Appendix 5

Area 14 Integrated Water Cycle Management Plan

STORM_CONSULTING

AREA 14 INTEGRATED WATER CYCLE MANAGEMENT PLAN

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Prepared by:
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EXECUTIVE SUMMARY

Area 14 is located south of Port Macquarie, on the coast between the villages of Lake Cathie and Bonny Hills and will comprise approximately 1800 new dwellings and accommodate up to 4,800 people, two new schools and commercial areas.

Port Macquarie Hastings Council (Council) has strongly committed to the implementation of Integrated Water Cycle Management (IWCM) on all new release areas in the LGA. This has involved the development and implementation of a strategic framework for integrated water cycle management in the Mid North Coast, partly funded from Stage 5 Stormwater Trust grants.

In response, Council has applied an IWCM planning approach on Area 14 examining four water cycle management options.

Area 14 is subject to many environmental constraints including those managed by SEPP14, SEPP71 and SEPP26. A major constraint to development is also the fact that there is significant community opposition to a new ocean outfall on Rainbow Beach combined with poor environmental performance associated with the existing dune based infiltration system that services the existing STP.

Objectives for development for stormwater management were suggested by STORM and based on the EPA Council handbook with the governing objective being to remove 45% of the average annual load of nutrients that is likely to be exported from Area 14.

Four options were assessed using numerical models to determine a preferred approach to development of the water cycle in Area 14.

The four options examined include:

0. Current Practice in Port Macquarie – this option involves the use of rainwater tanks to comply with BASIX and the use of constructed wetlands at the end of pipe to treat stormwater flows.
1. Involves the use of recycled water to meet BASIX – for use in the toilets, laundry and garden of each new dwelling in Area 14 and the use of constructed wetlands at the end of the pipe to treat stormwater flows.
2. Involves the use of rainwater tanks to meet BASIX and the use of water sensitive urban design techniques to manage stormwater at its source, within road median areas where possible and in sand filters at the end of the pipe.
3. Involves recycled water to supply toilets and gardens, rainwater tanks to supply laundry and hot-water demand and the use of water sensitive urban design techniques to manage stormwater at its source, within road median areas where possible and in sand filters at the end of the pipe.

A life cycle cost analysis was undertaken on each option and presented in this report. Option 2 has the lowest life cycle cost followed by Options 0, 3 with Option 1 being the most expensive. The options that used recycled water were more expensive and the options that used rainwater tanks were cheapest. A WSUD approach was found to have a cheaper life cycle cost than those that considered only end of pipe treatment.

A workshop was conducted with Council to select a preferred Option and based on the constraints to development and the life cycle costs it was agreed that Option 3 was to be the preferred approach. The somewhat poor performance of the existing dune based infiltration system together with the inability to construct an ocean outfall to discharge effluent dictated the need to recycle effluent. Recycling within Area 14 provides a year round demand for recycled water which will significantly reduce the loading on the infiltration system. Option 3 and 1 both considered recycling the effluent (other options did not) and Option 3 had a lower life cycle cost as was therefore selected as the preferred approach.

Moreover Option 3 considers the impacts of the whole water cycle on the receiving waters – it is represents a balance between effluent loads and stormwater loads and if implemented would export the least amount of nutrients from the development but at some additional cost.

From a cost perspective Option 3 will have a capital cost of approximately $3,000 per low or medium density lot greater than the capital cost of Option 0 but on a life cycle basis, i.e. when the cost of lower water bills is considered, the cost difference between Option 0 and Option 3 reduces to about $2,000 per low density lot and $2,800 per medium density lot.

Adoption and construction of this approach will depart from the more traditional approaches to watercycle management and importantly this is in line with Council's adoption of the IWCM Framework.

Adoption of Option 3 on Area 14 also gives Council an opportunity to become a leading proponent of integrated water cycle management in Australia.

