
# TWEED SHIRE COUNCIL

## DEMAND MANGEMENT STRATEGY - STAGE 1

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## REVISION SCHEDULE

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MWH

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# EXECUTIVE SUMMARY

## OBJECTIVES OF REPORT

Based on assessment undertaken as part of the Integrated Water Cycle Management Concept Plan, Tweed Shire Council (TSC) is facing a range of issues related to water. Specifically these issues relate to:

- The ability of existing surface water sources to adequately service future population, due to high population growth rates, recent reduction in the safe yield and the possibility of a reduced entitlement to water in the future under water sharing arrangements.
- A need to review and refine understanding of supply security and the potential impacts of environmental flow rules being applied at Bray Park Weir, together with the assessment of supply enhancement options such as raising Clarrie Hall Dam and constructing Byrrill Creek Dam.
- The need to have efficient water usage supported by effective demand side management, as well as diversification of water sources through the possible reuse of reclaimed effluent and stormwater.
- The need for consistency in the water supply business planning tools of the organisation (i.e. consistency between the directions and outcomes of the TSC Integrated Water Cycle Management (IWCM) Strategy 2006 and supporting instruments such as a Demand Management Strategy (DMS)).
- The need for compliance with the Department of Water and Energy (DWE) best practice requirements.

In recognition of the need to take action, TSC has decided to prepare a DMS (a recommendation of the TSC IWCM Concept Strategy) in two parts: an Interim (Stage 1) DMS and a Final (Stage 2) DMS. Ultimately, TSC aims to have an effective strategy to manage and monitor demand which is consistent with the organisation's overall water supply business directions and compliant with the DWE *Best Practice Management Guidelines (May 2004).*

The interim DMS focuses on the main water consuming customer category – the residential section, which consumed 60% of the total potable water supplied by TSC in 2004/05 (DWE, 2006). With respect to the new developments, namely Cobaki Lakes, Kings Forest, Bilambil Heights, Terranora (Area E), and West Kingscliff, the interim DMS considers the potential of source substitution of the potable supply through the capture of rainwater and the reuse of treated sewage effluent.

## POPULATION AND BASELINE DEMAND FORECAST

An assessment of the historic population and future growth was undertaken as part of the study. Population assessment indicated the following:

- The current population of the Tweed Shire that is served by the Bray Park Water Treatment Plant is estimated to be 73,185.

- Population served by Brays Park WTP is expected to grow to 157,048 by 2036, mostly due to the development of large greenfield areas and the redevelopment and infill development of the Tweed Heads area.
- Occupancy rates are expected to fall between 2006 and 2036. For single family residences the rate will fall from 2.8 to 2.5 persons/dwelling, and for multi family dwellings from 1.95 to 1.7 persons/dwelling.

A detailed assessment of the water production and billing data was undertaken to identify demand trends in per capita and sectoral demand. The assessment included the climate correction of data to assist in the understanding of demand drivers and underlying trends. Results indicated that:

- The average per capita usage (including all metered use and non-revenue water) in TSC is 370 L/person/day, which is a fall from pre-drought (2002) demands. Since restrictions were lifted residential demand has increased.
- Average use for 2004/5 was 231 kL/residential property/annum, which was higher than most northern NSW coastal centres and the NSW average, however many of these centers have been under drought restrictions.
- Non-revenue water is currently estimated to be around 13% of the total water produced. The Infrastructure Leakage Index is relatively high at 2.3 for the Bray Park system. For systems with this level of loss, it is recommended that an active leakage reduction program be implemented.
- The Baseline demand forecast for the shire, taking account of the natural replacement rate for fittings and fixtures, indicates that the demand in 2036 will be approximately 23, 800 ML/annum, with 20,280 ML/annum coming from existing brownfield areas.

## GREENFIELD OPTIONS

Five future demand scenarios were considered for the major greenfield development areas of Cobaki Lakes, Bilambil Heights, Terranora Area A, West Kingscliff and Kings Forest. The scenarios reviewed were:

- Scenario 1 – Implementation of BASIX including a 5,000 L rainwater tank connected to external uses, toilet flushing and cold water to the washing machine.
- Scenario 2 –BASIX together with recycled water for external use and toilet flushing.
- Scenario 3 – BASIX with a 5,000 L rainwater tank for internal uses and recycled water for external uses.
- Scenario 4 – Indirect Potable Reuse combined with rainwater tanks to further lower the reliance on dam sources.
- Scenario 5 – A 4th pipe system that would collect and treat greywater and blackwater separately for recycling of greywater to households and blackwater to open space.

For all scenarios the use of Reduced Infiltration Gravity Sewers (RIGS) was considered to increase the efficiency of collecting sewage. This had this effect of reducing the overall sizes and costs of the system through reduced wet weather flows.

A detailed assessment of the infrastructure and demand impacts was undertaken for Scenarios 1 to 4. Scenario 5 was not considered in detail due to the number of operational issues and higher capital and on-going costs associated with such a system.

The results of the assessment for the major *greenfield* development areas can be summarised as follows:

- Rainwater tanks would need to be 5,000 L and would save around 80 kL/a for the average household.
- Reduction of potable water use was determined to be approximately 36%, 42% and 61% for Scenarios 1, 2 and 3 respectively for all greenfield developments except West Kingscliff, where development is likely to be industrial.
- Significant savings in infrastructure will accrue from the introduction of smart sewers aimed at the reduction of infiltration and inflow.
- Scenario 1 has the lowest cost to the community. The majority of the capital cost and on-going cost for this scenario are the responsibility of the householder as a result of the legislative requirement to achieve savings under the BASIX program.
- Scenario 1 has the best return on investment with savings of 34 to 38% of the baseline demand forecasts. This scenario also has the lowest cost per kilolitre of savings.
- The cost of the recycled water scenarios (Scenario 2 and 3) is significantly higher than Scenario 1 due to the high cost of providing a third pipe network and establishing membrane treatment.
- From an environmental perspective Scenarios 2 and 3 reduce return effluent flows to the waterways by more than 10%. Scenario 1 will have a modest impact on urban water quality through the reduction of pollutants to waterways.
- The assessment of Scenario 4, involving Indirect Potable Reuse through pumping recycled water to the Clarrie Hall Dam, indicated that by 2036 a total volume of 28 ML/d or 10,220 ML/a could be provided. However the total cost of implementing the scheme would be in excess of $184m.

Additional work reviewing the options for a stand alone recycled water scheme at Cobaki Lakes indicated that the scheme would not be cost beneficial. However if a dual reticulation scheme were to be constructed it would be more cost effective to construct a the treatment facilities at the development rather than to opt for a centralised facility at the Banora Point STP. This option should be further pursued if the developer proposes a third pipe approach for Cobaki Lakes.

## BROWNFIELD OPTIONS

Four future demand scenarios were developed and reviewed for the brownfield areas of Tweed Shire. The scenarios reviewed were:

- Scenario 1 – BASIX with a Rainwater Tank serving external, cold water for washing machines and toilets combined with the WELS Program.
- Scenario 2 – BASIX with a Rainwater Tank serving external, cold water for washing machines and toilets combined with the WELS Program and a Loss Management Program.
- Scenario 3 – Selected Demand Management Options including a range of measures to reduce water demand in the residential sector.

- Scenario 4 – Enhanced Demand Management Options including Scenario 3 measures plus Non Residential sector measures.

The results of the assessment for the brownfield areas are summarised as follows:

- Rainwater tanks would need to be 5,000 L in size and would save around 80 kL/a for the average household if connected to toilets, cold water to the washing machine and to external taps.
- Reduction of potable water use was determined to be approximately 16 %, 20%, 21% and 23% for Scenarios 1, 2, 3 and 4 respectively for the brownfield areas with Tweed Shire.
- Scenario 3 has the highest savings potential at the lowest cost per kL saved to the community as a whole. This cost is however higher than the marginal cost of potable water due mainly to the overall cost of rainwater tanks. Scenario 4 includes water savings from a non-residential program that has not been evaluated, but is expected to result in savings of around 10% at a similar cost to the residential program.
- The majority of the capital cost and on-going costs are the responsibility of the householder. Council will need a management plan including regular inspections to ensure that health and water quality aspects are addressed through regular maintenance.
- From an environmental perspective Scenario 4 is the best performer, with reductions in river extractions due to the additional reductions in demand.
- Scenario 4 would have broad community acceptance as it involves all sectors of the community and council contributing to achieve a water reduction target.

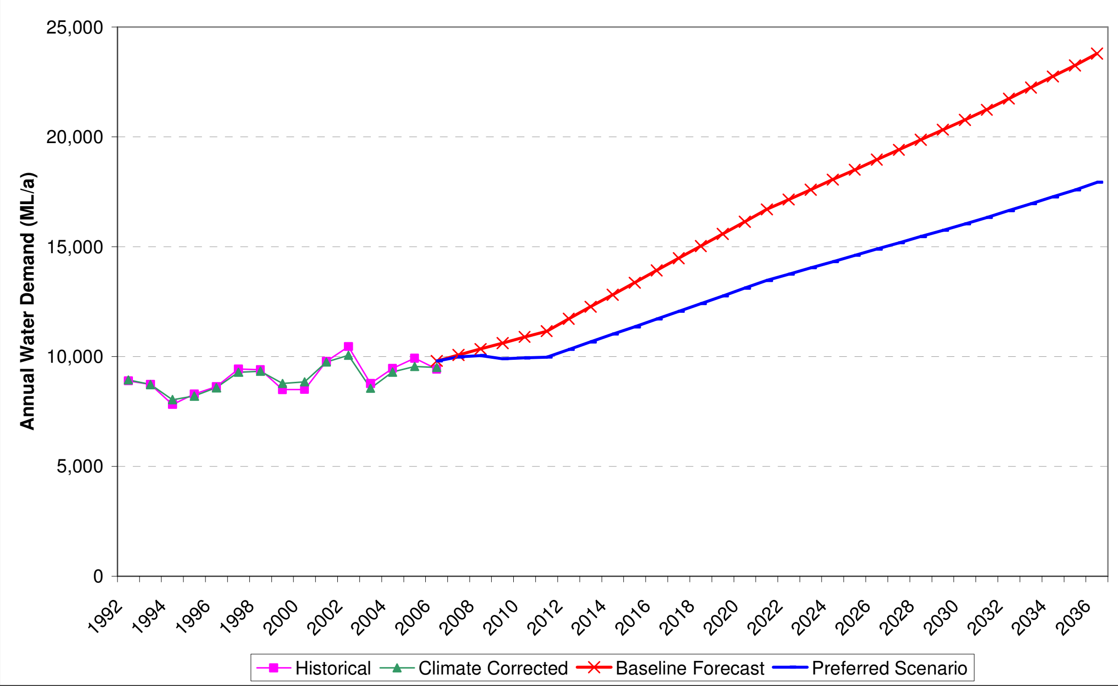
## PREFERRED APPROACH

A Triple Bottom Line assessment was undertaken of both the greenfield and brownfield scenarios investigated in this report. The assessment indicated that the preffered strategy is to implement the following:

- Greenfield Scenario 1 for the major development areas of including the adoption of BASIX with 5,000 L rainwater tanks (minimum of 160 $m^2$ roof area) connected to external uses, toilet flushing and cold water to washing machines. In addition new dwellings will have dual flush toilets as well as 3 star showerheads and taps.
- Brownfield Scenario 4 for existing and infill development areas, with a key focus on developing an extensive active leakage control and pressure management program. This scenario includes an interim allowance of 10% demand reduction for non-residential development.

Figure E1 summarises the forecast baseline (excluding BASIX) and preferred option forecast to 2036.

**Figure E1 Forecast Water Demand for the Preferred Demand Management Strategy**




## RECOMMENDATIONS

Based on the assessment of options in this report it is recommended that:

1. Brownfield Scenario 4 be adopted for the Tweed Shire existing and infill development areas, with a key focus on developing an extensive active leakage control and pressure management program.
2. Greenfield Scenario 1 be adopted for the Cobaki Lakes, Bilambil Heights, Terranora and Kings Forest developments. This will include the adoption of BASIX with 5,000 L rainwater tanks (minimum of 160 $m^2$ roof area) connected to external uses, toilet flushing and cold water to washing machines. In addition new dwellings will have dual flush toilets as well as 3 star showerheads and taps.
3. For West Kingscliff, recycled water be made available to future industrial land use areas where demand is identified.
4. Rainwater tank education programs be developed, focused on the correct use and maintenance including a regular program of inspections.
5. An on-going communication and education program be developed as part of the preferred program to ensure that savings are maintained in future.
6. The inclining block tariff structure be maintained and enhanced to provide a price signal for high users.
7. Options for a non-residential demand management program be considered further.
8. A review be undertaken of the potable water design standards based on the demand assessment undertaken in this report. A regular assessment should then be undertaken to review the adopted design standards.

# 1. INTRODUCTION

With many parts of Australia in the grip of one of the worst droughts on record and considerable uncertainty about the impact of global warming on our traditional surface water supplies, there is an increasing focus on the many opportunities to conserve and use water efficiently and to use rainwater and recycled water as a substitute for traditional potable sources.

Tweed Shire Council (TSC) is facing many of these same issues. Specifically:

- The ability of existing surface water sources to adequately service future population. This issue is driven by a number of factors including ongoing high population growth rates, a recent reduction in the estimate of safe yield, and the possibility of a reduced entitlement to water in the future under water sharing arrangements.
- The availability of alternative sources, such as groundwater, limited to emergency drought response only.
- A need to review and refine current estimates of system yields and supply security, including assessing the potential impacts of environmental flow rules being applied at Bray Park Weir and determining increased yields from supply enhancement options such as raising Clarrie Hall Dam and constructing Byrrill Creek Dam.
- The need to have a robust and effective water supply supported by effective demand-side management and diversification of water sources through the reuse of reclaimed effluent and stormwater.
- The need to demonstrate to the community paying for the scheme augmentation, the effectiveness and efficiency of the management of the system by TSC.
- The need for consistency in the water supply business planning tools of the organisation (i.e. consistency between the directions and outcomes of the TSC Integrated Water Cycle Management (IWCM) Strategy 2006 and supporting instruments such as a DMS).
- The need for compliance with the Department of Water and Energy (DWE) best practice requirements.

In recognition of the need to take action as quickly as possible, TSC has decided to prepare its DMS (a recommendation of the TSC IWCM Strategy) in two parts: an Interim DMS and a Final DMS. Ultimately, TSC aims to have an effective strategy to manage and monitor demand which is consistent with the organisation's overall water supply business directions and compliant with the DWE *Best Practice Management Guidelines (May 2004).*

## 1.1 OBJECTIVES

The overall study will be delivered in two parts. The interim DMS focuses on the main water consuming customer category – the residential section, which consumed 60% of the total potable water supplied by TSC in 2004/05 (DWE, 2006). This sector has been the focus of most of the demand management initiatives by governmental regulations and initiatives (i.e. BASIX and WELS). The interim DMS considers the effectiveness of these initiatives and formalise their adoption by council.

However, based on state benchmark figures, in per residential property terms, TSC residents consumed about 10% more water than the average home in NSW in 2004/05, indicating the potential for some improvement in water use efficiency. In addition, TSC reported in the same year a total system loss of 14%, approximately 4% higher than the state benchmark, again indicating some potential for efficiency gains (DWE, 2006).

The first part of this project includes the identification and assessment of additional measures for residential demand management. With respect to the new developments, namely Cobaki Lakes, Kings Forest, Bilambil Heights, Terranora (Area E), and West Kingscliff, the interim DMS considers the potential of source substitution of the potable supply through the capture of rainwater and the reuse of treated sewage effluent.

This report outlines a comprehensive analysis and forecasting framework based on the expertise of MWH in demand management.

## 1.2 SCOPE OF WORK

The first part of the interim DMS follows the scope outlined in MWH's proposal to TSC in January 2007 with a major emphasize on the new growth areas of Bilambil Heights, Cobaki Lakes, Kings Forest, West Kingscliff and Terranora. The second part if the interim DMS will be focusing on existing brownfield sites and potential savings that can be achieved by implementing leakage reduction programs.

Summarised the following steps have been undertaken to deliver Part 1:

- Data collection, review and compilation of information provided by TSC.
- Forecast of population considering previous studies and latest land use, settlement and demographic data.
- Assessment of TSC water demand performance considering water consumption and losses and comparison to average state-wide performances of similar sized utilities and characteristics.
- Assessment of climate corrected historical production and demands to provide baseline input data for the demand analysis.
- Determination of baseline demand for overall Shire and for each of the individual growth areas.
- Identification, costing and assessment of source substitution options for new residential dwellings in growth areas, such as rainwater, recycled water, on-site greywater re-use and indirect potable re-use.
- Cost-benefit assessment of residential demand management measures, including examinations of regulatory and policy instrument such as BASIX, WELS and education programs for individual and combined growth areas.
- Identification of potential deferral or avoidance of future infrastructure augmentation by implementing water efficient measures in new growth areas.
- Preparation of an Interim Demand Management Strategy.

# 2. METHODOLOGY

## 2.1 THE INTEGRATED APPROACH

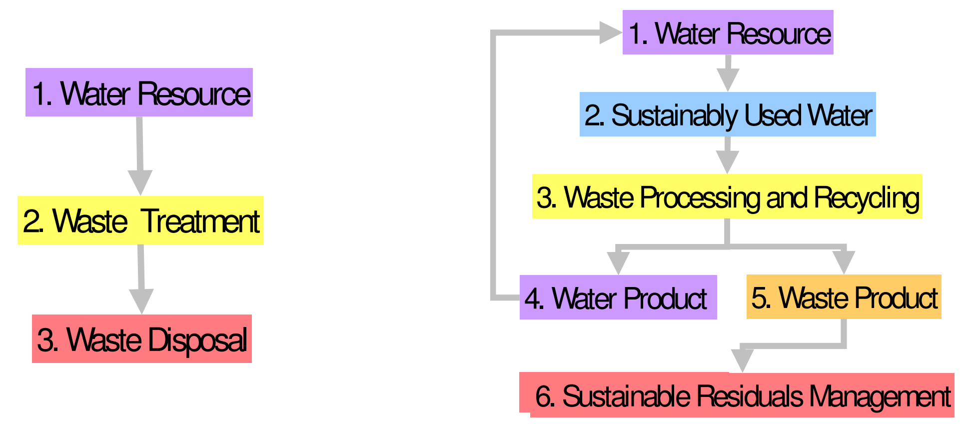
The management of catchments, water supply, wastewater and urban stormwater has traditionally been undertaken in a piecemeal manner. With pressures on water resulting from urban development it was recognised by DWE that the water cycle requires to be considered in an integrated manner. Integrated water management provides a framework to examine urban water supply, wastewater and stormwater management in a whole of catchment, triple bottom line context.

Conventional water cycle management (refer to Figure 2-1) where each element of the water cycle is treated sequentially, has provided us many important benefits. It has provided secure sources of clean water for drinking and use in industry and commerce, as well as treating our waste streams to minimise the impacts on the environment. With population growth and expansion of the urban footprint we are increasingly becoming aware that conventional water system management fails to take account of the interactions between the elements of the water cycle. The current system generally uses water only once, or not at all in the case of stormwater running off impervious surfaces.

Considering all water sources and uses in a single, integrated framework creates opportunities for increasing the efficiency of water use and improving management of the water cycle. By examining integrated options for management of the water cycle, we maximise the opportunity of discovering new ways of doing things as well as making ourselves aware of the interactions and synergies in all parts of water cycle management.

**Figure 2-1 Integrated System Management (Source DWE, 2003)**

**Conventional System Management** | **Integrated System Management**




- Sequential management of individual water system components
- Limited consideration of 'big picture' and resource utilisation impacts

**Leads to unsustainable outcomes**

- Integrated management of all water system components
- Full consideration of 'big picture' and resource management impacts (including triple bottom line)

**Leads to more sustainable outcomes**

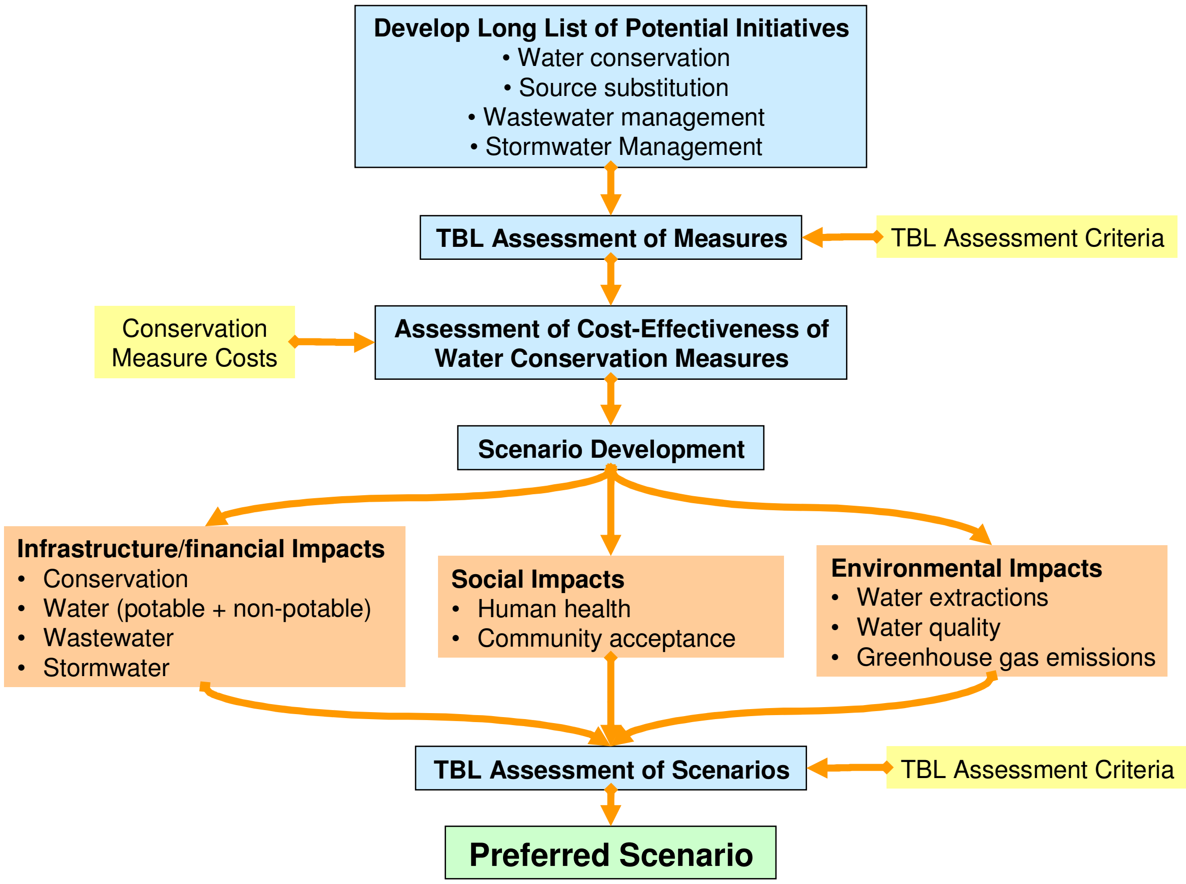
It is also becoming apparent that the current and increasing levels of natural resource use, including water and land uses, are not sustainable. The integrated approach to water management will seek to balance the competing demands on the available resources in Tweed Shire and develop a strategy that will ensure a sustainable water future.

## 2.2 METHODOLOGY OVERVIEW

The development of integrated water cycle scenarios for assessment as part of this study was based on techniques as required by the Department of Water and included stakeholder input and the Triple Bottom Line (TBL) principles. A long list of measures was initially screened and possible measures shortlisted for more detailed evaluation. Detailed evaluation involved an analysis of the cost effectiveness of water conservation initiatives followed by assessment of the impact of various combinations, or scenarios, comprising source substitution such as recycled water and rainwater use.

The water supply, recycled water and related infrastructure required for each scenario was assessed together with the financial, social and environmental impacts using the same TBL assessment process. An overview of the IUWCM process adopted for the project is summarised in Figure 2-2.

**Figure 2-2 Integrated Urban Water Cycle Management (IUWCM) Planning Process**



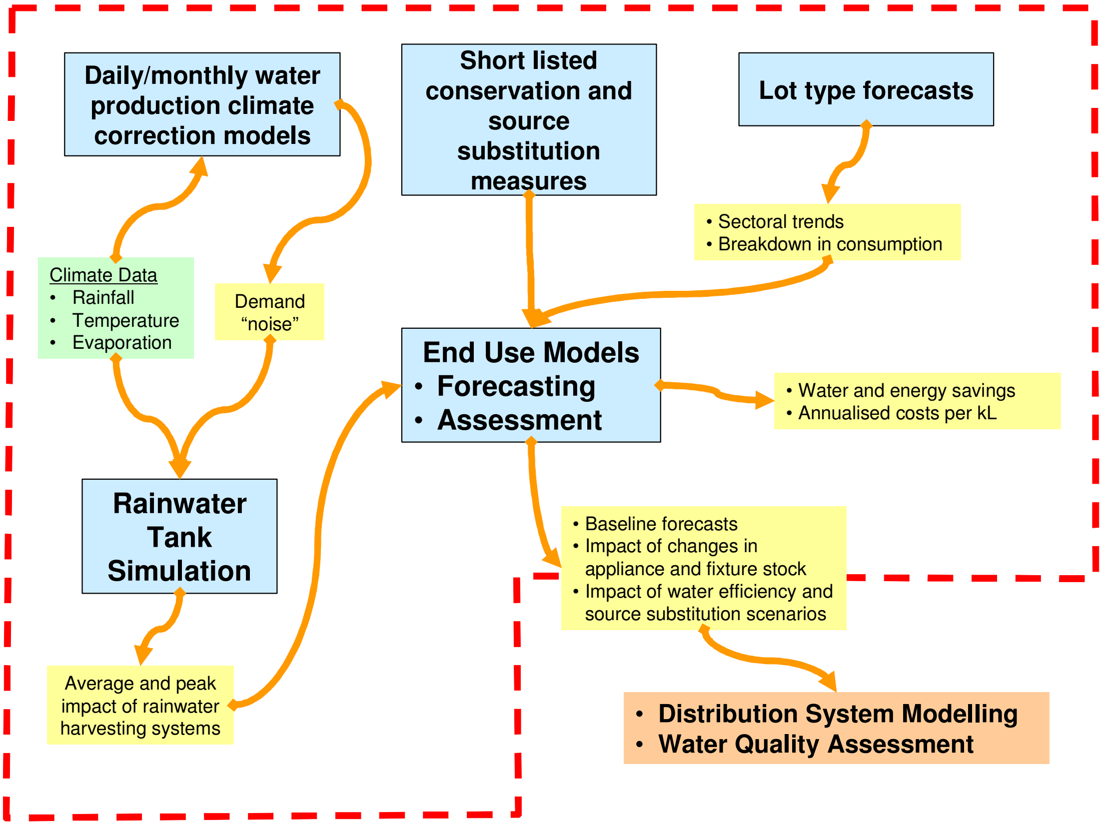
## 2.3 MODELLING TOOLS

The development of the Demand Management Strategy for Tweed Shire necessitates the use of a number of simulation and forecasting models as shown in Figure 2-3. The approach used for the assessment of options is reliant on a detailed End Use Model supported by various demand assessment tools. MWH's end use model (Decision Support System or DSS) is used to assess the impact of different water conservation and source substitution measures of future water end uses as well as determining the economic feasibility using a benefit cost analysis approach. The DSS is a more advanced version of the DWE's analysis software, however has the same assessment approach and software engine.

The End Use model is supported by the following demand assessment and analysis tools:

- Historic per Capita Water Demand Model. This model includes climate correction of total system production using a per capita approach to remove the influence of population growth. The underlying trends in demand can then be identified.
- Sectoral Demand Model. Assessment of actual consumption per account is important to understand the trends in usage for the various types of customer in the shire. Trends are climate corrected to provide an understanding of the demand drivers.
- Rainwater Tank Yield Model. A simulation model used to assess the impact of rainwater tanks, which was used to evaluate the reliability and yield of various tank sizes.

