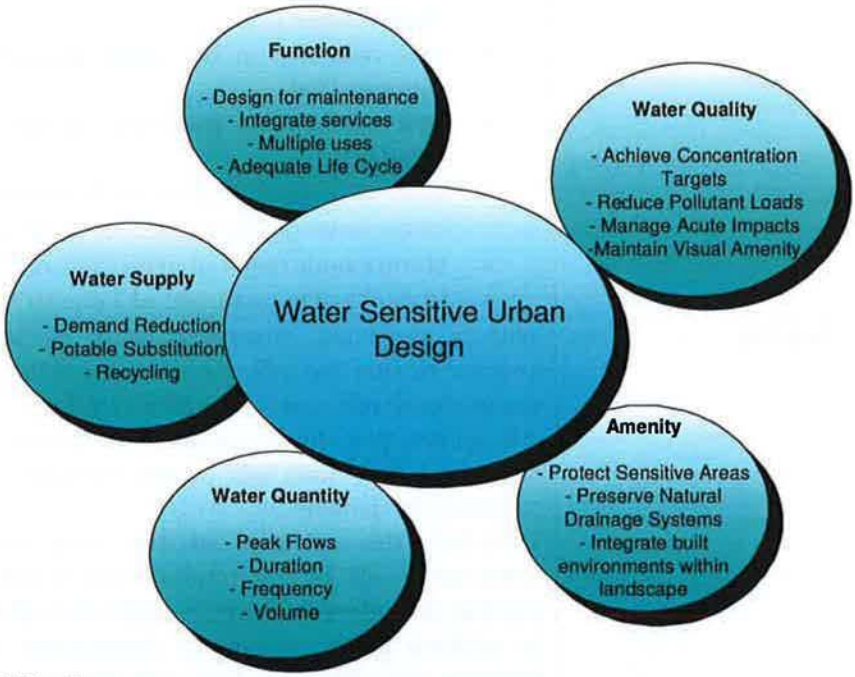


Figure WSUD Objectives

The overall objectives of WSUD include:
Reducing potable water demand through demand and supply side water management, incorporating the use of water efficient appliances and fittings as well as a fit-for-purpose approach to the use of potential alternative sources of water;

- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse and/or release to receiving waters;
- Treating stormwater to meet water quality objectives for reuse and/or discharge;
- Restoring or preserving the natural hydrological regime of catchments;
- Improving waterway health by the management of the previous two objectives;
- Improving aesthetics and the connection with water for the residents of developments where it is applied; and
- Promoting a significant degree of water related self sufficiency within a development by optimizing the use of water sources from within the development to minimise potable water inflows and water outflows from a development, both stormwater and wastewater.

The objectives adopted for the subject site are tabled below:

Objective	Performance Measure/target
Stormwater Quality Construction Phase	During the construction phase, total suspended solids concentrations for all flows up to the 1 yr Average Recurrence Interval event to be less than 100 mg/L
Stormwater Quality Operational Phase	Stormwater discharged from developed areas to be treated in accordance with best management practice (BMP): • 80% reduction in the mean annual load of Total Suspended Solids (TSS) • 45% reduction in the mean annual load of Total Phosphorous(TP) • 45% reduction in the mean annual load of Total Nitrogen (TN) • 90% reduction in the mean annual load of Gross Pollutants • Area of residential zoned land to potentially treat for storm water quality is 1.457 ha at 50% impervious. • Storm events required to be captured – 5year ARI. • Water Quality treatment of 3 month ARI.
Stormwater Quantity – Post development	With a projected impervious area of 50% it can be anticipated that the inflow from the additional runoff from the proposed rezoning will be 38% by volume. It is unlikely given the topographic constraints of the broader catchment that there will be any cumulative impact from similar developments. Therefore this sub-area of the total catchment only represents 6.5% of the total surface runoff entering the existing natural wetland and an additional volume of 2.7%. In addition to the above no downstream properties are between the subject property and the Macleay River (apart from crown land) which negates the need for detention to pre developed flows. However, stormwater retention may be required to meet stormwater quality targets and prevent erosion.
Erosion Control – Post development	Erosion and scour control to be a priority & integral to the ultimate system design. Appropriate measures required to reduce the potential damage to BMPs caused by high stormwater flows. Downstream stormwater calculations to confirm flow velocities are acceptable.
Landscape Integration	Selection of Landscape plantings which aid the ongoing achievement of water quality targets and integrate into the natural amenity of the area. Landscape planting to be utilised as part of erosion & scour control, as well as part of achieving high level water quality targets
Protection of habitats	Ensure compliance with water quality targets for unmodified natural water systems so that important habitats such as mangroves and SEPP 14 wetland areas are protected. Ensure landscape species chosen are non invasive & compatible with nearby native vegetation