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Proposed Road and Lot Layouts

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Options 0 to 4 and preferred option

1.0 INTRODUCTION

1.1. Background and Context

STORM_CONSULTING (STORM) has been commissioned by Port Macquarie-Hastings Council to prepare an integrated water cycle management (IWCM) plan for a new release area in the Hastings LGA known as Area 14. Area 14 is located between the existing developments of Lake Cathie and Bonny Hills and would effectively link these two areas with new, greenfield development.

This IWCM plan models the new greenfield development area, and does not include the townships of Lake Cathie and Bonny Hills.

STORM has prepared the following report to present a summary of the work undertaken to date, which includes:

- Finalised road and lot layouts for the greenfield areas (reviewed and approved by Council);
- Development objectives (reviewed and approved by Council);
- Opportunities and constraints relating to water cycle management;
- Developing options for water balance modelling,
- Actual modelling of the options,
- Undertaking a life cycle costing analysis of those options, and
- Documentation of a preferred option.

Council has already reviewed the finalised road and lot layouts, the development objectives and the options that were to be modelled. Council has also participated in a workshop to select a preferred option. This report is the final deliverable on this project.

1.2. Proposed road and lot layouts

The proposed road and lot layouts for the subdivision are presented in Appendix A. The drawings include:

- P01 – Overall Subdivision Masterplan
- P02 – Subdivision Masterplan Zoning – Southern Precinct
- P03 – Subdivision Masterplan – Southern Precinct
- P04 – Subdivision Masterplan Zoning – Northern Precinct
- P05 – Subdivision Masterplan – Northern Precinct
- P06 – Subdivision Masterplan Zoning – Western Precinct
- P07 – Subdivision Masterplan – Western Precinct
- P08 – Preliminary Typical Road Cross Sections

2.0 DEVELOPMENT OBJECTIVES

Development objectives for the following watercycle management areas have been addressed in this report:

- Stormwater quality
- Stormwater quantity (including frequency, volumes and flow durations)
- Stormwater peak flows
- Stormwater conveyance system performance (minor – major storm systems)
- Water distribution and reticulation system performance (as included in Hastings District & Villages Water Supply Schemes- DSP - October 2001)
- Potable water quality
- Recycled water quality
- Recycled water distribution

We have also included information relating to the following categories which have previously been confirmed by Council in the Task 4 Objectives paper by STORM (June 2005):

- Existing and predicted populations
- Development characteristics (such as roof areas, area impervious etc)
- Infill rates.

2.1. Stormwater Quality

Please note this section deals with physico-chemical water quality issues. It does not address water quantity issues which are dealt with in Section 2.2. The word quantitative is used below in reference to water quality not water quantity.

Council have produced a Development Design Specification - D7, for stormwater management which provides qualitative and quantitative stormwater "quality" management targets. This document requires that large developments (including Area 14) comply with:

1. Australian Runoff Quality (ARQ) which in turn requires some measure of compliance with ANZECC water quality targets,
2. EPA Council handbook targets and;
3. That the quality of runoff from the development be no worse than the predevelopment regime.

There are some questions about the applicability of this three tiered approach. ARQ is an approach with many unresolved inconsistencies.

Based on MUSIC modelling in the Hastings and other areas, the next most stringent requirement is considered to be the second approach – i.e. the EPA Council Handbook approach.

Qualitative and quantitative stormwater management targets have been developed by the NSW EPA in the "Managing Urban Stormwater: Council Handbook" (1998). This document was developed to assist in the development of stormwater management plans (SMPs) and both the qualitative and quantitative objectives have been adopted within numerous SMPs throughout the state.

Stormwater treatments shall be designed to meet the minimum level of pollutant criteria in accordance with Council Handbook targets presented in Table 1.

The criteria are load based, rather than specific target criteria based. It is believed that if these targets are adopted then the health of the receiving waters will not be compromised. This comment is based on extensive modelling within the Sydney Catchment Areas where we have compared the second and third approaches repeatedly. The second approach appears to be more stringent than the third approach but not to such an extent that it would require a significantly different response in terms of the treatment train to be put in place.

