3 Water Quality Assessment

3.1 Overview

This water quality assessment determines treatment measures required to achieve adopted water quality objectives. It allows for a general specification of water quality structures, and will require refinement at detailed design stage.

Given the site's location and the sensitive nature of downstream ecosystems, this assessment shall ensure compliance with water quality objectives at the following receiving environments (Figure 1):

- o SEPP 14 Wetlands between Billy's Island and the site
- o Crookhaven River
- o Lake Wollumboola

3.2 Water Quality Objectives

Element RE12 '*Water Quality Management*' of Shoalhaven Council's DCP 100 (2002) requires that proposals aim to ensure:

> '*existing downstream environments are not adversely affected and no net increase in pollution levels discharging from the development*'.

During consultation with Shoalhaven Council's subdivision engineer (March 14, 2012), it was noted that a draft '*Sustainable Stormwater Management DCP*' was being prepared. If adopted the following pollutant retention (i.e. treated versus untreated) objectives would apply:

- o 90% of gross pollutants
- o 85% of total suspended solids (TSS)
- o 65% of total phosphorus (TP)
- o 45% of total nitrogen (TN)
- o 90% of total hydrocarbons

Based on consultation with Shoalhaven Council and NSW OEH, project water quality objectives are adopted as follows:

- NorBE (neutral or beneficial) - pollutant loads in the post development scenario that are equal to or less than those currently generated from the site.

- Treatment train effectiveness will be designed to achieve the draft DCP (2012) requirements for pollutant retention.

Water quality objectives are adopted for all receiving environments (Section 3.1).

3.3 Modelling Methodology

3.3.1 Overview

The Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*, Version 5.1) developed by the CRC for Catchment Hydrology was utilised to evaluate pre and post development pollutant loads from the site.

Modelling has been undertaken in accordance with *Draft NSW MUSIC Modelling Guidelines* (BMTWBM, 2010).

The following modelling scenarios were considered:

1. Pre Development – the existing site.

2. Post Development (untreated) - the developed site without water quality structures.

3. Post Development (treated) – the developed site with water quality structures included to achieve adopted objectives.

Pre and post development MUSIC model layouts are provided Sheet 4 and 5 of Attachment A.

3.3.2 Approach

An iterative approach was used for post development modelling to determine appropriate types, sizes and locations of stormwater treatment devices for the site to achieve adopted objectives.

3.3.3 Climate Data

Rainfall data was sourced from Nowra RAN from 1964 – 1970 in accordance with the NSW MUSIC guidelines. Average monthly areal potential evapotranspiration (PET) was sourced from *'Climatic Atlas of Australia – Evapotranspiration'* (Bureau of Meteorology, 2001).

3.3.4 Input Parameters

Input parameters for source and treatment nodes are consistent with the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010). Attachment B summarises input parameters.

3.3.5 Catchment Areas

Pre and post development catchment areas and pervious/impervious areas of each catchment are provided in Attachment D.

The following should be noted with regards to catchment areas:

- Development on the southern side of the ridge line and continuing to discharge south to Lake Wollumboula i.e. C4 (parkland) and C20 (retirement village) is modelled separately to catchments going to the Crookhaven River (remaining catchments).

- The catchment area directed to the SEPP14 area between Billys Island and the site was determined for the post development based on maintaining wetland hydrology (Section 4.4).

- This wetland outlet was assessed independently and as part of the total Crookhaven River catchment, to assess water quality impacts on the wetlands.

- All residential/accommodation development catchments have been split into 'roof', 'road' and 'remaining' sub-catchments. The cumulative areas of each of these sub-catchments are based on the catchment area, the proposed landuse and the proposed site coverage (Attachment A).

3.3.6 Model Parameters

Event Mean Concentration (EMC) inputs were derived from Sydney Metropolitan Catchment Management Authority (SMCMA) (2010) *'Draft NSW MUSIC Modelling Guidelines'*

Table 2: Adopted EMCs for source nodes.