Community health and safety	Design a stormwater management system so as to ensure community health & safety: • avoiding , where possible the provision of wet detention areas (mosquito hazard), • fencing basins to reduce risk to public • ensure free & clear access for maintenance of stormwater treatment measures. • To protect the public from risk of injury or death. The velocity x depth product of flow across the footpath and within the road reserve shall be such that safety of children and vehicles is considered. The maximum allowable depth of water is 0.2 metres and the maximum velocity x depth product of $0.4m^2/s$ is permitted. Where the safety of only vehicles can be affected, a maximum velocity x depth product of $0.6m^2/s$ is permitted.
Community Awareness	Erect signage relating to water quality treatment areas to ensure community awareness re the role the treatment area (eg landscaped swales) and minimize the risk of it being damaged or used otherwise.
Optimal Infrastructure	Design the stormwater treatment system that fits within the natural topography and does not create an eyesore nor become an unreasonable burden to maintain as a large piece of infrastructure.

6.0 STORMWATER MANAGEMENT ISSUES

6.1 WATER QUALITY & DOWNSTREAM HABITAT PROTECTION

Different types of land use typically generate specific stormwater pollutants in significant quantities. The subject site is proposed to be rezoned to low density residential which is likely to generate the following pollutants: Litter, Total phosphorous and Total nitrogen. Coarse sediment, fine particles, hydrocarbons, motor fuels, oils and grease are considered to not be significant from a low density residential development.

Frequent flows and stormwater pollutants need to be intercepted and managed by stormwater treatment elements prior to being discharged and entering the sensitive downstream aquatic environment.

The treatment elements are to ensure stormwater quality is acceptable thus, protecting the existing hydrological regime, avoiding disturbance to vegetation and scour, and ultimately ensuring the protection of the downstream SEPP 14 wetland areas.

6.2 WATER QUANTITY & EROSION

The retention of pollutants is only one part of stormwater management at new development sites. There are a number of stormwater management objectives that, although not quantifiable, are nonetheless critical to the pursuit of more sustainable stormwater management practices at new development sites.

WSUD measures can lead to a severing of the connection between the hard surfaces and the drainage system which can therefore lead to both a reduction in flow volumes through increased infiltration and/or retention, and also a slowing down of water travelling to the drainage system, resulting in reduction in flow velocities and opportunities for settlement and biological removal of pollutants.

There are obvious synergies between the various water conservation elements of WSUD (e.g., rainwater tanks, stormwater harvesting and reuse, aquifer storage and recovery) and stormwater quantity requirements which should be considered when conceptualising, designing and evaluating a WSUD project.

One important concept of water supply provision associated with WSUD is 'fit for purpose'. Specifically, this implies that not all water used in a household or urban area needs to necessarily be potable quality. An example in this regard is toilet flushing, for which lower grade water can readily be used. By the addition of rainwater tanks in accordance with the requirements of BASIX there will be a reduction of stormwater quantity. Rainwater tanks can be connected to outdoor taps, laundry cold tap and potentially the hot water system. Relevant State and Local guidelines which define acceptable qualities of water which embrace the 'fit for purpose' concept need to be consulted and used to advance the water conservation and recycling aspirations of WSUD.

Erosion control is to be addressed by the design of the stormwater capture system and the treatment of the release areas, depending on whether the ultimate system utilizes swales or basins with single point discharge.

In either situation, a combination of selected hard-works to prevent erosion & scour as well as informed selection and maintenance of landscape plantings suitable to the task is essential to managing this particular stormwater issue.

7.0 STORMWATER MANAGEMENT OPTIONS

The implementation of a preferred WSUD option in a greenfield context, requires careful consideration of the broad principles of WSUD and the required objectives specific to the site. A formalised assessment process is beneficial to determine whether a proposed strategy is suitable and/or appropriate in terms of the defined principles and objectives.

Stormwater Management Options that may meet the objectives include but are not limited to:

- Gross Pollutant Traps
- Sediment Basins
- Bioretention Systems - Bioretention Swales, Bioretention Basins
- Sand Filters
- Swales, Vegetated Swales
- Vegetated Filter Strips
- Buffer Strips
- Constructed Wetlands
- Ponds and Lakes
- Infiltration Systems - Infiltration Trenches, Infiltration Basins
- Porous Pavements
- Aquifer Storage and Recovery
- Permeable Pavements
- Rainwater Tanks (single lot above ground)
- Landscape Developments

To select a WSUD treatment the measures can be grouped into three main categories: primary, secondary and tertiary.