Based on the above assessment of the three listed approaches for stormwater quality management, Table 1 documents the water quality criteria proposed to be adopted for Area 14.

Table 1: Stormwater Quality Criteria for Area 14

Pollutant/Issue	Retention Criteria
Coarse Sediment	80% of average annual load for particles ≤ 0.5mm
Fine Particles	50% of average annual load for particles ≤0.1mm
Total Phosphorus	45% of average annual pollutant load
Total Nitrogen	45% of average annual pollutant load
Litter	90% of average annual litter load > 5mm
Hydrocarbons, motor fuels, oils and grease	90% average annual pollutant load

2.1.1. State Environmental Planning Policy No 14 – Coastal Wetland No. 509

Area 14 adjoins the southern boundary of Lake Innes Nature Reserve (SEPP 14 Wetland No.509). The Lake Innes Nature Reserve covers an area of approximately 3,510 ha to the north of the Area 14 site and comprises coastal plains and wetlands. The reserve is bounded by the industrial estate of Port Macquarie to the north and the village of Lake Cathie to the south. The Lake Cathie road bounds the reserve to the east and the western edge of Lake Innes generally forms the western boundary.

Lake Innes and Lake Cathie are joined by Cathie Creek to form an estuarine system which enters the ocean at the village of Lake Cathie. Prior to 1933 when it was deliberately drained, Lake Innes was not part of the Lake Cathie estuarine system but a separate freshwater lake. Lake Innes is no longer a freshwater lake, however it now supports a variety of salt tolerant bird species. Much of the reserve is designated as Wetland No.509 under SEPP14.

The "Lake Innes Nature Reserve Plan of Management" (NSW National Parks and Wildlife Service 1999) was established to identify policies and actions for the protection of the reserve. Policies aimed at managing hydrology include:

- The water quality of the wetlands and lakes will be protected;
- Further research into the impacts of catchment runoff on fringing wetlands, estuarine sediments and water quality will be encouraged;
- Lake Innes Nature Reserve will be protected from runoff from developments within the catchment;
- The reversion of Lake Innes to freshwater will be supported pending further investigation of its feasibility.

The above aims have been considered while devising the watercycle management plan for Area 14.

2.2. Stormwater Quantity

The following field investigations were undertaken to determine suitable development objectives for stormwater quantity:

- An assessment of the existing Duchess Creek morphology with a view to determining the long term ability of the creek to cope with predicted changes in the flow regime.
- An assessment of the impact of existing development on the Lake Cathie Wetland system. This was based on visual inspections of a number of existing stormwater outlets, specifically looking for evidence of degradation.

The results of the filed investigations are included in Section 4.10.

In summary provided that there is sufficient water quality treatment, water quantity issues are not likely to require specific measures to mitigate their impacts. Together with water quality management measures general flow reducing measures such as rainwater tanks, and the use of buffer strips are likely to be enough to mitigate against the impacts of development. This is based on a comparison of the likely frequency of runoff events occurring in a predevelopment and post development state together with field observations.

2.3. Stormwater Conveyance System Performance

When the stormwater conveyance system is designed, its performance will need to comply with *Development Design Specification D5 - Stormwater Drainage* (Hasting Council, 2003). The system design ARIs detailed in the above document include:

- 5 years – residential area (minor system)
- 5 years – rural residential (minor system)
- 20 years – commercial/industrial area (minor system)
- 20 years – trunk drainage (minor system)
- 100 years – all developments (major system)

In < 100yr ARI storm events, flows across private property will be contained through the underground system.

Footpath/Road Reserve Safety Factors

- The maximum allowable depth of water is 0.2m.
- The max VD ratio is 0.4 in areas where the safety of children and vehicles is considered.
- The max VD ratio is 0.6 in areas where the safety of vehicles only is considered.

2.4. Water Distribution and Reticulation System Performance

The water distribution and reticulation system performance will adhere to *Table 5: Levels of Service in Hastings District & Villages Water Supply Schemes DSP – October 2001*. This is to include the levels of service presented in Table 2.

