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Riverside at Tea Gardens

Integrated Water Cycle Management Strategy and Sewerage Servicing

301015-00560-03 – 301015-00560-03-EN-TEN-0002

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INTEGRATED WATER CYCLE MANAGEMENT STRATEGY AND SEWERAGE SERVICING

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PROJECT 301015-00560-03 - RIVERSIDE AT TEA GARDENS

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APPENDIX 1 - WATER BALANCE MODEL DATA

1. INTRODUCTION

Riverside at Tea Gardens is a proposed development located approximately 80 kilometres north-east of Newcastle on the NSW Central Coast. WorleyParsons was engaged by Crighton Properties to prepare a Water Management and Servicing Strategy for the proposed development.

The *Riverside at Tea Gardens Concept Plan and Project Application - Environmental Assessment Report* was issued by ERM in January 2009 (herein referred to as the EA). This was submitted to the Department of Planning as a Part 3A application.

Mid Coast Water submitted a response to the EA (David McKellar, 19/3/09) which outlined concerns in regard to the development projections for Riverside Tea Gardens and the limited capacity of Mid Coast Water's water and sewerage infrastructure.

This report has been undertaken to address the issues raised in Mid Coast Water's submission.

The report titled *Riverside at Tea Gardens Integrated Water Management* (Cardno, November 2010) includes investigations into flooding and drainage, groundwater and water quality for the proposed development. The flooding, groundwater and water quality and quantity components of the report are extracts from the Cardno study.

The site was formerly referred to as Myall Quays.

2. SITE DESCRIPTION

Riverside at Tea Gardens is located within the Great Lakes Council LGA. The site is 229 hectares in area and lies between Myall Street to the west of the site and Myall River to the east of the site. The Shearwater Residential Estate lies to the north and the residential development of Tea Gardens lies to the south. On the western side of Myall Street lies the Myall River Downs development.

The majority of the site was previously used for a pine plantation. In its existing form, the site has largely been cleared of native vegetation. There are some scattered, isolated occurrences of both pines and natives.

2.1 Topography and Soil Conditions

The site is flat with generally sandy soils. There is a slight fall to the south and the south-east. The site ranges in height from RL 0.6 m AHD (along the foreshore of the Myall River) to 20-25 m AHD (at the northern end of the site adjacent to Shearwater Estate. However, most of the site ranges from RL 1.6 m AHD to 5.0 m AHD.

2.2 Groundwater

Coffey Geotechnics has undertaken numerous groundwater investigations at Riverside at Tea Gardens. In 2007, Coffey Geotechnics completed a groundwater assessment for the site which is presented in Appendix G of the Cardno report (2010).

Martens & Associates has also completed studies for the site, including a Preliminary Hydrogeological Study and Concept Groundwater Management Plan (2010).

The following information has been extracted from the Coffey and Martens reports.

2.2.1 Existing

The surface of the Riverside at Tea Gardens site contains a series of sand ridges which trend roughly in a north-south direction across the site. An elevated bedrock outcrop, rising to about RL 25 m AHD is present at the northern end of the property. Elevated bedrock levels are also present at the north-western limit of the site.

The sandy aquifer local to the development is contained within a discrete area and groundwater users further afield are not likely to be affected by activities at the Riverside development site. The shallow rock levels to the north of the site provide a barrier to groundwater inflow. The sand aquifer is expected to extend to the south and west of the site and be in hydraulic contact with the waters of the Myall River to the south, Wobbegong and Pindimar Bay (Port Stephens) to the south-west and Kore Kore Creek to the west.

Losses from the groundwater system occur due to seepage to the Myall River and evapotranspiration from areas of shallow water table. Rainfall infiltration forms the main groundwater recharge mechanism and previous monitoring results from the bores over the site show a marked groundwater level response to rainfall events.

Groundwater is in general quite shallow, in the most recent round of monitoring (2007) groundwater was measured to be between 0.5 and 1.7 m below ground surface, and shallower in the vicinity of the Myall River and the lake.

Groundwater quality results indicate that the groundwater from the aquifer at Riverside is not suitable for potable use although it is possible that reclaimed water can be used for irrigation purposes provided an appropriate treatment is undertaken. Groundwater quality was generally found to be below the key criteria for protection of species in marine water (90%) protection presented in the ANZECC (2000) Guidelines.

2.2.2 Potential Acid Sulphate Soils

An assessment of potential acid sulphate soils was undertaken in a previous study by Coffey (2007), which indicated elevated levels of total potential sulphidic acidity and peroxide oxidisable sulphur were present in the samples tested. It was considered that the potential acid sulphate soils were likely to be present in the area. The lake extension would cause groundwater level reductions on the north-western tip of the lake extension to fall slightly below levels interpreted to have acid soil producing potential. However, the area affected and the exceedence of criteria is considered to be limited for the predicted resulting groundwater levels.

The groundwater results suggest that the reclaimed water from treatment facilities in the area may be suitable for irrigation of open spaces and gardens within the development area, subject to a small reduction in total nitrogen concentrations.

2.3 SEPP 14 Wetlands

State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14) applies to wetlands within a major part of its frontage to Myall River. A buffer zone was established at the time of rezoning to protect the SEPP 14 Wetlands.

2.4 Flooding

Parts of the site are subject to flooding from Myall River. The Great Lakes Council has adopted a 100 year average recurrence interval (ARI) flood level of 2.1 m AHD for the foreshore area (which includes the Myall River at Riverside at Tea Gardens).

Local runoff is to be managed through the design of appropriate flood conveyance pathways.

2.5 Rainfall and Evaporation

Cardno used rainfall data from the Hawks Nest Station (Langi St) (Station 060123) from 01/01/1982 to 31/5/2004. During this period the total annual rainfall ranged from 918 mm (1993) to 2524 mm (1990) with a mean annual rainfall of 1,399 mm. In comparison, the long term (104 years) average rainfall record at Nelson Bay (Nelson Head) (Station 06154) us 1,347 mm.

Pan evaporation data was adopted for previous catchment based water quality modelling for Myall River Downs, west of Riverside at Tea Gardens. The evaporation data adopted for the Myall River Downs assessment was the average monthly pan evaporation collected at Williamtown Air Base. An evaporation multiplier of 0.85 was applied to the pan evaporation data to calculate the potential evapotranspiration (PET) for the catchments. The adopted average monthly PET for Tea Gardens is summarised in **Table 2—1**.

Table 2—1 – Average Monthly PET for Tea Gardens

Month	PET (mm)
January	182
February	150
March	132
April	97
May	69
June	66
July	66
August	93
September	127
October	148
November	166
December	192
Annual Total	**1488**

3. PROPOSED DEVELOPMENT

The proposed development of Riverside at Tea Gardens would include a residential/mixed use precinct over the majority of the site and a tourist and residential component located within the north eastern portion of the site. Key elements of the overall concept plan include:

- A residential subdivision to accommodate 970 dwellings;
- An internal road network, upgrading of intersections and associated road and other construction works, such as cycleways;
- Water Sensitive Urban Design (WSUD) measures including the creation of four new freshwater detention basins and numerous additional ponds surrounded by parklands to provide water quality management; and
- An eight hectare tourist/residential development (including a conference centre and accommodation) and a foreshore park of 5.6 hectares.

The breakdown of land types for the proposed development is shown in **Table 3—1**.

Table 3—1 – Land Usage at Riverside

Land Usage	Area (ha)	% of Total
Open Space		
SEPP 14 Wetland Zone	28.4	12.8
SEPP 14 Wetland Buffer Zone	20.6	9.2
Additional Conservation Buffer	12.3	5.5
Wildlife Corridor	32.8	14.8
Myall Foreshore Park	5.6	2.5
Drainage Corridors, Ponds and Large Parks	23.1	10.4
Pocket Parks	2.6	1.2
Existing Detention and Water Quality Lake	6.7	3.0
Open Space Subtotal	132.1	59.4
Built Upon Area		
Residential (including roads and	77.2	34.7

Land Usage	Area (ha)	% of Total
community facilities)		
Tourist/Residential (lodgings)	8.2	3.7
Future Development Site	5.0	2.2
Built Upon Area Subtotal	90.4	40.6
Total	**222.5**	**100**

4. PERFORMANCE OBJECTIVES

This section outlines the performance objectives applicable to the Riverside development.

4.1 Relevant Documentation

Following are the key documents that yield objectives for the Riverside development.