Category	Definition	Typical Retained Pollutant	Typical WSUD Measures
Primary	Physical screening or rapid sedimentation techniques	Gross pollutants and litter, coarse sediments, free oil/grease	Gross pollutant traps (GPT's), sediment traps, oil/grit separators
Secondary	Finer particle sedimentation and filtration techniques	Fine particles and attached pollutants	Sand filters, permeable pavements, vegetated filter strips, vegetated swales, infiltration systems
Tertiary	Enhanced sedimentation and filtration, biological uptake, absorption onto sediments	Nutrients and heavy metals	Constructed wetlands, bioretention systems, natural stream systems

Each stormwater treatment measure operates over particular hydraulic loading rates and pollutant size ranges, however the pollutants typically targeted for removal by the stormwater elements of a WSUD (e.g. sediment, nutrients, litter etc) can have very large size ranges. This is shown in the table below *'Relationship of Particle Size and Hydraulic Loading'*. It can be seen that to treat a certain suite of pollutants, one treatment measure will not be suitable. For example, while a vegetated swale may be able to remove some nutrients, it will not be effective in removing colloidal and dissolved material, and a wetland or bioretention system may provide more efficient treatment. The swale may then become the pre-treatment measure for the wetland, and hence a 'treatment train' is created.

Table - Relationship of Particle Size and Hydraulic Loading

Size Range (µm)	Pollutant					Treatment Measure					Hydraulic Loading Rate Inflow/Surface Area (m/yr)
	Litter	Sediment	Nutrients	Organics	Metals	Gross Pollutant Traps	Sediment Basins	Swales and Buffer Strips	Constructed Wetlands	Biofilters	
>5000 (Gross solids)											1,000,000 - 100,000
5000 - 125 (Coarse)											50,000 - 5,000
125 - 10 (Fine)											2,500 - 1,000
10 - 0.45 (Colloidal)											500 - 50
<0.45 (Dissolved)											10

The table above also shows that to treat gross pollutants and coarse sediment in stormwater, the hydraulic loading rate (i.e. the quantity of water able to pass through a given surface area of a treatment measure) can be very high, whereas to treat nutrients or metals a much smaller hydraulic loading rate is required. This means that either less water can be treated, or the treatment measure needs to be much larger to treat an equivalent amount of water. The space requirements for a device are then inversely proportional to the hydraulic loading rate; the lower the loading rate, the larger the measure.

For this reason, treatment trains should be focussed on treating gross particulates (litter, larger organic matter etc) first, then coarse particulates (sediment) and finally fine, colloidal and dissolved material.

One treatment measure cannot treat all of the particle size ranges and a combination of measures will be most effective.

Particular measures may not achieve all objectives and some may be completely unsuitable. As such, guidance is also required on which types of measure or practices are most appropriate to specific objectives. This is provided in the Table below *'WSUD BMP Functionality Assessment'*.

Table - WSUD BMP Functionality Assessment

Measure	Objective: Water Quality					Water Quantity			Water Supply		Wastewater	Amenity					Functionality		
	Primary Treatment	Secondary Treatment	Tertiary Treatment	Achieve WQOs	Reduce Pollutant Loads	Disconnect impervious areas	Provide detention	Allow Stormwater Harvesting	Can provide alternative water source	Reduce potable demand	Reduce wastewater flows	Measure allows multiple uses	Form can be integrated into landscape	Retain natural features and enhance or restore riparian corridor	Minimal public safety issues	Linkages (pedestrian, bicycle, vehicular) maintained or enhanced	Maintenance elements can be incorporated within measure	Maintenance plans can be provided	Allows integration with service corridors
Potable Water Demand/Wastewater Generation Reduction Techniques																			
Water Efficient Appliances																			
Water Efficient Fittings																			
Rainwater Tanks																			
Reticulated Recycled Water																			
Greywater Treatment/Reuse																			
Stormwater Harvesting/Reuse																			
Changing Landscape Form																			
Water Use Education Programs																			
Stormwater Management Techniques																			
Sediment Basins																			
Bioretention Swales																			
Bioretention Basins																			
Sand Filters																			
Swales																			
Buffer Strips																			
Constructed Wetlands																			
Ponds and Lakes																			
Infiltration Systems																			
Porous Pavements																			
Aquifer Storage and Recovery																			
Water Quality Education Programs																			

Practice/Measure ideally suited
Practice/Measure may assist
Measure generally unsuitable
Not applicable

The table below presents a summary of the limitations of each WSUD measure and incorporates the key physical attributes that can significantly influence the design of WSUD Measures.