**Figure 2-3 Modelling and Assessment Framework**



# 3. TWEED SHIRE OVERVIEW AND ISSUES

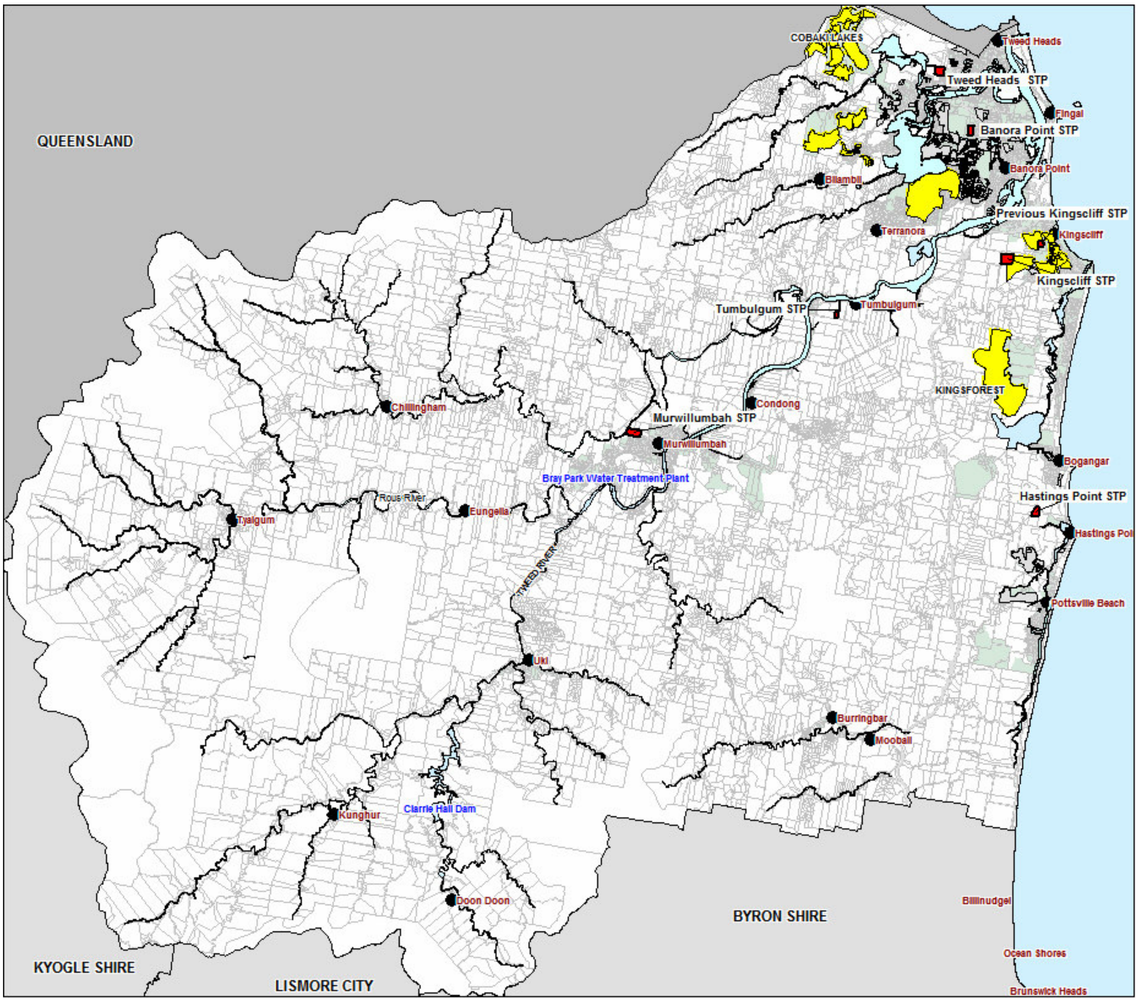
## 3.1 STUDY AREA

The area of study is shown in Figure 3-1. Tweed Shire is located on the far north coast of New South Wales and is characterised by mountain ranges to the north, west and south dropping to coastal plateau to the east with major floodplain areas in the central catchment.

The shire covers an area of 1,340 km$^2$, the majority of which (1,080 km$^2$) comprises the Tweed River catchment with the remaining area draining to 3 relatively small coastal estuaries: Cudgen Creek, Cudgera Creek and Mooball Creek (260km$^2$).

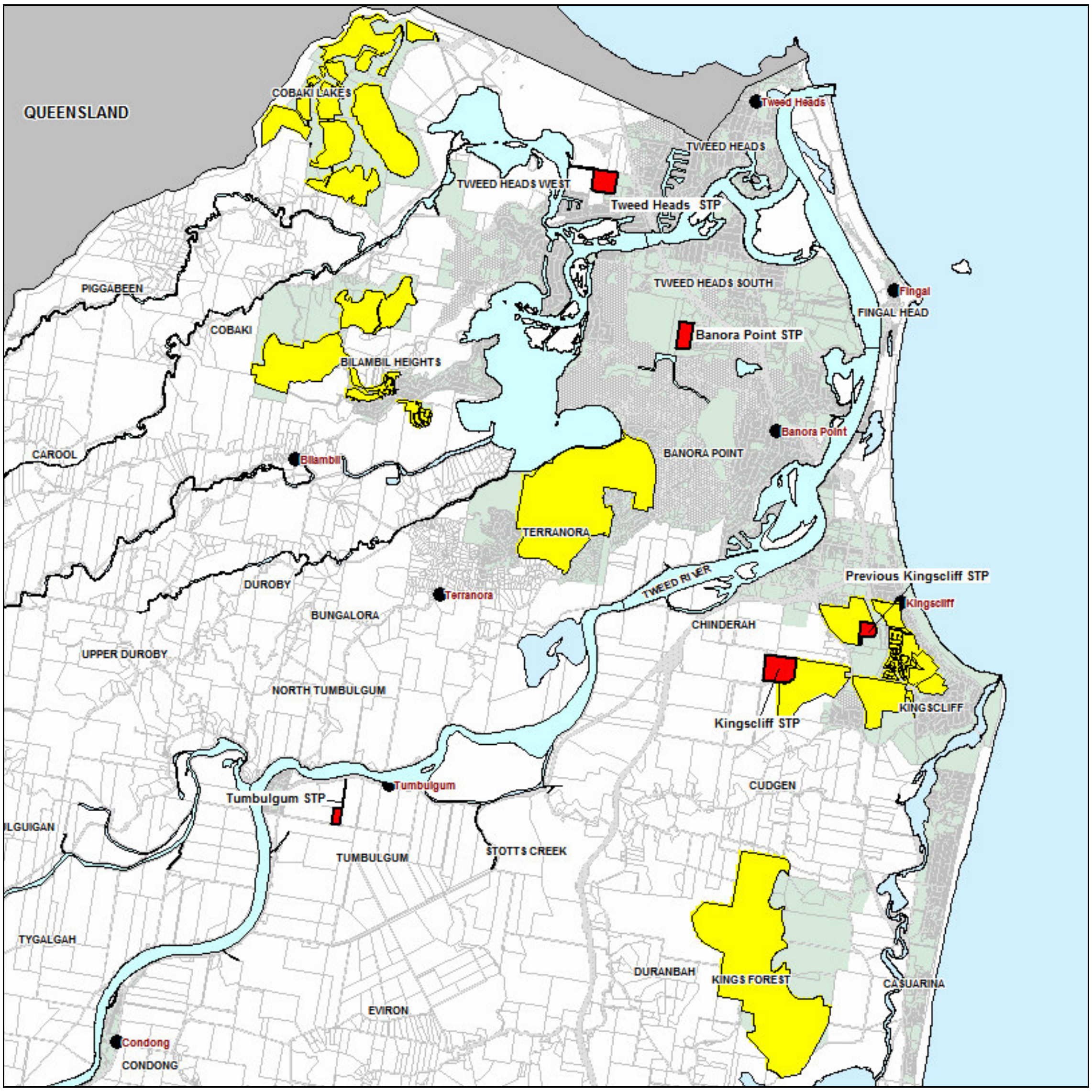
The study is focussed on the urban areas supplied by the Clarrie Hall Dam and Bray Park Water Treatment Plant water supply system. The small systems serving the villages of Uki and Tyalgum are not specifically addressed in the study, however it is anticipated that any demand management programs recommended for the shire would include customers in these areas.

**Figure 3-1 Tweed Shire Study Area**



Within the shire future development is concentrated in the areas of Cobaki Lakes, Kings Forest, West Kingscliff, Terranora and Bilambil Heights. These areas are to be developed as essentially mixed residential and non-residential developments between 2012 and 2036 and are shown in the following Figure 3-2.

**Figure 3-2 New Growth Areas**

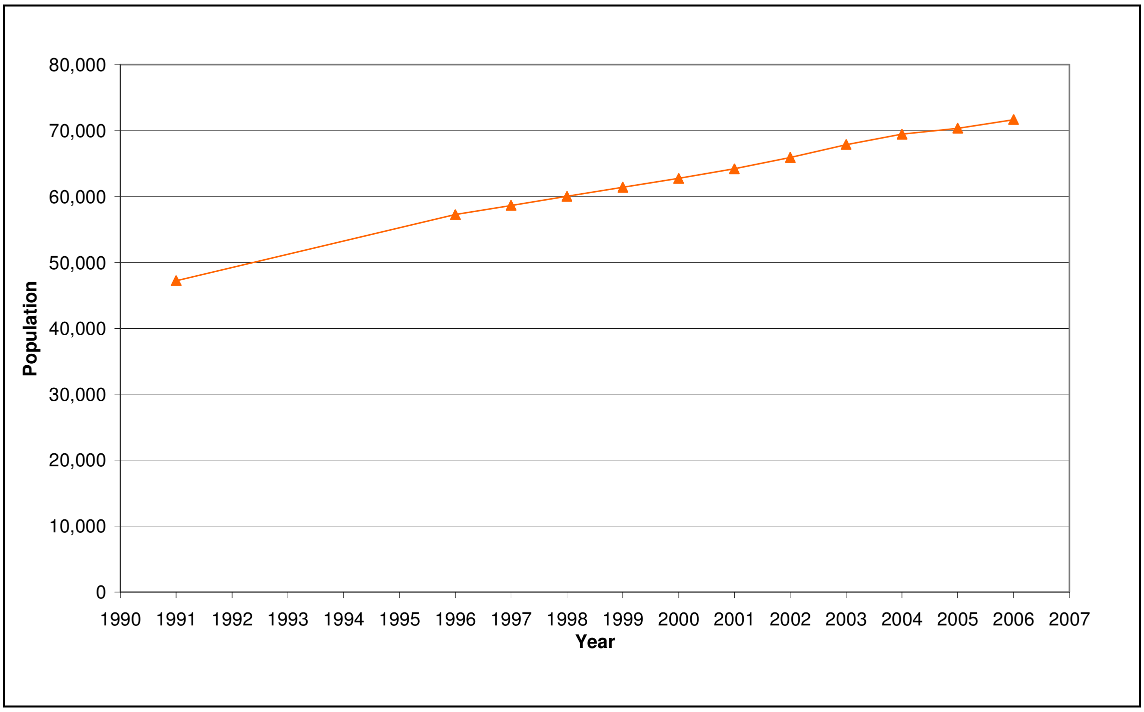



## 3.2 POPULATION ASSESSMENT

### 3.2.1 HISTORIC POPULATION GROWTH

The figure below highlights the historic population and annual growth rates of Tweed Shire. According to information provided by TSC the estimated serviced population in 2006 was 73,185 persons. Although the annual growth rates have reduced from above 3.5% to below 2% over the past 15 years, future annual growth is expected to be of the order of 2% to 4%.

**Figure 3-3 Historic Population and Growth Profile**



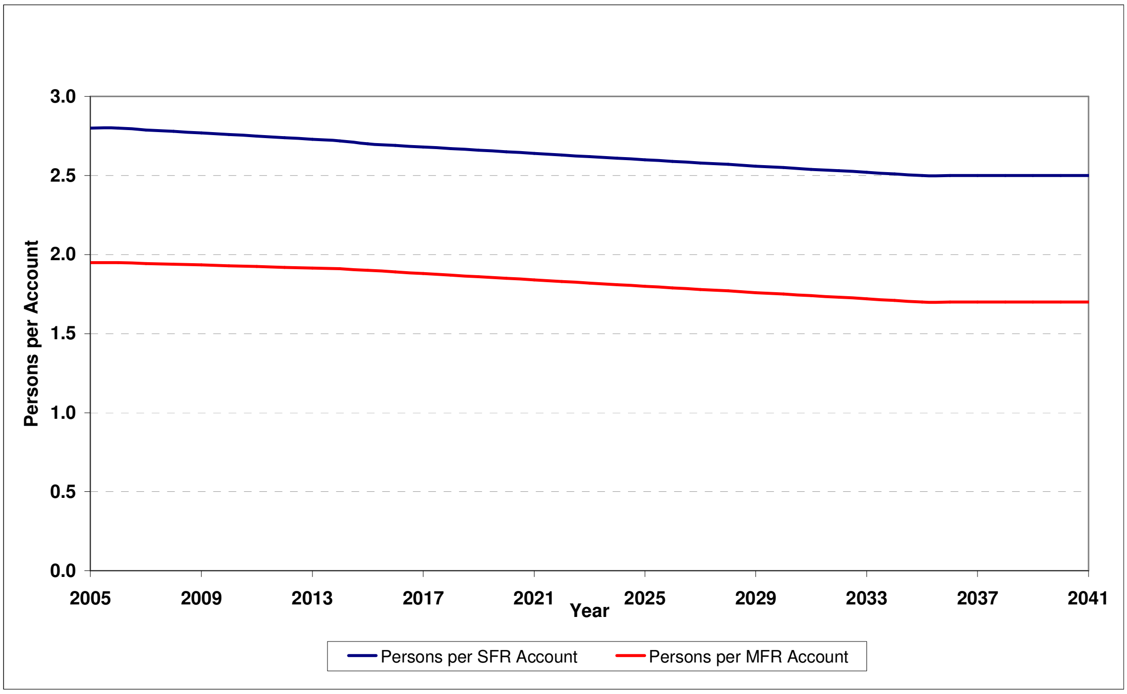

### 3.2.2 OCCUPANCY RATE

Initial occupancy rates (or persons per account) estimates were obtained from the Australian Bureau of Statistics (ABS) 2001 Census data. The 2001 occupancy rate for flats and units (referred to in this report as Multi-Family Residential or MFR) was found to be1.9 persons per dwelling. The actual rate for detached dwellings (referred to in this report as Single-Family Residential or SFR) was identified as 2.7 persons per dwelling.

During determination of the 2006 population calculations using the number of accounts and the assumed occupancy rates it was found necessary to adjust the persons per dwelling. The final applied occupancy rates for MFR and SFR for 2006 are 1.95 and 2.8 respectively.

In line with current trends in many parts of Australia, the occupancy rates for SFR and MFR dwellings are likely to reduce in future. Initially the adopted occupancy rates assumed a reduction in 0.1 persons per dwelling every 10 years for both MFR and SFR dwellings. The rate for MFR was subsequently reduced to 0.05 persons per dwelling for the period up to 2015. This was in order to account for the higher number of unit dwellings with lower occupancy, being built during this period. Figure 3-4 shows the adopted persons per account rates over time. The adopted average occupancy rates for 2036 were 2.5 for SFR and 1.7 for MFR.

**Figure 3-4 Adopted Occupancy Rates for MFR and SFR Dwellings**




### 3.2.3 MAJOR DEVELOPMENT AREA PROJECTIONS

Details of proposed development in the five identified Major Development Areas were provided by the individual developers and developer's engineers and planners. Table 3-1 summarises the number of dwellings in each of the major development areas for the residential sector.

Using the dwelling numbers supplied for each of the major development areas, populations were estimated using the occupancy rates adopted for the balance of the shire. At ultimate development the total residential population of these areas will be 34,003 persons.

**Table 3-1 Summary of Dwellings and Population in Major Development Areas**

| Development Area | Single Family Residential | Multi Family Residential | Estimated Population at 2041 |
|---|---|---|---|
| Bilambil Heights* | 1,704 | 1,542 | 6,881 |
| Cobaki Lakes** | 2,880 | 1,920 | 10,464 |
| Kings Forest** | 3,000 | 2,000 | 10,900 |
| Terranora*** | 1,108 | 177 | 3,071 |
| West Kingscliff**** | 216 | 1,263 | 2,687 |
| **Totals** | **8,908** | **6,902** | **34,003** |

Source: * Stuart Brogan, ML Design
**Franz Van den Brink, Leda Pty Ltd
***PB LAS Draft Report – December 2003, Appendix G
****Darren Gibson, Gales Holdings

### 3.2.4 SHIRE POPULATION PROJECTIONS

Population projections by locality at ten yearly intervals were provided by Tweed Shire Council for 2001, 2011, 2021, 2031 and 2041. From these projections a serviced population was derived. Projections were commenced in 2006, for which a review of occupancy and number of residential accounts was used to verify the data.

Projections for the major development areas utilised the ultimate populations as outlined in Section 3.2.3. It was assumed that the development would commence in 2012 and continue linearly to 2036. For new greenfield areas outside the major development areas, it was assumed that the proportion of SFR and MFR population would be 60% and 40% respectively. For new infill areas this population split was altered to 20% SFR and 80% MFR.

The serviced population projections for each locality were allocated to the following categories:

- Existing Serviced Areas – areas served with water supply
- Infill Development – development and redevelopment of existing lots in areas such as Tweed Heads
- Major Greenfield Development Areas – large consolidated development areas, namely Cobaki Lakes, Kings Forest, West Kingscliff, Terranora and Bilambil Heights
- Greenfield Outside Major Areas – minor greenfield development outside the main growth areas.

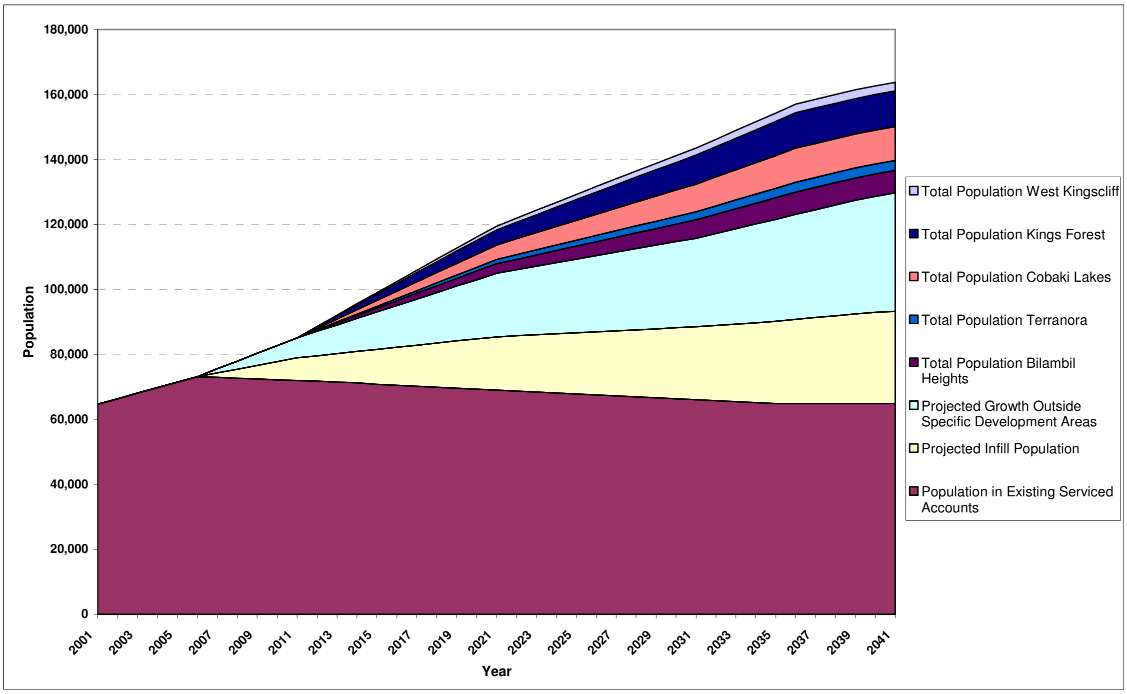
Guidance was obtained from TSC planners in order to determine the proportion of future population in each locality that should be allocated to greenfield or infill development. The results of this allocation are shown in Appendix A.

A summary of the estimated population growth for the shire to 2041 is provided in Table 3-2 and Figure 3-5. A comparison was undertaken to ensure that the adopted population was realistic and not excessively high.

**Table 3-2 Serviced (Water) Population Projection for Tweed Shire**

| Estimated Population | 2006 | 2011 | 2021 | 2031 | 2036 | 2041 (Ultimate) |
|---|---|---|---|---|---|---|
| Existing Serviced Population | 73,185 | 71,966 | 69,018 | 66,044 | 64,854 | 64,854 |
| Projected Infill Population | 0 | 6,951 | 16,402 | 22,435 | 25,896 | 28,461 |
| Major Development Areas | | | | | | |
| Bilambil Heights | 0 | 0 | 2,934 | 5,609 | 6,881 | 6,881 |
| Cobaki Lakes | 0 | 0 | 4,454 | 8,525 | 10,464 | 10,464 |
| Kings Forest | 0 | 0 | 4,640 | 8,880 | 10,900 | 10,900 |
| Terranora Area A | 0 | 0 | 1,300 | 2,498 | 3,071 | 3,071 |
| West Kingscliff | 0 | 0 | 1,158 | 2,197 | 2,687 | 2,687 |
| Total of Major Development Areas | 0 | 0 | 14,486 | 27,709 | 34,003 | 34,003 |
| Greenfield outside Major Areas | 0 | 6,182 | 19,540 | 27,301 | 32,295 | 36,395 |
| **Tweed Shire Total** | **73,185** | **85,099** | **119,446** | **143,488** | **157,048** | **163,714** |

**Figure 3-5 Tweed Shire Growth Summary**




## 3.2.5 NON-RESIDENTIAL DEVELOPMENT

At the time of investigation no information regarding future non-residential developments in the Shire was available. Therefore the following assumptions for Shire-wide growth were agreed with TSC:

- Commercial Sector – Growth proportional to residential population growth
- Industrial Sector – Assumed growth rate of 1% each year, which is similar to historic growth. Growth will in future be limited by the available land.
- Public Sector – Growth proportional to residential population growth.
- Rural Sector – No growth assumed.

These assumptions were applied to the overall forecasts outlined in Section 4 of this report.

### 3.2.5.1 NON-RESIDENTIAL DEVELOPMENTS IN GROWTH AREAS

Estimated areas of non-residential development within the major development areas were obtained from the developers and are summarised in Table 3-3. Non-residential development was distributed to four sectors - commercial, industrial, public and open space irrigation. Where no data was provided by the developer an estimate was made based on similar developments.

**Table 3-3 Adopted Non-Residential Development Area (ha)**

| Development Area | Commercial (ha) | Industrial (ha) | Public (ha) | Open Space Irrigation (ha) |
|---|---|---|---|---|
| Bilambil Heights | 4.5 | 0.0 | 8.6 | 25.0 |
| Cobaki Lakes | 3.0 | 0.0 | 6.3 | 15.8 |
| Kings Forest | 3.0 | 0.0 | 6.3 | 15.8 |
| Terranora | 1.0 | 0.0 | 16.2 | 16.0 |
| West Kingscliff | 8.1 | 9.0 | 4.3 | 9.7 |

Conversion factors as outlined in Table 3-4 were applied to determine the number of equivalent persons (EP) for each sector.

**Table 3-4 Applied Non-Residential EP Conversion Figures**

| Non-residential Sector | Adopted Density (EP/ha) |
|---|---|
| Commercial | 30 |
| Industrial | 15 |
| Public | 30 |
| Open Space Irrigation | 5 |

Table 3-5 outlines the final determined EP figures of the identified non-residential sectors for the new growth areas.

**Table 3-5 Estimated Number of Non-residential EP for Major Development Areas**

| Development Area | Commercial | Industrial | Public | Open Space | Total EP |
|---|---|---|---|---|---|
| Bilambil Heights | 135 | 0 | 129 | 128 | 392 |
| Cobaki Lakes | 90 | 0 | 94 | 174 | 358 |
| Kings Forest | 90 | 0 | 94 | 174 | 358 |
| Terranora | 30 | 0 | 243 | 82 | 355 |
| West Kingscliff | 242 | 135 | 65 | 49 | 490 |

## 3.3 WATER CYCLE ISSUES

### 3.3.1 STORMWATER AND WATER QUALITY

Key initial water quality related observations in relation to Tweed Shire are as follows:

- Stormwater monitoring has been carried out in high priority drains in Tweed Shire since 1997, and has highlighted high pollutant loads in stormwater which has a significant effect on receiving waters.
- There is currently limited treatment of urban stormwater runoff in Tweed Shire, resulting in a nutrient and sediment load being discharged to the Shire's catchments. The effect of this is most notable in the coastal estuaries particularly the Lower Tweed Estuary where stormwater flows account for 70-90% of the variation in quality.

- The Stormwater Management Plan (TSC, 2000) has identified the areas of Cudgen Creek, Cobaki Lakes and Cudgera Creek to be under increasing pressure from future development

In regard to existing water quality in the region, based on information presented in the Tweed Integrated Water Cycle Management Context Study and Strategy Report (TSC, 2006) the following comments can be made:

- Water quality in the Tweed Estuary is generally poor with high concentrations of nutrients, suspended sediments and faecal coliforms. Water quality objectives for concentrations of faecal coliforms, total nitrogen and total phosphorus are generally exceed in the lower, mid and upper Tweed Estuary.
- The poor water quality in the Tweed catchment is a general reflection of the anthropogenic activities in the catchment:
  - The Upper Tweed catchment is characterised by elevated levels of nutrients and suspended solids as a result of poor management of agricultural and modified rural runoff containing fertilisers and animal waste;
  - The Mid to Upper catchment and Rous River are impacted by wastewater discharges and agricultural runoff;
  - The Mid Estuary is impacted by wastewater discharges; and
  - The Lower to Mid Estuary is heavily impacted by urban runoff processes;
  - Water quality at the mouth of the Estuary is generally good as it is well flushed by tidal sea waters.
- Water quality processes are dominated by point source loading during the dry months (e.g. wastewater discharges) and diffuse loads from the whole catchment during wet periods (e.g. rural and urban runoff). This leads to a strong seasonal variation with a water quality dropping significantly during wet periods.
- Cudgen, Cudgera and Mooball Estuaries are effected by similar issues as described for the Tweed catchment in addition the following issues;
  - Cudgen Creek - Reported erosion and transport of topsoil from vegetable growing areas;
  - Cudgera Creek – A significant factor is the impact of wet season pollution events on the lower estuary;
  - Mooball Creek – Acid flows from acid sulphate soils disturbance and increasing recreational use.

### 3.3.2 SUMMARY OF ISSUES

Poor water quality in the Upper, Mid and Lower Tweed catchment is a general reflection of the anthropogenic activities in the catchment. In general these can be characterised by agricultural runoff in the Upper and Mid catchment, wastewater discharges in the Mid catchment and urban runoff in the Lower catchment.

Cudgen, Cudgera and Mooball Estuaries are effected by similar issues as described for the Tweed catchment with topsoil erosion and increasing recreational use being particular issues in these catchments.

## 3.4 WATER SUPPLY AND WASTEWATER SYSTEMS

The following sections outline the current water supply and sewage systems of the areas assessed in this study. The information has been adopted from the Tweed IWCM Context Study & Strategy Report (March 2006) and from correspondence with TSC.

### 3.4.1 WATER SUPPLY

The major water supply system of Tweed Shire is Pray Park, which is supplied from Clarrie Hall Dam via Bray Park Weir (Tweed River). It serves the areas of Murwillumbah, Tweed Heads, the two smaller villages of Mooball and Burringbar and the coastal areas from Kingscliff to Pottsville.

With 60km$^2$ Clarrie Hall Dam is the major water supply catchment for the area. It has an estimated storage capacity of 15,000 ML with a secure yield of 11,600 ML/annum. The storage of Bray Park Weir is limited to 840 ML.