4.1.1 Tea Gardens, Hawks Nest and Buladelah Stormwater Management Plan (2000)

This Stormwater Management Plan (SMP) applies to stormwater from the major urban areas within the Myall River catchment. The report provides a summary of the existing condition of the receiving waters adjacent to the proposed development site and also identifies key objectives for proposed urban areas.

The quantitative and qualitative objectives in the SMP for post construction of new developments are reproduced below in **Table 4—1** and **Table 4—2** respectively.

Table 4—1 – Quantitative Post Construction Phase Stormwater Management Objectives

Pollutant / Issue	Retention Criteria
Coarse Sediment	80% of average annual load for particles of 0.5mm or less
Fine Particles	50% of average annual load for particles of 0.5mm or less
Total Phosphorus	45% retention of average annual load
Total Nitrogen	45% retention of average annual load
Litter	70% of average annual litter load greater than 5mm
Hydrocarbons, motor fuels, oils and grease	90% of average annual pollutant load

Table 4—2– Qualitative Post Construction Phase Stormwater Management

Pollutant / Issue	Management Objective
Runoff volumes and flows	- Impervious areas connected to the stormwater drainage system are minimised; and - Reuse of stormwater for non-potable purposes maximised.
Stormwater quality	- Use of vegetated flow paths maximised; and

Pollutant / Issue	Management Objective
	- Use of stormwater infiltration in source where appropriate.
Riparian vegetation and aquatic habitat	- Protect and maintain natural wetlands, watercourses and riparian corridors. All natural (or unmodified) drainage channels within the site which possess either: a) Baseflow b) Defined bed and / or banks; or c) Riparian vegetation is to be protected and maintained. - Natural channel design should be adopted in lieu of floodways in areas where there is no natural (or unmodified) channel.
Flow	- Alteration to natural flow paths, discharge points and runoff volumes from the site is to be minimised. - The frequency of bank full flows should not increase as a result of development. Generally, there should be no increase in the 1.5 year ARI and 100 year ARI peak flows.
Amenity	- Multiple use of stormwater facilities to the degree compatible with other management objectives.
Urban Bushland	- Impact of stormwater discharges on urban bushland areas minimised.

4.1.2 Myall Quays Development Control Plan No. 22

The Myall Quays Development Control Plan 22 was developed prior to recent environmental studies and investigations into the capabilities and suitability of the site. Some of the controls are no longer appropriate as they are based on a previous masterplan that has little resemblance to the current (and proposed) development of the site. It is anticipated that the DCP will be repealed and replaced by a concept plan for the Riverside at Tea Gardens and Myall River Downs estates.

4.1.3 Tea Gardens – Hawks Nest Sewerage Scheme – Sewerage Servicing Strategy

The Sewerage Servicing Strategy for the Tea Gardens – Hawks Nest Sewerage Scheme (*Ellis Karm & Associates Pty. Ltd. January 2003*) was prepared to assist MidCoast Water with planning the sewerage infrastructure requirements to meet anticipated development over the next 30 years.

The Sewerage Scheme identifies that 1,100 lots may be developed at Riverside (referred to as Myall Quays), with an average occupancy of 1.8 EP/ET and an average sewerage load of 240 L/EP.d. A summer peaking factor of 1.5-1.6 has been used in calculating peak flows through the various periods of growth. It has been assumed that the lots will be serviced utilising a vacuum sewerage system, with a storm infiltration allowance of 0.012 L/ET.s.

The Servicing Strategy looks at two scenarios, (A) without the transfer of secondary treated effluent from North Port Stephens and (B) with the transfer of secondary treated effluent from North Port Stephens. It was found that the dune based effluent exfiltration ponds are adequate for the ultimate predicted loads in scenario (A), but not in scenario (B).

4.1.4 Tea Gardens Water Supply Scheme Servicing Strategy

The Tea Gardens Water Supply Scheme Servicing Strategy was released by MidCoast Water in draft format in November 2004, it is now a 'live' document but it has not officially been adopted. The paper was prepared to assist MidCoast Water with planning the water supply infrastructure requirements to meet anticipated development over the next 30 years.

The Water Supply Scheme identifies 1,105 lots to be developed at Riverside at Tea Gardens (referred to as Myall Quays) and has assumed that development would be completed in 2021. Design demands are based on an average demand of 335 kL/ET.y, inclusive of unaccounted water usage and residential and non-residential consumption. The peak residential demand is 2.3 kL/ET.d and factored into these demands is a 15% unaccounted water (leakage) allowance.

It was found that the water supply borefield will require augmentation to supply future development water demands but identified that capacity was available to achieve this. As for the sewerage system, it can be noted that lower design allowances can be achieved as discussed further in **Section 7.**

4.1.5 State Environmental Planning Policy No 14 – Coastal Wetlands

State Environmental Planning Policy No.14 ensures coastal wetlands are preserved and protected for environmental and economic reasons. Land clearing, levee construction, drainage work or filling may only be carried out within these wetlands with the consent of the local council and the agreement of the Director-General of Planning.

Given the significant importance of the SEPP 14 and the proximity of the development, any stormwater runoff must be treated prior to discharge into the groundwater which flows into these areas. This is discussed further in **Section 6.3**.

4.1.6 Mid Coast Water, Briefing paper to the Project Assessment Committee

Mid Coast Water's briefing paper to the Riverside at Tea Gardens Project Assessment Committee was submitted in response to the public exhibition of the EA. The document requests that an integrated water management plan be formulated for the application, which would consider water supply, stormwater, sewage and effluent in an integrated manner.

Mid Coast Water request that effluent management for the proposed development be investigated, to ensured that adequate effluent management capacity is available at Hawks Nest WWTP.

There is an emphasis on considering recycling before further effluent management expansion occurs. The infrastructure demand calculations account for demand caused by the transient population, such as tourists and holiday home owners in addition to the number of dwellings through the proposed development and the occupancy rate of the dwellings.

This document aims to meet the requirements of the Mid Coast Water Briefing Paper.

4.1.7 State Environment Planning Policy (Building Sustainability Index: BASIX 2004)

The Building Sustainability Index (*BASIX*) assesses the potential performance of new homes against a range of sustainability indices, viz Landscape, Stormwater, Water, Thermal Comfort and Energy. BASIX aims to reduce the environmental impact on these features by new development by setting targets for these indices which all new developments must meet.

BASIX requirements include single dwelling developments and all new larger scale developments in the entire NSW region.

According to the BASIX requirements, residential developments must be designed and built to use 40% less drinking-quality water and produce 40% less greenhouse gas emissions than average NSW homes of the same type. These targets represent significant yet readily achievable savings in water use and greenhouse gas emissions by homes.

4.1.8 Director-General's Environmental Assessment Requirements

The Director-General's Environmental Assessment Requirements for water cycle management issued on 13 October 2010 are in part as follows:

> *Address potential impacts on the water quality of surface and groundwater during both construction and occupation, having regard to the relevant State Groundwater, Rivers, Wetlands and Estuary Policies. Consideration must be made for water impacts to the River and identified SEPP 14 and RAMSAR Wetlands. Particular regard must be given to how the proposal will minimise altered salinity, pH, litter, weeds, exotic fauna, gross disturbance of these wetlands, nutrient intake to receiving water bodies, and any other issues raised by the PAC relating to groundwater and groundwater ecosystems.*
>
> *Stormwater management should be designed to ensure ongoing protection of the groundwater aquifer in accordance with the principles of ANZECC & ARMCANZ: Guidelines for Groundwater Protection in Australia, National Water Quality Management Strategy, Commonwealth of Australia, 1995. Ensure there is no impact on the existing groundwater aquifer and existing groundwater quality resulting from the proposal. Suitably justify the stormwater treatment measures to be used in the proposal.*

4.1.9 Great Lakes Council Draft Water Sensitive Design DCP

The draft Water Sensitive Design DCP (Version 1.1, May 2010) for Great Lakes Council has not been formally adopted yet, but was taken into consideration. The draft DCP sets out the following objectives that are relevant to the subject development:

- stormwater quality target for new development of a 'neutral or beneficial effect on water quality' for TSS, TP and TN;
- Reduce consumption of potable water;
- Reduce wastewater discharges into the receiving environment;
- Harvest wastewater where appropriate; and
- Harvest rainwater and urban stormwater where appropriate.