Table - Site Constraints for WSUD Measures

WSUD Measure	Steep Site	Shallow Bedrock	Salinity Hazard	Low Permeability Soils	High Permeability Soils	High Water Table	High Sediment Input	Land Availability Limitation	Hydraulic Head Loss limitation
Vegetated Swales	C	M	M	✓	✓	M	M	C	✓
Vegetated Filter Strips	C	M	M	✓	✓	M	M	C	✓
Sand Filters	M	M	M	✓	M	C	C	M	C
Bioretention Systems	C	M	M	✓	M	C	C	C	C
Permeable Pavements (Infiltration)	C	C	C	C	✓	C	C	C	C
Permeable Pavements (Detention)	C	M	M	✓	M	C	C	C	C
Infiltration Trenches	C	C	C	C	✓	C	C	M	C
Infiltration Basins	C	C	C	C	✓	C	C	C	✓
Rainwater Tanks	✓	✓	✓	✓	✓	✓	✓	C	✓
Landscape Developments	✓	M	M	✓	✓	M	M	C	✓

Key:
C – constraint may preclude the use of this WSUD
M – constraint may be overcome with appropriate modifications to design
✓ – generally not a constraint (i.e. design specifications apply)

In greenfield WSUD applications the initial construction costs are higher for WSUD measures when compared to equivalent conventional measures (e.g. grassed swales used for conveyance compared to underground pipe work), however these costs are equivalent and in some cases, less than conventional measures when construction staff become more familiar with the methods required for WSUD implementation.

During the planning and evaluation process for applying WSUD, a thorough analysis of the costing implications is warranted. This process has to account for both the cost of construction and ongoing operation (maintenance and occasional refurbishment), and also the costs of replacing the measure at the end of its operational life.

Education and other non structural measures of the WSUD strategy should be explained for the residents of a development as their support is important for the ultimate success of the strategy. The practices of individuals can have significant implications in terms of water quality and water conservation. Many residents may be interested in actively engaging with the eco-medians and may assist in maintaining these public space areas particularly in terms of surveillance and identifying problems that may arise

The characteristics of the subject site limit the stormwater management options available for compliance with the objectives listed in Section 5.0. Using the evaluation tables the following options would be suitable for inclusion in a Water Sensitive Urban Design for the development:

- Vegetated Swales
- Vegetated Filter Strips
- Sand Filters
- Bioretention Systems
- Permeable Pavements (Infiltration)
- Permeable Pavements (Detention)
- Infiltration Trenches
- Infiltration Basins
- Rainwater Tanks
- Landscape Developments

Further evaluation at the detailed design stage will be required to confirm the best management practices have been achieved.

To show that the objectives can be met a design was evaluated and is shown in Appendix 1. This is only a concept for the purpose of showing compliance is achievable and further detailed design is required along with Kempsey Shire Council at the Development Application stage.

8.0 IMPLEMENTATION STRATEGY

In developing a Stormwater Quality Management Plan & Water Sensitive Urban Design Strategy for a development, all elements of urban development need to be integrated into the design; aquatic and terrestrial ecosystems. roads, water infrastructure, earthworks and landscape.

In this egard there is a wide range of WSUD and stormwater management technology available to deliver the objectives outlined in Section 5.0. Selection of the most appropriate suite of measures for the development requires the matching of available technology to the climate, site conditions (i.e. topography), management objectives and the desired urban form.

The strategy for implementation will be dependant on development constraints, timing,

capacity, resources and temporary measures required during the construction phase/s of the development. The strategy must meet the specific objectives listed in this report to comply.

A erosion and sediment plan during construction must address pollutants (suspended solids and turbidity) from soil types encountered on the site which may range from Type D (dispersible), Type F (fine) to Type C (coarse).

Typically the development of a Greenfield site, includes two phases:

- Sub-Division Construction - involves the civil works required to create the landforms associated with a development and install the related services (roads, water, sewerage, power etc.) followed by the landscape works to create the softscape and streetscape features. These activities can generate large sediment loads during runoff events which must be intercepted before entering the receiving environs. Importantly these works can be readily controlled through the contract with the principal contractor.