		Base Flow (mg/L)		Storm Flow (mg/L)	
Land Use	Parameter	Log (mean)	Log (stdev)	Log (mean)	Log (stdev)
Roof	TN	na	na	0.300	0.190
	TP	na	na	-0.890	0.250
	SS	na	na	1.300	0.320
Agricultural	TN	0.040	0.130	0.480	0.260
	TP	-1.050	0.130	-0.220	0.300
	SS	1.300	0.130	2.150	0.310
Residential	TN	0.110	0.120	0.300	0.190
	TP	-0.850	0.190	0.600	0.250
	SS	1.200	0.170	2.150	0.320
Forest	TN	-0.520	0.130	-0.050	0.240
	TP	-1.520	0.130	-1.100	0.220
	SS	0.780	0.130	1.600	0.200
Commercial	TN	0.110	0.120	0.300	0.190
	TP	-0.850	0.190	-0.600	0.250
	SS	1.200	0.170	2.150	0.320
Sealed roads	TN	0.110	0.120	0.340	0.190
	TP	-0.850	0.190	-0.300	0.250
	SS	1.200	0.170	2.430	0.320
Industrial	TN	0.110	0.120	0.300	0.190
	TP	-0.850	0.190	-0.600	0.250
	SS	1.200	0.170	2.150	0.320

Land use parameters for each catchment node are provided in Attachment D.

3.4 Treatment Train Philosophy

The preferred stormwater treatment strategy for the site utilises stormwater reuse, at source controls, and end of line controls to ensure treatment objectives are satisfied. Individual SQIDs are outlined in the following sub-sections.

3.4.1 Rainwater Tanks

Rainwater tanks shall be utilised across the site to reuse rainwater to satisfy toilet flushing and laundry demands. The following tank sizes were assumed:

- 3 KL per dwelling for freestanding dwellings
- 3 – 5KL per dwelling for tourist facilities
- 3 KL per unit for multi-unit buildings
- 10 KL per industrial 'lot'

Water usage demands were based on figures provided by Shoalhaven Water (16 November, 2012):

- 1 ET for dwellings and units
- 15 ET/gross ha/yr for light industrial

where 1 ET = 200KL/yr.

According to NSW Department of Water and Energy (DWE) (2008) '*NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises*', toilet flushing and laundry uses account for 44% of total internal water demands. Therefore, total rainwater tank demands have been calculated based on 0.274 KL/day/dwelling (ET).

The total number of dwellings (and hence the cumulative tank volume and cumulative demand) was based on the sub catchment area and the proposed lot sizes within the sub-catchment. A single 'roof' node and 'tank' node was created to model each sub catchment.

3.4.2 SPEL '*Stormceptor*' Treatment Device

All road, tank overflow and pervious lot runoff areas shall pass through a '*Stormceptor*' (produced by SPEL) unit to remove gross pollutants, suspended solids and nutrients from stormwater runoff. The node (with treatment efficiencies) utilised in modelling was supplied by the manufacturer. Based on additional information from the supplier, high flow bypass for each unit is based on the 90th percentile of daily maxima inflow from the catchment.

Devices to be used onsite shall be confirmed at detailed design stage. If different devices are proposed, treatment removal efficiencies should meet or exceed those used in this assessment.

3.4.3 Bioretention Swales

Road side bioretention swales ('bioswales') are proposed to provide at source treatment of developed areas.

Bioswales provide treatment through media filtration, biological uptake of nutrients, evapotranspiration and detention. Assumed infiltration for modelling of proposed filter media is 50% of the specified design figure to account for reduced infiltration capacity of the swales over their life.

All flow is directed to the bioswales from upslope catchments.

Bioswale input parameters are provided in Attachment B. Typical bioswale design is provided in Attachment F.

3.4.4 Bioretention Basins

Given the character of the surrounding local environment, vegetated bioretention basins are considered an appropriate option for end of line treatment prior to controlled discharge to receiving waters. Bioretention basins provide treatment through filtration, biological uptake of nutrients, infiltration, evapotranspiration and detention. Overflow outlets of basins will include baffles to retain floating pollutants such as gross pollutants and hydrocarbons.

Individual basin input parameters are provided in Attachment E with typical basin sections in Attachment F.

3.4.5 Wetlands

Two different wetlands are proposed as part of the proposed development. These are discussed in the following sections. Typical wetland sections are provided in Attachment F with wetland input parameters in Attachment E.