Further detailed objectives are listed in relation to stormwater flows with the intent of reducing the impacts of development on stream erosion.

4.2 Water Management Objectives

With consideration of the relevant documentation listed in **Section 4.1**, the following key objectives have been adopted to achieve a 'total water cycle' management approach for the Hawks Nest North site:

4.2.1 Protect water quality of SEPP 14 Wetlands and Myall River

- Nil or Beneficial Effect ie, no increase in the overall TSS, TP and TN exports to the Myall River (based on the performance targets identified in the Great Lakes Council Draft Water Sensitive Design DCP (Version 1.1, May 2010);
- Median TP and TN concentrations in discharges to window lakes/ponds to not exceed limits identified by Martens & Associates, namely TN < 1.0 mg/L and TP < 0.2 mg/L.
- Adopt the principles of water sensitive urban design; and
- Treat effluent and manage disposal to minimise environmental impacts.

4.2.2 Minimise impact on natural flow regimes

- Integrate urban water management into the maintenance of sustainable ecosystem process, as well as promoting scenic, landscape and recreational values; and
- Replicate, where possible, natural stormwater infiltration and flows in the post development environment.

4.2.3 Conserve water and use it efficiently

- Meet and where possible improve on the requirements of BASIX to reduce demand for imported mains water; and
- Utilise water as a resource and maximise reuse.

5. GROUNDWATER

Groundwater is particularly significant at the Riverside development due to shallow groundwater levels, aquifers and the subsequent interactions with stormwater and potential use as a water resource.

The following information was extracted from the Coffey Geotechnics Groundwater Assessment (2007), as presented in the Cardno report (2010).

Groundwater modelling shows that the groundwater levels would not be significantly affected by the proposed development. Modelling was conducted in an earlier investigation phase was built upon and used to simulate the expected impacts from the proposed development. The modelling indicated that the extension of the lake and the introduction of a series of stepped freshwater lakes will cause localised drawdown on the north-western most extremity of the extended lake by up to 0.75 m. There was negligible impact indicated from the modelling on the wetland area fringing the Myall River.

Groundwater quality modelling indicates that quality has remained relatively stable when recent results were compared to earlier testing periods. Tested groundwater quality values are generally below (i.e. better than) the key criteria for protection of species in marine water with the exception of some metal concentrations. Groundwater from monitoring bores closer to the Myall River tends to be characterised by higher electrical conductivity and a similar anion to cation ratio to seawater, suggesting the dilution of seawater is occurring as a result of rainfall recharge from the catchment.

Groundwater quality was compared to the Australian Drinking Water Guidelines (NHMRC, 2004) and is not potable due to concentrations of a range of analytes exceeding the drinking water guidelines. Groundwater in all bores and the surface water in the lake are acidic to slightly acidic and outside the lower criterion for drinking water of pH 6.5. Groundwater near the Myall River is also unsuitable for drinking water. Elevated ammonia concentration found in some bores also renders groundwater unsuitable for potable use. Groundwater away from the Myall River may be considered for irrigation purposes, however high concentrations of phosphorus have the potential to result in bioclogging of irrigation equipment.

Martens & Associates has also completed studies for the site, including a Preliminary Hydrogeological Study and Concept Groundwater Management Plan (2010). The report outlines risks and management objectives and methods, including ph management. Stormwater is to be treated to a level equal to or better than the groundwater quality prior to discharge into waterbodies in contact with groundwater. The report also provides comments regarding the use of recycled effluent for irrigation, concluding that nutrient uptake by irrigated vegetation would be higher than the applied loading by recycled water.

6. STORMWATER

Information in this section has been extracted from the Cardno report (2010).

6.1 Options Assessment

The surface water catchment for Riverside extends well beyond the boundaries of the Riverside at Tea Gardens site and requires the consideration of how best to manage the significant runoff from adjacent rural residential development and its likely quality.

The site is virtually flat in profile and the ground level rises only a couple of metres over more than a kilometre. The shallow grades across the site, combined with a high water table and sandy soils pose challenges for traditional drainage and WSUD techniques particularly if the stormwater conveyance systems are forced to be connected to the existing detention lake in the southern boundary of the site. This approach would require the importation of massive quantities of fill material to establish even minimal grades on swales and floodways and to fill residential lots to the required level above 100 year ARI flood levels.

The site presents only three real opportunities for stormwater runoff to discharge from the site. From the south to north these opportunities are;

(i) The existing outlet at the southern end of the lake outlet that discharges into an area adjoining the Myall River (under existing conditions the 100 year ARI peak outflow is around 14.7 m^3/s)

(ii) Dispersed flows across the existing Conservation Zone that abuts the SEPP 14 wetland (under existing conditions the 100 year ARI peak outflow is around 10.9 m^3/s)

(iii) To the Myall River via an existing watercourse in the north of the site (under existing conditions the 100 year ARI peak outflow from the site is around 1.25 m^3/s)

A significant determining factor with regard to water movement across the site and detention requirements relates to the gradient available to drain water to each of these outlets and the peak flow limitations at each outlet.

A detailed assessment of existing and future catchment runoff and pollutant exports and water management options to maintain as far as possible the existing lake water quality and its ancillary role as a fish habitat was undertaken in September 2004.

A Do Nothing option and seven schemes to mitigate the impact of planned future development on lake water quality were assessed. These schemes were:

0. Do nothing – keep the current water body as it is without increasing the size (but with BASIX implemented).
1. Existing lake (6 ha) with increased tidal flushing (x4);

2. **Extended lake (13.5 ha) with increased tidal flushing (x2);**
3. Existing lake with increased tidal flushing (x1.6) and a new freshwater lake (12 ha);
4. **Partially extended lake (8 ha) with increased tidal flushing (x1.8) and new freshwater lake (6.5 ha);**
5. Existing lake (6 ha) with increased tidal flushing (x1.6) and new wetlands (16 ha); and
6. Existing lake (6 ha) and dry swales.
7. A reach of freshwater lake was replaced with a swale and four ponds removed in the upper arms of drainage lines. The two remaining major ponds (N10Pond and E8Pond) were converted into shallow wetlands.

Possible stormwater quantity (retardation) management strategies were also assessed. Retardation modelling was undertaken for Schemes 2 – 6.

A multi-criteria assessment of water quality performance, environmental impacts and viability was undertaken. The assessment criteria included:

- Water Quality
  - Salinity
  - Dissolved Oxygen
  - Algae
  - Total Nitrogen
  - Total Phosphorous
- Environmental Impacts
  - Impact on existing water body
  - Impact on SEPP 14 wetlands
  - Impact on Myall River
  - Impact on groundwater
- Viability
  - Loss of potential lots
  - Aesthetic/Health
  - Land take for Basins
  - Land take for Ponds / Wetlands
  - Filling

While it was concluded from the multi-criteria assessment that extending the tidally flushed lake to a 13.5 ha water body in combination with ancillary local ponds and local wetlands (Scheme 3) is the most viable approach and delivers the best overall outcomes for water quality and the environment it was also concluded that the partial extension of the existing detention lake in combination with a freshwater lake(s) and ponds and wetlands (Scheme 5) could deliver similar water quality and environmental outcomes.

Discussions held with the NSW Department of Planning highlighted a number of concerns held by NSW Government stakeholders with concept Scheme 3. Consequently the preferred approach to integrated water management is based on Scheme 5, which was defined as a partially extended lake with increased tidal flushing and new freshwater lakes, ponds and/or wetlands, swales and a biofilter as appropriate.

6.2 Water Quantity

Information through this section has been extracted from the Cardno report (2010).

An XP-RAFTS rainfall/runoff model was formulated for the hydrological analysis of the Riverside at Tea Gardens catchment. The model was used to estimate catchment runoff under existing and developed catchment conditions for the comparison of the 5, 20 and 100 year Average Recurrence Interval (ARI) storm events. For more detail on the hydrological model, refer to the Cardno report (2010).

6.2.1 Existing Conditions

The catchment of Riverside at Tea Gardens is bounded to the north by the ridgeline of the rock outcrop, and to the south-west by Myall Street. Riverside at Tea Gardens represents a major portion of the catchment. With the exception of the portion at the south of the site that has already been developed, there is little natural development of surface drainage features and as the surface soils are generally sandy such that a high level of rainfall infiltration to the groundwater system takes place. As a result, significant surface runoff is unlikely except during periods of high rainfall.