- Allotment Building - Once the Sub-Division Construction works are complete and the development plans are approved then building on the allotments can commence (i.e. construction of the houses or built form). This phase of development is effectively 'uncontrolled' due to the number of building contractors and subcontractors present on any given allotment. For this reason the Allotment Building Phase represents the greatest risk to the successful establishment of WSUD systems

Both these phases of construction introduce different risks both in terms of sediment and erosion control and also to the successful establishment of the WSUD systems. The following sections summarise the initiatives to be adopted during both these phases of construction to deliver appropriate sediment and erosion control whilst also protecting the WSUD systems from damage.

SUB-DIVISION CONSTRUCTION STAGE

'Managing urban stormwater: soils and construction' publications prepared by Department of Environment and Climate Change NSW provide guidance on erosion and sediment control during construction and other land disturbance activities. The publications are considered the industry standard and cover the sediment and erosion control and pollution control during the infrastructure construction stage. This stage will involve:

- Minimising the generation of silt laden runoff and interception at the source (i.e. within the road reserves):

- Limiting the area disturbed during construction to the immediate construction area and associated access routes.

- Preventing overland flow from entering earthworks areas by utilising diversion channels and bunds.

- Erecting silt fences where required to prevent sediment from being transported to receiving waterways. The silt fences will be designed. installed and maintained in

accordance with Kempsey Shire Council policy.

- Removing sediment trapped by silt fences and sediment traps on a regular basis and using it as top dressing for rehabilitated landscaped areas.

- Establishing vegetated buffers along the road edge. which filter the runoff by trapping sediment. between the road verge construction activities and the road pavement and drainage.

- Stabilising soil stockpile areas to prevent erosion.

- Revegetating the site at the earliest opportunity during construction.

- Constructing sediment traps and sediment basins at appropriate locations to collect silt contained in the runoff. prior to discharge to the receiving waterways.

- Undertake daily inspections of the measures listed above to ensure proper operation and to identify requirements for remediation or clean out works.

ALLOTMENT BUILDING STAGE
Builders will be required to undertake allotment building works in accordance with Kempsey Shire Council Codes and Policies. Council's *'Guidelines for Erosion and Sediment control'*, specifies erosion control measures to be installed for all development.

The following management actions during the allotment building stage are expected:

- Erecting silt fences where required to prevent sediment from being transported to road reserves and receiving waterways. The silt fences will be designed. installed and maintained in accordance with Kempsey Shire Council Policy.

- Undertake daily inspections of the measures listed above to ensure proper operation and to identify requirements for remediation or clean out works.

9.0 MONITORING /REPORTING

Monitoring WSUD measures is a complex undertaking and should not be simply considered as a way of ensuring that compliance is being achieved.

There are two levels of monitoring that could provide useful outputs:
- To assess achievement of overall WSUD objectives; and
- To assess the performance of individual WSUD measures.

To develop a monitoring program which will provide useful information, it is imperative that the objectives of the program are clearly identified.

Typical objectives can be:

- Hydraulic performance - % of total flow treated, % of flow bypassed, water levels etc;
- Water quality performance – Inflow concentrations, outflow concentrations, loads captured;
- Economic – Capital cost of treatment measures, maintenance cost, potential savings through deferment of large infrastructure, land costs, lost opportunity costs;
- Maintenance – Inspection records, maintenance frequencies, maintenance activities, plant establishment performance;
- Ecological – Fauna and/or flora assessments, ecosystem health monitoring (e.g. primary production);
- Public health – Pathogen levels and other potential hazardous compounds which may be associated with recycled stormwater or wastewater; and
- Social/Aesthetic - Photographic records, resident surveys.

The above list is not exhaustive and the monitoring program objectives should be closely aligned with the objectives that were intended to be satisfied through the implementation of the WSUD measure or treatment train.

The need for monitoring a WSUD element or treatment train should be determined by the degree of confidence in the performance of the element. Obviously, those measures which have been studied in depth by research agencies are not likely to require further monitoring to ensure that they are going to be successful. If any monitoring is to be conducted, it should focus on the consistency of the delivered WSUD implementation to that proposed in the conceptual and detailed design phases, as this is an area where there is the highest likelihood of non-compliance. If a particular measure is an application of existing, well understood WSUD practice in a different environment, or is a new technique or element, then monitoring is likely to be beneficial.

A monitoring programme will be required to ensure the WSUD Strategy performs in accordance with the design intent and to guide the corrective actions, adaptive management responses and maintenance requirements. Monitoring is broadly split into two parts:

- WSUD Infrastructure monitoring to ensure the systems are performing as designed and are not exhibiting problems.

- Receiving environment monitoring to ensure ecosystem health is being sustained during construction and operation. This will focus on aquatic ecosystem health and water quality during the Construction Phase.