Water is treated at Pray Park Water Treatment Plant (WTP) with a current maximum capacity of 55ML/d. Augmentation is underway to increase the capacity to 100 ML/d, to cater for population growth and to increase the reliability of the treatment process.

Potable water from the treatment plant is stored at two reservoirs located at Hospital Hill in Murwillumbah before distributed via three main DN600 trunk mains to the northern, central and southern parts of the area. The central and northern trunk mains follow the Tweed River and supply the areas of Tweed Heads, Kingscliff and Bilambil. The southern trunk main delivers water to Duranbah Reservoir from where it is distributes to the southern areas, between Kings Beach and Pottsville and to the inland areas of Mooball and Burringbar.

An overview of the water supply system proposed to serve the new development areas are provided in section 5.4.1

In addition to Bray Park two smaller independent treatment systems supply the areas of Uki and Tyalgum. The Uki water supply system caters for approximately 350 EP with a total annual production of 55 Ml/annum. Raw water for Uki WTP is pumped from Tweed River. For Tyalgum raw water is extracted from Tyalgum Creek. Tyalgum WTP produces approximately 32 ML/annum supplying around 250 EP. Both water supply systems are independent from Bray Park. Their assessment has been excluded from this demand study.

### 3.4.2 WASTEWATER

In total 98% of urban population or 80% of the shire population is connected to a centralised sewage system, with the exception of several smaller villages (including Burringbar and Mooball), which are currently not serviced. The total capacity of the Tweed Shire sewage system is 29 ML/day and corresponds to 122,300 EP at 240 L/EP/day. The combined dry weather flow (at 2006) has been estimated at 21.6 Ml/day. Further, there are approximately 4000 local and rural onsite wastewater treatment systems.

The area is serviced by five major wastewater treatment plants:

- Banora Point STP – This plant is the largest sewage treatment plant in the region currently catering for estimated sewer flows of 62,500 EP from Tweed Heads and surrounding suburbs. Future augmentations are proposed to treat additional flows from Tweeds Heads STP (to be decommissioned in late 2007) and from the new growth areas of Bilambil Heights, Cobaki Lakes and Terranora. Depending on future water demand measures the final serviced population is estimated at 80,000 to 125,000 EP. The plant discharges to the Terranora Inlet.

- Tweed Heads STP – The plant is currently serving 12,000 EP in the area of Tweed Heads and is proposed to be decommissioned in late 2007. All sewage flows of this area will then be forwarded to Banora Point STP for treatment.

- Kingscliff STP – The plant is proposed to be replaced in the near future to cater for increased EP figures while maintaining better effluent qualities according to EPA criteria. Kingscliff STP currently serves approximate 14,000 EP. Additional flow contributions are expected by new developments in the West Kingscliff area and Kings Forest. Stage 1 of the new treatment plant is expected to be completed in December 2007. The final capacity will be increased to serve a population of up to 25,000 EP.

- Hastings Point STP – The treatment plant is currently being augmented with opportunities for effluent re-use identified for a nearby turf farm and irrigation of local sporting fields. The STP serves an equivalent population of 16,000 EP.

- Murwillumbah STP – The recently in 2001 upgraded sewage treatment plant is servicing the township of Murwillumbah with an estimated population of 16,000 EP. The majority of the produced effluent is recycled through use in the Condong sugar mill with any excess effluent being discharged into the Rous River. The reuse scheme has a 20 year life with a further 20 year option. Further reuse opportunities such as the golf course, racecourse and open space irrigation for new developments are being investigated.

Besides the five major sewage treatment plants, the villages of Uki, Tumbulgum and Tyalgum are serviced by their own individual treatment systems. Their capacities are estimated at 600 EP, 700 EP and 500 EP, respectively. For all three plants effluent re-use opportunities such as irrigation have been identified.

# 4. WATER DEMAND ANALYSIS AND BASELINE FORECAST

## 4.1 OVERVIEW

To assess water savings for various demand management initiatives and scenarios, it is necessary to understand current water demand as well as the drivers of demand in the shire. This section outlines the methodology and results of the analysis of historic demand and applies the outcomes to the development of a baseline demand forecast. This forecast identifies the water supply that would be required under a 'do nothing' scenario.

## 4.2 HISTORIC DEMAND ASSESSMENT

The aim of the water demand analysis is to utilise data held by Tweed Shire Council to assess:

- the factors influencing water demand, and
- to provide a detailed understanding on the factors that have influenced water demand in the past and the implications for forecasts of future demands.

The historic demand analysis includes the following assessments:

- Climate correction of historical water production records.
- Estimation of the amount of water used in each customer sector
- Estimation of the current level of non-revenue water.

It is noted that the climate correction of historic data does not provide a climate change impacts assessment. However the climate responses can be used to assess the impacts of climate change. This was not part of the terms of reference for this project.

### 4.2.1 TOTAL WATER PRODUCTION TRENDS

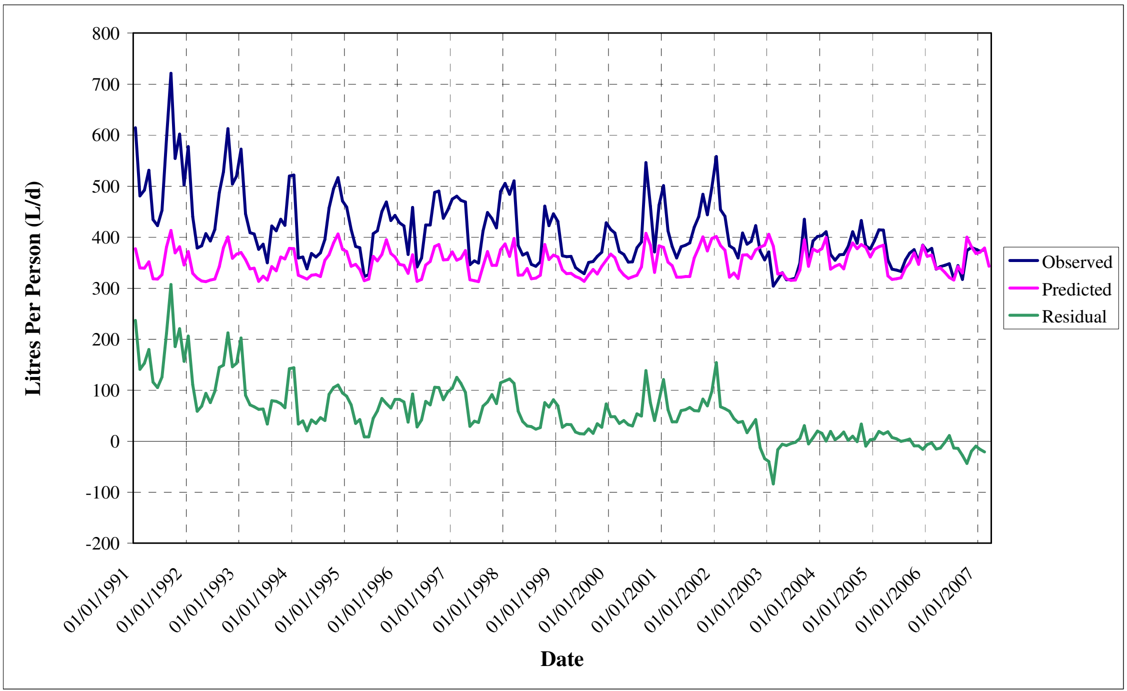
The analysis of historic water production utilised a climate correction water production trend tracking model to analyse historic trends in order to understand the underlying drivers and timing of trend changes.

The key outputs from this process are an indication of the recent trends in gross water production per capita, highlighting the impact of operational changes such as pricing and water restrictions. The water production data, when compared with water consumption, provides input to recent trends in Non Revenue Water (NRW).

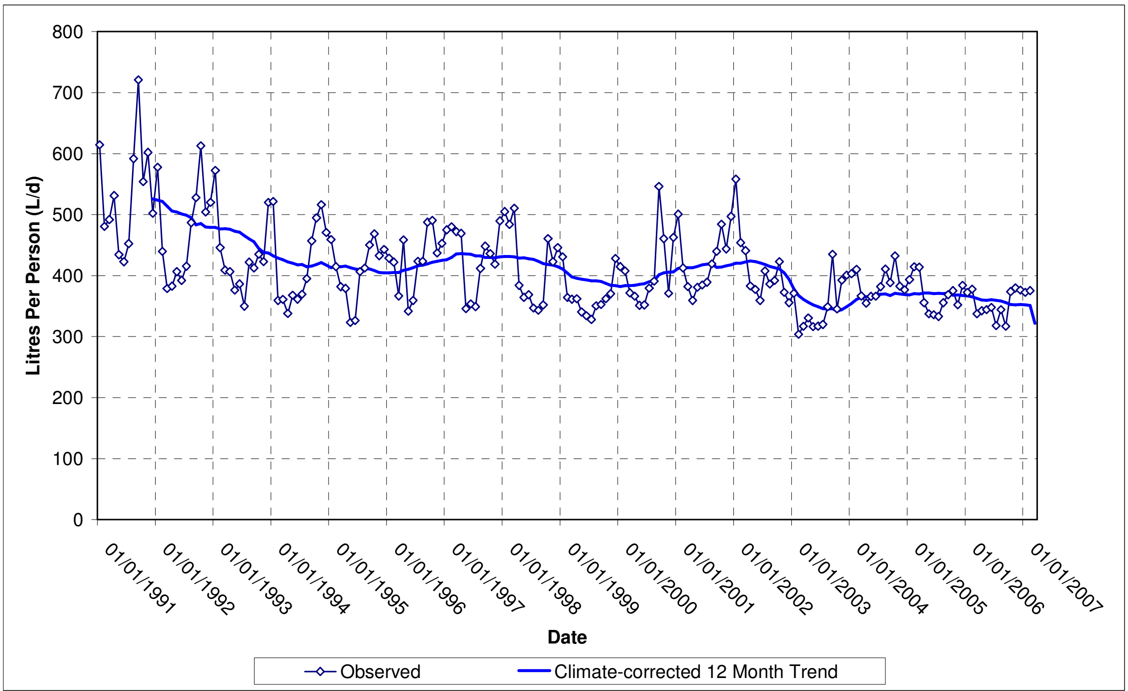
Figure 4-1 shows the calibration of the water production model for Tweed Shire. The model was calibrated for a period from mid 2004 and mid 2006. Based on the residual demand (difference between the modelled and observed demand) the per capita demand has shifted significantly since the early 1990's. This shift cannot be explained by climate alone.

The climate corrected demand is shown in Figure 4-2. The underlying trend indicates that water production per capita has a twelve month climate corrected rolling average of 370 L/capita/day. The trend has fluctuated and declined over the 1990s and again since the drought in 2002/3, but appears to have stabilised at current levels. As a result of this trend tracking, it appears that the most recent demand data available is an appropriate starting point for forecasting.

### Figure 4-1 Water Production Model for Tweed Shire




### Figure 4-2 Climate Corrected Historic Demand



### 4.2.2 SECTORAL WATER CONSUMPTION TRENDS

In order to analyse the customer water consumption (i.e. water drawn from the network by customers through customer meters) in the various customer sectors, information from the Tweed Shire water billing system was extracted and analysed. Annual billing data including the total consumption and number of accounts in each customer sector was used. This data was rolled up into groups of land use codes (LUC). A summary of the number of accounts, total consumption and average consumption per account for the period 2001/2 to 2005/6 is provided in Table 4-1, Table 4-2 and Table 4-3 respectively.

It is noted that some of the billing data could not be allocated to a particular land use and therefore was not included in this assessment. This data was however included in the assessment of NRW.

**Table 4-1 Number of Accounts Served per Sector**

| Sector | Abbreviation | Number of Accounts | | | | |
|---|---|---|---|---|---|---|
| | | 2001/2 | 2002/3 | 2003/4 | 2004/5 | 2005/6 |
| Single Family Residential | SFR | 16,381 | 16,319 | 16,708 | 17,328 | 15,977 |
| Multi-Family Residential | MFR | 1,819 | 2,196 | 2,229 | 1,888 | 2,104 |
| Bulk Sales | BS | 1,652 | 827 | 774 | 195 | 1,896 |
| Commercial | COM | 798 | 939 | 914 | 922 | 887 |
| Industrial | IND | 0 | 32 | 24 | 50 | 128 |
| Public Uses | PUB | 465 | 305 | 312 | 212 | 280 |
| Rural | RUR | 230 | 232 | 238 | 232 | 212 |

**Table 4-2 Annual Consumption (ML/annum) per Sector**

| Sector | Abbreviation | Total Consumption (ML/a) | | | | |
|---|---|---|---|---|---|---|
| | | 2001/2 | 2002/3 | 2003/4 | 2004/5 | 2005/6 |
| Single Family Residential | SFR | 4,626 | 3,767 | 3,942 | 4,304 | 3,938 |
| Multi-Family Residential | MFR | 1,495 | 1,411 | 1,508 | 1,545 | 1,476 |
| Bulk Sales | BS | 87 | 96 | 71 | 75 | 46 |
| Commercial | COM | 1,692 | 1,724 | 1,576 | 1,548 | 1,157 |
| Industrial | IND | 0 | 40 | 104 | 67 | 27 |
| Public Uses | PUB | 625 | 394 | 459 | 421 | 334 |
| Rural | RUR | 175 | 145 | 168 | 170 | 191 |

**Table 4-3 Average Account Consumption (L/day) by Sector**

| Sector | Abbreviation | Average Consumption per Account (L/day) | | | | |
|---|---|---|---|---|---|---|
| | | 2001/2 | 2002/3 | 2003/4 | 2004/5 | 2005/6 |
| Single Family Residential | SFR | 774 | 632 | 646 | 717 | 767 |
| Multi-Family Residential | MFR | 2,251 | 1,760 | 1,853 | 2,362 | 2,182 |
| Bulk Sales | BS | 144 | 317 | 252 | 1,104 | 76 |
| Commercial | COM | 5,808 | 5,031 | 4,724 | 4,848 | 4,060 |
| Industrial | IND | 0 | 3,450 | 11,917 | 3,864 | 658 |
| Public Uses | PUB | 3,681 | 3,536 | 4,027 | 5,729 | 3,708 |
| Rural | RUR | 2,090 | 1,713 | 1,932 | 2,122 | 2,798 |

Further assessment was undertaken for the residential sectors to assess the current average per person usage to be used as a basis for baseline forecasting. The average daily residential consumption per person was determined based on the billing information stated above and the estimated persons per account (2.8 for SFR and 1.9 for MFR respectively). The results are shown in Table 4-4 and Figure 4-3.

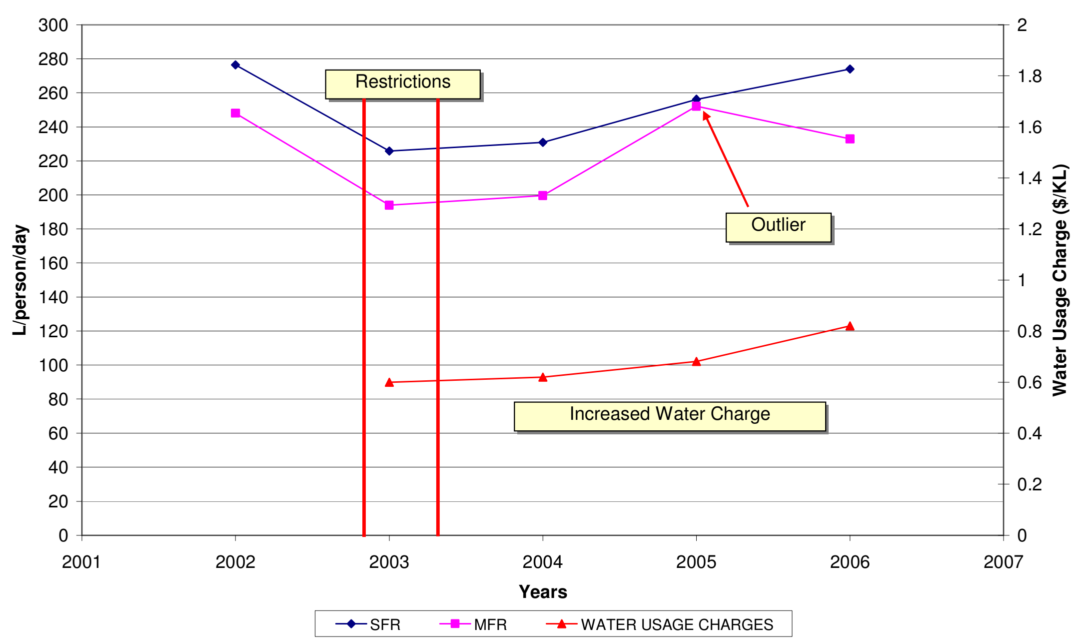
Within the assessment of the historic consumption further information including introduction of new water charges and drought restrictions were considered. The impact of these measures on residential consumption is also shown in Figure 4-3. Details about historical drought restrictions and increased water user charges can be found in Appendix B.

During the assessment it was found that the MFR consumption for 2005 was unusual high compared to previous usage. It was concluded that this figure was not representative and the data was excluded from the assessment.

**Table 4-4 Average Daily Residential Consumption per Person (L/day)**

| Sector | Abbreviation | Daily Consumption (L/person/day) | | | | |
|---|---|---|---|---|---|---|
| | | 2001/2 | 2002/3 | 2003/4 | 2004/5 | 2005/6 |
| Single Family Residential | SFR | 276 | 226 | 231 | 256 | 274 |
| Multi-Family Residential | MFR | 248 | 194 | 200 | 252 | 233 |

**Figure 4-3 Historic Average Daily Water Consumption per Person**



When reviewing the climate corrected production data, a downwards trend is evident since 2004. However the residential demand was slightly higher in 2006. This would normally have been explained through the climate correction of the billing record, that is the higher demand is related to climate and therefore the underlying trend is lower than the actual demand. For forecasting the baseline demand it was therefore it was decide to adopt a sectoral account demand of the average demand for the past three years.

The adopted per account consumptions are shown in Table 4-5.

**Table 4-5 Adopted Average Daily Consumption per Account (L/day)**

| Sector | Abbreviation | Adopted Account Usage (L/day) |
|---|---|---|
| Single Family Residential | SFR | 710 |
| Multi-Family Residential | MFR | 411 |
| Bulk Sales | BS | 197 |
| Commercial | COM | 4,060 |
| Industrial | IND | 3,657 |
| Public Uses | PUB | 4,136 |
| Rural | RUR | 2,131 |

### 4.2.3 WATER CONSUMPTION COMPARISON TO STATEWIDE PERFORMANCE

Information regarding statewide utility performance indicators was obtained from the Tables 3 and 4 of the DWE Water Supply and Sewerage Benchmark Report 2004/05. Table 4-6 outlines the average annual residential consumption for NSW and six coastal water service providers similar to Tweed Shire. For comparison, the sectoral consumption analysis results outlined in this report has been converted into annual residential consumption taking account of both single family residential and multi-family residential dwellings.

**Table 4-6 Comparison of TSC Average Residential Demand to other NSW Centres**

| Area | Residential Consumption (kL/property/annum) | | | |
|---|---|---|---|---|
| | 2001/2 | 2002/3 | 2003/4 | 2004/5 |
| **NSW (Average)** | **240** | **220** | **215** | **200** |
| Byron Shire Council | - | - | - | 214 |
| Ballina City Council | - | - | - | 220 |
| Lismore City Council | - | - | - | 179 |
| Coffs Harbour City Council | - | - | - | 186 |
| Port Macquarie-Hastings | - | - | - | 186 |
| Mid Coast Water | - | - | - | 204 |
| **Tweed Shire Council (based on analysis in this report)** | **244** | **193** | **197** | **231** |

According to the statewide figures there is a current downward trend in residential consumption. This is likely to be related to drought restrictions imposed during 2004/5, particularly in Sydney. In comparison the residential consumption for Tweed Shire has rebounded to 231 in 2004/5 following a lower consumption due to drought conditions of previous years. The 2004/5 is lower than pre-drought consumption in 2001/2. This leads to the conclusion that increased residential water awareness and elevated water charges have an effect on water usage.

### 4.2.4 NON-REVENUE WATER (NRW)

#### 4.2.4.1 HISTORIC LEVEL OF NRW

The volume of Non-Revenue Water (NRW) was determined as the difference between total water production (treated water from the Bray Park Water Treatment Plant) and total water consumption (as measured at customer meters). For initial assessment purposes NRW is expressed as a percentage of the total production volume.

Table 4-7 outlines the derivation of the percentage of NRW. Fluctuations of NRW percentages can be related to major construction work and water infrastructure commissioning using un-metered water. For the purposes of this report a baseline NRW level of 13% of the total production was adopted for future demand modelling and assessment.

**Table 4-7 Summary of NRW Assessment**

| Demand Component | 2001/2 | 2002/3 | 2003/4 | 2004/5 | 2005/6 |
|---|---|---|---|---|---|
| Annual Production (ML/a) | 10,449 | 8,773 | 9,461 | 9,917 | 9,428 |
| Annual Consumption (ML/a) | 8,699 | 7,576 | 7,785 | 8,567 | 8,142 |
| Non-Revenue Water | 16.7% | 13.6% | 17.7% | 13.6% | 13.6% |

#### 4.2.4.2 KEY PERFORMANCE INDICATORS

A report was undertaken by Tweed Shire to assess the level of NRW and determine the Annual Key Performance Indicators (KPI) for the water supply network. The report indicates that the current performance of the system can be summarised in the following KPIs of 2005/2006:

- Percentage of NRW: 13.3% (level of service is 15%)
- Annual NRW per person: 17 kL/annum
- Estimated leakage: 600 ML/annum
- Estimated percentage of leakage: 6.4%
- Number of pipeline breaks failures: 29 / annum
- Number of pipeline breaks and failures per 100 km of mains: 4.4 / annum (level of service is 10).

The indicators show that the current water supply system satisfies the relevant targets of the 2006 Levels of Service.

#### 4.2.4.3 INFRASTRUCTURE LEAKAGE INDEX (ILI)

The Infrastructure Leakage Index or ILI, developed by the World Bank Institute (WBI), can be used to provide a guide to the performance of water supply system losses. ILI is the ratio of the Current Annual Real Losses (CARL) and Unavoidable Annual Real Losses (URAL). Based on the ILI evaluation, the following network parameters and assumptions were adopted to calculate the ILI for the Bray Park water supply system for 2005/2006:

- Total pipeline length: 654 km
- Average operating pressure: 60 m
- Number of service connections: 29,459
- CARL = (18 x total pipeline length + 0.8 x no. of service connections) x average operating pressure = 2.12 ML/day
- URAL: 4.78 ML/day

Therefore, the ILI for Bray Park water supply system is about 2.3 and falls into Band B of the WBI grading system. Based on the WBI target matrix, the following actions are recommended:

- Investigate pressure management options, speed and quality of repairs
- Introduce / improve active leakage control
- Check the economic intervention frequency
- Identify options for improved maintenance
- Assess economic leakage level
- Review break frequencies and asset management policy.

## 4.3 BASELINE DEMAND FORECAST

### 4.3.1 OVERVIEW

As discussed in the previous sections, the first phase of the demand analysis was a historical examination of past and present trends in water usage. The outcome of this assessment is a starting point for reviewing the trends in water usage. Based on this analysis, the per account and per capita demands are adopted for use in future water needs forecasting.

For the Tweed Shire Demand Management strategy, the MWH “Decision Support System” (DSS) has been used to develop the detailed demand forecast. The DSS is an end use model, designed for assessing baseline water demand forecasts as well as evaluating various demand management, water use efficiency or source substitution (e.g. rain water tanks or recycled water) measures.

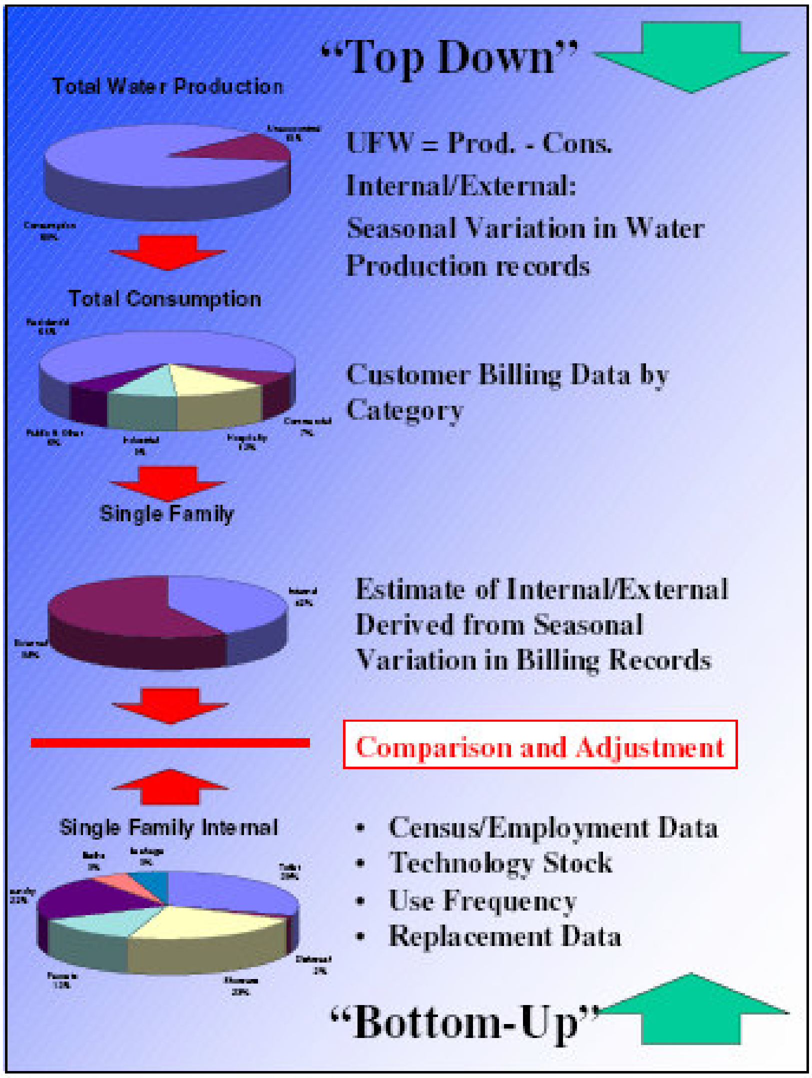
### 4.3.2 CALCULATION METHODOLOGY

The DSS end use model utilises 'top down' and 'bottom up' approaches to define a current demand breakdown as shown in Figure 4-4. In the 'top down' the internal water use is derived from both the water production model and sectoral consumption trend models. The default internal / external split for the Bottom Up used is based on examination of the production record for minimum demand periods as well as available end use studies completed in Australia (for example, the Perth "Domestic Water Use Study" and the more recent Yarra Valley End Use Study). Sewer gauging studies are also used to provide data on residential internal use.

The calibration process undertaken to ensure accuracy of the initial demand end use breakdown (existing development) is as follows:

- Entry of typical end use breakdown of internal and external uses in existing residential accounts
- Entry of the starting point per account daily demands
- Entry of population forecasts across the different sectors and people per account forecasts
- Review and adjustment of the external and internal split given the residential consumption and the number of people per account
- Definition of the non revenue water percentage
- Determination of a 'bottom up' total water production value by summing the consumption and the NRW
- Comparison of the 'bottom up' water production figure with the 'top down' observed and climate corrected water production obtained from the historic trend tracking. Adjustment of parameters is then undertaken where necessary.

**Figure 4-4 Calibration Process for the Decision Support System**




New dwellings incorporated into the forecast are assumed to have reduced internal water consumption, as a result of the use of more efficient water use fixtures. In particular it is assumed that all new dwellings will have dual flush toilets. The reduction in internal usage is generally is approximately 22 litres per person per day.

### 4.3.3 ADOPTED END USE BREAKDOWN

End use forecasting is an emerging field which relies on many small assumptions to build up a big picture. As such, a review of recent end use studies was conducted in order to determine a set of 'best available' end use assumptions for the project.