Table 2: Potable Water Supply Level of Service

Description	Unit	Level of Service
Normal Quantity Available - Domestic peak day - Domestic annual	 Litres/tenement/day kL/tenement/year	 3,000* 340*
Pressure - Minimum pressure (at flow rate of 0.15L/s per tenement in Council's main adjacent to property boundary) - Maximum static pressure	 Metres head Metres head	 20 90

* These are Council's DSP design values. Note that the trunk water supply infrastructure for Area 14 has already been sized with a servicing strategy firmly in place. Thus on future projects it may be possible to review some of these parameters in light of an integrated approach however it is not proposed to do so on this project.

2.5. Potable Mains Water Quality

Potable water quality shall comply with the most recent *Australian Drinking Water Guidelines* (2004) by National Health & Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC).

2.6. Recycled Water Quality

It is anticipated that during the development of water management options, the use of recycled water may be included. In the event that a recycled water system is used, the following water quality guidelines will be adopted:

- National Water Quality Management Strategy (NWQMS) *Guidelines for Sewerage Systems – Use of Reclaimed Water* (ANZECC, 2000);
- *NSW Guidelines for Urban and Residential Use of Reclaimed Water* (NSW Recycled Water Coordination Committee (NSW RWCC, 1993).

Neither guideline provides indicator details for salt & nutrients, or heavy metals & pesticides. Both refer to DEC requirements, which include NSW DEC Environmental Guidelines: *Use of Effluent by Irrigation* (2003). It is proposed that the NSW RWCC guidelines be used as the primary guideline document. Table 3: Recycled Water Quality Requirements for Urban and Residential Use of Reclaimed Water, is derived from the NSW RWCC guidelines.

Table 3: Recycled Water Quality Requirements for Urban and Residential Use of Reclaimed Water

Microbiological Requirements*	Units	Value
Faecal Coliforms	counts	< 1 in 100mL
Coliforms	counts	< 10 in 100mL (in 95 % of samples) < 2.5 in 100mL (geometric mean over 5 consecutive samples) – sampling point is from consumer services < 25 in 100mL (in 95% of samples) – sampling point is from consumer services
Virus	none	< 2 in 50L
Parasites	none	< 1 in 50L
Physical Requirements		
Turbidity	NTU	< 2 (geometric mean) < 5 (95% of samples)
Total Dissolved Solids#	mg/L	< 500
pH	units	6.5 – 8.0 (allowable) 7.0 to 7.5 (desirable range)
Colour	TCU	< 15
SS or NFR (Suspended Solids)	mg/L	< 30
BOD_5 (Biochemical Oxygen Demand)	mg/L	< 20
Tertiary Filtration required?		Required.
Chemical Requirements		
Free residual chlorine	mg/L	0.5 (maximum) at the point of use
Salts and Nutrients		No need to remove nitrogen, phosphorus and sulphur where it can be demonstrated that the land management system effectively uses these nutrients in the short and long term
Heavy Metals, Pesticides and Herbicides		To be established by supply authority during commissioning of reclaimed water scheme

* Recycled water must satisfy microbiological requirements at the outlet from the water reclamation plant or defined entry point into the distribution system.

The NSW DEC (2004) Use of Effluent by Irrigation suggests that "when using effluent that consistently contains more than 500 mg/L of TDS, a higher level of salinity control to maintain a viable and lasting system is required".

Discussions with Council suggest that a target TDS level of < 300mg/L should be adopted to ensure that there is no corrosion of plumbing, fittings or fixtures in which recycled water is used.

It is estimated by Parsons Brinkerhoff (PPK (2002)) that the median TDS level in the treated effluent from the Bonny Hills STP after augmentation will be < 600mg/L.

Council has indicated that a reverse osmosis plant would be adopted if the water is used for urban non potable purposes to remove chemicals of concern, viruses, pathogens and importantly to reduce TDS levels in the recycled water to less than 300 mg/L.