3.4.6 Foreshore Wetlands

A continuous wetland is required downslope of the development in the vicinity of the inlet between Billys Island and the site to achieve water quality outcomes. Catchment runoff will discharge into the foreshore wetland which will detain and treat runoff through biological uptake of nutrients, evapotranspiration and detention. Wetland shall spill evenly along it's length to promote even dispersal of flow and controlled discharge during major events.

3.4.7 Parkland Wetland

A wetland is proposed in Catchment C4 (proposed oval and parkland). Inclusion of a wetland here, as opposed to a bioretention basin, allows detained water to be reused for irrigation of the sub catchment. A reuse demand of 6 ML/ha/yr was assumed based on typical irrigation rates for playing fields.

3.4.8 CDS GPT

CDS GPT units (produced by Rocla) are proposed to treat runoff from C16 (proposed electrical substation) to remove gross pollutants and some nutrients. In reality, minimal gross pollutants are expected from this area given staff will only be present periodically.

Devices to be used onsite shall be confirmed at detailed design stage. If different devices are proposed, performance should be adequate to achieve outcomes detailed in this assessment. Unit is to include hydrocarbon removal.

3.4.9 Vegetated Buffer

An open reserve and forest area (C15a and C15b) is proposed in the site's east to provide vistas of the Crookhaven River for surrounding development and to maintain some of the existing forest vegetation. A portion of the forest area has been utilised as a 'buffer' area to treat discharge from the proposed electrical substation (C12).

In reality, the 2.8 ha open reserve area as well as the 4.52 ha of forest area will act as a buffer (and hence provide treatment) to all upslope catchments. However due to the nature of MUSIC software (only source nodes can drain to buffers) this could not be modelled.

3.5 MUSIC Results

3.5.1 NORBE Assessment

Results of MUSIC modelling are provided in Table 3, Table 4, and Table 6 for each catchment considered.

Table 3: MUSIC results - NORBE assessment – Crookhaven River

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	13500.0	10500.0	22%	Y
TP (kg/year)	32.9	32.9	0%	Y
TN (kg/year)	245.0	245.0	0%	Y
Gross Pollutants	898.0	898.0	0%	Y

Table 4: MUSIC results - NORBE assessment – Lake Wollumboula

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	513.0	321.0	37%	Y
TP (kg/year)	1.55	1.47	5%	Y
TN (kg/year)	16.3	15.6	4%	Y
Gross Pollutants	0.0	0.0	0%	Y

Table 5: MUSIC results - NORBE assessment – Billys Island inlet

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	1580.0	761.0	52%	Y
TP (kg/year)	4.7	4.1	12%	Y
TN (kg/year)	50.7	47.9	6%	Y
Gross Pollutants	0.0	0.0	0%	Y

3.5.2 Treatment Train Effectiveness

Table 6, Table 7 and Table 10 provide assessment of the treatment train effectiveness (i.e. post development untreated versus post development with treatment) for receiving environments.

Table 6: MUSIC results - treatment train effectiveness – Crookhaven River

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	49280.00	1227.00	98%	Y
TP (kg/year)	104.20	13.17	87%	Y
TN (kg/year)	774.00	115.40	85%	Y
Gross Pollutants	8910.00	0.00	100%	Y

Table 7: MUSIC results - treatment train effectiveness – Lake Wollumboula

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	3800.00	321	92%	Y
TP (kg/year)	8.97	1.47	84%	Y
TN (kg/year)	60.6	15.6	74%	Y
Gross Pollutants	462	0	100%	Y

Table 8: MUSIC results - treatment train effectiveness – Billys Island Inlet

Parameter	Sources	Residual	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	13600.00	483	97%	Y
TP (kg/year)	31.8	3.23	90%	Y
TN (kg/year)	246	38	85%	Y
Gross Pollutants	2780.00	0	100%	Y

3.6 Conclusions

Results indicate that post development water quality objectives will be met by the proposed stormwater treatment train.

It is noted that further refinement of the model at the detailed design stage of the development may alter the sizes of proposed treatment structures, however, performance outcomes of final design must achieve specification provided in this report.