The applicability of the data gained in any end use study must be considered by examining the following factors:

- Location of study region
- Length of study period

- Demographic and socio-economic nature of study region
- Climate of study region
- Technique used for data collection (e.g. Phone survey, data logging )
- Sample size
- Confidence intervals (if available).

The end-use studies which have been considered as part of this study are:

- Perth *Domestic Water Use Study*, Western Australia, 1998-2001, Water Corporation Western Australia
- 2003/2004 Yarra Valley Water End Use Studies
  - 2003 Appliance Stock and Usage Patterns Survey
  - 2004 Residential End Use Measurement Study.
- American Water Works Association (AWWA), "Residential End Uses of Water Study" (USA)

The most recent end use study is from Yarra Valley Water (YVW). This study is also noteworthy due to its sound methodological approach. One limitation with the study was a relatively small sample size (100 houses in measurement stage of study, compared to 244 single and multi residential households measured in Perth). The other limiting factor was that the measurement stage focused entirely on single family dwellings and hence covered a relatively higher than average household size. Results from this study have been the major influence on values chosen in this study, but data has been modified where necessary.

The YVW study identified and quantified the link between household size and per capita water use. The results clearly showed decreasing per capita use with increasing household size. The results of the study resulted in an average per capita internal use of 169 L/person/day, based on an average household size of 3.1 persons. When this is factored to reflect an average household size across the YVW customer base it equates to 178 L/person/day. This correlates well with sewer flow gauging studies undertaken in Australia.

For both the Perth and YVW studies, the study period coincided with a period of drought and low level water restrictions. Although indoor use is less influenced by climate and water restrictions than outdoor, surveys have shown that people may also modify their indoor use during periods of restrictions, although this usually occurs for the later stages of restrictions rather than for the more outdoor and voluntary levels. However, the results of both studies may represent a lower than average indoor use total.

A second factor which will play a part in any study of end use is the problem of participants being a 'self selecting sample'. This means that the way participant's use water is not representative of how people use water on average, because they are already more water conscious than average and hence use less water than average. This was evident in the evaluation of the 'Every Drop Counts Residential Retrofit Program" (Beatty, K. et al 2005). The participant group in this program used consistently less water than the control group before the retrofits occurred in all four billing quarters. This difference was in the order of 5%.

Given the two factors above, the overall average per person indoor consumption figure used in the study has been set higher than the figure derived from YVW (unless specific consumption data suggests otherwise). A number of factors used to build up the total indoor use per person vary significantly from those estimated in YVW. These main differences are:

- *Shower frequency.* The measurement stage of YVW recorded an average frequency of use of 0.85 showers per person per day (in a sample size of 100). The survey stage recorded 1.0 showers per person per day (in a sample size of 840). A figure of 1.0 has been used in the is study as the lower figure from the YVW study is likely to be significantly influenced by the disproportionate number of children under twelve in the houses in the YVW measurement stage.
- *Toilet usage.* The measurement stage of YVW recorded and average of 4.2 flushes per person per day. It is likely that this was influenced by the higher household size of this group (more likelihood of young children and parents being present in the house during full day). The YVW report suggests that a figure of 3.8 flushes per person per day would be reasonable when extrapolating to their entire customer base. Given that Tweed Shire household size lies somewhere between these two figures, a figure of 4.0 flushes per person per day was adopted.
- *Existing proportion of water efficient appliances.* ABS survey information for NSW has been considered to establish the current baseline residential fixture profile for Tweed Shire. Appliance ownership figures for dishwashers, washing machines and toilets show that there is a natural tendency for more water efficient fixtures and appliances to increase in popularity (George Wilkenfeld and Associates, 2003). This trend towards increasing appliance efficiency is anticipated to continue into the future and will result in changes in household water use per account.

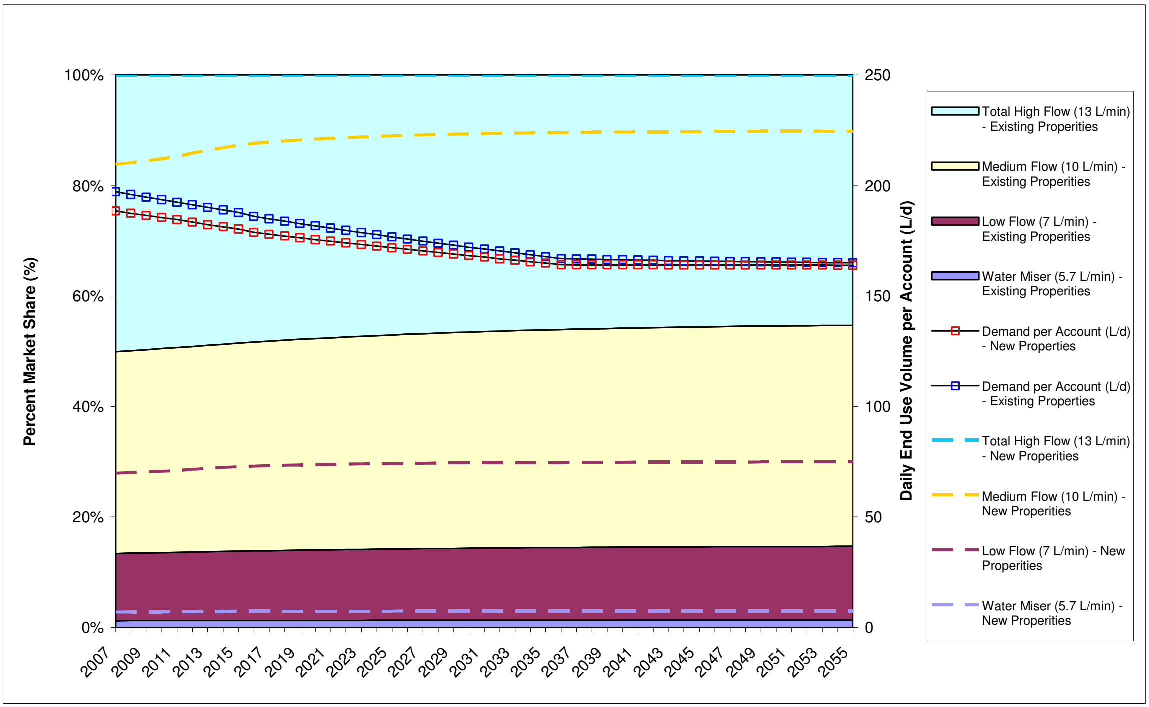
Estimated baseline figures for each fixture type are shown in Table 4-8. It is noted that figures for new residential reflect the current market share of fixtures without the additional impact by WELS and legislative requirements under the BASIX program. WELS and BASIX will further increase the uptake of water efficient fixtures and appliances, particularly showerheads and washing machines. Additional savings by these initiatives are discussed in Section 5.

### Table 4-8 Baseline Fixture Market Share 2006/7

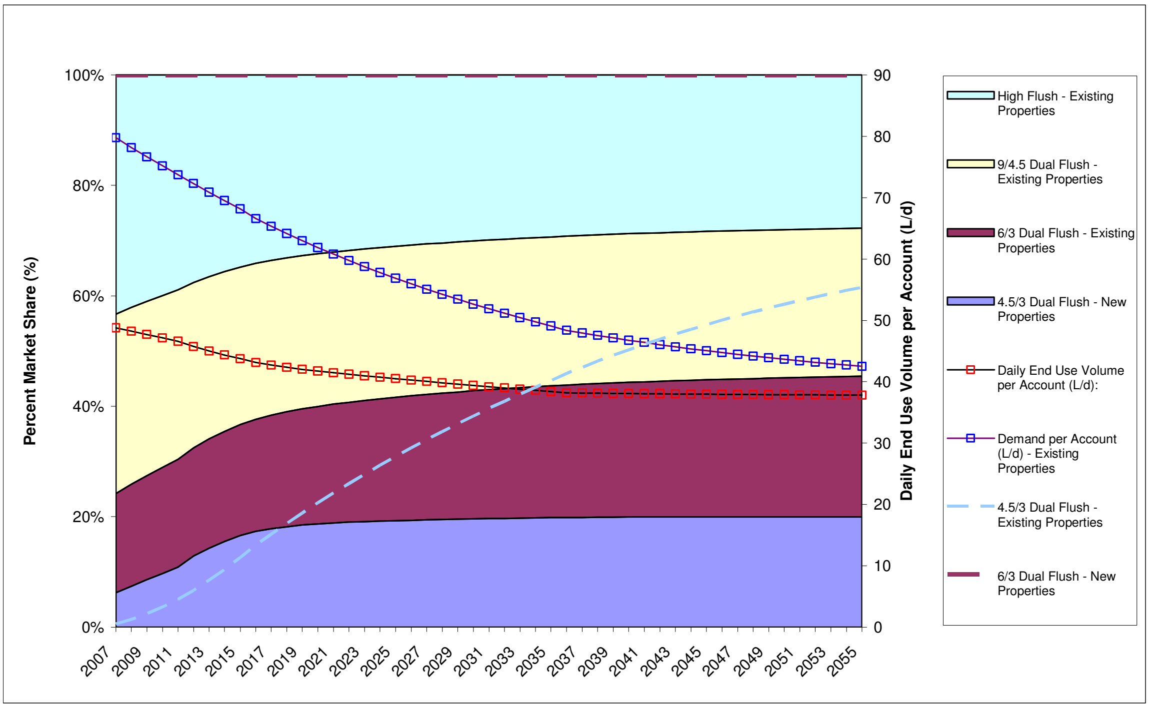
| Fixture | | Flow Rate (L/min) | Time of Usage (min) | Frequency of Use (Uses/person/day) | Total Volume (L/person/day) |
|---|---|---|---|---|---|
| Shower | Existing | 10.1 | 7.0 | 1 | 71 |
| | New | 9.4 | 7.0 | 1 | 66 |
| Toilet | Existing | 7.2 | - | 4 | 29 |
| | New | 3.8 | - | 4 | 15 |
| Washing Machine | Existing | 144.7 | - | 0.33 | 48 |
| | New | 114 | - | 0.33 | 38 |
| Tap | Existing | - | - | - | 27 |
| | New | - | - | - | 27 |
| Dishwasher | Existing | - | - | - | 2.7 |
| | New | - | - | - | 2.7 |

Figure 4-5, Figure 4-6 and Figure 4-7 show the adopted ownership projections for single family residential dwellings for showerheads, toilets and washing machines respectively. The relationships outlined in these figures are termed Fixture Models and are used to predict future water use as the more efficient fixtures replace existing stock.

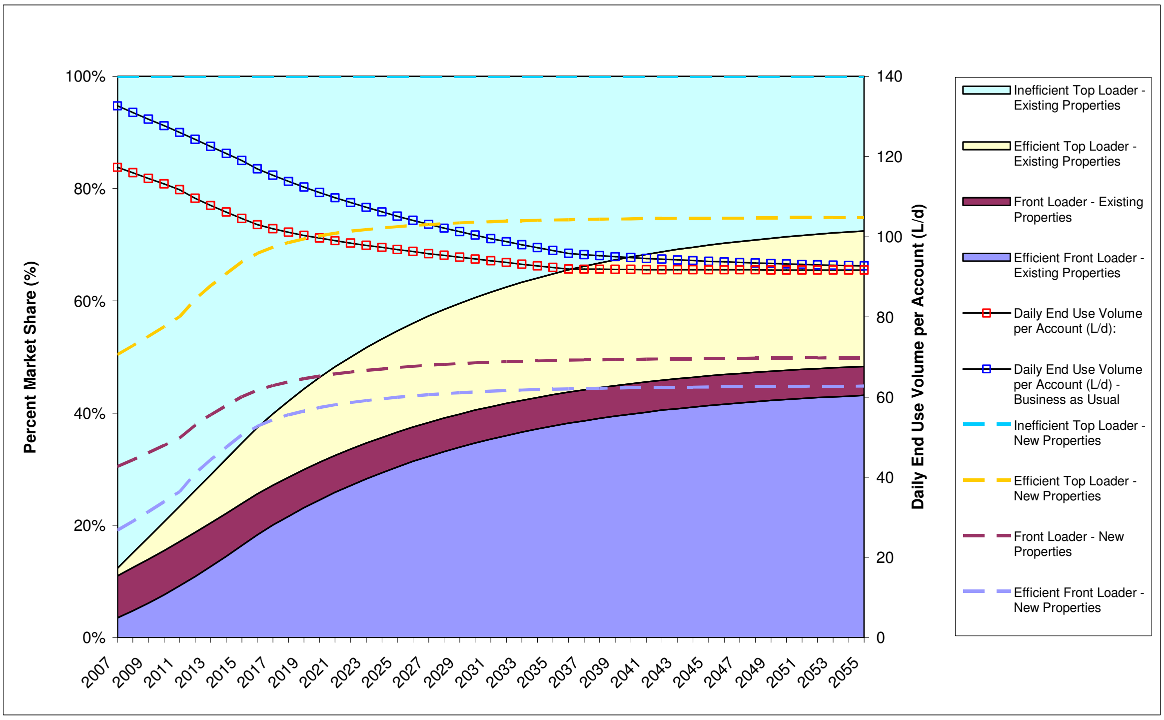
### Figure 4-5 Projected Installed Shower Stock – Baseline Case (existing and new SFR)



## Figure 4-6 Projected Installed Toilet Stock – Baseline Case (existing and new SFR)




## Figure 4-7 Projected Installed Washing Machine Stock – Baseline Case (existing / new SFR)



The adopted end use breakdown for the various sectors is shown in Table 4-9. Figure 4-8 and Figure 4-9 summarise the end use breakdown for an existing single family residential household based on 2.8 persons per account.

**Table 4-9 Sectoral End Use Breakdown for 2007**

| Customer Sector | Internal Breakdown (Total 100%) | | | | | | | Total Usage | |
|---|---|---|---|---|---|---|---|---|---|
| | Toilet | Shower | Laundry | Bath | D/washer | Taps | Leakage | Internal | External |
| Existing SFR / MFR | 15% | 36% | 24% | 1% | 1% | 14% | 2% | 77% | 23% |
| New SFR / MFR | 10% | 38% | 24% | 2% | 2% | 15% | 9% | 75% | 25% |
| Commercial | Each non-residential sector has specific end uses, e.g. Industrial Process, Tourist Kitchen Spray, and Public Toilets | | | | | | | 80% | 20% |
| Industrial | | | | | | | | 80% | 20% |
| Public | | | | | | | | 80% | 20% |
| Bulk Sales | | | | | | | | 20% | 80% |

**Figure 4-8 Existing Single Family Internal / External Use**

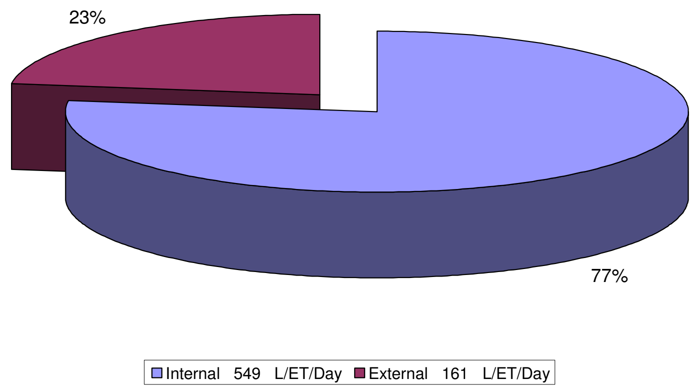
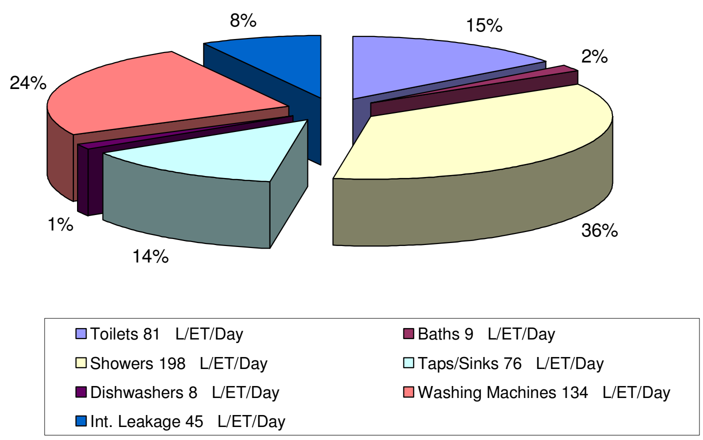



**Figure 4-9 Existing Single Family Internal End Use**



#### 4.3.4 CURRENT WATER DEMAND SUMMARY

Figure 4-10 shows both the volume of water metered and the Non Revenue Water. As discussed in 4.2.4 the non-revenue percentage of the total water production has been assumed to continue its current trend of 13% if additional measures are not put in place.

**Figure 4-10 Current Total Water Use**

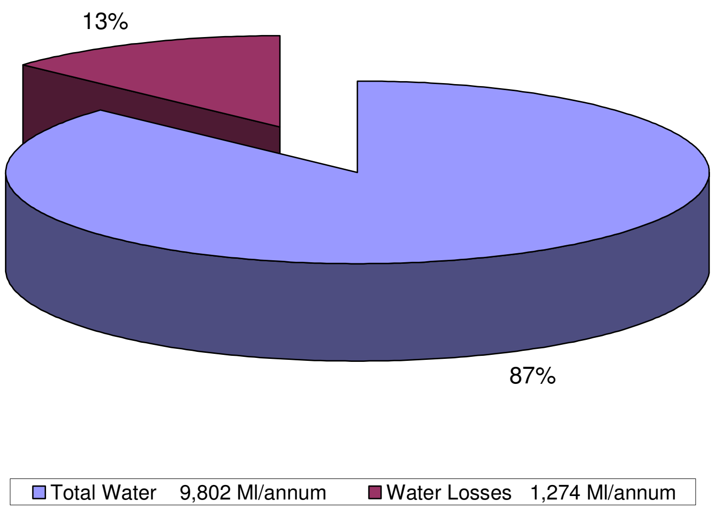
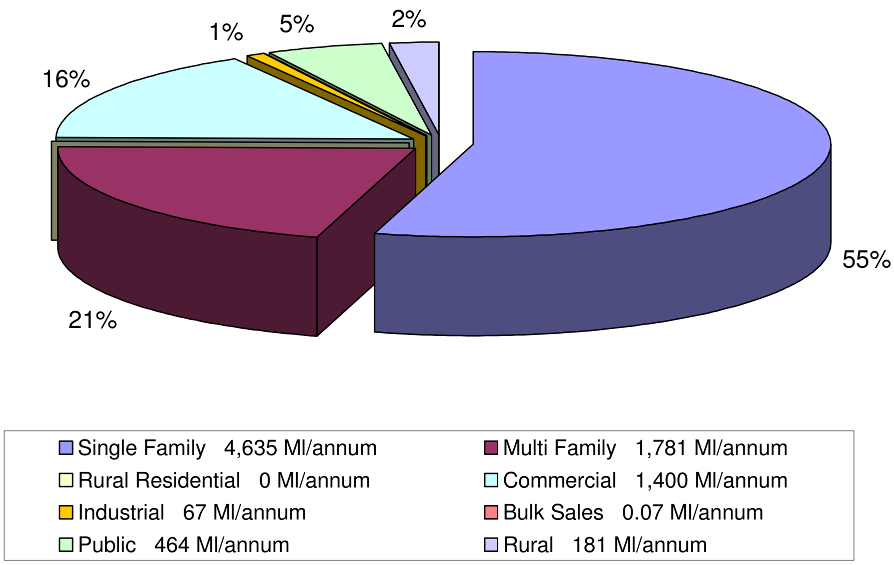



Figure 4-11 outlines the estimated sectoral consumption breakdown for the main supply areas of the shire. These figures are based on billing data analysis.

**Figure 4-11 Total Sectoral Water Consumption Breakdown**



### 4.3.5 FORECASTING ASSUMPTIONS

There are numerous assumptions and processes used within the end use model to provide an estimate of future water use. The key underlying processes can be divided into two groups: those which drive the demand per capita up; and those that drive the demand per capita down.

The two key processes which drive the overall demand per capita ***up*** are as follows:

- Household size or dwelling occupancy trends; the end use model reflects a decreasing household size
- Increased discretionary usage in new dwellings; the end use model adopts an increase of 0.8% per annum. Discretionary usage is defined as usage not controlled by fixtures, and includes external use, and the increased use of dishwashers, baths, spas or pools.

The main process that drives the overall demand per capita ***down*** is 'natural' conservation which results from the replacement of inefficient fixtures and fittings over time. This process is built into fixture models.

These key assumptions are summarised, in conjunction with other demand drivers in Table 4-10.

**Table 4-10 Impact of Demand Drivers on Future Demand**

| Driver | Sensitivity | Adopted Action | Impact on Demand | | |
|---|---|---|---|---|---|
| | | | Overall Residential | Overall Non-Residential | Overall Per Capita Demand |
| Population and Dwellings Growth | High | Increase (based on projections) | Increase | No change | No change |
| Non-residential Account Growth | Medium | Maintain current use | No change | No Change | No Change |
| Household Size | High | Decrease, results in increased account formation | Increase | No change | Increase |
| Housing Mix (SFR/MFR) | Medium | Increase proportion of Multi-Family Residential in Greenfield and Infill areas | Decrease | No change | Decrease |
| Residential Lot Size | Not modelled specifically although overlaps with housing mix assumptions. | | | | |
| Market share of efficient fixtures | High | Increase | Decrease | No change | Decrease |
| Real household income | No change specifically modelled, but overlaps with lifestyle drivers | | | | |
| Lifestyle | Medium | Increase discretionary use (baths, dishwashers, external) | Increase | Increase | Increase |
| Climate change | Low | Increased temperature, decreased rainfall | Potential increase | Potential increase | Potential increase |

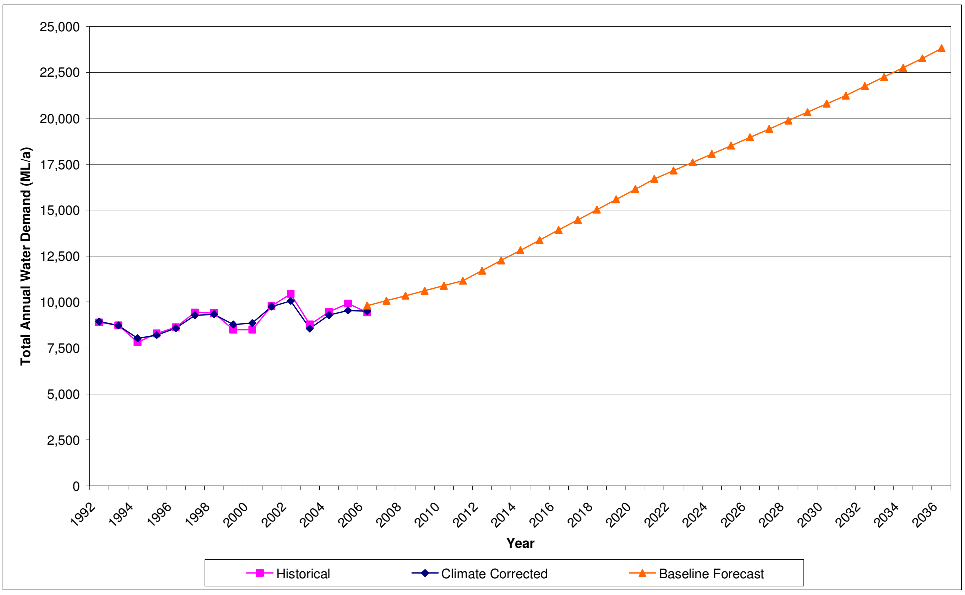
### 4.3.6 BASELINE FORECAST

Table 4-11and Figure 4-12 and Figure 4-13 provide a summary of the baseline forecast for Tweed Shire to the ultimate development in the year 2041. It noted that the Baseline Forecast is based on current and future predicted market share of fixtures **without** the impact of WELS or BASIX.

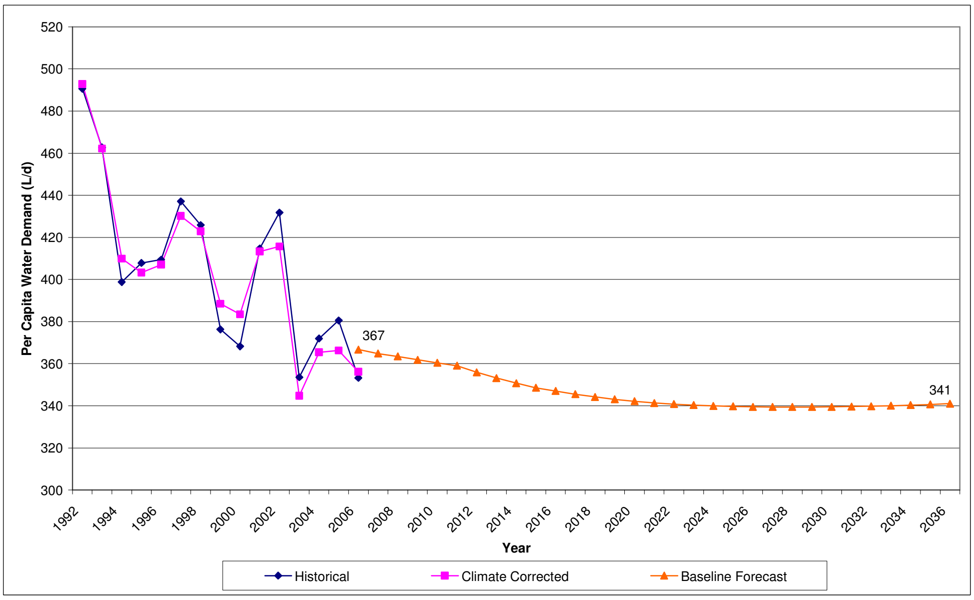
### Table 4-11 Baseline Water Demand Forecast – (Brownfield and Greenfield - Bray Park System)

| Forecast | Baseline Water Demand Forecast | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Total Annual Demand | ML/a | 9,804 | 11,160 | 13,922 | 16,699 | 18,960 | 21,239 | 23,796 |
| Per Capita Demand | L/Capita/day | 367 | 359 | 347 | 341 | 340 | 340 | 341 |

### Figure 4-12 – Total Annual Baseline Demand (Brownfield and Greenfield – Bray Park System)




### Figure 4-13 - Baseline Per Capita Demand Forecast (Brownfield and Greenfield – Bray Park System)



# 5. ASSESSMENT OF GREENFIELD SCENARIOS

## 5.1 OVERVIEW

An assessment was undertaken to identify and analyse the costs and benefits of implementing demand management measures in the existing brownfield areas as well as the future growth areas of Cobaki Lakes, Bilambil Heights, Terranora Area E, West Kingscliff and Kings Forest. This section of the report outlines the development of the integrated scenarios, the assessment of the revised water forecasts and the costs and benefits of the options.

## 5.2 OUTLINE OF SCENARIOS

### 5.2.1 SUMMARY

Five scenarios, comprising a range of water efficiency measures, source substitution and water loss management were developed in conjunction with representatives of the Tweed Shire Council. The scenarios are defined as follows:

- Baseline – assumes that demand increases as per historic trends. The replacement of fittings and fixtures with more efficient units is assumed to occur at an unassisted rate through repairs and refurbishment.
- Scenario 1 – BASIX with Rainwater Tanks serving external, cold water for washing machine and toilets
- Scenario 2 – BASIX with Dual Reticulation serving external and toilets.
- Scenario 3 – BASIX with both Dual Reticulation (external and toilets) and Rainwater Tanks (serving cold water to washing machine and showers)
- Scenario 4 – BASIX with Rainwater Tanks (serving external and toilets) and Indirect Potable Reuse. This combination will increase the level of source substitution and reduce the reliance on the current dam supply.
- Scenario 5 – BASIX with 4$^{th}$ Pipe Network (separated greywater collection and reuse, and blackwater collection and disposal) as proposed by Leda for development of Cobaki Lakes and Kings Forest.

Each of the above scenarios reflects the current legislative requirements for new residential developments in New South Wales (NSW) according to the Building Sustainable Index (BASIX). All scenarios consider the installation of water efficient fixtures including showerheads, taps and dual flush toilets. According to BASIX these fixtures were considered to be 3 Stars or higher. Furthermore, a minimum of one source substitution option has been applied.