2.7. Sustainable Effluent Reuse Load Rate

The development objective is to ensure that the capability of the land to receive treated effluent is not exceeded. Thus any reuse of treated effluent must be sustainable in the long term and effluent application rates must be kept to a sustainable loading rate.

Despite the fact that if a reverse osmosis plant is used and virtually all slats will be removed from the recycled water, a basic assessment of the ability of the site soils to manage the nutrient and salt loads that may be disposed of when recycling some of the effluent from the development is presented in Section 4.9. The assessment has been based on a desktop study involving an examination of soil types from Department of Natural Resources (DNR) Soil Landscape maps. No site specific testing has been undertaken at this stage.

2.8. Recycled Water Distribution

In the event that recycled water is used, compliance with Building Codes and Fire Brigade requirements will need to be achieved. The proposed levels of service are provided in Table 4.

Table 4: Level of Service

Fire Fighting	Unit	Level of Service
Minimum pressure	Metres head	12 (reticulation system to supply the peak instantaneous demand by gravity) whilst maintaining a residual head of 12m at the property boundary throughout the system).
Mains sizing	Diameter	to be assessed following water balance modelling

Source: DPWS, 1986

3.0 CRITICAL ASSUMPTIONS

3.1. Land Use Planning and Masterplan Objectives

Following the consideration of housing densities, occupation rates and development characteristics, the number of lots and population for Area 14 has been estimated for 2021. Table 7 in Section 3.1.2 presents these estimates.

Tables 5 and 6 present the housing density (based on Deicke Richards, 2003) and occupation rates which will be adopted for modelling purposes.

Table 5: Proposed housing density

Housing	Proposed Density
Low density	15 dwellings/ha
Medium density	25 dwellings/ha

To achieve the density of development proposed in Table 5 and based on the proposed road and lot layouts, low density lot sizes are approximately 570m^2 and medium density lot sizes are 300m^2.

We acknowledge that a mix of development density will occur in practice as the land use will also be influenced by market forces.

Table 6: Typical occupancy rates and development characteristics (based on STORM, 2004)

Housing	Occupancy	Impervious area break down	Typical lot size (m^2)
Low density	3	Roof - 250 m^2 (average – maximum roof area is 285m^2 based on max 0.5 FSR) Garage - 18 m^2 (6*3 typical) Driveway - 36m^2 (assumes 6m setback length x 6m wide for double garage) Paving (courtyard/pergola) - 15 m^2 Total impervious = 319 m^2 (i.e. 56% impervious). Note this applies to the lot not the whole subdivision. The whole subdivision will have a higher % impervious as it includes road pavements and footpaths.	570
*Medium density	2	Roof - 180 m^2 Garage - 18 m^2 (6*3 typical) Driveway - 27m^2 (assumes 6m setback length x 4.5m wide for single garage) Paving (courtyard/pergola) - 15m^2 Total impervious = 240m^2 (i.e. 80% impervious)	300

* These values taken off from a medium density subdivision in Port Macquarie.

Note that an occupancy rate of 2.15 has been assumed in the Masterplan. It is noted that a rate of 2.15 may be the long term average rate for a development such as Area 14 however for planning purposes it is prudent to assume that early in the life of Area 14 there will be younger families with higher occupancy rates leading to a medium term (say the next 10 years) average occupancy rate that is higher. In the long term it is noted that the average occupancy rate (say the next 20 years) may then drop to 2.15 as children leave home and the community ages.

Note for modelling purposes an assessment of the road corridor's degree of imperviousness was based on the typical cross sections documented by STORM and included on Drawing D08 in Appendix A.

3.1.1. Masterplan Yield Assessment

STORM has prepared road and lot layouts based on the proposed Masterplan together with input from Council, Luke and Company and King and Campbell. The drawings prepared include concept road layouts and an ability to estimate the number of lots that may be yielded with some certainty. Table 7 provides an opportunity to compare the likely yields from the development in Area 14 against those predicted by the Masterplan. It is important to undertake this comparison because the yield provides an estimate of the future populations in this release area. Water infrastructure and other investment decisions have been based on the predicted populations. Future recycled water and sewerage infrastructure will also be based on the predicted populations.