10.0 CONCLUSION/RECOMMENDATIONS

Using items from the list of stormwater options that have been listed as suitable for the subject site a Stormwater Quality Management Plan and Water Sensitive Urban Design Strategy can be developed to support the future Development Applications to Kempsey Shire Council and Construction Certificates following the pending rezoning of the site.

Following consideration of options, this broad strategy represents the best outcomes for the development given constraints of steep topography and vegetation protection (in particular the existing SEPP 14 wetlands) to the west of the site.

The measures recommended in this strategy represent current best practice in urban stormwater management and achieve effective stormwater quantity and quality treatment, thereby affording appropriate protection to not only the remaining 7(d) – Scenic Protection land located on site but also to the ultimate receiving environment.

References

Evaluation Options for Water Sensitive Urban Design (July 2009) – a national guide

Technical Guidelines for Western Sydney (May 2004)

Landcom (Jan 2004). WSUD Strategy

South-East Queensland WSUD Technical Design Guidelines(June, 2006)

APPENDIX A - Concept Option

Pipe stormwater from road & roof to lineal Bio Retention Swales with landscaped sheet overflow.

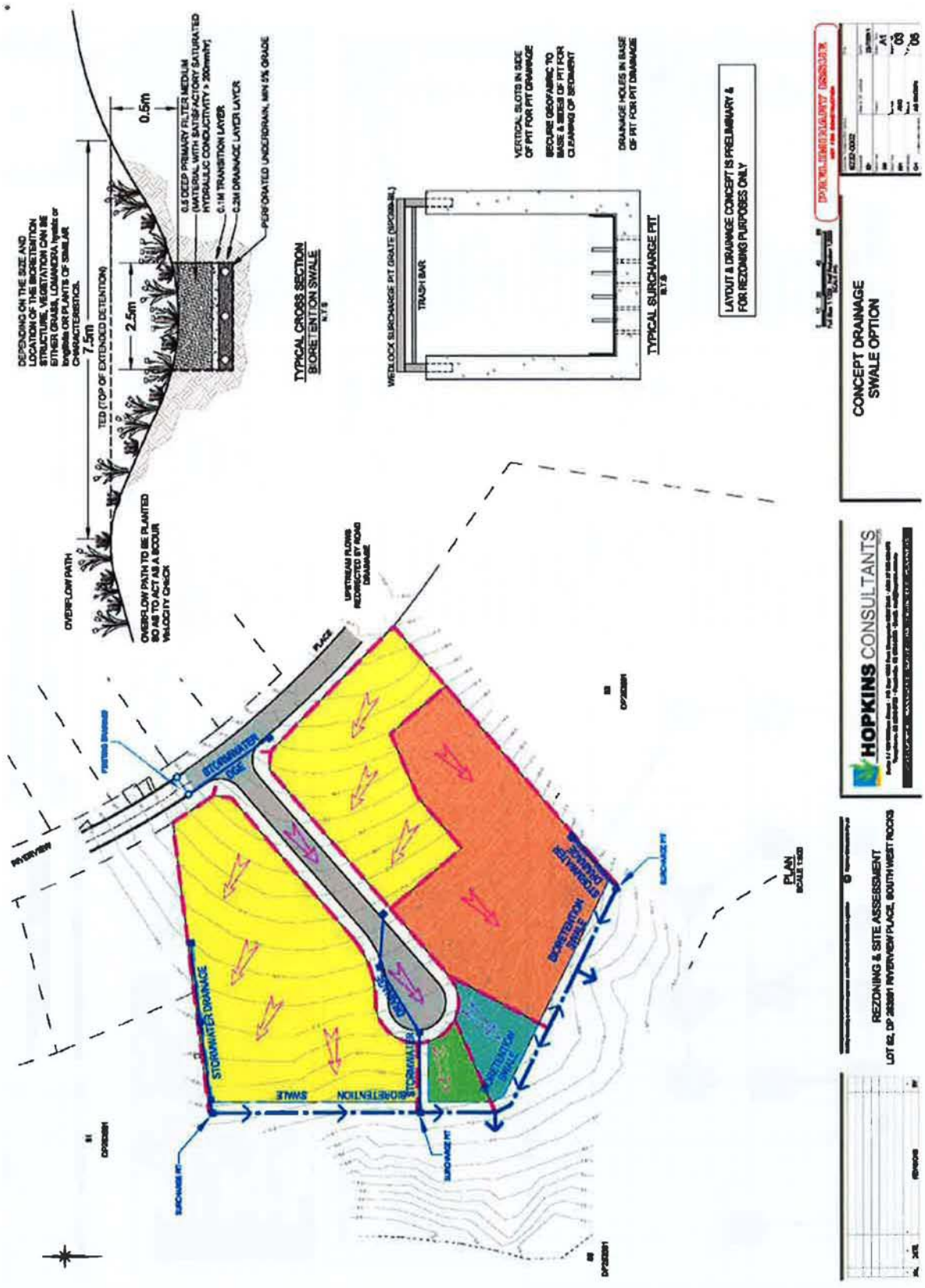
Area of residential zoned land to potentially treat for storm water quality is
1.457 ha at 50% impervious.
Storm events required to be captured – 5year ARI.
Water Quality treatment of 3 month ARI.