Besides the water savings generated through BASIX, additional savings from residential and non-residential education programs and the national water efficiency labelling and standards (WELS) scheme have been considered.

Table 5-1 summarises the general components of the adopted scenarios together with key assumptions.

**Table 5-1 Overview of Demand Management Measures for New Development**

| Program | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| **WELS Program** | | | |
| Water efficient washing machines | All new single and multi-family residential dwellings | Increased sale of efficient washing machines by 7% | 30% savings of original household washing machine demand |
| Water efficient dishwashers | | Increased sale of efficient dishwashers by 2% | 20% savings of original dishwasher demand |
| **Education** | | | |
| Behavioural changes and awareness | All new single and multi-family residential dwellings | 100% of residential accounts | 1% savings for all internal end uses and 2% of external end uses |
| Non-Residential Training of Landscape Managers and Workers | New commercial, public and open space irrigation | 80% of identified accounts | 10% of external and internal irrigation demand |
| **BASIX Efficient Fixture Requirements** | | | |
| Water efficient taps (minimum 3 Star) | All new single and multi-family residential dwellings | 100% of new residential accounts | 20% savings of current demand for taps and sinks |
| Water efficient shower heads (minimum 3 Star) | | 100% of new residential accounts | 15% savings of current shower demand |
| Water efficient dual flush toilet (minimum 3 Star) | | 100% of new residential accounts | 40% savings current existing toilet demand |
| **BASIX Source Substitution (Rainwater Tanks or Recycled Water)** –This application is site and scenario specific. Separate analysis has been undertaken. Refer to Sections 5.2.2 to 5.2.6 | | | |
| **Non-Residential Savings Program** | | | |
| Water efficient non-residential fixtures and management program | All new non-residential accounts | 100% of non-residential accounts | 20% savings of original internal and external demand |
| **Loss Management Program** | | | |
| Leakage detection and Pressure Reduction Program | Non Revenue Water | Three years to achieve savings | Reduction of NRW from 13 to 10% of production |

### 5.2.2 SCENARIO 1 – BASIX WITH 5KL RAINWATER TANK

Scenario 1 reflects the most common application of BASIX as defined through the DWE survey of development activity since the commencement of the regulation. Based on a state wide survey, the most widely adopted BASIX action includes a 5,000 L rainwater tank connected to external uses, toilets and cold water to the washing machine. The average connected roof area was 160 $m^2$ (80% of the average 200$m^2$).

Assessment of the required tank size for TSC is provided in Section 5.3.1. It was found that the most appropriate tank size for the Tweed Shire was 5,000L for a residential detached dwelling.

**Table 5-2 Scenario 1 Source Substitution Components**

| Source Substitution | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| 5 kL Rainwater Tank (connected to 160m$^2$ roof area) | Single Family and Multi Family residential accounts Connected to external, toilet and cold water laundry | 100% of all new accounts | Daily average yield of tank is 231 L/day for single residential dwellings (average 66% water savings) |

### 5.2.3 SCENARIO 2 – BASIX WITH DUAL RETICULATION

Scenario 2 involves the use of the BASIX demand management measures plus the provision of dual reticulation as a further potential source substitution option. Scenario 2 assesses potential savings to be made by connecting a third pipe system to all external end-uses and toilets.

**Table 5-3 Source Substitution – Scenario 2**

| Source Substitution | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| Dual Reticulation | Single Family and Multi Family residential accounts Connected to external and toilet | 100% of all new accounts | 100% potable water savings of external and toilet demand |

### 5.2.4 SCENARIO 3 – BASIX WITH DUAL RETICULATION AND RAINWATER TANK

Scenario 3 involves the use of the BASIX demand management measures plus the provision of dual reticulation and the use of a rainwater tank to optimise the potable substitution within the dwelling. Table 5-4 summarises the application of Scenario 3 to proposed residential development.

**Table 5-4 Source Substitution – Scenario 3**

| Source Substitution | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| Dual Reticulation | Single Family and Multi Family residential accounts Connected to external and toilet | 100% of all new accounts | 100% potable water savings of external and toilet demand |
| 5 kL Rainwater Tank – connected to 160m2 roof area[1] | Single Family and Multi Family residential accounts Connected to cold water washing machine and showers | 100% of all new accounts | Daily average RWT yield – 192 L/day for single residential dwellings – on average 67% water savings of connected end-uses |

[1] Note – 160m$^2$ roof area referring to single residential dwellings. Connected roof area for Multi-residential dwellings determined on per person per account basis.

### 5.2.5 SCENARIO 4 – BASIX WITH RAINWATER TANK AND INDIRECT POTABLE REUSE

Scenario 4 examines the option of Indirect Potable Reuse in conjunction with water efficient fixtures and mandatory rainwater tanks connected to external and toilet use for new residential developments. The potable water demand can be expected to be the same as determined in Scenario 1. The indirect potable reuse yield has been determined as the 75%ile of dry weather flows entering Banora Point and Kingscliff STPs in 2041. Further details about the methodology of this analysis are provided in Section 5.4.4. Table 5-5 summarises the application of Scenario 4 to proposed residential development.

**Table 5-5 Source Substitution – Scenario 4**

| Source Substitution | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| 5 kL Rainwater Tank (connected to 160m$^2$ roof area) | Single Family and Multi Family residential accounts Connected to external, toilet and cold water laundry | 100% of all new accounts | Daily average yield of tank is 231 L/day for single residential dwellings (average 66% water savings) |
| Indirect Potable Reuse | All of water Bray Park scheme | 100% of existing and future development | Refer to Section 5.4.4 |

### 5.2.6 SCENARIO 5 – BASIX WITH 4TH PIPE NETWORK

The '4th Pipe' reticulation concept consists of two classes of water being separately collected from each property:

- Greywater (from other uses such as baths, showers, hand basins and laundry)
- Black water (from toilets, kitchen sinks and dishwashers).

Table 5-5 summarises the application of Scenario 5 to proposed residential development.

**Table 5-6 Source Substitution – Scenario 5**

| Source Substitution | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| Dual Reticulation – treated greywater | Single Family and Multi Family residential accounts Connected to external and toilet | 100% of all new accounts | 100% potable water savings of external demand |
| Open Space Irrigation – treated blackwater | Open Space areas such as golf course, parks, gardens and median strips | As required to dispose of treated blackwater and excess effluent from greywater treatment | Depends on the end use (not known at this stage) |

The recycled greywater would be returned from a treatment plant to the property and used for garden use and toilet flushing.

There are three options available for treatment of the recycled grey water, these are:

- On-site treatment for each property

- Cluster treatment for a small group of properties
- Regional treatment at a central location, most likely a new STP close to the development.

This option was assessed through both a literature search and consideration of the construction, operations and maintenance aspects of the system. Discussion of related issues is provided below:

- The benefit of a 4 pipe greywater reuse system is proposed by the development to be greater public acceptability as no water is reused inside the house. Based on surveys undertaken as part of the development of the Pimpama Coomera project the public acceptance of highly treated recycled water is very high. No problems are anticipated in acceptance where comprehensive education occurs.
- There is a reduction in sewage loading allowing for lower capital and operational costs for blackwater transport. However due to change in loading and reduced flow in sewers, it is believed that sewer slopes will need to be steeper than for traditional systems and additional costs will result. In addition there will be a requirement to have two collection pipes thus increasing the capital cost, maintenance cost and the future replacement burden on the council.
- If the scheme is implemented extensively it would result in a more concentrated blackwater effluent going to the STP, which could impact on the ability of the STP to treat the effluent to the required standard.
- There is potential for septicity of the greywater to occur if allowed to stand untreated for a time as short as a few hours. This may lead to difficulty in consistent treatment.
- Effective operation relies on householder education and 'buy-in' so that there is an awareness of what can and cannot be discharged to the system (i.e. detergent type).
- The scheme requires more management than a traditional system (i.e. disinfection system needs regular maintenance, which particularly in the decentralised options can be a significant cost).
- There is potential in some instances for decentralised grey water treatment to reduce the total lifecycle costs as compared to centralised treatment for all wastewater given the reduction in capital and transportation costs.
- Given the potential for septicity and the need for regular maintenance there are potential health risks associated with treatment especially if treatment is on a household level and the householder does not understand or take responsibility for the treatment system.

Based on an initial review, it is believed that the considerable disadvantages, relating to operations risk and high initial and on-going cost, significantly outweigh the perceived advantage of public acceptance of this scenario. This option was not assessed further in the detailed assessment of options, but was included for the overall qualitative Triple Bottom Line Assessment undertaken in Section 7 of this report.

### 5.2.7 RELATED WATER CYCLE ISSUES AND OPTIONS

The aim of the following section is to provide background information on additional integrated water cycle options not mentioned above, including the reduction of wet weather flows by the installation of smart sewers and the harvesting and use of recycled water via sewer mining.

#### 5.2.7.1 SMART SEWERS / LOW PRESSURE SEWERS / VACUUM SEWERS

*Smart Sewers*

Reduced Infiltration Gravity Sewerage (RIGS) Systems as the name suggests, are sewer systems designed to reduce infiltration of stormwater and groundwater inflows into the sewer system and therefore reduce Wet Weather Flows (WWF). This reduction is estimated to be in the region of 40-50% of WWF, which can be especially advantageous in areas where stormwater infiltration is high (WWFs have been observed with flows in excess of 10 x ADWF in some catchments).

Essentially, RIGS systems are a ‘smart’ way of using the available technology in sewer design hence, the alternative epithet of ‘Smart Sewers’. A reduction in infiltration is achieved through a combination of the following:

- Use of flexible polyethylene (PE) pipes and fittings which allow the introduction of bends in the system in both the vertical and horizontal plane. This reduces the need for maintenance holes, a major point of entry for water.
- The assumption of sole use of CCTV apparatus for inspection activities and jet-rodding for clearing blockages (i.e. no allowance for man entry) further reduces the need for maintenance holes.
- Access is provided using water tight maintenance structures in place of manholes.
- Fusion wielding of pipe joints; this not only reduces infiltration at the joints it reduces the possibility of tree root infiltration and hence damage to sewers.

A summary of key findings based on a review of RIGS systems found that:

- RIGS systems can offer a savings in capital costs through fewer maintenance access points due to the reduction in maintenance access and smaller pipe requirements due to the decrease in WWFs.
- They can offer a reduction in pumping and treatment costs, due to the lower dry weather and wet weather flows.
- They can offer a reduction in maintenance costs, due to fusion welded joints reducing the likelihood of tree root ingress.
- RIGS can be applied to both trench and trenchless installations using directional drilling.

*Low Pressure Sewers*

On a household level pressure sewer systems involve waste draining by gravity to a pump. Flows are then discharged to the transport main using the collective pressure generated by the pumps in the property pumping units. The pump also contains a grinder which reduces solids to a slurry to minimises the possibility of pipe blockages. Typically these systems are used where conventional sewers become expensive or impractical due to site conditions.

A summary of key findings based on a review by MWH of pressure sewer systems found that pressure sewers:

- May be the more economic option in areas with a largely rocky sub-surface as they only require shallow, narrow trenches, compared with the wider, deeper trenches needed by conventional sewers.
- Are suitable for areas with a higher groundwater table as de-watering may not be necessary due to the shallow depths.
- May be the more economic option in areas where properties are widely spread where conventional gravity sewers would need deeper trench depths and more lift stations.
- May be the more economic option in areas of flat topography due to the depth of conventional sewers construction.
- Reduce infiltration problems as pipes are pressurized and therefore sealed. This does not however reduce inflow from illegal connections and therefore high wet weather flows can occur.
- Have been used widely across the world including Australia and well designed pressure systems have been proved relatively easy to maintain.
- In some cases, pressure sewers and other alternative systems have been use inappropriately incurring additional expense unnecessarily.
- Each installation causes significant disturbance and inconvenience to the household, therefore a considerable amount of time is required for public relations.
- Need to use a backup generator in areas where prolonged power outages occur.

*Vacuum Sewers*

In locations of flat topography and high water table, such as many areas of the Tweed Shire coastal plain, conventional gravity sewerage systems may not be the most suitable option. Gravity systems require a certain pipe gradient to maintain flows which results in the need for deep excavations and/or numerous lifting stations. Installation costs can be high especially so in the case of a high water table as installation can be slow and difficult.

A summary of key findings based on a literature review by MWH of Vacuum Sewer systems found that:

- Conditions that favour the selection of vacuum sewer systems include unstable soils, flat topography, high water table and rocky sub-surface.
- The vacuum system is sealed and soil contamination is controlled, therefore suitable for environmentally sensitive sites, such as deltas or river shores.
- One central vacuum station is required as opposed to a number of rising stations. However, topography is a limiting factor in the location of a vacuum station, as the vacuum produced by the vacuum pumps is only able to lift about 4.5 - 6m.
- Construction cost savings may come at the expense of higher operation and maintenance costs when compared to a conventional sewer. Savings of up to 20% have been quoted however; the relatively small cost savings achieved make this option cost affective only in situations where a conventional sewer system is difficult or expensive to install.

- The major risk with this system is the vacuum valve failing in a closed position, this can result in wastewater backing-up the gravity drains and flooding into the property, this risk is exacerbated where raw sewerage is being transported without the intervention of a septic tank system.

There is limited data available in Australia where vacuum systems have generally only been used in small scale specialist situations. However, in both Europe and the US vacuum sewers have been installed with some success in situations where conventional gravity sewers would be costly. Examples of developments where vacuum sewer systems have been implemented in Australia are as follows:

- The coastal town of Minnamurra, New South Wales, where a vacuum sewage system was chosen due to flat topography, high water table, and environmentally sensitive surroundings;
- The Sanctuary Lakes development in South Australia where a vacuum system was chosen due to a high water table with clay fill soil in a highly saline location;
- Couran Cove Eco Resort, South Stradbroke Island where flat topography and environmentally sensitive surroundings resulted in this option being chosen.

Given the low lying nature and high water table of the Tweed Shire coastal plain the cost of implementing a conventional sewerage system may be prohibitive. This, in combination with the environmentally sensitive nature of some of the development areas, may make a vacuum sewerage system appropriate.

#### 5.2.7.2 SEWER MINING

Sewer mining is the process of tapping directly into a sewer (either before or after a sewage treatment plant) and extracting wastewater for treatment and reuse as recycled water. Some sewer mining by-products may be returned into the sewerage system (sydneywater.com.au).

While the use of treated effluent for source substitution option is not a new concept, sewer mining is considered as a more decentralised / localised option for accessing recycled water. In cases where areas identified for potential recycled water supply schemes are found to be economically impractical (e.g. due to distance from a sewerage treatment plant), sewer mining may provide more feasible opportunities.

Potential uses for sewer mining applications include small scale residential areas (typically greenfield), irrigation, industrial use and fire fighting. A summary of key issues related to sewer is as follows:

- The average cost of fitting a third pipe system to a single dwelling is estimated as $2,000, which excludes trunk infrastructure.
- Recycled water is a possible application for outdoor and toilet flushing end uses.
- The application of recycled water in a residential dwelling for outdoor and toilet end uses is estimated to provide potable water savings between 30 to 50%.
- General industry has the potential to use large amount of recycled water.
- The issue of use of recycled water for urban fire fighting water supply is currently being resolved in Queensland and is critical to allowing potential downsizing the potable water supply system and the associated financial benefits.

Proponents of sewer mining schemes typically undertake preliminary discussions with referral and approval authorities, gain initial development approval, and then construction approval. Local councils approve the installation, operation and maintenance of privately operated recycled water schemes and the use of recycled water. Local government needs to seek the approval of the relevant Minister if Council itself is the proponent.

Benefits of sewer mining include a reduction on potable water sources and a reduction in the effluent discharged to receiving environments. When considering costs of sewer mining projects, the opportunity costs related to the alternative use of potable water made available as a result of recycling should also be considered.

#### 5.2.7.3 OPEN SPACE IRRIGATION WITH RECYLED WATER

In the previous concept study "Tweed Shire Council - Recycled Water Opportunities" (February 2006) MWH outlined various options and costs for recycled water supply from several sewage treatment plants within Tweed Shire. These included the assessment of existing potential recycled water sites, i.e. memorial gardens, parks, sporting fields, private golf courses, a turf farm and plant nursery. The key driver for this concept study was the NSW EPA endorsement of the TSC Recycled Water Strategy.

Summarised, the progressive implementation of recycled water will have clear environmental benefits including reduction in nutrient loads and other pollutants currently discharged to the Tweed River. Future effluent water quality licence requirements set by the EPA for discharges to Tweed River may depend on the extent of recycled water achieved and the resultant reduction in pollutant loads on the river.

Although the demand for open space irrigation for the new growth areas has been included in the future potable demand assessment, it can be envisaged that this part of the future demand will be substituted to comply with the TSC Recycled Water Strategy.

It can be expected that in the event of introducing dual reticulation (Scenario 2 and 3) to the new growth areas, the installed third pipe system will be sufficiently designed to cover the additional demand for open space irrigation in the new growth areas.

*Recycled Water (treated effluent)*

Recycled water for use in open space irrigation is the most common source of potable water substitution. Using recycled water for irrigation has associated with it a number of considerations. As the source of treated effluent is relative constant throughout the year and not subject to seasonality, the issues with supply are not as significant as for other sources. Consequently, the need for storages is reduced to reflect the inflow of effluent, the treatment capacity and demand for the water source. Further advantages include a reduction in the detrimental impacts of wastewater discharges on the receiving environment and conservation of potable water supplies.

Although recycled water is commonly used on open spaces such as golf courses, open space irrigation of residential developments is subject to greater controls due to the increased risk of human contact. Recycled water is required to be of Class A+ quality and to meet stringent requirements to ensure that risk to human health is minimized. To that end, developments that intend to use recycled water as a water source for irrigation need to undertake a risk assessment / management approach to ensure that public health is not compromised. This may include subsurface or underground irrigation, which eliminates the chance of direct contact with people and also results in efficiency gains as it reduces water loss due to evaporation and surface runoff.

*Stormwater*

The use of stormwater for large scale irrigation is not common in urban areas. Reasons for this are primarily due to the cost of the storage (in terms of capital outlay, maintenance and space required) that would be required to store adequate supplies to meet annual demand. The uncertainty of supply is also a major factor that would make stormwater an unlikely source for open space irrigation.

*Greywater*

Greywater reuse is regarded as an alternative substitution option within the residential sector. Similar to Scenario 5, it is very unlikely that greywater will prove to be a likely source of potable water substitution for open space irrigation due to the infrastructure and treatment costs involved and the need to separate water sources from those that would normally be treated for recycling (i.e. including black water). On lot greywater use is also problematic due to public health concerns of the rapid water quality deterioration on storage. Although some systems do exist the cost of storage and treatment on site are prohibitive.

#### 5.2.7.4 ADOPTED APPROACH

Based on considerations of options outlined above, the following actions were progressed as part of the report:

- stormwater and greywater recycling were not pursued as no extensive applications were identified. Stormwater recycling opportunities should be investigated on a site by site basis. Greywater reuse will not likely progress at any rate until more practical and cost effective systems are available.
- sewer mining may be viable for local area irrigation use, however the economic viability is questionable. This option was not taken forward as part of the assessment.
- reduced infiltration gravity sewers (RIGS) or “smart” sewers are being implemented in a number of areas such as Brisbane and the Gold Coast. In an area of high rainfall such as TSC it is logical to adopt the principle of low infiltration sewers to reduce peak wet weather flows. It was agreed to include smart sewers in all scenarios. The benefits include a reduction in the capital and operating cost of sewer, rising main and pumping stations. These cost reductions can offset the higher cost of other options such as the construction of recycled water systems.

## 5.3 REVISED DEMAND FORECASTS

This section outlines the resultant managed potable water needs forecasts for all scenarios. The forecasts discussed in this report cover a number of different parameters:

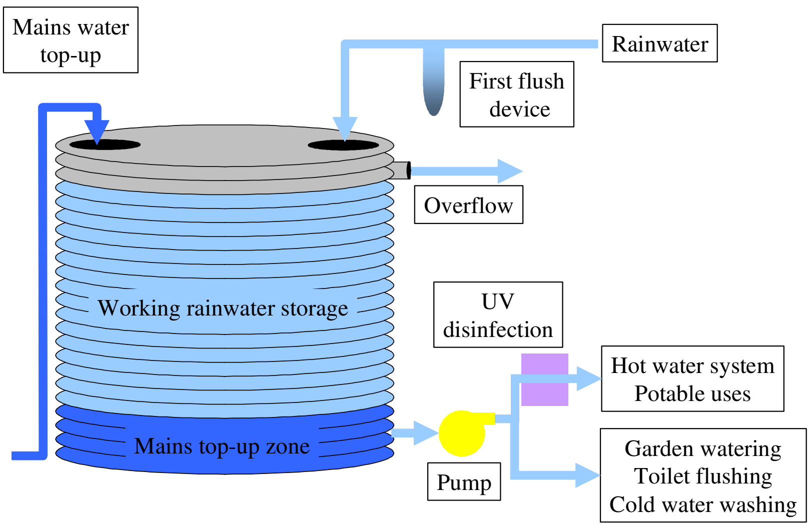
- Total annual water demand for water resources needs.
- Per capita demands which are useful to give an overview of the changes in unit demand, e.g. increasing components of non-residential demand.
- A usage per SFR account forecast which can be used as a forecast for a 'per Equivalent Tenement' (ET) demand in system planning.
- A usage per person in a SFR account forecast which can be used as a forecast for a 'per Equivalent Person' (EP) demand in system planning.
- The reduction in annual greenhouse gas emissions for the individual measures components as part of the environmental assessment.
- The Net Present Value (NPV) of the forecast expenditure and annual costs for the individual demand measurement components of each scenario.
- A demand profile for each scenario to determine annual and average water savings.

The combined results of the scenario assessment for the five growth areas is summarised in this section. Individual demand forecasts and assessments have been undertaken for each of the greenfield areas. Detailed information of these outcomes are given in Appendices G, H, I, J and K.

### 5.3.1 RAINWATER TANK PERFORMANCE

Rainwater tanks are an acceptable solution to most householders in Australia. The tanks can provide water for end uses such as toilet flushing, garden watering, bathroom use, hot water and cold water to the laundry. It is important to model the performance of the rainwater tanks to enable the balance of the scenario assessments to be undertaken. These systems would have a top-up feed from the potable distribution system as shown in Figure 5-1.

**Figure 5-1 Typical Rainwater Tank Configuration**



A hydrological assessment of the impact of rainwater harvesting systems on water demands was undertaken utilising a probabilistic rainwater harvesting simulation. The simulation generates a large number of virtual dwellings, each with random occupancy patterns with seasonal water use determined by climate and a random element. The analysis assumed the following:

- Area of roof connected – 160 $m^2$
- End uses assumed - outdoor use, toilet flushing and cold water to washing machine
- End use was assumed as per Table 4-9 adjusted for the assumed greenfield development water fittings and fixtures.

Results of the assessment are outlined in Appendix L. Assessment indicated that the yield from a 5 kL rainwater tank would be approximately 260 L/dwelling/day for Single Family Residential dwellings. This yield was compared with detailed PURRS analysis results for the Gold Coast. Based on this comparison (and the fact that the average connected roof area expected in Gold Coast development was 100 $m^2$) the yield for the TSC developments was reduced to 231 L/dwelling/day for SFR.

### 5.3.2 FUTURE WATER DEMAND FORECASTS

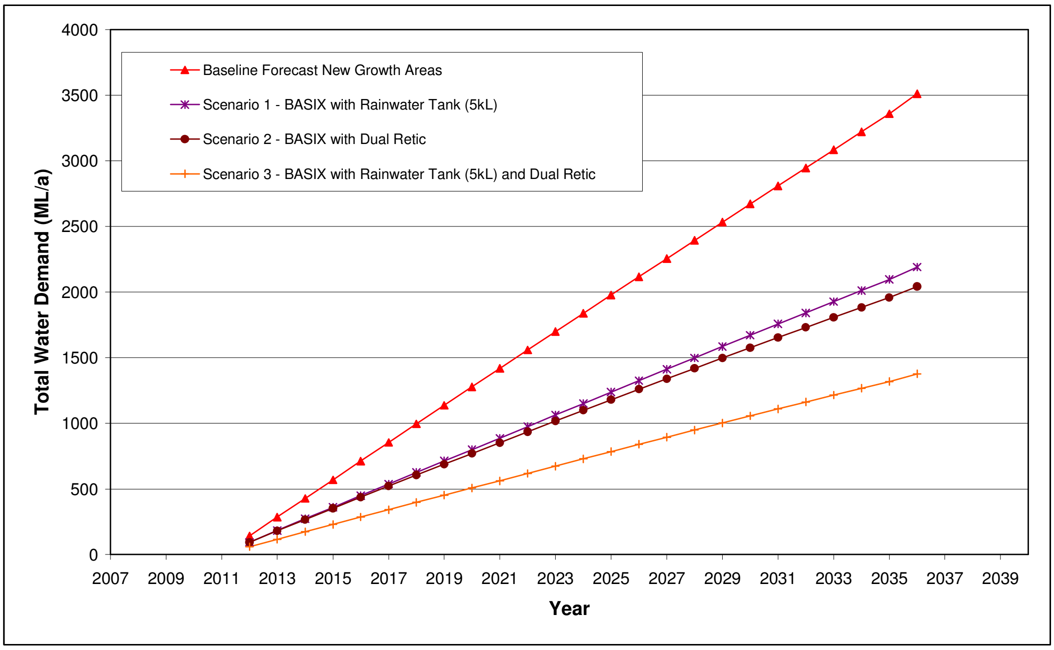
#### 5.3.2.1 ANNUAL FORECAST

Table 5-7 and Figure 5-2 outline the combined annual demand forecast results for the five growth areas. The demand addresses the total water production including all sectoral consumption and water losses, which are forecast at the targeted level of 10%.

**Table 5-7 Total Annual Demand Forecast (ML/annum) – Greenfield Areas**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast | 142 | 712 | 1418 | 2,116 | 2,808 | 3,511 |
| Scenario 1 - BASIX with Rainwater Tank | 94 | 450 | 886 | 13,25 | 1,756 | 2,190 |
| Scenario 2 - BASIX with Dual Reticulation | 93 | 438 | 852 | 1,260 | 1,654 | 2,043 |
| Scenario 3 - BASIX with Dual Reticulation and Rainwater Tank | 59 | 287 | 561 | 840 | 1,109 | 1,377 |

**Figure 5-2 Total Annual Water Demand Forecast – New Growth Areas**




### 5.3.2.2 PER CAPITA DEMAND

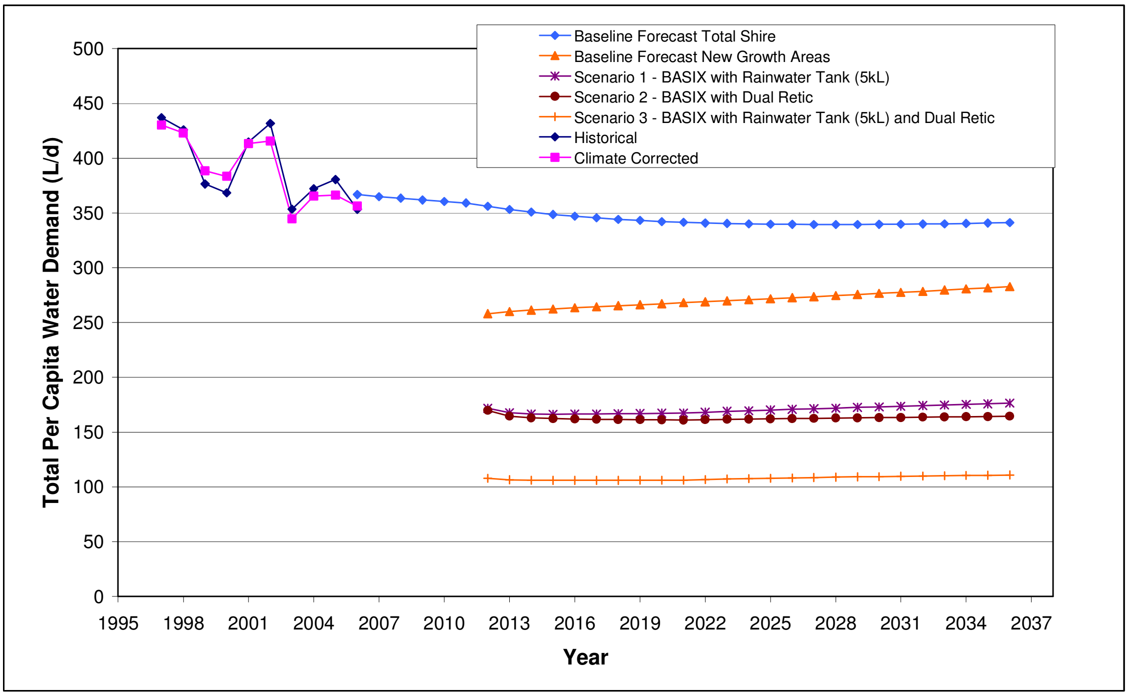
Table 5-8 summarises the per capita demand derived from the total demand of the new growth areas. It has to be mentioned that per capita demand will vary for each of the areas, since the it is related to the sectoral structure of each area (e.g. proportions of SFR, MFR and non-residential accounts). For individual per capita demands please refer to Appendices G, H, I, J and K.