The site contains several low natural sand ridges which tend to channel runoff from in the western half of the site from north to south. However, a number of shallow drains have previously been constructed to convey runoff from the western areas of the site to the east to join with runoff from the eastern area of the site that flows toward the SEPP 14 Wetlands and the Myall River.

During wet periods, water ponds in low lying areas in the western and northern areas of the site.

The existing conditions model includes a shallow basin to represent depression storage and shallow ponding of runoff in low lying areas in the western and northern areas of the site. The flows in the shallow drains convey runoff from the western areas of the site to the east, this is represented as a diversion link. This diversion link conveys frequent runoff up to around the 1 year ARI flow (around 4 m^3/s) east towards the SEPP 14 wetlands and the Myall River.

Flows greater than the adopted threshold flow are split with 90% of flows in excess of the threshold flow discharging south to the existing detention lake and the remaining 10% of flows in excess of the threshold flow discharging east.

The active storage available in the existing detention lake and the existing lake outlet were also represented as a retarding basin in the existing conditions model.

The estimated peak 100-year ARI outflows from the Riverside at Tea Gardens site are summarised in **Table 6—1**.

Table 6—1 Estimated Peak Outflows under Existing Conditions (m^3/s)

5 year ARI	20 year ARI	100 year ARI	Comment
3.3	8.6	14.7	Outflow from the existing detention lake
6.9	8.7	10.9	Aggregated flow to the Conservation Zone
0.58	0.88	1.25	Outflow to an existing drainage line that discharges directly into the Myall River

6.2.2 Developed Conditions – Scheme 8

Under scheme 8, it is proposed to direct runoff in events up to the 100 year ARI event from the upper catchment areas east along the proposed open space corridor on the northern boundary of the proposed development. Runoff would be directed to a major retarding basin with outflows from the basin discharging south east to a swale located on the eastern boundary of the site. The swale is intended to distribute runoff along the western boundary of the buffer zone to reduce the concentration of runoff into the buffer zone and the SEPP 14 Wetland. There would also be a retarding basin for local flows from subcatchment N42, which would reduce peak flows discharging directly to the Myall River.

With the exception of limited areas of planned development on the eastern boundary of the site that will drain to the buffer zone, the planned development located south of the open space corridor will drain southwards towards a series of ponds and a freshwater lake that will discharge into the proposed extended detention lake. Active storage has been modelled through the freshwater lakes and ponds and also in the extended area of the saline lake.

Cardno modelled the storage throughout the waterbodies in the XP-SWMM hydraulic model, for more detail on the modelling. The peak outflows under scheme 8 developed conditions are presented in **Table 6—2**.

Table 6—2 Estimated Peak Outflows under Scheme 8 Developed Conditions (m^3/s)

5 year ARI	20 year ARI	100 year ARI	Comment
5.9	9.5	14.4	Outflow from the extended detention lake
5.5	7.1	9.0	Aggregated flow to the Conservation Zone
0.55	0.83	1.25	Outflow to an existing drainage line that discharges directly into the Myall River

6.3 Water Quality

Information through this section has been extracted from the Cardno report (2010).

6.3.1 Stormwater Management Controls

The stormwater management controls for Riverside at Tea Gardens site were selected to address the water management objectives in **Section 4.2** as well as responding to the rapid infiltration characteristics of the sandy soils and the limited ground slope.

The full range of applicable stormwater management controls will depend on the water quality treatment option that is includes, the controls include:

a) Source Controls – these would be applied at the lot level:

- Possibly rainwater tanks to capture roof water runoff and for reuse within the lot.

b) Conveyance Controls - apply at the street level and would incorporate:

- Wetlands would be used for localised treatment in the north-east section of the development. Two of the three wetlands would discharge to the vegetated swale, the third discharges directly to Myall River;
- A series of ponds/lakes would be integrated into the open space areas, these would receive runoff from the majority of the development;

c) End of Line Controls - apply at the end of the stormwater system and would incorporate:

- Freshwater lakes integrated into open space areas within the development.

6.3.2 Treatment Train

Generally, the stormwater treatment flow path for the development would be:

(i) North-eastern section of the development

a. Runoff from building roof areas would be collected for reuse in a rainwater tank (if applicable);

b. Runoff from the ground surface would be directed to a wetland; and

c. The wetland would discharge treated runoff in a distributed manner to the SEPP 14 Wetland buffer zone.

(ii) Remaining area of proposed development

a. Runoff from building roof areas would be collected for reuse in a rainwater tank (if applicable);

b. Surface runoff would be directed toward local ponds which provide water quality treatment. Most ponds are part of a series of treatment waterbodies. Stormwater receives additional treatment as it travels through a series of ponds before reaching the freshwater lake and the saline lake;

c. Runoff from some catchments would be drained directly to either the freshwater or saline lake.

Refer to Cardno (2010, Appendix D) for full details.

6.3.3 Catchment Water Quality Modelling

MUSIC is a continual-run conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH). MUSIC can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. MUSIC is able to conceptually simulate the performance of stormwater treatment measures to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

The Existing Conditions were defined as the conditions at around 2004 with the lake area extended to 6 ha with dwellings constructed in subcatchments L1L, L2R, WQB1, and Nat3.

MUSIC water quality models were assembled for the Existing and Scheme 8 Developed Conditions. The models were used to estimate the pollutant load generated from the development and assess the performance of the stormwater controls.

The estimated average annual runoff and TSS, TN and TP exports to the Myall River, saline lake and SEPP 14 Wetland under the Scheme 8 scenarios are summarised in **Table 6—3**. Details of adopted properties of the lakes, ponds, wetlands and swale are summarised in Cardno's report (2010).

It was concluded from the results that under Scheme 8 Developed Conditions:

- The export to the Myall River of TSS, TP and TN is reduced to that under Existing Conditions; and
- Median concentrations of TP and TN to the window lakes/ponds do not exceed the limits as set out by Martens & Associates.

Table 6—3 Scheme 8 Water Quality Treatment, Myall River as Receiving Water Body

	Pollutant Loads		
	TSS (kg/y)	**TP (kg/y)**	**TN (kg/y)**
Existing Condition	127,330	271	2,088
Developed no Treatment	210,280	445	3,414
Developed with Treatment (Scheme 8 without rainwater tanks)*	27,100	168	2,060

* Swale seepage of 0 mm/hr reported only. Refer to Cardno (2010) for further details.

It is also concluded that the decision on implementation of rainwater tanks would not impact on the ability of the development to meet stormwater quality objectives, as they can be met without rainwater tanks.

6.3.4 Construction Phase

During construction, sediment and erosion control structures would be designed and installed in accordance with the NSW Department of Housing *Managing Urban Stormwater – Soils and Construction (Blue Book)*. Staging of the development will minimise impacts during construction. These controls will ensure that there are no significant adverse impacts on receiving water quality during the construction stage.

7. POTABLE WATER, RECYCLED WATER AND WASTEWATER

The investigation considers the Riverside at Tea Gardens development together with the entire catchment to be serviced by the Hawks Nest Sewage Treatment Plant. In particular, the three new developments Riverside at Tea Gardens, Myall River Downs and North Shearwater are considered. The projected populations for these areas is shown in **Table 7—1**.

Table 7—1 – Ultimate Projected Tenements and Population

Development Area	Ultimate ET	EP per ET	Ultimate EP (Winter)	Summer to Winter	Ultimate EP (Summer)
North Shearwater	400	1.8	720	1.5	1,080
Riverside at Tea Gardens	970	1.8	1746	1.5	2,619
Myall River Downs	1,200	1.8	2,160	1.5	3,240
TOTAL	**2,570**		**4,626**		**6,939**

7.1 Potable Water

7.1.1 Existing Services

The traditional water supply for the Tea Gardens scheme is from the Tea Gardens aquifer, 6 km north of Tea Gardens. Groundwater is pumped from the aquifer, treated and transferred to reservoirs prior to distribution.

The existing capacity of the borefield is 8.6 ML/d. The Water Supply Scheme identifies that augmentation of the borefield to 12.4 ML/day in 2016 and 16.2 ML/day in 2031 will be required to meet future demands.

7.1.2 Potable Water Servicing Concept

The water management objectives adopted in developing a potable water supply concept for the site include the following:

- Minimise the potable water demand from the site by using water saving devices on fixtures and water efficient appliances;
- Use of alternative water supply sources, where possible (eg rainwater, recycled water);
- Retention of native vegetation and minimal use of turf to reduce irrigation requirements; and
- Infrastructure to be designed with long term sustainability in mind.