Based on the data included in Tables 5 and 6 above - the following table compares the Masterplan areas against likely actual areas based on the road and lot layouts prepared by STORM.

Table 7: Comparison of Masterplan versus predicted areas

Layout type	No. of lots on Actual Road and Lot Layouts (Ha)	Masterplan lots*	Estimated population based on Actual Road and Lot Layouts	Masterplan Population (between the villages)
Low density residential (both assumed 15 dw/Ha)	1229	1110	3/dwelling = 3,687	2.15/dwelling=2386.5
Medium density residential (both assumed 25 dw/Ha)	552	750	2/dwelling = 1,104	2.15/dwelling = 1612.5
		TOTAL	4,791	3,999

* Based on area "between the villages" of Lake Cathie and Bonny Hills multiplied by the density shown. (Source: Deicke Richards, 2003).

The estimated population based on actual layouts is higher than the Masterplan population. Given that Council has already sized some of the water supply infrastructure, they may wish to check that the infrastructure has the capability of supporting slightly higher populations than that suggested in the Masterplan.

3.2. Water balance modelling – water consumption

The average water consumption rates adopted for modelling will need to be tested during the modelling process to ascertain their sensitivity. It is not clear whether adopting high values are necessarily conservative due to the integrated nature of the approach to be adopted. For example, overestimating water demand could result in overestimating rainwater tank performance and underestimating the impact on the water supply system.

It is also clear from discussions with Council that potable water trunk infrastructure for Area 14 has already been sized and will cater for other Southern Arm communities. Therefore, because the Area 14 system is part of a much larger system it may not be possible to reduce the size of the planned potable water trunk infrastructure. However, trunk mains and a reservoir for a potential recycled water supply will need to be developed.

Hastings Council has noted in its DSP that design values for water supply (of 310 kL/annum/connection) are to be adopted to include allowance for leakage, dry weather and demand management. The modelling to be undertaken in Area 14 starts at the consumer end and works back by simulating wet and dry weather, allowing for leakage and demand management. Thus the values proposed for adoption below do not need to then be inflated or deflated to allow for dry weather, leakage and demand management. However it is noted that design values have a base consumption rate of 263 kL/annum/connection which is higher than the 240 kL/annum/connection recommended below. Note that peak day demands may not be easily modelled by the use of a soil moisture driven model. It may be necessary to rely on an assessment of peaking factors and/or a temperature driven model capable of estimating peak day demand.

Annual average water demand for the period 1989 to 1993 was 303kL/annum/connection and declined to an average of 263kL/annum/connection over the 9 years prior to 2003 (Hunter Water Australia, September 2003). The decline in water consumption has been attributed to demand management initiatives implemented since the early 1990s. It is recommended that the more recent demand figures will be more representative of future demand rather than relying on an average over a 9 year period with a clear downward trend.

3.2.1. Low Density (Single Dwellings)

Hunter Water reviewed a draft of this report and recommended that STORM adopt a residential consumption rate of 240kL/annum/dwelling which equates to 658L/day/dwelling for Area 14.

It is worth noting that the Camden Haven Zone was found to have the lowest residential water consumption in the Hastings Area with a 2001 total of 198 KL/yr/dwelling. The Camden Haven Zone has low consumption due to the number of holiday houses and retirees located in this area. Thus adopting an average of 240kL/annum/dwelling would appear to be slightly conservative and better suited to the likely development in Area 14.

3.2.2. Medium Density

Hunter Water estimated the medium density water consumption for 2001 to be 121.22 KL/yr/unit. This equates to 332L/d/unit, which has been adopted for modelling purposes for this study

The Camden Haven Zone consumption rate was again lower than the rest of the Hastings area.

3.2.3. Disaggregated Water Consumption

In order to undertake detailed modelling for Area 14 it is necessary to disaggregate the average water consumption rates documented above.