**Table 5-8 Total per Capita Demand (L/Capita/Day) – Greenfield Areas**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast | 258 | 264 | 268 | 273 | 277 | 283 |
| Scenario 1 - BASIX with Rainwater Tank | 172 | 166 | 167 | 171 | 174 | 176 |
| Scenario 2 - BASIX with Dual Reticulation | 170 | 162 | 161 | 162 | 163 | 164 |
| Scenario 3 - BASIX with Dual Reticulation and Rainwater Tank | 108 | 106 | 106 | 108 | 110 | 111 |

Table 5-8 and Figure 5-3 show that significant reductions in per capita demand can be expected by combining water efficient demand measures. The gradual increase in the per capita demand over time is related to an increase in discretionary use in the new residential growth areas. The effect of discretionary use is explained in Section 4.3.5.

**Figure 5-3 Per Capita Demand Forecast – Combined Growth Areas**




### 5.3.2.3 SINGLE FAMILY RESIDENTIAL DEMAND

Table 5-9 and Table 5-10 show the demand per person and per account respectively for SFR households between 2012 and 2036 for the new developments. The SFR results are used as a measure of the average demand per EP and ET. The corresponding details for MFR development and for overall residential demand per person refer to further details in Appendix F.

**Table 5-9 SFR Demand per Person or EP (L/person/Day)**

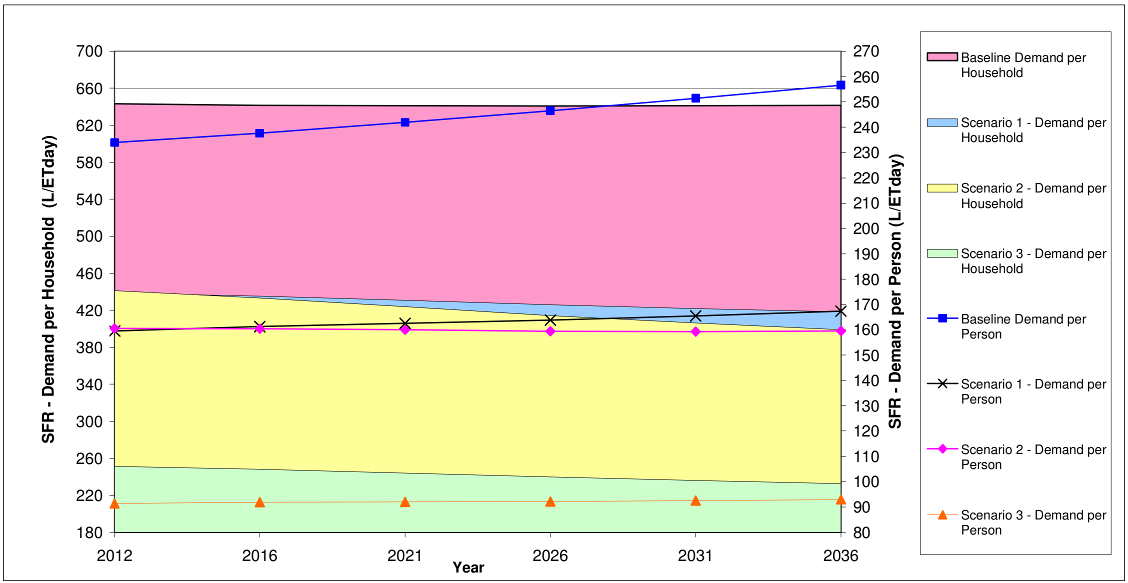
| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast | 234 | 238 | 242 | 246 | 251 | 257 |
| Scenario 1 - BASIX with Rainwater Tank | 160 | 161 | 163 | 164 | 165 | 167 |
| Scenario 2 - BASIX with Dual Reticulation | 160 | 160 | 160 | 160 | 160 | 160 |
| Scenario 3 - BASIX with Dual Reticulation and Rainwater Tank | 91 | 92 | 92 | 92 | 93 | 93 |

**Table 5-10 - SFR Demand per Account or ET (L/ET/Day)**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast | 643 | 642 | 641 | 641 | 641 | 641 |
| Scenario 1 - BASIX with Rainwater Tank | 439 | 435 | 431 | 426 | 422 | 418 |
| Scenario 2 - BASIX with Dual Reticulation | 441 | 433 | 424 | 414 | 406 | 399 |
| Scenario 3 - BASIX with Dual Reticulation and Rainwater Tank | 251 | 248 | 244 | 240 | 236 | 232 |

Figure 5-4 summarises the results shown in the previous tables. It can be seen that as the demand per person increases into the future the demand per household decreases slightly. This is a function of decreasing household sizes into the future.

**Figure 5-4 Demand Forecast – Single-Family Residential Dwellings**




### 5.3.3 FORECAST DEMAND AND SAVINGS FOR INDIVIDUAL GREENFIELD AREAS

Table 5-11 outlines the water forecasts and benefits in terms of annual water saved over the baseline demand of each scenario.

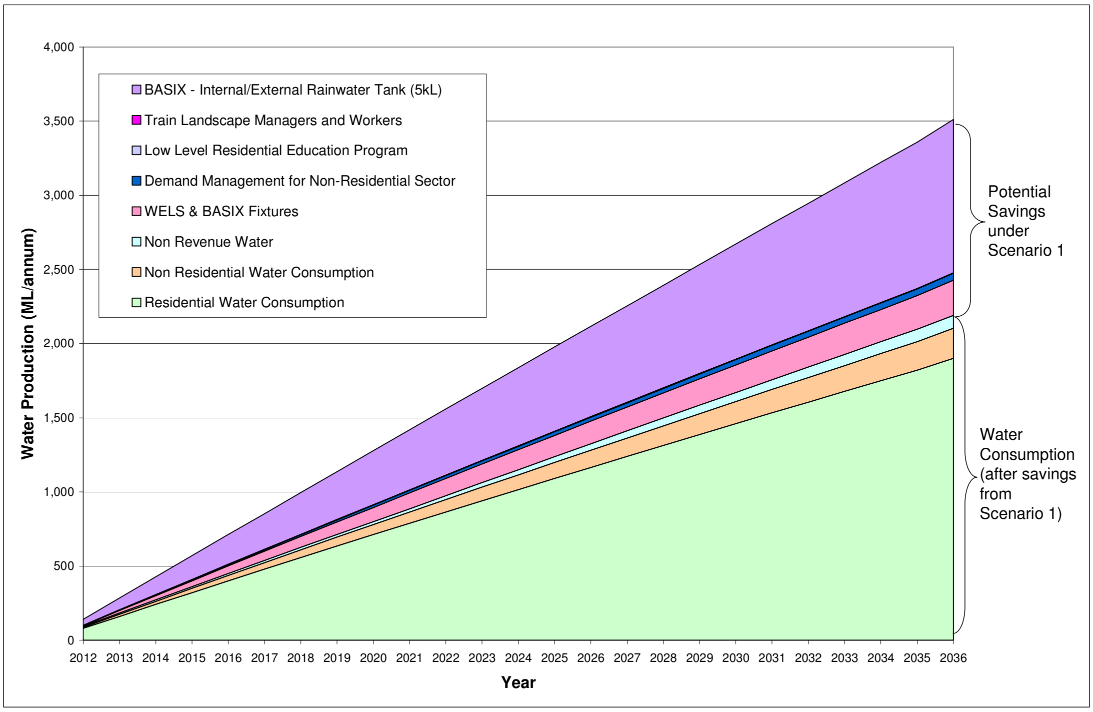
**Table 5-11 Forecast Demand Savings for Greenfield Scenarios**

| Greenfield Development Area | Scenario | Average Demand @ 2036 (ML/annum) | Average Savings @ 2036 (ML/annum) | Savings over Baseline Demand |
|---|---|---|---|---|
| **Cobaki Lakes** | Baseline | 1,054 | 0 | 0% |
| | Scenario 1 | 669 | 386 | 37% |
| | Scenario 2 | 615 | 440 | 42% |
| | Scenario 3 | 407 | 647 | 61% |
| **Bilambil Heights** | Baseline | 705 | 0 | 0% |
| | Scenario 1 | 440 | 265 | 38% |
| | Scenario 2 | 412 | 293 | 42% |
| | Scenario 3 | 279 | 426 | 60% |
| **Terranora Area A** | Baseline | 373 | 0 | 0% |
| | Scenario 1 | 246 | 127 | 34% |
| | Scenario 2 | 200 | 173 | 46% |
| | Scenario 3 | 135 | 238 | 64% |
| **West Kingscliff** | Baseline | 286 | 0 | 0% |
| | Scenario 1 | 260 | 26 | 9% |
| | Scenario 2 | 182 | 104 | 36% |

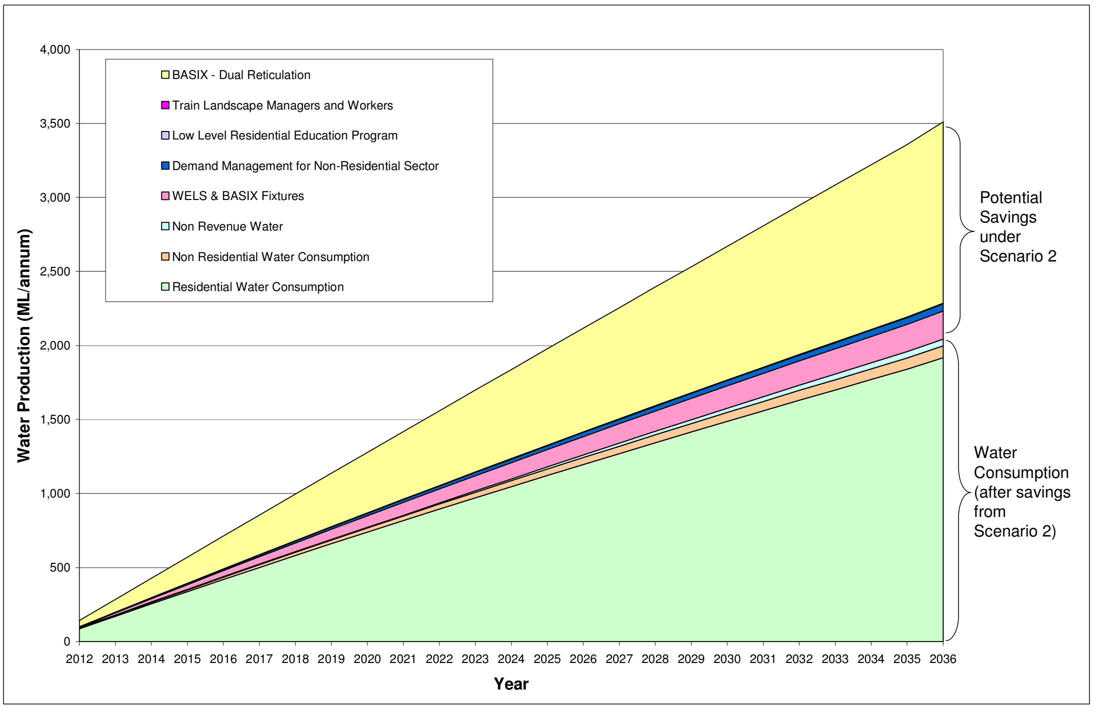
| Greenfield Development Area | Scenario | Average Demand @ 2036 (ML/annum) | Average Savings @ 2036 (ML/annum) | Savings over Baseline Demand |
|---|---|---|---|---|
| | Scenario 3 | 137 | 149 | 52% |
| Kings Forest | Baseline | 1,096 | 0 | 0% |
| | Scenario 1 | 677 | 420 | 38% |
| | Scenario 2 | 639 | 457 | 42% |
| | Scenario 3 | 424 | 673 | 61% |
| **Totals** | **Baseline** | **3,514** | **0** | **0%** |
| | **Scenario 1** | **2,292** | **1,222** | **35%** |
| | **Scenario 2** | **2,048** | **1,466** | **42%** |
| | **Scenario 3** | **1,382** | **2,132** | **61%** |

Figure 5-5, Figure 5-6 and Figure 5-7 show a breakdown of the potential water savings under Scenarios 1, 2 and 3 respectively from 2012 to 2036. In addition a breakdown of the residual water consumption is provided for each case.

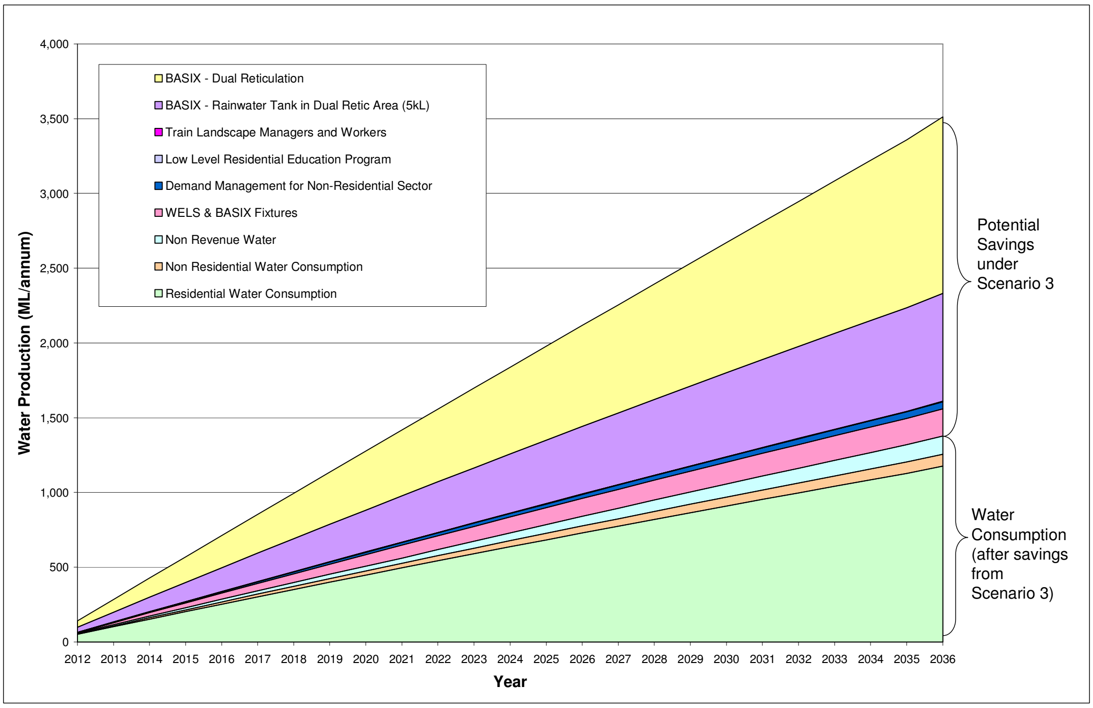
**Figure 5-5 – Demand Projections and Water Savings – Scenario 1**



### Figure 5-6 Demand Projections and Water Savings – Scenario 2




### Figure 5-7 Demand Projections and Water Savings – Scenario 3




### 5.3.4 FORECASTING RISKS AND UNCERTAINTIES

The following issues are identified as risks to the realisation of the managed water forecasts. Issues are listed in order from perceived highest to lowest risk.

- The accuracy of the population projections and growth rate used.

- The assumed uptake or penetration rates of the non-mandatory WM opportunities.
- The projected ongoing shrinking of household size continues as forecast.
- The accuracy of non-residential demand forecasts based on area and assumed growth rate. Coupled with this is the ability to maximise opportunities for non-residential source substitution.
- The modelled understanding of market share of water efficient fixtures and fittings along with the end use breakdown of demand across different customer sectors.

## 5.4 IMPACT ON INFRASTRUCTURE

### 5.4.1 POTABLE WATER SYSTEM

#### 5.4.1.1 OVERVIEW

Generally it is anticipated that future augmentations can be downsized or avoided based on the reduced demands of the demand management scenarios. The asset needs for the Baseline, Scenario 1 (with BASIX) and Scenario 3 (with BASIX and dual reticulation) were analysed to determine where savings could be achieved compared to the water supply capital works program from 2008 to 2036.

Rainwater tank scenarios were not assessed as it is assumed that tanks will not be available during periods of peak system demand, that is, tanks will not reduce the peak water demand. Although this assumption may be conservative for many normal demand years it is considered to be a prudent approach to system planning.

#### 5.4.1.2 APPROACH

As it was not possible as part of the project scope to undertake network modelling of the revised demands, a desktop analysis was used to assess the impact on the trunk system. The approach to this assessment adopted the following key assumptions:

- The existing infrastructure is assumed to be capable of catering for the 2007 demands.
- Only growth in Cobaki Lakes, Bilambil Heights, Terranora, West Kingscliff, Kings Forest and infill development of Tweed heads area were considered as contributing to future system augmentation.
- Average day demands of Baseline, Scenario 1 and Scenario 3 were evaluated using the DSS as described in previous sections.
- Rainwater tanks were considered not to available during peak demand conditions.
- A peak day factor of 1.89 was adopted. It was assumed that the peak demand factor was constant for all scenarios.
- System leakage of 13% was included for the baseline and 10% for other scenarios.
- Infrastructure is sized to cater for the peak day demand at 2036.
- A total of 50% of future Bilambil Heights growth is assumed to be served by Mcallisters Reservoir No.4, Country Club Reservoir (No.2).
- A total of 50% of future Kings Forest and 100% of other growth will be served by the augmentation between South Tumbulgum to Tweed River Crossing.

- A total of 100% of the future Cobaki Lakes and 20% of the Tweed Heads infill growth will be served by Walmsleys Road Reservoirs No. 2 and No.3.

#### 5.4.1.3 POTABLE WATER DEMAND

Table 5-12 shows the calculated average and peak day demand for each demand management scenario. By comparing the existing design standard and the calculated Baseline average day demand, it is noted that the current demand is approximately 34% higher than the actual demand. For this study the adjusted or current Baseline was used for the purposes of comparing options. It is also noted that the Baseline (current) average daily demand includes a network factor of safety of 10% to account for uncertainty when sizing potable water infrastructure.

**Table 5-12 Adopted Potable Peak Day Demand**

| Scenario | Average Day Demand (L/EP/day) | Peak Day Demand (L/EP/day) |
|---|---|---|
| Existing Design Standard | 450 | 850 |
| Baseline (current) | 297 | 562 |
| Scenario 1 | 274 | 517 |
| Scenario 2 | 172 | 324 |
| Scenario 3 | 172 | 324 |

A summary of the peak day demands for the greenfield development areas is given in Table 5-13.

**Table 5-13 Peak Day Potable Demands for Greenfield Development Areas**

| Greenfield Development Area | Scenario | Potable Peak Day Demand (ML/day) |
|---|---|---|
| **Cobaki Lakes** | Baseline (current) | 5.49 |
| | Scenario 1 | 5.09 |
| | Scenario 2 and 3 | 3.18 |
| **Bilambil Heights** | Baseline (current) | 3.67 |
| | Scenario 1 | 3.39 |
| | Scenario 2 and 3 | 2.13 |
| **Terranora Area A** | Baseline (current) | 1.94 |
| | Scenario 1 | 1.78 |
| | Scenario 2 and 3 | 1.04 |
| **West Kingscliff** | Baseline (current) | 1.49 |
| | Scenario 1 | 1.35 |
| | Scenario 2 and 3 | 0.94 |
| **Kings Forest** | Baseline (current) | 5.71 |
| | Scenario 1 | 5.30 |
| | Scenario 2 and 3 | 3.31 |
| **Total Peak Day Demand** | **Baseline (current)** | **18.30** |
| | **Scenario 1** | **16.91** |
| | **Scenario 2 and 3** | **10.60** |

#### 5.4.1.4 IMPACT ON TRUNK WATER MAIN AUGMENTATIONS

Augmentations outlined in the Water Conveyance Study (GHD 1999) were identified for possible downsizing as part of the assessment of scenarios. Figure 6.1 of this study was used as the basis for the identification of assets that were likely to be impacted. A marked up version of Figure 6.1, which was used as the major reference for this work is included in Appendix M.

Due to the reduction in baseline demand over the current design standard, it was first necessary to amend the sizing of the proposed infrastructure so that a more accurate level of savings could be assessed. The revised sizes are provided in Table 5-14.

In total, 20 scheduled water main augmentations were selected for the downsizing assessment as listed in Table 5-14. The highlighted items can not be resized because they are not directly impacted by five identified greenfield developments or by the Tweed Heads infill development.

**Table 5-14 Revised Sizes of Scheduled Water Main Augmentations**

| Scheduled Water Main Augmentation | Length (m) | Original Diameter (mm) | Baseline Diameter (mm) | Scenario 1 Diameter (mm) | Scenarios 2/3 Diameter (mm) |
|---|---|---|---|---|---|
| Kings Forest Duplication | 4,000 | 600 | 375 | 300 | 300 |
| Civic Centre To Condong | 3,757 | 750 | 600 | 600 | 500 |
| South Tumbulgum to Tweed River Crossing | 1,600 | 750 | 600 | 500 | 450 |
| Tumbulgum - Tweed River Crossing | 300 | 600 | 500 | 500 | 450 |
| North Tumbulgum - River Crossing To WPS 9 | 1,700 | 600 | 500 | 500 | 450 |
| WPS 9 to WPS 12 | 2,500 | 600 | 500 | 500 | 450 |
| WPS 12 To Duroby Crk | 1,300 | 500 | 500 | 500 | 450 |
| Duroby Crk To Marana St Reservoir | 4,600 | 450 | 450 | 375 | 375 |
| Lloyd St to Razorback 450 mm | 2,700 | 300 | 300 | 300 | 300 |
| Kennedy Drive Bypass To Boyds Bay Bridge | 1,500 | 300 | 300 | 300 | 300 |
| Kyogle Rd Tree St Nth to cane drain St 2 | 1,500 | 250 | 250 | 250 | 250 |
| To Country Club Reservoir | 1,700 | 250 | 250 | 200 | 200 |
| Coast Rd To Koala Beach 2 Reservoir | 1,800 | 300 | 300 | 300 | 300 |
| Walmsley Res to Piggabeen Rd | 1,700 | 450 | 375 | 300 | 300 |
| Reserve Creek Rd | 570 | 300 | 300 | 300 | 300 |
| North Arm Road Duplication St 1 | 1,000 | 250 | 250 | 250 | 250 |
| North Arm Road Duplication St 2 | 950 | 250 | 250 | 250 | 250 |
| Simpson Drive to Mcallisters 4 Reservoir | 400 | 450 | 250 | 200 | 200 |
| WPS 32 McAllister Reservoir Booster to Bilambil Height High Level | 2,300 | 300 | 200 | 200 | 150 |
| Cobaki Lakes Intake Pump to Cobaki Lakes | 4,405 | 450 | 300 | 300 | 250 |

#### 5.4.1.5 IMPACTS ON RESERVOIR AUGMENTATIONS

Eight scheduled reservoir augmentations were selected for downsizing assessment as listed in Table 5-15**.** The items highlighted in yellow were not resized because they are not directly impacted by five identified greenfield development and Tweed Heads infill development.

**Table 5-15 Revised Sizes of Scheduled Reservoir Augmentation**

| Scheduled Reservoir Augmentation | Original (ML) | Baseline (ML) | Scenario 1 (ML) | Scenarios 2/3 (ML) |
|---|---|---|---|---|
| Country Club Reservoir No 2 | 3 | 1.5 | 1.5 | 1 |
| Duranbah Reservoir No 3 | 7.5 | 7 | 6 | 4 |
| Koala Beach Reservoir No 2 & 3 | 10 | 10 | 10 | 10 |
| Mcallisters Reservoir No 4 | 5 | 3 | 2.5 | 2 |
| North Tumbulgum Reservoir No 2 | 5 | 5 | 5 | 5 |
| Walmsleys Road Reservoir No 2 and 3 | 15 (7.5x2) | 15 (7.5x2) | 15 (7.5x2) | 15 (7.5x2) |
| Bilambil Heights High Level Reservoir | 3 | 1.5 | 1.5 | 1 |
| Cobaki Lakes Reservoirs | 12 | 7 | 6 | 4 |

#### 5.4.1.6 IMPACTS ON WATER PUMPING STATION AUGMENTATIONS

Four scheduled pumping stations augmentations were impacted by the reduced demands resulting from the scenarios. A summary of the revised augmentations is provided in Table 5-16.

**Table 5-16 Summary of Revised Pumping Station Augmentations**

| Scheduled Pumping Station Augmentation | Original | Baseline | Scenario 1 | Scenarios 2/3 |
|---|---|---|---|---|
| WPS 2 Durroon Ave Bray Park | 2 x (650 kW, 465 L/s@85m) | 650 kW, 465 L/s@86m | 650 kW, 465 L/s@86m | 650 kW, 465 L/s@85m |
| WPS 9 North Tumbulgum | 2 x (360 kW, 350 L/s@67m) | 2 x (380 kW, 370 L/s@67m) | 2 x (370 kW, 360 L/s@67m) | 2 x (350 kW, 340 L/s@67m) |
| WPS 19 Cudgera Ave Koala Beach | 10 kW, 25 L/s@25m | 10 kW, 25 L/s@25m | 10 kW, 25 L/s@25m | 10 kW, 25 L/s@25m |
| WPS 24 Tumbulgum Booster Ps | 2 x (70 kW, 190 L/s@25m) | 2 x (70 kW, 190 L/s@25m) | 2 x (70 KW, 190 L/s@25m) | 2 x (70 kW, 190 L/s@25m) |
| WPS 32 McAllister Reservoir Booster | - | 30 kW, 25 L/s@75m | 30 kW, 22 L/s@75m | 20 kW, 15 L/s@75m |
| New Cobaki Lakes Intake Pump | 20 kW, 120 L/s@20m | 20 kW, 75 L/s@20m | 20 kW, 65 L/s@20m | 10 kW, 42 L/s@20m |

#### 5.4.1.7 COST ASSESSMENT

The assessment of capital costs was undertaken assuming the following:

- Costs of trunk infrastructure were derived based on the 2006 unit rates provided by TSC.
- The cost to the developer to provide baseline reticulation was adopted as $2,800 per lot based on assessment of similar developments. This cost reduced to $1, 880 per lot for areas with dual reticulation.

Operation and maintenance costs were considered for the treatment plants and distribution assets are estimated in accordance with the following assumptions:

- Electricity cost of $0.12 / kWh
- Average day demand was assumed for calculation of operation costs
- Operation of the Bray Park WTP was assumed to be $20 / ML.

An NPV analysis was undertaken with a discount rate of 7%. It is noted that all capital works expenditure was assumed to be scheduled to occur between 2012 and 2014. The cost assessment results are summarised in Table 5-17.