The Hawks Nest WWTP may be upgraded to include a facility to provide recycled water to new developments (including Riverside at Tea Gardens). The provision of recycled water to Riverside at Tea Gardens would reduce potable water consumption through the development.

7.1.3 Minimising Potable Water Demand

Potable water demand could be minimised through a combination of the following measures:

- Where required, landscaping lots and road verges with natural vegetation and plant species that require no irrigation;
- Using water conservation measures throughout households, such as water efficient taps, dual flush toilets, shower roses or flow restricting devices, washing machines and dishwashers.
- Installing rainwater tanks to reuse runoff for toilet flushing, washing machines and irrigation. Alternatively, utilising treated effluent from the future Hawks Nest WWTP recycling plant for reuse in toilets, washing machines and irrigation. The reuse application would depend on the level of treatment applied to the effluent;

The main uses of potable water in a traditional household (refer **Table 7—2**) are shower (23%), garden irrigation (21%), washing machine (20%) and toilet (14%).

Table 7—2 Typical Household Water Usage

Area	Traditional Household (L/person.day)	Breakdown of Consumption	Water Efficient Fitting/Appliance	Household with Water Efficient Fittings and Devices (L/person.day)
Internal				
Shower	56.9	23%	2 star	37.3
Toilet	34.7	14%	3 star	19.3
Washing Machine	49.5	20%	2 star	34.7
Kitchen Sink	12.4	5%	2 star	8.1
Bathroom Basin	5.0	2%	2 star	3.2
Dishwasher	2.5	1%	2 star	2.0
Bath	9.9	4%		9.9
Laundry Trough	5.0	2%		5.0
Other	12.4	5%		12.4
External				
Outdoor	52.0	21%	Could be reduced through selection of native vegetation	52.0
Pool and Spa	7.4	3%		5.2
Total	**247.5**			**176.1**

Data based on the *Single Dwellings Outcomes 05-08 BASIX Building Sustainability Index Ongoing Monitoring Program* NSW Government Department of Planning (2009), and *AS/NZS 6400:2005 Water Efficient Products – Rating and Labelling* Standards Australia (2005).

The proposed residential development could minimise external water use by retaining existing native vegetation and promoting new native vegetation in the residential landscaping.

7.1.4 Potable Water Demand

MCW have advised that a typical design water demand per ET for their area of operation is 205 kL/ET/year, which is equivalent to 312 L/EP/day (assuming 1.8 EP/ET). This figure is seasonally variable, in that:

- 30% of total annual demand occurs in summer months
- 25% of total annual demand occurs in spring and autumn months
- 20% of total annual demand occurs in winter months

These seasonal variation assumptions account for the assumed peaking factor of 1.5 for summer to winter population. The potable water demands assumed in the Water Supply Strategy are shown in **Table 7—3**, along with a comparison of the expected demands of the proposed development.

Table 7—3 Potable Water Demands

	Potable water Reduction (%)	Potable water average daily demand (m^3/d)	Potable water peak daily demand (m^3/d)
MCW Water Supply Strategy (1,085 ETs)		996	2,496
Potable water consumption with WSD plus recycled water used for toilet	40%	597	1,497
Potable water consumption if alternative supply for both toilet and washing machine	45%	548	1,373
Potable water if alternative supply for washing machine, toilet and outdoor	66%	339	848

The above projections are based on the following:

- A total of 1,085 ETs through Riverside at Tea Gardens (as noted in the MCW *Briefing Paper to the Project Assessment Committee*, 7/4/09), however only 970 lots are proposed,
- Average Daily Demand 335 m^3/ET.y (MCW, *Tea Gardens Water Supply Scheme Servicing Strategy*, 2004), which includes non-domestic and unaccounted for water;
- Unaccounted water allowance of 15% of the Average Daily Demand (MCW, *Tea Gardens Water Supply Scheme Servicing Strategy*, 2004); and

- Peak Day Demand of 2.3 m^3/ET.d (MCW, *Tea Gardens Water Supply Scheme Servicing Strategy*, 2004).

The potable water reductions in **Table 7—3** have been calculated based on BASIX household water consumption calculations, as presented in **Table 7—2**.

MCW have provided a breakdown of the water usage in a typical household. This breakdown will be used to estimate sewage generation and potential recycled water demand. The adopted proportion of total internal and external household water usage is included in **Table 7—4**.

Table 7—4 Breakdown of design water demand (MidCoast Water)

Area of Usage	Percentage breakdown	Design Demand (L/EP/day)	Percentage Hot Water demand	Hot Water Demand (L/EP/day)
Outdoor	27%	84.2	0%	0
Toilet	12%	37.4	0%	0
Laundry	22%	68.6	30%	20.6
Bathroom	29%	90.5	50%	45.2
Kitchen	5%	15.6	50%	7.8
Other	5%	15.6	0%	0
	100%	**312.0**	**-**	**73.6**

Design water demand and sewage generation would be expected to be less for new development areas due to the uptake of water saving devices to satisfy BASIX requirements, water restrictions and heightened awareness of the general public to minimise water usage.

MCW have advised that their design water demand of 205 kL/ET/day has taken into account some uptake of water efficient devices in existing dwellings. For the purpose of this study and the estimation of recycled water demand, the following assumptions on water demand reduction compared to the MCW benchmark have been adopted:

- 20% reduction for water saving shower heads (2 star rated)
- 35% reduction for dual flush toilets
- 15% reduction for water efficient washing machines (2 star rated)
- 20% reduction for water efficient kitchen taps (2 star rated)
- A comparison between the benchmark water demand and reduced water demand with the assumed demand reductions is included in **Table 7—5**.

Table 7—5 – Comparison between design demand and reduced water demand

Area of Usage	Design Demand (L/EP/day)	Reduced Demand (L/EP/day)
Outdoor	84.2	84.2
Toilet	37.4	24.3
Laundry	68.6	58.3
Bathroom	90.5	72.4
Kitchen	15.6	12.5
Other	15.6	15.6
	312.0	**267.3**

The reduced demand represents a 15% decrease in total water demand, which is consistent with MCW's objective of offsetting effluent generation and potable water supply. It is also significantly less than the statutory BASIX requirement for a 40% reduction in potable water use for all new development. As such, it is a very conservative allowance.

Using the numbers in **Table 7—2**, the incorporation of 2-star flow restrictors in the kitchen and bathroom, 2-star shower heads, 3-star dual flush toilets and 2-star dishwashers is estimated to directly reduce total potable water usage by approximately 24%.

The values for potable daily consumption (generated from consumption rates published in the MCW Water Supply Strategy, 2004) were reviewed and compared to the BASIX traditional water Consumption of 247.5 L/person.day. The comparison shows that the values generated from the MCW demands are very high compared to demands generated from BASIX.

Based on the MCW value of 335 m^3/ET/y, average daily demand for Riverside at Tea Gardens, with 970 lots, is 890 m^3/day.

The peak summer population at Riverside at Tea Gardens is predicted to be 2,619 (based on 970 lots with 1.8 EP/ET and a summer peaking factor of 1.5 per the MCW Briefing Paper to the Project Assessment Committee, 7/4/09). Based on potable water consumption of 247.5L/person.day (BASIX traditional consumption), through the development, potable water demand is equal to 648 m^3/day, this is significantly less than 890 m^3/ET.day, which also includes non-domestic and un-accounted for water. A dwelling which is compliant with BASIX would consume 148.5 L/person.day, or the development demand of 389 m^3/day for the summer peak population.

7.2 Rainwater

The re-use of rainwater from rainwater tanks has the potential to make considerable reductions in potable water consumption. However, rainwater can compete with recycled water as they are both used for non-potable applications. Hence the use of rainwater and recycled water needs to be considered in an integrated manner.

It was concluded in **Section 6** that the decision on implementation of rainwater tanks would not impact on the ability of the development to meet stormwater quality objectives, as identified by Cardno (2010).

It has been previously proposed to reuse harvested rainwater for toilet flushing, washing machines and irrigation/outdoor use with a mains water supply top-up system.

Full substitution could not be guaranteed due to the variability of rainfall. Infrastructure would need to be sized to deliver potable demand, assuming the rainwater tanks are empty due to extended periods of dry weather.