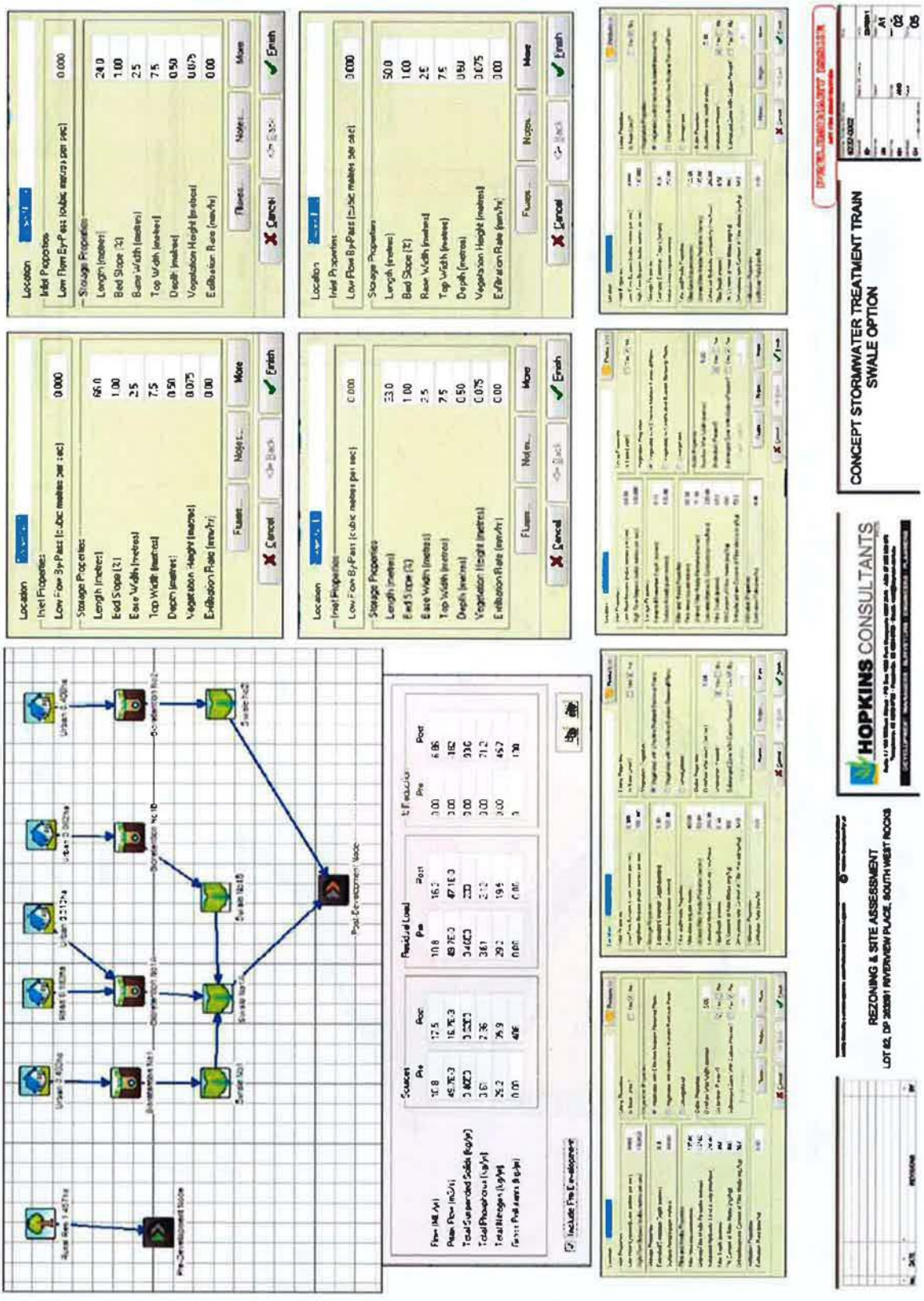
Investigation of the potential post development stormwater flows is illustrated below. It sets out possible site sub catchments and behaviour of flows based on a central access road and swale controls. It is conceptual only and should be refined in more detail at Development Application phase.