**Table 5-17 Summary of Costs for Potable Water Provision**

| Development | Scenario | Trunk Capital Cost | Opex Cost / annum at 2036 | Reticulation Cost | Net Present Value of Costs |
|---|---|---|---|---|---|
| Cobaki Lakes | Baseline | $11,218,209 | $126,646 | $10,022,400 | $11,478,720 |
| | Scenario 1 | $10,427,347 | $81,225 | $10,022,400 | $10,795,686 |
| | Scenario 2 | $8,531,504 | $73,274 | $6,497,280 | $8,258,593 |
| | Scenario 3 | $8,531,504 | $48,580 | $6,497,280 | $8,168,536 |
| Bilambil Heights | Baseline | $10,699,118 | $35,815 | $6,283,140 | $9,491,756 |
| | Scenario 1 | $10,127,402 | $27,394 | $6,283,140 | $9,081,556 |
| | Scenario 2 | $8,618,784 | $22,311 | $4,073,208 | $7,275,322 |
| | Scenario 3 | $8,618,784 | $15,067 | $4,073,208 | $7,248,983 |
| Terranora | Baseline | $1,894,018 | $35,815 | $3,367,190 | $2,581,443 |
| | Scenario 1 | $1,795,730 | $27,394 | $3,367,190 | $2,487,189 |
| | Scenario 2 | $1,256,928 | $22,311 | $2,182,868 | $1,691,906 |
| | Scenario 3 | $1,256,928 | $15,067 | $2,182,868 | $1,665,566 |
| West Kingscliff | Baseline | $631,650 | $34,621 | $1,725,210 | $1,154,191 |
| | Scenario 1 | $578,004 | $22,819 | $1,725,210 | $1,077,312 |
| | Scenario 2 | $490,184 | $22,026 | $1,118,412 | $802,386 |
| | Scenario 3 | $490,184 | $16,629 | $1,118,412 | $782,533 |
| Kings Forest | Baseline | $7,064,517 | $109,081 | $10,440,000 | $8,794,273 |
| | Scenario 1 | $5,788,407 | $67,308 | $10,440,000 | $7,799,998 |
| | Scenario 2 | $5,024,446 | $63,619 | $6,768,000 | $5,979,859 |
| | Scenario 3 | $5,024,446 | $42,154 | $6,768,000 | $5,901,579 |
| **Total Greenfield** | **Baseline** | **$31,507,512** | **$341,978** | **$31,837,940** | **$33,500,383** |
| | **Scenario 1** | **$28,716,890** | **$226,140** | **$31,837,940** | **$31,241,741** |
| | **Scenario 2** | **$23,921,846** | **$203,541** | **$20,639,768** | **$24,008,066** |
| | **Scenario 3** | **$23,921,846** | **$137,497** | **$20,639,768** | **$23,767,197** |

### 5.4.2 SEWERAGE SYSTEM

#### 5.4.2.1 OVERVIEW

For both the baseline and demand managed scenarios, sewer loadings were determined for the growth areas based on calculation of the average dry weather flow from the DSS end use model. It is noted that wastewater estimates are identical under all the demand management scenarios, as the measures identified do not influence the amount of water returned to the sewer, over and above BASIX measures which is also included in the baseline estimates.

#### 5.4.2.2 APPROACH

The sewer infrastructure needed to service the greenfield areas was separately evaluated for the following groups of development:

- areas treated at the Banora Point STP - Terranora (Area E), Cobaki Lakes and Bilambil Heights
- areas treated at the Kingscliff STP – Kings Forest development was assessed. An evaluation was not carried out for the Kingscliff area as, due to the relatively small size of the development, there are negligible opportunities for demand savings. In addition, TSC have indicated that limited infrastructure upgrades are needed to manage the additional loading from this area due to existing capacity in the system.

To estimate the cost savings of the implementing demand management scenarios, an assessment was undertaken for the following options:

- Baseline Conventional - sewer loading determined under baseline demand, with conventional reticulation within the developments (revised population and demand estimates mean that this assessment differs from the current TSC development plan).
- Conventional Sewer with BASIX – the sewer loading determined under the demand management scenarios, with conventional reticulation within the developments.
- RIGS with Baseline Demands - sewer loading determined under the baseline demand, with Reduced Infiltration Gravity Sewer (RIGS) reticulation within the developments.
- Rigs with BASIX - sewer loading based on reduced flows from the demand management scenarios, with RIGS reticulation within the developments.

The following approach was used to determine Peak Wet Weather Flows (PWWF) for each scenario:

- Domestic Dry Weather Flow was determined based on the internal use sourced from the DSS.
- Dry Weather Infiltration (DWI):
  - An estimate of 60 L/p/d for dry weather infiltration was adopted for conventional sewer networks (derived from TSC's current standard)
  - A value of 30 L/p/d was used in the RIGS case, constituting a 50% reduction in DWI;

- Peak Wet Weather Flow (PWWF):
  - For conventional reticulation systems a standard of 7 x ADWF was used in line with current TSC guidelines
  - For the RIGS systems a 50% reduction was assumed resulting in a factor of 3.5 x ADWF.
- A network factor of safety of 10% was added to the design flows to account for variation in performance

It is noted that the above standards are adopted for the assessment of scenarios in this study. Smart sewers are a recent innovation and their effectiveness in reducing dry and wet weather sewer flows has not been proven. It is therefore suggested that a more conservative standard be adopted by TSC in the early stages of implementation until the smart sewers are proven to be effective.

In order to evaluate the cost effectiveness of the demand management and RIGS scenarios in the new development areas, the additional infrastructure needed to service these areas was determined. Trunk mains and other infrastructure external to the developments were assessed individually but due a lack of detailed development plans within the development areas, conventional and RIGS reticulation systems were assessed on a cost per property basis.

The lack of detailed plans for the development areas means that a detailed assessment of sub-development level sewer loadings cannot be carried out. Therefore, the assumption was made that development with each area would be uniform and therefore WWF loadings were apportioned on a geographical area basis.

#### 5.4.2.3 DESIGN FLOWS

For each of the cases outlined above the design average dry weather and peak wet weather flows were calculated. A summary is provided in Table 5-18.

**Table 5-18 Design Wastewater Flows for Greenfield Areas**

| Contributing Area | Baseline Case (ML/d) | | Demand Scenarios (ML/d) | | | |
|---|---|---|---|---|---|---|
| | Conventional Sewers | | Conventional Sewers | | RIGS | |
| | ADWF | PWWF | ADWF | PWWF | ADWF | PWWF |
| **Banora Point STP Catchment** | | | | | | |
| Cobaki Lakes | 2.3 | 17.5 | 2.1 | 16.5 | 1.9 | 7.5 |
| Bilambil Heights | 1.3 | 9.8 | 1.17 | 9.0 | 1.1 | 4.1 |
| Terranora Area A | 0.8 | 6.0 | 0.7 | 5.6 | 0.2 | 0.7 |
| **Total** | 4.3 | 33.3 | 4.0 | 31.2 | 3.2 | 12.3 |
| **Kingscliff STP Catchment** | | | | | | |
| Kings Forest | 2.4 | 18.2 | 2.2 | 17.2 | 2.0 | 7.8 |

### 5.4.2.4 INFRASTRUCTURE ASSESSMENT

Where information was available, trunk mains and pumping stations were located as previously determined by the TSC investment plan, otherwise locations and routes were determined on the existing network and local geographical considerations. The following criteria were adopted for the initial design:

- Gravity and rising mains were sized in line with diameters currently used by TSC.
- Gravity main minimum grades determined from WSAA guidelines.
- A minimum velocity in gravity mains of 1m/s was used, conforming to WSAA guidelines.
- Pumps were assumed to have an overall efficiency of 75%.

The preliminary layout of required sewer infrastructure needed to service the new developments for the Barona Point and Kingscliff systems is given in Appendix N. Capacity of the required trunk infrastructure to deliver recycled water to the proposed developments are listed in Table 5-19.

Flows from the diversion of the Tweed Heads STP and a small sub-catchment in the vicinity of Bilambil Heights were included in the infrastructure assessment. An adjustment was made to the costs to account for this input.

**Table 5-19 Major Infrastructure of Sewer System Augmentation**

| Trunk Infrastructure | Qty | Capacity Required | | |
|---|---|---|---|---|
| | | Baseline | Scenarios 1 to 3 | Scenario 1 to 3 with RIGS |
| ***1. Barona Point System*** | | | | |
| 1.1 Trunk Mains | | | | |
| 1.1.1 SRM Terranora to STP | 4135 m | 250 mm | 250 mm | 200 mm |
| 1.1.2 SGM Cobaki Lakes to STP - Sect 1 | 600 m | 300 mm | 300 mm | 225 mm |
| 1.1.3 SGM Cobaki Lakes to STP - Sect 2 | 830 m | 375 mm | 375 mm | 300 mm |
| 1.1.4 SRM Cobaki Lakes to STP - Sect 3 | 1300 m | 300 mm | 300 mm | 200 mm |
| 1.1.5 SRM Bilambil Heights to STP - Sect 1 | 840 m | 250 mm | 200 mm | 150 mm |
| 1.1.6 SRM Bilambil Heights to STP - Sect 2 | 1400 m | 250 mm | 250 mm | 200 mm |
| 1.1.7 SGM Area 1 Bilambil to Main - Sect 1 | 500 m | 225 mm | 150 mm | 150 mm |
| 1.1.8 SGM Area 1 Bilambil to Main - Sect 2 | 450 m | 300 mm | 300 mm | 225 mm |
| 1.1.9 SGM Area 2 Bilambil to Main - Sect 1 | 250 m | 150 mm | 150 mm | 150 mm |
| 1.1.10 SGM Area 2 Bilambil to Main - Sect 2 | 250 m | 225 mm | 225 mm | 150 mm |
| 1.1.11 SGM Area 3 Bilambil to Main | 1100 m | 225 mm | 225 mm | 225 mm |
| 1.1.12 SRM Bilambil / Cobaki to SPS2052 | 2460 m | 375 mm | 375 mm | 300 mm |
| 1.1.13 SRM from SPS2053 STP - Sect 1 | 375 m | 375 mm | 300 mm | 0 mm |
| 1.1.14 SRM from SPS2053 STP - Sect 2 | 450 m | 450 mm | 375 mm | 150 mm |
| 1.2 Pumping Stations | | | | |
| 1.2.1 PS serving Terranora | 1 | 50 KW, 69 L/s @ 54 m | 50 KW, 65 L/s @ 51 m | 30 KW, 32 L/s @ 48 m |
| 1.2.2 LS serving Cobaki Lakes | 1 | 2 KW, 50 L/s @ 3 m | 1 KW, 47 L/s @ 3 m | 1 KW, 24 L/s @ 3 m |

| Trunk Infrastructure | Qty | Capacity Required | | |
|---|---|---|---|---|
| | | Baseline | Scenarios 1 to 3 | Scenario 1 to 3 with RIGS |
| 1.2.3 PS serving Cobaki Lakes | 1 | 100KW, 203L/s @ 35m | 100 KW, 191 L/s @ 33 m | 100 KW, 96 L/s @ 54 m |
| 1.2.4 PS serving Bilambil Heights - No 1 | 1 | 30 KW, 67 L/s @ 30 m | 30 KW, 62 L/s @ 29 m | 20 KW, 31 L/s @ 45 m |
| 1.2.5 PS serving Bilambil Heights - No 2 | 1 | 7 KW, 25 L/s @ 20 m | 5 KW, 23 L/s @ 16 m | 3 KW, 12 L/s @ 17 m |
| 1.2.6 SPS 2052 serving Cobaki / Bilambil | 1 | 250 KW, 316 L/s @ 58 m | 250 KW, 296 L/s @ 54 m | 100 KW, 148 L/s @ 49 m |
| 1.2.7 PS serving Cobaki Lakes/Bilambil & diverted Tweed Heads flow | 1 | 300 KW, 531 L/s @ 37 m | 350 KW, 509 L/s @ 47 m | 250 KW, 346 L/s @ 50 m |
| ***2. Kingscliff System*** | | | | |
| 2.1 Trunk Mains | | | | |
| 2.1.1 SRM Kings Forest to STP - Section 1 | 1700 m | 300 mm | 300 mm | 250 mm |
| 2.1.2 SRM Kings Forest to STP - Section 2 | 3900 m | 375 mm | 375 mm | 300 mm |
| 2.2 Pumping Stations | | | | |
| 2.2.1 PS at Kings Forest - No 1 | 1 | 100 KW, 211 L/s @ 32 m | 100kW, 199L/s @ 32m | 40 KW, 100 L/s @ 23 m |
| 2.2.2 PS at Kings Forest - No 2 | 1 | 150 KW, 211 L/s @ 49 m | 150 KW, 199 L/s @ 47 m | 100 KW, 100 L/s @ 43 m |

### 5.4.2.5 INFRASTRUCTURE COSTING

Current TSC unit costs were used for all infrastructure costs. An NPV was carried out assuming a discount rate of 7%, and a period of 30 years. Original capital works costs were derived from TSC's 10 year and long run financial plan, with the short term 10 year plan taking precedence where inconsistencies occurred.

It was assumed that all infrastructure required for these developments is constructed in 2012. The internal reticulation systems for each area were assumed to be developed over the subsequent 5 years, with costs distributed linearly over this period.

The assessment of capital costs was undertaken assuming the following:

- Costs of other major infrastructure are derived based on the 2006 unit rates provided by TSC.
- The cost to the developer to provide conventional reticulation was adopted as $3,628 per property based on assessment of similar developments.
- The cost to the developer to provide RIGS reticulation was adopted as $2,643 per property based a case study of the Pimpama Coomera scheme.

Operation and maintenance costs were considered for the distribution assets are estimated in accordance with the following assumptions:

- Electricity cost of $0.12 / kWh
- Average day demand was assumed.

A summary of the costs for the sewerage system are provided in Table 5-20.

**Table 5-20 Summary of Sewer System Costs**

| Trunk Infrastructure | Total Cost | | | NPV | | |
|---|---|---|---|---|---|---|
| | Baseline | Scenarios 1 to 3 | Scenario 1 to 3 with RIGS | Baseline | Scenarios 1 to 3 | Scenarios 1 to 3 with RIGS |
| ***1. Barona Point System*** | | | | | | |
| 1.1 Trunk Mains | $10,505,355 | $9,594,185 | $6,022,525 | $7,010,847 | $6,402,769 | $4,019,189 |
| 1.2 Pumping Stations | $7,048,182 | $7,069,931 | $4,920,052 | $4,703,670 | $4,718,185 | $3,283,443 |
| 1.3 Reticulation | $33,852,868 | $33,852,868 | $24,661,833 | $17,287,962 | $17,287,962 | $12,594,290 |
| 1.4 Distribution Opex | $172,561/a | $172,933/a | $135,671/a | $1,296,129 | $1,298,921 | $1,019,043 |
| **Total NPV (1)** | | | | **$30,298,608** | **$29,707,837** | **$20,915,965** |
| ***2. Kingscliff System*** | | | | | | |
| 2.1 Trunk Mains | $4,265,500 | $4,265,500 | $2,974,100 | $2,846,621 | $2,846,621 | $1,984,794 |
| 2.2 Pumping Stations | $2,500,885 | $2,500,885 | $1,656,071 | $1,668,989 | $1,668,989 | $1,105,195 |
| 2.3 Reticulation | $18,140,000 | $18,140,000 | $13,215,000 | $9,263,724 | $9,263,724 | $6,748,628 |
| 2.4 Distribution Opex | $57,491/a | $55,206/a | $38,794/a | $431,824 | $414,657 | $291,385 |
| **Total NPV** | | | | **$14,211,158** | **$14,193,991** | **$10,130,002** |

Note 1 – Costs include for diversion of the Tweed Heads STP and additional area near Bilambil Heights

### 5.4.2.6 SUMMARY

Table 5-21 contains a summary of all the capital costs associated with the new developments under each scenario. Costs for the diversion of the Tweed Heads STP and an additional small development area near Bilambil Heights were excluded to determine an allocated cost to each development.

**Table 5-21 Summary of Costs for Sewerage Options**

| Development | Scenario | Trunk Capital Cost | Opex Cost / annum at 2036 | Reticulation Cost | NPV |
|---|---|---|---|---|---|
| Terranora | Baseline | $2,550,005 | $12,703 | $4,661,980 | $4,177,963 |
| | Scenarios 1 to 3 | $2,528,906 | $11,907 | $4,661,980 | $4,157,905 |
| | Scenarios 1 to 3 with RIGS | $1,969,096 | $8,746 | $3,396,255 | $3,114,185 |
| Cobaki Lakes | Baseline | $6,867,376 | $81,146 | $17,414,400 | $14,085,684 |
| | Scenarios 1 to 3 | $6,647,342 | $79,081 | $17,414,400 | $13,923,332 |
| | Scenarios 1 to 3 with RIGS | $4,477,633 | $63,678 | $12,686,400 | $9,945,167 |
| Bilambil Heights | Baseline | $5,231,952 | $56,820 | $11,776,488 | $9,932,382 |
| | Scenarios 1 to 3 | $4,841,847 | $54,655 | $11,776,488 | $9,655,784 |
| | Scenarios 1 to 3 with RIGS | $3,122,145 | $42,802 | $8,579,178 | $6,786,293 |
| Kings Forest | Baseline | $6,766,385 | $57,491 | $18,140,000 | $14,211,159 |
| | Scenarios 1 to 3 | $6,766,385 | $55,206 | $18,140,000 | $14,193,992 |
| | Scenarios 1 to 3 with RIGS | $4,630,171 | $38,794 | $13,215,000 | $10,130,002 |
| **Total Greenfield** | **Baseline** | **$21,415,718** | **$208,160** | **$51,992,868** | **$42,407,188** |
| | **Scenarios 1 to 3** | **$20,784,480** | **$200,849** | **$51,992,868** | **$41,931,013** |
| | **Scenarios 1 to 3 (RIGS)** | **$14,199,045** | **$154,020** | **$37,876,833** | **$29,975,647** |

It can be seen that the demand management scenarios have little impact on predicted infrastructure costs. This is mainly because the decrease in ADWF due to the demand management options is generally not enough to allow for downsizing of mains, unless flows are near the pipe threshold. However, there are some savings to be made from downsizing of pumps and wet wells.

On the other hand, RIGS systems decrease WWFs by 50%, which is a large enough decrease to allow for considerable downsizing of mains to occur. This is reflected in the lower infrastructure costs. The overall capital cost of trunk system assets would reduce by around $7.2m or 34% over the conventional baseline case.

### 5.4.3 RECYCLED WATER SYSTEM

#### 5.4.3.1 OVERVIEW

The initial option considered for the recycled water system was a centralised treatment approach where water would be produced at the Barona Point Water Reclamation Plan (WRP) and Kingscliff WRP. These plants would supply Class A+ recycled water to the five identified greenfield developments. The Cobaki Lakes, Bilambil Heights and Terranora developments would be served by the Barona Point WRP, and West Kingscliff and Kings Forest will be supplied by a new facility at Kingscliff WRP.

Alternatives to this approach would involve the construction of water mining plants closer to the Cobaki / Bilambil developments or use of the West Tweed WRP. These options were not considered in the initial assessment.

TSC has previously investigated the reuse of water from the treatment plants for open space irrigation using a quality of water lower than the Class A+ that would be required for the proposed dual reticulation systems. Consideration of combining these systems needs to be taken into account as part of the final decision making process.

#### 5.4.3.2 APPROACH

A desktop analysis was undertaken to determine the required capacity for recycled water infrastructure to serve the greenfield developments. The approach to this assessment adopted the following key assumptions:

- The average recycled water demand is determined based on the end use assessment.
- Treatment facilities, pumping stations, reservoirs and trunk mains are sized based on the 2036 peak day demand.
- A peak day factor of 3.49 was adopted based on assessment of end use for similar recycled water systems at the Gold Coast. This is significantly higher than the potable water peaking factor due to the fact that the majority of the volume used during peak periods is irrigation which has been substituted with recycled water. That is the buffering of the other potable end uses has been removed, resulting in a significant increase in the peaking factor. In practice the factor will be modified by the proportion of SFR to MFR in the development, however for this assessment the simplifying assumption of SFR was used.
- System leakage of 10%.
- A minimum service pressure of 20m head.

#### 5.4.3.3 RECYCLED WATER DEMANDS

Table 5-22 summarises the average and peak day demand derived for the five identified greenfield developments. Peak day demand is calculated using a peaking factor of 3.49.

**Table 5-22 Adopted Recycled Water Demand**

| Identified Development | 2036 Average Day Demand (ML/day) | 2036 Peak Day Demand (ML/day)* |
|---|---|---|
| Cobaki Lakes | 1.17 | 4.07 |
| Bilambil Heights | 0.77 | 2.68 |
| Terranora | 0.45 | 1.58 |
| **Barona Point Total** | **2.38** | **8.32** |
| West Kingscliff | 0.25 | 0.85 |
| Kings Forest | 1.21 | 4.23 |
| **Kingscliff Total** | **1.46** | **5.08** |

#### 5.4.3.4 INFRASTRUCTURE REQUIRED

The preliminary layout of required infrastructure including recycled water treatment plants, trunk mains, pumping stations and reservoirs for the Barona Point and Kingscliff recycled water supply systems is given in Appendix O. Capacity of the required trunk infrastructure to deliver recycled water to the proposed developments (excluding local reticulation within the greenfield areas) is listed in Table 5-23.

**Table 5-23 Summary of Trunk Recycled Water Infrastructure**

| Trunk Infrastructure | Capacity Required | Quantity |
|---|---|---|
| ***1. Barona Point System*** | | |
| 1.1 Treatment Plant and Balancing Storage | 8.3 ML/day | 1 |
| 1.2 Reservoirs | | |
| 1.2.1 Terranora | 2 ML | 1 |
| 1.2.2 Cobaki Lakes | 3 ML | 1 |
| 1.2.3 Cobaki Lakes HL | 1 ML | 1 |
| 1.2.4 Lower Bilambil Heights | 1.5 ML | 1 |
| 1.2.5 Upper Bilambil Heights | 1.5 ML | 1 |
| 1.3 Pump | | |
| 1.3.1 Pump serving Terranora | 50 KW, 19 L/s @ 185 m | 1 |
| 1.3.2 Pump serving Cobaki Lakes / Bilambil | 110 KW, 78 L/s @ 90 m | 1 |
| 1.3.3 Pump serving Upper Cobaki Lakes | 10 KW, 12 L/s @ 50m | 1 |
| 1.3.3 Pump serving Lower Bilambil Heights | 40 KW, 31 L/s @ 91 m | 1 |
| 1.3.4 Pump serving Upper Bilambil Heights | 20 KW, 16 L/s @ 74 m | 1 |
| 1.4 Trunk Mains | | |
| 1.4.1 RWTP to Terranora | 200 mm | 5,500 m |
| 1.4.2 RWTP to Flow Split Point | 375 mm | 6,850 m |
| 1.4.3 Flow Split Point to Cobaki Lakes | 300 mm | 2,500 m |
| 1.4.4 Cobaki Low to High | 150 mm | 500 m |
| 1.4.5 Flow Split Point to Lower Bilambil Heights | 250 mm | 2,100 m |

| Trunk Infrastructure | Capacity Required | Quantity |
|---|---|---|
| 1.4.6 Flow Split Point to Upper Bilambil Heights | 200 mm | 2,300 m |
| ***2. Kingscliff System*** | | |
| 2.1 Treatment Plant and Balancing Storage | 5.1 ML/day | 1 |
| 2.2 Reservoirs | | |
| 2.2.1 Kings Forest | 4.5 ML | 1 |
| 2.3 Pumps | | |
| 2.3.1 Pump served West Kingscliff & Kings Forest | 80 KW, 59 L/s @ 88 m | 1 |
| 2.4 Trunk Mains | | |
| 2.4.1 WRP to Flow Split Point | 300 mm | 1,000 m |
| 2.4.2 Flow Split Point to West Kingscliff | 150 mm | 2,500 m |
| 2.4.3 Flow Split Point to Kings Forest | 300 mm | 7,200 m |

#### 5.4.3.5 COST ASSESSMENT

The assessment of capital costs was undertaken assuming the following:

- Costs of recycled water treatment plants was based on recent SEQ projects. A unit cost of $5m per ML of production was assumed for the micro-filtration and disinfection process required to achieve a Class A+ output.
- Costs of other major infrastructure are derived based on the 2006 unit rates provided by TSC.
- The cost to the developer to provide reticulation was adopted as $2,800 per lot based on assessment of similar developments.

Operation and maintenance costs were considered for the treatment plants and distribution assets are estimated in accordance with the following assumptions:

- Vendor quotations for membrane replacement
- Electricity cost of $0.12 / kWh
- Average day demand was assumed
- 10% labour of one operator ($100,000 per year) for distribution network
- 50% labour of one crew ($150,000 per year) for routine maintenance of distribution network

The NPV analysis was undertaken with a discount rate of 7%. It is noted that all capital work expenditure was assumed to be scheduled evenly from 2012 to 2014. Table 5-24 summarises the cost assessment results.

**Table 5-24 Summary of Recycled Water Trunk System Costs**

| Trunk Infrastructure | Capital Cost | 2007 NPV |
|---|---|---|
| **1. Banora Point System** | | |
| Trunk Mains | $12,539,800 | $8,368,553 |
| Reservoirs | $3,190,380 | $2,129,130 |
| Pumping Stations | $1,598,713 | $1,066,916 |
| MF/UV Treatment Plants | $12,480,000 | $8,328,645 |
| **Capital Cost Sub total** | **$29,808,893** | **$19,893,244** |
| Treatment Opex | - | $533,830 |
| Distribution Opex | - | $1,007,289 |
| **Total for Banora Point System** | | **$21,434,363** |
| **2. Kingscliff System** | | |
| Trunk Mains | $6,038,300 | $4,029,716 |
| Reservoirs | $1,111,863 | $742,012 |
| Pumping Stations | $458,417 | $305,929 |
| MF/UV Treatment Plants | $7,650,000 | $5,105,299 |
| **Capital Cost Sub total** | **$15,258,580** | **$10,182,956** |
| Treatment Opex | - | $499,102 |
| Distribution Opex | - | $833,701 |
| **Total for Kingscliff System** | | **$11,515,759** |
| **Total Cost for Recycled Water Trunk System** | **$45,067,472** | **$32,950,123** |

An assessment of the costs was undertaken to determine the cost allocation for each of the greenfield development areas. These costs are summarised in Table 5-25.

**Table 5-25 Summary of Recycled Water Costs by Development Area**

| Development | Total Capital Cost | Opex Cost / annum at 2036 | Total Reticulation Cost | Net Present Value of Costs |
|---|---|---|---|---|
| Cobaki Lakes | $13,490,453 | $9,676,800 | $117,423 | $17,933,269 |
| Bilambil Heights | $10,407,859 | $6,066,480 | $77,032 | $13,009,242 |
| Terranora Area A | $5,910,580 | $3,251,080 | $45,516 | $7,237,935 |
| Kingscliff | $2,433,131 | $1,665,720 | $29,630 | $3,432,941 |
| Kings Forest | $12,825,449 | $10,080,000 | $146,212 | $18,215,316 |

### 5.4.4 INDIRECT POTABLE REUSE ASSESSMENT

#### 5.4.4.1 OVERVIEW

This section explores the feasibility of Scenario 4 which comprises the implementation of an Indirect Potable Reuse (IPR) scheme in conjunction with the use of rainwater tanks in new development areas. The scheme would collect and treat flows at the Banora Point and Kingscliff Sewage Treatment Plants (STPs) and transport the renewed water to Clarrie Hall Dam.

5.4.4.2 APPROACH

Estimates of design flows for infrastructure sizing were based on estimates of Average Dry Weather Flow for Banora Point and Kingscliff STPs in 2036. ADWFs were calculated from the non-residential and residential internal flow estimates, excluding irrigation flows. It was assumed that for efficient, cost effective IPR treatment only 75% of these flows would be available as product water. Table 5-26 summarises the design flows.