The rainwater reuse tank system can be installed in many different configurations. In the proposed development the tanks could be free standing or installed underneath the dwelling with pump used to deliver water to its end use.

The rainwater tank system would also employ a mains top-up scheme to ensure reliable water supply from the tank. When tank water levels are low, during periods of little rainfall, the tank is topped up with mains water via a trickle system. This trickle system reduces the peak demands on the mains water distribution network. A level control system would be installed such that mains top up would be initiated should the level of the rainwater tank fall below 20% of its capacity.

An air gap between the rainwater tank and the top up system along with a one way valve would be installed to ensure no rainwater enters the mains water supply system. These devices are mandatory as required by the Department of Health. Tanks would be fitted with a first flush device which causes the initial volume of runoff (containing the highest concentration of pollutants) to bypass the tank.

The optimum size of the rainwater tank would need to be confirmed by detailed design, but is expected to be about 3-5 kL in size.

7.3 Water Balance

The WorleyParsons in-house water balance model has been used to estimate the likely recycled water irrigation demand and assess recycled water storage volumes for Myall River Downs, Riverside and North Shearwater. It also provides a check against the design demands provided by MCW (refer **Table 7—4**). The model utilises local catchment data, historical rainfall and evaporation records to estimate the irrigation demand within a soil profile. The model comprises a daily time step balance that can assess combinations of recycled water supply, recycled water demand and reservoir storage volumes. Detailed water balance model input data is included in **Appendix 1**.

The results of the water balance model are summarised below.

- Average daily irrigation: 52 L/EP/day
- Average annual irrigation: 91 ML (3 ML/ha/year)

The average daily irrigation calculated in the water balance represents approximately 60% of the MCW design ET outdoor usage (84.2 L/EP/day including garden irrigation, car washing, pools and spas).

A number of reservoir volumes were input into the water balance model to determine the number of days the recycled water reservoir would overtop and an average overtopping volume, refer to **Table 7—6**. These results indicate the extent of upgrade required for the effluent disposal system at Hawks Nest STP with a recycled water system due to periods of rainfall when there is no recycled water irrigation demand.

Table 7—6 – Recycled water reservoir and overtopping volumes

Reservoir volume (ML)	Number of days reservoir overtops (days per year)	Average Overtopping volume (ML/day)	Maximum overtopping volume (ML/day)
0	365	0.74	0.894
1.0	280	0.42	0.894
2.5	267	0.40	0.894
5.0	263	0.39	0.894

Table 7—6 indicates that increasing the reservoir volume does not greatly reduce overtopping. Therefore a reservoir would be sized purely to cater for the likely recycled water demand within the development areas.

It is noted that in utilising a lower irrigation demand the water balance is conservative in assessing the reservoir volumes and sizing effluent disposal infrastructure as there is a higher volume of excess recycled water.

7.4 Wastewater

7.4.1 Existing Services

The existing settlements at Tea Gardens and Hawks Nest are serviced by the existing Hawks Nest WWTP. However, due to limited treated effluent disposal capacity at the plant, the extent of augmentation to service further development is limited.

7.4.2 Wastewater Servicing Concept

The water management objectives adopted in developing a servicing concept for the site include the following:

- Minimise impacts on existing infrastructure by reducing the sewage loads where possible;

- Minimise impacts on receiving waters by designing optimal effluent management practices and minimising effluent discharge;
- Reuse of treated effluent where possible and appropriate; and
- Infrastructure to be designed with long term sustainability in mind. This will involve location of sewerage systems with adequate buffer zones and flexibility for future expansion to meet potential augmentation requirements.

It is proposed to service the development using a vacuum sewerage system. This will deliver sewage from the development site to the existing sewage treatment plant. A vacuum sewerage system is considered to be the most appropriate technology due to the topography of the site.

The Sewerage Servicing Strategy identified that the exfiltration basins (existing and proposed) had sufficient capacity to cater for all of the predicted development loads.

It is understood that the sewage treatment plant itself can be augmented to cope with additional flows. Space could be made available on the sewage treatment plant site should extra treatment (e.g. tertiary filters) be provided to support the use of recycled water. Use of water saving devices within the residential development will reduce the amount of potable water entering the sewerage system. The net effect of a 23% saving in potable water demand (refer **Section 7.1**) will reduce the sewer loadings by approximately 10%. The potential reuse of recycled water for irrigation and toilet flushing within the development would also offset some of the effluent disposal volumes.

7.4.3 Loading Projections

The future population numbers were extracted from the MCW briefing paper, including both summer and winter estimates**.** No population estimates were available for the proposed Myall Way development and as such this has been excluded from our analysis. If MCW were to supply approximate numbers we would incorporate this into our study. However, this is unlikely to change the principal outcomes and would only change the numbers by a relative proportion.

Data from the NSW Department of Planning, including in the report titled *Single Dwelling Outcomes 05-08 BASIX Ongoing Monitoring Program*, was reviewed and yielded the following information:

- BASIX achieved an overall reduction in potable water use of 41%.
- Non-potable water uses account for 50-70% of total demand and hence recycled water could achieve even greater reductions than BASIX.
- Usage data for single dwellings indicates that effluent production is generally in the order of 75% of the water used.
- Water saving devices alone may achieve a 35% reduction in potable water consumption. More typical uptake of these devices would yield at least a 20% reduction for water saving devices alone.

The original sewage generation volume adopted by Mid Coast Water was 240 L per person per day, however it is expected this number would now be lower for both existing and new developments due to:

- Uptake of water saving devices in existing dwellings,
- Water restrictions and heightened awareness,
- Current building codes, and
- BASIX requirements for new dwellings.

As a minimum, it is considered that in line with a reduction in potable water consumption the sewage production of new areas would be reduced by at least 20% due to the implementation of water saving devices including regulated minimum requirements. Hence, a rate of 192 L per person per day would apply for new dwellings.

However, monitored data, from the NSW Department of Planning report titled *Single Dwelling Outcomes 05-08 BASIX Ongoing Monitoring Program*, indicates that the current average (i.e. of all old and new dwellings) water consumption is 250 L per person per day, which would result in sewage production of 188 L per person per day. Under BASIX, new dwellings are estimated to produce only 131 L effluent per person per day, with adoption of water saving devices.

Previous monitoring data quoted in the 2003 EKA report indicated that the sewage generation from the Hawks Nest STP was in the order of 250 L per person per day. Recent flow monitoring data was provided by MCW for the STP. Given the existing peak summer EP of 6689 and the observed 2008-2009 summer school holiday peak sewage generation rate of 1550 kL/day, an average sewage generation of 230 L/EP/day results. This value is not substantially different to the 240 L per person per day previously adopted by MCW, but is lower. Further, more detailed analysis, with more population information may yield more significant findings. The population data available at the time of this study was limited to that found in the MCW briefing paper.

If the use of rainwater tanks were limited to hot water systems, hot water usage would not be expected to change. Hence there would be no impact on the sewage loads.

7.5 Ultimate Loadings at Hawks Nest STP

The ultimate loadings based on current development projections and information provided by MCW is included in **Table 7—7**.

Table 7—7 Ultimate Sewage Loadings within the Hawks Nest STP catchment

Precinct	Permanent (Winter) Loadings			Summer to Winter	Peak (Summer) Loadings
	ET	EP / ET	EP		
Hawks Nest [1]	1,558	1.5	2,368	2.4	5,724
Tea Gardens [1]	1,174	2.1	2,470	1.6	3,830
North Hawks Nest [2]	*900*	1.3	1,125	2.0	2,250
Tea Gardens Industrial / Shearwater Estate [3]	*170*	1.8	306	1.2	378
North Port Stephens [3]	*715*	1.8	1,288	1.7	2,217
Myall Way (unknown yield) [4]	-	-	-	-	-
North Shearwater	*400*	*1.8*	*720*	*1.5*	*1,080*
Riverside	*970*	*1.8*	*1,746*	*1.5*	*2,619*
Myall River Downs	*1,200*	*1.8*	*2,160*	*1.5*	*3,240*
TOTAL	**7,087**	**1.72**	**12,183**	**1.75**	**21,338**

1. Projected ultimate development within existing townships
2. Future development area
3. Existing development not currently connected to reticulated sewer
4. Included in Mid North Coast regional strategy, however no dwelling yield available for this development area

7.6 Recycled Water

The opportunity may exist to recycle treated effluent from the existing Hawks Nest WWTP.