In order to demonstrate that the aforementioned stormwater quality objectives the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was selected due to its superior ability (compared with other commercially available catchment based pollutant export models) to simulate the pollutant removal performance of current best practice stormwater quality improvement measures.

In summary the swale filter area of approximately 432 m^2 was proposed, which can be achieved on this site through lineal length of swale 173m, base with 2.5m and top width 7.5m, depth 0.50m and have grades suitable for this type of device.

Below are water quality data and results from MUSIC.


CONCEPT DRAINAGE
SWALE OPTION
HOPKINS CONSULTANTS
REZONING & SITE ASSESSMENT
LOT 62, DP 262691 RIVERVIEW PLACE, SOUTH WEST ROCKS
LAYOUT & DRAINAGE CONCEPT IS PRELIMINARY & FOR REZONING PURPOSES ONLY
TYPICAL CROSS SECTION
BIORETENTION SWALE
TYPICAL SURCHARGE PIT
VERTICAL SLOTS IN SIDE OF PIT FOR PIT DRAINAGE
SECURE GEOFABRIC TO BASE & SIDES OF PIT FOR CLEANING OF SEDIMENT
DRAINAGE HOLES IN BASE OF PIT FOR PIT DRAINAGE
TRASH BAR
PERFORATED UNDERDRAIN, MIN 0% GRADE
0.5m
2.5m
7.5m
TED (TOP OF EXTENDED DETENTION)
OVERFLOW PATH
RIVERVIEW PLACE
STORMWATER DRAINAGE
SWALE
BIORETENTION
STORMWATER
SURCHARGE PIT
PLAN


CONCEPT STORMWATER TREATMENT TRAIN
SWALE OPTION
HOPKINS CONSULTANTS
REZONING & SITE ASSESSMENT
LOT 62, DP 263891 RIVERVIEW PLACE, SOUTH WEST ROCKS

The management plan proposes implementation of current best practice WSUD technologies that utilise vegetative systems to promote the interception, adsorption and biological processing of water borne pollutants across a range of climate conditions.

The management plan provides an ideal opportunity to incorporate the stormwater treatment systems into the landscape in a low impact and unobtrusive manner.

The option of a lineal bio retention swale system at the bottom of the developable area is desirable in the circumstances of this site in that it enables capture and treatment of not only roof water and road run off, but also domestic garden borne contaminants.

The landscape elements of a bioretention swale system and overflow path are essential to its effectiveness and in achieving the water quality targets. Further contour banks/infiltration trenches may be required to assist in infiltration of stormwater and conversion of flows to sheet flow preventing possible erosion.

The effectiveness of this management plan to achieve the stormwater quality objectives was assessed using the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Model Version 4 developed by the CRC for Catchment Hydrology.

NOTE ON GROSS POLLUTANT TRAPS

It is not considered necessary to provide gross pollutant traps within the drainage system at the subject site. The reasoning for this is twofold:

- Monitoring undertaken by Brisbane City Council of GPTs receiving runoff from residential catchments has found that generally less than 5% by weight of gross pollutants captured within GPTs is anthropogenic (i.e. plastic, paper). The vast majority of the captured material is organics (i.e. leaf litter) or coarse sediment. This indicates the development density associated with residential allotments, coupled with the high level of general house and yard keeping by individual householders is resulting in only a low generation of anthropogenic litter.

- The BCC, monitoring and observations indicates that when this organic material is captured in wet vault type GPTs there is a tendency for this material to transform under anaerobic conditions to more bio available forms of nutrients. This can result in a net export of nutrients in a form that is more deleterious to downstream ecosystems. Stormwater management needs to target the various forms of gross litter using appropriate management responses. For example targeting gross litter from residential catchments, which contain a high proportion of organics, should occur through aerobic systems.

In response, the WSUD Strategy for the development does not adopt GPTs but rather applies the following approaches for capturing gross litter and coarse sediment from the residential catchments:

- Gross litter, which is predominantly organic, is to be captured in aerobic conditions within the vegetated bioretention basins. This effectively precludes the discharge of anthropogenic litter to downstream environs.

- Coarse sediment is to be captured within vegetated swale at the start of the bioretention swale to avoid the smothering of vegetation.