It is assumed that the existing areas of Tea Gardens and Hawks Nest would not be serviced with recycled water and that only new developments would be included.

7.6.1 Recycled Water Supply Concept

The water management objectives adopted in developing a supply concept for the site include the following:

- Minimise the discharge of treated effluent to the environment by maximising the reuse of recycled water;

- Minimise impacts of recycled water reuse on the surrounding environment by designing optimal management practices (minimise runoff, effective irrigation practices etc.);
- To achieve unrestricted reuse status, the recycled water will most likely require tertiary filtration and disinfection at the Hawks Nest STP before distribution; and
- Infrastructure to be designed with long term sustainability in mind. This will involve location of additional treatment trains, recycled water management systems with adequate buffer zones and flexibility for future expansion to meet potential future reuse opportunities.

Additional treatment will most likely be required to achieve an effluent standard that allows unrestricted reuse. This is necessary to allow use of the recycled water in potentially primary contact situations. The most likely technology that would be used to achieve this would be tertiary filters and disinfection.

The tertiary filters and disinfection treatment trains could be staged to allow for future upgrade of the plant and accommodate possible future reuse opportunities.

The recycled water supply to the development site would require a pumping station at the sewage treatment plant and a transfer main (nominally DN150mm) to deliver recycled water to a small recycled water reservoir, recycled water would be distributed from the reservoir, through the development.

7.6.2 Recycled Water Demand

Appropriate re-use applications for the recycled water from the sewerage treatment plant would be dependent on the level of treatment in provided in the recycled water plant.

It is understood that concerns were raised regarding use of recycled water for irrigation, as it could affect the health of the aquifer that lies below Riverside at Tea Gardens. These concerns have been addressed by the Martens 2010 report, which concludes that nutrient loadings from the recycled water irrigation would be far less than the potential uptake by vegetation.

The potential demand for recycled water use in future development areas would be based on the reduced water demand (including the MCW outdoor demand) and sewage generation including provision for water demand reduction.

It is assumed that recycled water would be used for external and internal use, including:

- Outdoor irrigation (27% of total water demand)
- Toilet flushing (12% of total water demand)
- Washing machines (22% of total water demand)

Based on these assumptions, recycled water demand could comprise as much as 61% of total household water demand. It is acknowledged that there is likely to be public perception issues with the use of recycled water in washing machines and that outdoor demand could vary depending on climatic conditions. However, for the purposes of this study and for sizing the trunk recycled water infrastructure, it is conservatively assumed that recycled water demand would include laundry use and the MCW design outdoor demand.

Based on the benchmark water demand, adopted water demand reduction and recycled water usage assumptions, the design flows that have been adopted for sewage generation, potable water demand and recycled water demand are included in **Table 7—8**.

Table 7—8 – Design flows for future development areas

Area of Usage	Adopted Demand (L/EP/day)	Wastewater to sewer (L/EP/day)	Potable Water Demand (L/EP/day)	Recycled Water Demand (L/EP/day)
Outdoor	84.2	0	0	84.2
Toilet	24.3	24.3	0	24.3
Laundry	58.3	58.3	0	58.3
Bathroom	72.4	72.4	72.4	0
Kitchen	12.5	12.5	12.5	0
Other	15.6	15.6	7.8	7.8
TOTAL	**267.3**	**183.1**	**92.7**	**160.9**

It is noted that based on the MCW design water demand shown in **Table 7—3** and the potable water demand shown in **Table 7—8**, the reduction in potable water demand as a result of BASIX demand reduction measures and a recycled water system could be up 75%.

Based on the MCW design water demand and reduced water demands included in **Table 7—3**, the ultimate estimated sewage production and recycled water demands within the Hawks Nest STP catchment are summarised in **Table 7—9**. These figures are based on the following assumptions:

- Recycled water would only be supplied to Riverside, Myall River Downs and North Shearwater. Allowance for recycled water supply to existing townships and other potential development areas are not included in this study.
- Recycled water demand is based on internal and external reuse including connection to toilets and washing machines.
- An average demand for outdoor usage of 84 L/EP/day has been adopted (refer **Table 7—4**). This figure would vary day to day depending on climate conditions (i.e. temperature and rainfall), which would impact upon the total daily recycled water demand.
- New sewerage systems (including conventional gravity sewerage) would be designed and constructed to ensure minimal inflow and infiltration.

- The projected sewage loadings do not account for non-residential sewage loadings.

Table 7—9 Ultimate Sewage Production and Recycled Water Demands (Summer)

Precinct	Sewage generated (kL/day)	Recycled Water Demand (kL/day)	Excess effluent (kL/day)
Hawks Nest	1304	0	1304
Tea Gardens	872	0	872
North Hawks Nest	412	0	412
Tea Gardens Industrial / Shearwater Estate	69	0	69
North Port Stephens	406	0	406
Myall Way (unknown yield)	0	0	0
North Shearwater	*198*	*189*	*9*
Riverside	480	458	*22*
Myall River Downs	*593*	*566*	*27*
TOTAL	4,334	1,212	3,122

MCW has prepared an Effluent Management Scheme concept design for recycled water use at Hawks Nest Golf Course (MCW 2008). It is estimated that the scheme would supply up to 1.5 ML/day and could reuse an average of 101 ML/year (274 kL/day), which is equivalent to approximately 35% of the existing annual effluent load from Hawks Nest STP. This potential reuse is not included in the potential recycled water demand presented above.

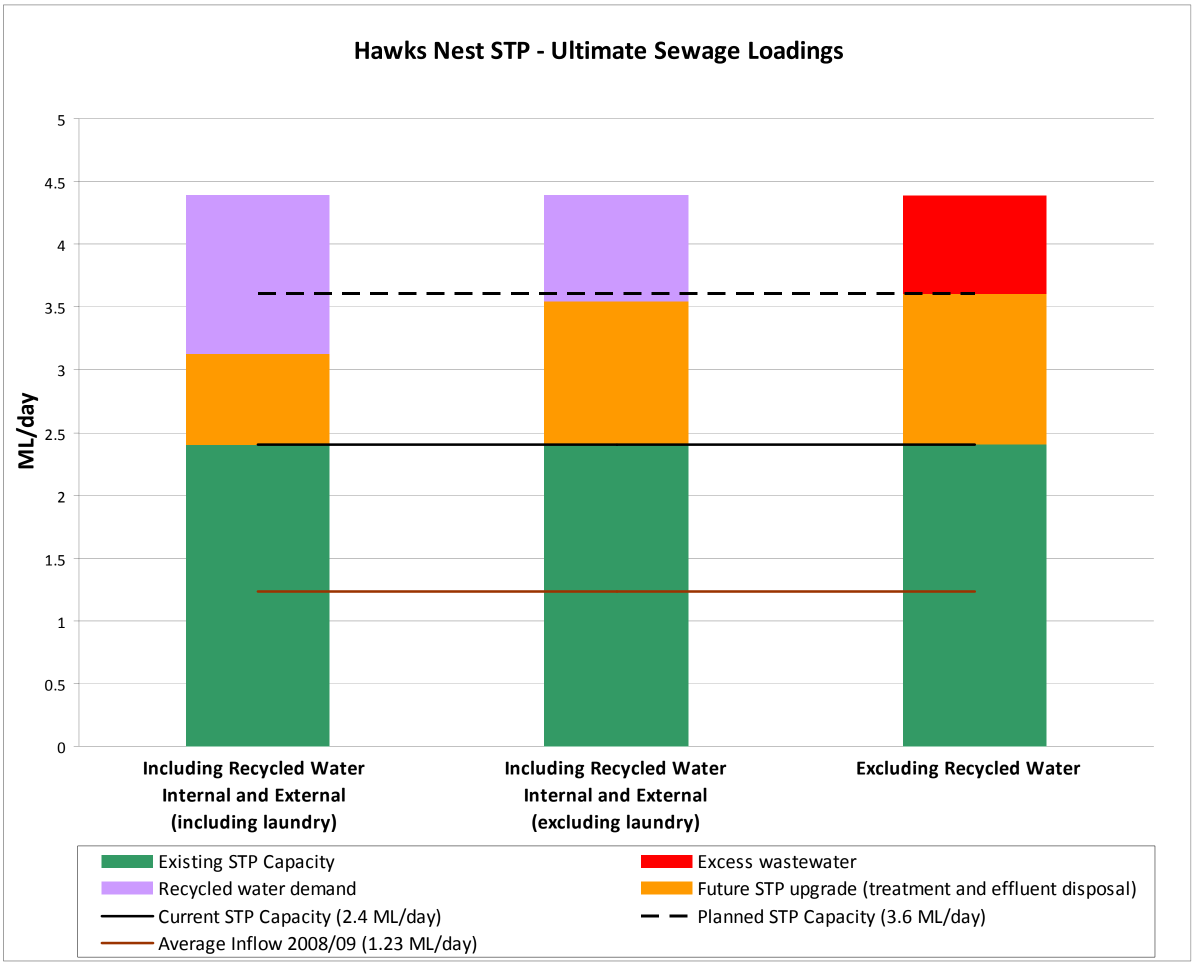
7.7 Future Supply Scenarios

Three potential scenarios for future water supply to new developments within the Hawks Nest STP catchment are presented in **Diagram 7—1**. These are:

- **Scenario 1**: Internal and external recycled water supply (including laundry)
- **Scenario 2**: Internal and external recycled water supply (excluding laundry)
- **Scenario 3**: No recycled water supply

Under Scenario 1, the ultimate excess effluent of 3.1 ML/day is within the ultimate capacity of Hawks Nest STP (3.6 ML/day). Under Scenario 2, the excess effluent would increase to 3.5 ML/day, which would still be within the ultimate STP capacity. Under Scenario 3, the ultimate STP capacity would be insufficient to service the total projected development.

Diagram 7—1 Sewage Generation and Recycled Water Treatment Rates (Summer Loadings)



The total ultimate sewage generation (4.4 ML/day) is shown to be greater than the future planned STP capacity, meaning the STP would need to be upgraded to cater for the projected development. These upgrades would be dependent on the timing and staging of future developments. It is envisaged that timing and staging of upgrades to the STP would be considered in further detail in subsequent studies. The size of any future upgrades of the STP would be dependent on the projected recycled water demand and any changes to future development projections.

Due to the limited ultimate capacity of the effluent disposal system (3.6 ML/day), some form of offset of effluent disposal would be required to ensure the proposed development precincts can be adequately serviced. **Diagram 1** demonstrates that a recycled water system could offset effluent disposal at the STP and ensure the STP has adequate effluent disposal capacity to cater for the sewage generated by Riverside at Tea Gardens, Myall River Downs and North Shearwater.

7.8 Recycled Water Infrastructure

The recycled water strategy to service the development precincts would consist of constructing trunk infrastructure to transfer recycled water from Hawks Nest STP to the development. The trunk infrastructure would include the following components:

- A recycled water treatment facility at Hawks Nest STP, to produce recycled water of a standard suitable for unrestricted public access and internal reuse.
- A recycled water pumping station at the STP site.
- A recycled water reservoir adjacent to existing MidCoast Water potable water reservoirs.
- A rising main from the treatment facility at Hawks Nest STP to the proposed recycled water reservoir.
- Distribution mains from the reservoir to the site.

8. CONCLUSION

This Integrated Water Cycle Management Strategy and Sewerage Servicing Report was prepared addressed in response to a request from MidCoast Water to address aspects of sewerage servicing.

This report has demonstrated the options available for servicing the Riverside development and informs the requirements for sewerage infrastructure moving forward.

This study has considered stormwater, water and effluent in an integrated manner and illustrated that:

- The use of rainwater tanks need not affect the sewerage/recycled water servicing strategy.
- The Hawks Nest Waste Water Treatment Plant would need to be augmented to meet the needs of future developments.
- A recycled water system would offset effluent generation at Hawks Nest STP and ensure the ultimate development yield within the STP catchment would not exceed the ultimate effluent disposal capacity at the STP.

9. REFERENCES

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4. Ellis Karm & Associates Pty. Ltd., January 2003, *Sewerage Servicing Strategy for the Tea Gardens – Hawks Nest Sewerage Scheme*
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6. Great Lakes Council,1998, *Myall Quays Estate Development Control Plan No. 22*
7. Great Lakes Council, May 2010, *Draft Water Sensitive Design DCP (Version 1.10)*
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10. MidCoast Water, *Hawks Nest Effluent Management Scheme, Stage 1 Concept Report*, September 2008
11. MidCoast Water, November 2004, *Tea Gardens Water Supply Scheme Servicing Strategy*
12. NHMRC 2004, *Australian Drinking Water Guidelines*
13. NSW Government State Environmental Planning Policy No 14 – Coastal Wetlands
14. NSW Government State Environmental Planning Policy (Building Sustainability Index: BASIX)

Appendix 1 - Water Balance Model Data

MODEL INPUT DATA

The following input data was used in the development of the water balance model.

CATCHMENT DATA

The table below contains the input data for the catchment, losses and soil profile adopted in the water balance.

Table A1.1 Catchment Data

General Catchment Data	**Area (m2)**	**To Infiltration (%)**		
- Impervious Area to Reservoir	0	0%		
- Impervious Area not to Reservoir	0	0%		
- Pervious Area to be Irrigated	268500	0%	(assumed 100m^2 per lot)	
- Pervious Area not to be Irrigated	0	0%		
- Forested Area	0	0%		
- Infiltration system (inf)	0	-		
- wetland (assumes all site drains to wetland)	0	-		
- Total Area	268500	0%		
Interception				
- Proportion of Irrigated Pervious Area as Canopy	0%			
- Proportion of No Irrigated Pervious Area as Canopy	25%			
- Proportion of Forested Area as Canopy	100%			
- Maximum Canopy Storage	1.5	mm		
Depression Storage				
- Impervious Depression Storage	0.5	mm		

- Pervious Depression Storage	0.5	mm		
- Forested Depression Storage	1	mm		
Forest Soil Moisture Storage				
- Maximum Storage	60	mm		
- Initial Moisture Storage	30	mm		
- Storage Before Infiltration Occurs	60	mm		
- Deep Infiltration Rate	24	mm/day		
Pervious Soil Moisture Storage				
- Maximum Storage	20	mm		
- Initial Moisture Storage	10	mm		
- Storage Before Infiltration Occurs	20	mm		
- Deep Infiltration Rate	2	mm/day		
- Storage Before Watering	2.4	mm		
- Water Until Storage Reaches…	3.3	mm		

CLIMATE DATA

A review of available climate data was undertaken to select the most appropriate data set for the water balance model. There are four nearby weather stations identified as outlined in **Table A1.2** below.

Table A1.2 Bureau of Meteorology Weather Stations near to Hawks Nest

Station (NSW)	Distance from Hawks Nest (km)	Historical Average Rainfall (mm/yr)	Year Opened	Elevation (m)
061054 Nelson Bay (Nelson Head)	7.9	1348.9	1881	25
061303 Salamander Bay (Randell Dr)	10.8	1273.3	1971	9
061072 Carrington (Church St)	12.6	1199	1887	3
061078 Williamstown RAAF	33.3	1127.9	1942	9

Records from the Nelson Bay station were incomplete. A data set from Nelson Bay records that included 1941-1971 and 1984-2008 was selected. This data set contained 55 years of records with a mean annual rainfall of 1,361mm. This is considered to be representative of the historical average rainfall for the site.

Average aerial evapotranspiration rates for the site were sourced from the Climate Atlas of Australia refer, **Table A1.3**.

Table A1.3 Average Aerial Evapotranspiration and Crop Factors for Pervious Irrigation

Month	Average Aerial Evapotranspiration (daily)	Crop Factor for Pervious Irrigation
January	5.65	0.75
February	4.82	0.75
March	4.03	0.7
April	3.3	0.7
May	2.72	0.6
June	2.26	0.6
July	2.54	0.55
August	3.11	0.55
September	3.69	0.55
October	4.51	0.6
November	5	0.75
December	5.32	0.7

RECYCLED WATER INPUT PARAMETERS

The input parameters for effluent generation and internal reuse of recycled water are outlined below.

- Number of Equivalent Tenements: 2685 ET
- Equivalent Population per Tenement: 1.8 EP/ET
- Effluent generation – Summer: 185 L/EP/day
- Effluent generation – Autumn and Spring: 154 L/EP/day
- Effluent generation – Winter: 123 L/EP/day

- Internal recycled water demand: 52 L/EP/day
  (BASIX demands for toilet flushing and washing machine)