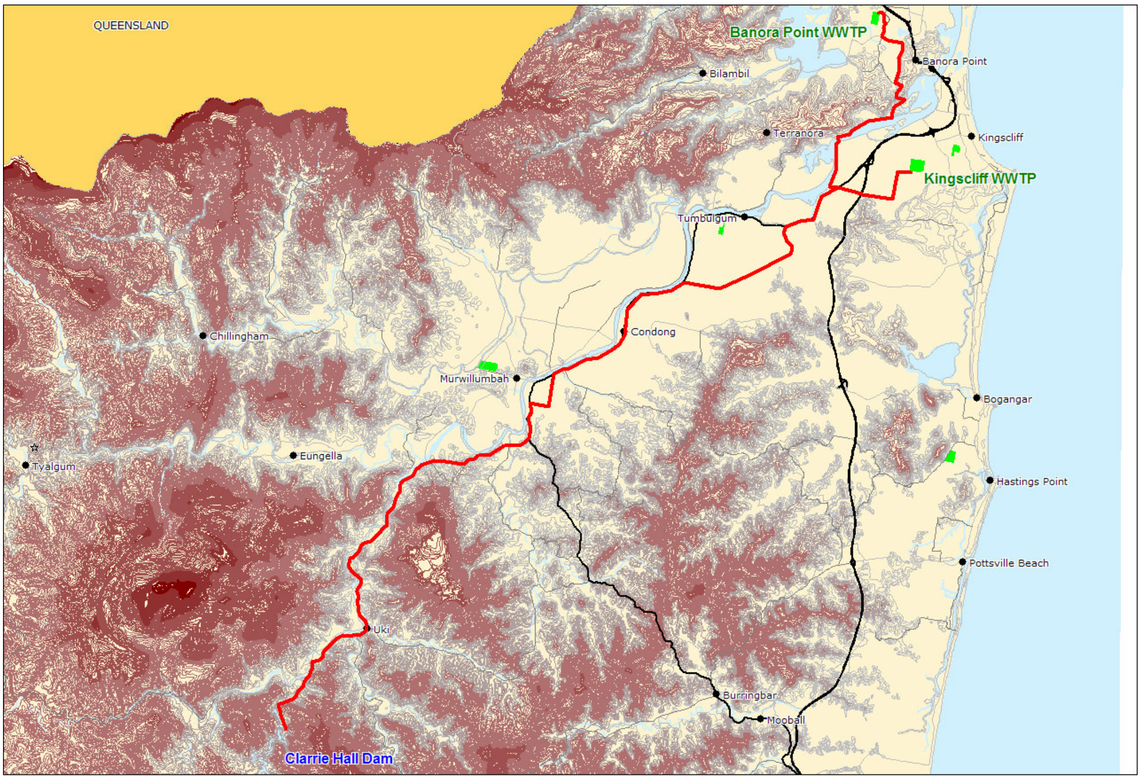
**Table 5-26 IPR Design Flows**

| Treatment Plant | ADWF | Treatable STP Outflows (75% Return) | |
|---|---|---|---|
| | ML/d | ML/d | L/s |
| Banora Point STP | 26.0 | 19.5 | 225.7 |
| Kingscliff STP | 11.0 | 8.3 | 95.5 |
| **Total** | **37.0** | **27.8** | **321.2** |

5.4.4.3 INFRASTRUCTURE ASSESSMENT

- The infrastructure required for the scheme was evaluated based on the assumptions above. A route was selected for the trunk main with associated pumping station locations selected as shown in Figure 5-8.

**Figure 5-8 Possible Route to Clarrie Hall Dam**



The following infrastructure was found to be required:

- Recycled water treatment plant consisting of micro-filtration, reverse osmosis and advanced oxidation at both Banora Point and Kingscliff STPs.
- Main (RM1a and RM1b) and associated pumping station from Banora Point STP to point of convergence with the Kingscliff main (200 kW pump serving 10.8 km of 450mm diameter main).
- Main (RM2) and associated pumping station from Kingscliff STP to point of convergence with Banora Point main (100 kW pump serving 3.6 km of 300mm diameter main).
- Main (RM3a & RM3b) from point of convergence of Kingscliff and Banora Point main to Clarrie Hall Dam (36 km of 600 mm diameter main).
- Pumping Station at point of convergence of Kingscliff and Banora Point main servicing the Clarrie Hall Main (400 kW pump).
- Booster Pumping Station, located approximately half way along the main trunk (250 kW pump).

Discharge structure at Clarrie Hall Dam.

#### 5.4.4.4 INFRASTRUCTURE COSTING

Current TSC unit costs were used for all infrastructure costs. The Net Present Value (NPV) of future asset costs were used to determine the final discounted values. The NPV calculations assumed a discount rate of 7%. It was assumed that all the infrastructure is constructed in 2012 and the IPR plant costs are distributed equally over the 2 year period 2011 to 2012. IPR plant cost estimates were based on actual costs for recent projects in South East Queensland. A capital cost of $7,000,000 / ML of production was adopted for the smaller Kingscliff plant and $6,000,000 / ML for the larger Banora Point plant, taking into account some economies of scale.

Table 5-27 provides a summary of all the capital costs associated with an IPR network from Banora Point and Kingscliff STPs.

**Table 5-27 Summary of Costs for Scenario 4 – Indirect Potable Reuse**

| Description | Net Present Value |
|---|---|
| Capital Cost - Mains | $49,838,590 |
| Capital Cost - Discharge Structure | $549,641 |
| Capital Cost - IPR Treatment Plants | $128,955,137 |
| Capital Cost - Pumping Stations | $2,621,402 |
| Opex Cost | $2,388,676/a |
| **Total NPV** | **$184,353,445** |

It is noted that costs presented in Table 5-27 do not include for rainwater tank installation in new residential development.

It can be seen that discounted capital costs for installation of an IPR network are estimated to be of the order of $180m with an operational cost of $2.4m (approx. $0.25m/annum). Additional inflow to Clarrie Hall Dam will be approximately 28 ML/d or 10,220 ML/a at 2036. Such a scheme is unlikely to be cost effective when compared to other options for bulk supply augmentation.

## 5.5 ENVIRONMENTAL IMPACT OF SCENARIOS

An initial review of the environmental impacts was undertaken. The two major areas of focus were the change of greenhouse gas emissions and the quality impacts on receiving waters from the reduced discharge through STP outfalls. As a surrogate for the water quality impacts the percentage reduction to the discharges at 2036 was used.

#### 5.5.1.1 GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions for the proposed greenfield scenarios were assessed based on a quantitative review of energy consumption of the scenarios. The change in energy use will vary for the various aspects of the water cycle. The following impacts are evident:

- Reduced water use will reduce energy required for both water treatment and transfer.
- Reduced sewage dry weather flow will reduce energy use.
- Widespread use of rainwater tanks has an associated and quite inefficient use of energy for pumping.
- Recycled water has an energy impact due to treatment and transfer.
- Reduced household energy use due to lower demand on hot water.
- Reduced extractions from the river for potable water.

The greenhouse gas emissions were assessed for each of the developments and the various scenarios. Assessment does not include the embedded carbon in materials or equipment. Results of the assessment are summarised in Table 5-28.

**Table 5-28 Summary of Greenhouse Gas Emission Reductions in 2036 (tonnes CO2/annum)**

| Greenfield Development | Scenario | Customer Hot Water Savings (1) | Potable Water System | Sewerage System | Recycled Water System | Rainwater Tank System | Total GGE Reduction (tonnes CO2) |
|---|---|---|---|---|---|---|---|
| Cobaki Lakes | Scenario 1 | 1,727 | 346 | 160 | 0 | -346 | 1,887 |
| | Scenario 2 | 1,727 | 409 | 160 | - 435 | 0 | 1,861 |
| | Scenario 3 | 1,727 | 597 | 160 | - 435 | -273 | 1,776 |
| Bilambil Heights | Scenario 1 | 1,165 | 387 | 80 | 0 | -225 | 1,407 |
| | Scenario 2 | 1,165 | 442 | 80 | - 373 | 0 | 1,314 |
| | Scenario 3 | 1,165 | 635 | 80 | - 373 | -180 | 1,327 |
| Terranora Area A | Scenario 1 | 578 | 54 | 36 | 0 | -105 | 563 |
| | Scenario 2 | 578 | 92 | 36 | - 187 | 0 | 519 |
| | Scenario 3 | 578 | 147 | 36 | - 187 | -80 | 494 |
| West Kingscliff | Scenario 1 | 476 | 90 | N/A | 0 | -82 | 484 |

| Greenfield Development | Scenario | Customer Hot Water Savings (1) | Potable Water System | Sewerage System | Recycled Water System | Rainwater Tank System | Total GGE Reduction (tonnes CO2) |
|---|---|---|---|---|---|---|---|
| | Scenario 2 | 476 | 96 | N/A | - 61 | 0 | 511 |
| | Scenario 3 | 476 | 138 | N/A | - 61 | -70 | 483 |
| Kings Forest | Scenario 1 | 1798 | 306 | 172 | 0 | -360 | 1,916 |
| | Scenario 2 | 1798 | 333 | 172 | - 299 | 0 | 2,004 |
| | Scenario 3 | 1798 | 490 | 172 | - 299 | -284 | 1,877 |
| Total Greenfield | **Scenario 1** | **5,744** | **1,183** | **448** | **0** | **-1118** | **6,257** |
| | **Scenario 2** | **5,744** | **1,373** | **448** | **- 1,168** | **0** | **6,397** |
| | **Scenario 3** | **5,744** | **2,007** | **448** | **- 1,168** | **-887** | **6,144** |

Note 1 – Assumes 68% electric hot water systems, 27% gas heating and 5% solar heating.

### 5.5.2 WATER QUALITY

The reduction in the discharge of effluent and therefore nutrients to the Tweed River will have a significant impact on waterway water quality. As the assessment of water quality is not part of this study, it is only possible to assess the volume of treated water that will be reused and as such not discharged to the river. Table **5-29** summarises the reduced discharges for the various scenarios. It is noted that these figures do not include for open space irrigation from these plants which would increase the volume of reuse.

**Table 5-29 Reduction of River Discharges**

| Scenario | Reduction in Discharge at 2036 (ML/a) | |
|---|---|---|
| | Banora Point STP | Kingscliff STP |
| Scenario 1 | 0 | 0 |
| Scenario 2 | 868 | 533 |
| Scenario 3 | 868 | 533 |
| Scenario 4 | 7,117 | 3,030 |

## 5.6 SUMMARY OF GREENFIELD SCENARIO ASSESSMENT

### 5.6.1 WATER SAVINGS

Water savings are outlined in Table 5-11. The assessment of water savings for the scenarios indicated that:

- Scenario 1 will save of the order of 34 to 38% in all areas except West Kingscliff, where the savings are likely to be around 9%.
- Scenario 2 will save of the order of 42% for all areas except West Kingscliff, where the savings will be lower at around 36%.
- Scenario 3 will save around 62% for all developments except West Kingscliff, where the savings are likely to be around 52%.

Of the total savings the largest of the developments (Cobaki Lakes and Kings Forest) account for 70% of the total. In total savings from these areas range from around 800 ML/a for Scenario 1 to 1,300 ML/a for Scenario 3. To put this in perspective the baseline forecast for 2036 is around 21,000 Ml/a.

### 5.6.2 OVERALL COST COMPARISON

An overall cost assessment was undertaken for each of the scenarios for each greenfield development area. The total NPV contained costs for the following elements:

- Council Capital Costs – assumed to be costs related to the provision of headworks for potable water, recycled water and sewerage. For sewerage it was assumed that RIGS would be adopted.
- Customer Capital Costs – assumed to be the costs related to provision of rainwater tanks and reticulation costs for potable water, recycled water and sewerage.
- Council Operational Costs – assumed to be the on-going costs of operating the systems including , operational costs for pumping stations, marginal treatment costs (energy and chemicals), as well as the cost of compliance testing and inspections.
- Customer Operational Costs – assumed to be the costs of operating a rainwater tank as well as the benefits of lower energy costs from hot water savings.

The cost assessment is summarised in **Error! Reference source not found.** and Figure 5-10 for the total NPV and the per person cost respectively. A summary by development with assessment of the costs relating to the council and the customer is provided in Table 5-30.

**Table 5-30 Summary of Costs for Greenfield Scenarios**

| Greenfield Development | Scenario | Capital Cost NPV | | | Operational Cost NPV | | | Total NPV | $/kL saved |
|---|---|---|---|---|---|---|---|---|---|
| | | NPV - Council | NPV - Customer | Total Capital Works NPV | NPV - Council | NPV - Customer | Total Opex NPV | | |
| Cobaki Lakes | Baseline | $12,069,585 | $13,070,927 | $25,140,512 | $920,627 | $0 | $920,627 | $26,061,139 | |
| | Baseline (RIGS) | $10,474,767 | $10,487,421 | $20,962,188 | $0 | $0 | $860,797 | $21,822,985 | |
| | Scenario 1 | $9,946,978 | $14,982,092 | $24,929,070 | $252,733 | $1,297,723 | $2,256,010 | $27,185,080 | 2.14 |
| | Scenario 2 | $17,684,750 | $12,669,596 | $30,354,346 | $1,573,247 | $0 | $2,257,376 | $32,611,722 | 3.86 |
| | Scenario 3 | $17,684,750 | $17,164,267 | $34,849,017 | $1,825,980 | $1,297,723 | $3,717,775 | $38,566,792 | 3.98 |
| Bilambil Heights | Baseline | $10,631,749 | $8,663,705 | $19,295,454 | $497,615 | $0 | $497,615 | $19,793,068 | |
| | Baseline (RIGS) | $9,223,750 | $6,916,608 | $16,140,358 | $0 | $0 | $448,900 | $16,589,258 | |
| | Scenario 1 | $8,842,210 | $9,878,205 | $18,720,415 | $199,682 | $855,055 | $1,474,976 | $20,195,391 | 2.09 |
| | Scenario 2 | $14,781,202 | $8,284,578 | $23,065,780 | $827,043 | $0 | $1,247,282 | $24,313,062 | 4.14 |
| | Scenario 3 | $14,781,202 | $11,246,175 | $26,027,377 | $1,026,725 | $855,055 | $2,260,130 | $28,287,507 | 4.22 |
| Terranora Area A | Baseline | $2,965,760 | $3,741,999 | $6,707,759 | $199,206 | $0 | $199,206 | $6,906,965 | |
| | Baseline (RIGS) | $2,578,085 | $3,050,373 | $5,628,458 | $0 | $0 | $185,641 | $5,814,099 | |
| | Scenario 1 | $2,512,492 | $4,361,436 | $6,873,927 | $132,779 | $378,580 | $668,340 | $7,542,267 | 2.10 |
| | Scenario 2 | $6,097,398 | $3,783,590 | $9,880,989 | $423,929 | $0 | $565,359 | $10,446,348 | 4.22 |
| | Scenario 3 | $6,097,398 | $5,094,653 | $11,192,051 | $556,709 | $378,580 | $1,050,379 | $12,242,430 | 4.18 |
| Kings Forest | Baseline | $9,230,183 | $13,615,549 | $22,845,732 | $720,898 | $0 | $720,898 | $23,566,629 | |
| | Baseline (RIGS) | $6,798,165 | $8,391,258 | $15,189,423 | $0 | $0 | $702,351 | $15,891,774 | |
| | Scenario 1 | $6,952,936 | $15,606,346 | $22,559,281 | $259,560 | $1,351,795 | $2,125,511 | $24,684,792 | 3.22 |
| | Scenario 2 | $15,446,079 | $13,197,496 | $28,643,575 | $1,266,068 | $0 | $1,772,484 | $30,416,060 | 5.01 |
| | Scenario 3 | $15,446,079 | $17,879,445 | $33,325,524 | $1,525,627 | $1,351,795 | $3,305,558 | $36,631,083 | 4.75 |
| West Kingscliff | Baseline | $421,538 | $611,722 | $1,033,260 | $120,931 | $0 | $120,931 | $1,154,191 | |
| | Baseline (RIGS) | $421,538 | $611,722 | $1,033,260 | $0 | $0 | $120,931 | $1,154,191 | |
| | Scenario 1 | $385,737 | $1,781,871 | $2,167,608 | $139,352 | $337,764 | $556,969 | $2,724,576 | 2.41 |
| | Scenario 2 | $1,950,902 | $987,193 | $2,938,095 | $411,031 | $0 | $489,722 | $3,427,817 | 3.40 |
| | Scenario 3 | $1,950,902 | $2,157,342 | $4,108,244 | $550,382 | $337,764 | $946,985 | $5,055,229 | 4.00 |

| Greenfield Development | Scenario | Capital Cost NPV | | | Operational Cost NPV | | | Total NPV | $/kL saved |
|---|---|---|---|---|---|---|---|---|---|
| | | NPV - Council | NPV - Customer | Total Capital Works NPV | NPV - Council | NPV - Customer | Total Opex NPV | | |
| Total Greenfield | **Baseline** | **$35,318,814** | **$39,703,902** | **$75,022,717** | **$2,459,276** | **$0** | **$2,459,276** | **$77,481,993** | |
| | **Baseline (RIGS)** | $29,496,305 | $29,457,382 | $58,953,687 | $0 | $0 | $2,318,620 | $61,272,307 | |
| | **Scenario 1** | $28,640,351 | $46,609,950 | $75,250,301 | $984,106 | $4,220,918 | $7,081,805 | $82,332,106 | 2.45 |
| | **Scenario 2** | $55,960,331 | $38,922,453 | $94,882,784 | $4,501,318 | $0 | $6,332,224 | $101,215,009 | 4.28 |
| | **Scenario 3** | $55,960,331 | $53,541,883 | $109,502,213 | $5,485,424 | $4,220,918 | $11,280,828 | $120,783,041 | 4.29 |

**Figure 5-9 Summary of Total NPV for Greenfield Scenarios**

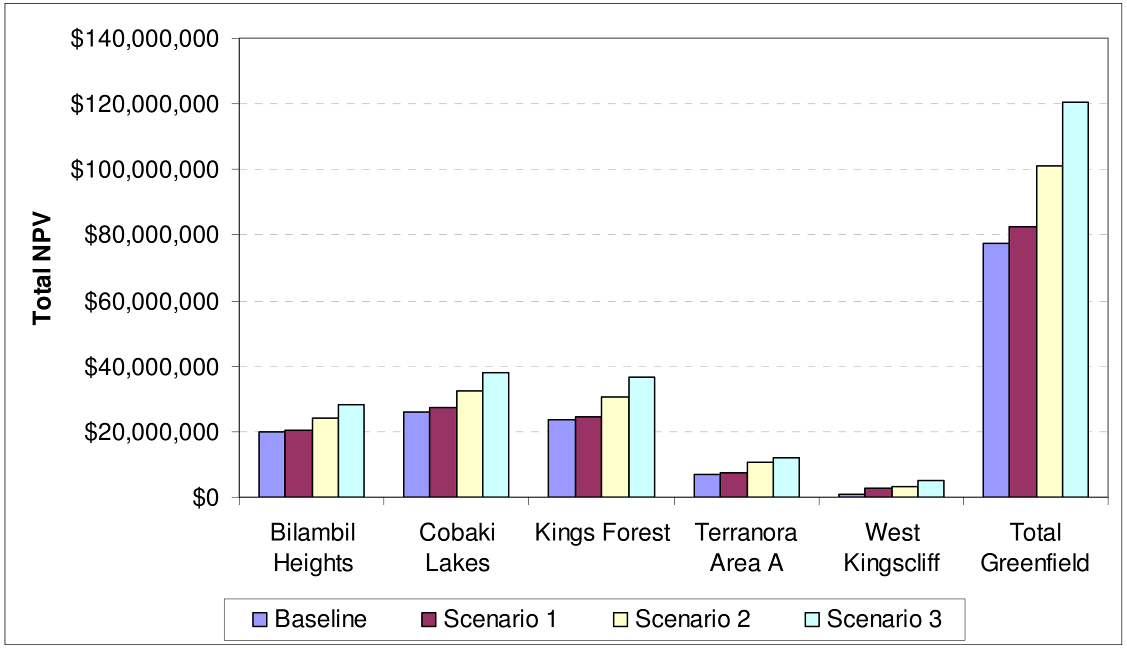
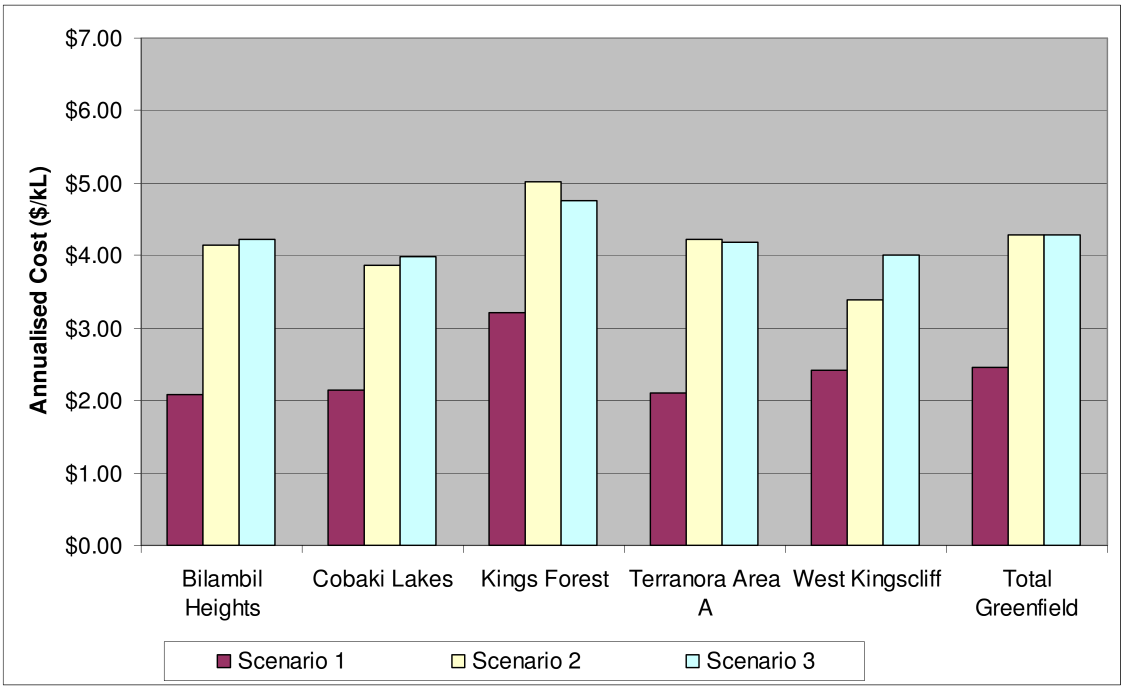


**Figure 5-10 Estimated Annualised Cost ($/kL Saved) in Greenfield Developments**




The cost summary indicates that:

- Scenario 1 has an increase of $4.7m (or 6%) in the capital NPV over the baseline case. If this assessment only included potable water costs there would be an increase of a further $4.1m to around $8.2m. The lower NPV is due to the downsizing of the sewerage system resulting from to the implementation of RIGS. This option also has the cost impost of rainwater tanks which increases the whole of community cost to be higher than the baseline.
- Scenario 2 and 3 have a significantly increased cost for capital works due to the inclusion of the recycled water system. Although these costs are offset through reductions in the potable supply system and the sewerage system, these are not sufficient to prevent major cost increases.
- Operational costs increase significantly for the addition of a recycled network.
- From an overall cost perspective the Scenario 1 has only a small increase (6%) in whole of life costs compared to the baseline, however Scenarios 2 and 3 (which include recycled water) have an increase of 17 and 56% respectively. The high cost of Scenario 3 is primarily the result of competition for water end uses for the two source substitution measures. Therefore the costs are doubled but the savings are not impacted to the same level.

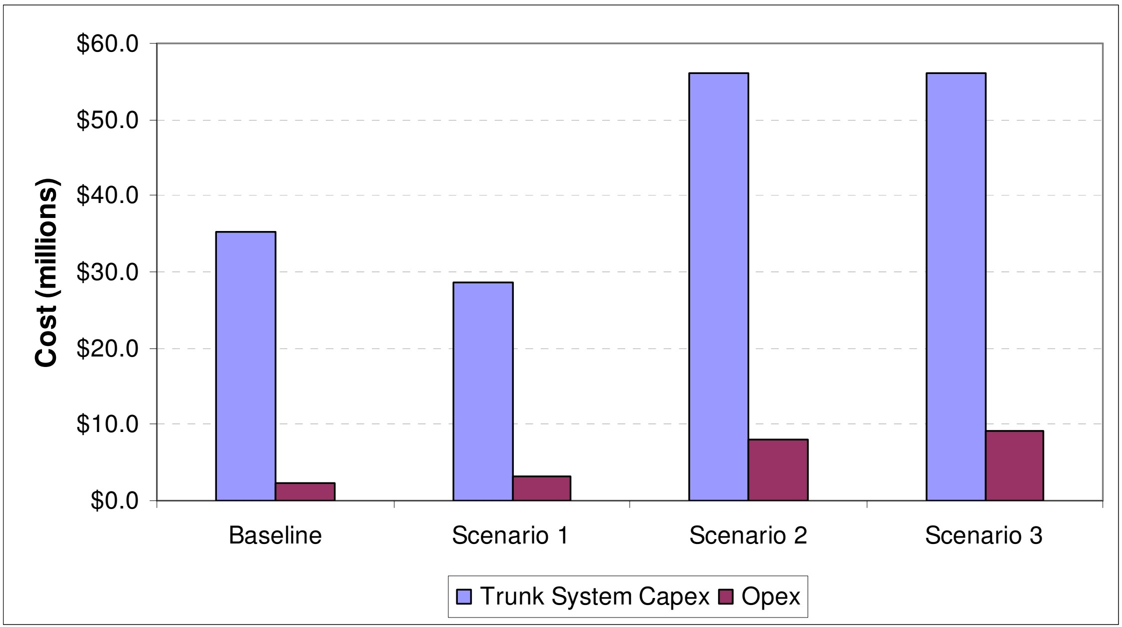
### 5.6.3 TRUNK SYSTEM COST COMPARISON

One of the major issues relating to the development of land is the level of infrastructure charges that are applied for access to water related services. The scope of this study did not include the full assessment of Headworks Charges or the impact of the scenarios on the current charges, however the trunk infrastructure assessments undertaken provide a guide to the relativity of the charges. Table 5-31 summarises the overall costs of the trunk infrastructure for the various scenarios.

**Table 5-31 Summary of Trunk System Costs for Greenfield Scenarios**

| Greenfield Development | Scenario | Potable Water NPV | Sewerage NPV | Recycled Water NPV | Total Net Present Value |
|---|---|---|---|---|---|
| Cobaki Lakes | Baseline | $7,486,577 | $4,583,008 | N/A | $12,069,585 |
| | Scenario 1 | $6,958,788 | $2,988,190 | N/A | $9,946,978 |
| | Scenario 2 | $5,693,579 | $2,988,190 | $9,002,980 | $17,684,749 |
| | Scenario 3 | $5,693,579 | $2,988,190 | $9,002,980 | $17,684,749 |
| Bilambil Heights | Baseline | $7,140,157 | $3,491,592 | N/A | $10,631,749 |
| | Scenario 1 | $6,758,617 | $2,083,593 | N/A | $8,842,210 |
| | Scenario 2 | $5,751,826 | $2,083,593 | $6,945,783 | $14,781,202 |
| | Scenario 3 | $5,751,826 | $2,083,593 | $6,945,783 | $14,781,202 |
| Terranora Area A | Baseline | $1,263,991 | $1,701,770 | N/A | $2,965,760 |
| | Scenario 1 | $1,198,397 | $1,314,095 | N/A | $2,512,492 |
| | Scenario 2 | $838,822 | $1,314,095 | $3,944,481 | $6,097,399 |
| | Scenario 3 | $838,822 | $1,314,095 | $3,944,481 | $6,097,399 |
| Kings Forest | Baseline | $4,714,572 | $4,515,611 | N/A | $9,230,183 |
| | Scenario 1 | $3,862,947 | $3,089,988 | N/A | $6,952,935 |
| | Scenario 2 | $3,353,111 | $3,089,988 | $9,002,980 | $15,446,079 |
| | Scenario 3 | $3,353,111 | $3,089,988 | $9,002,980 | $15,446,079 |
| West Kingscliff | Baseline | $421,538 | N/A | N/A | $421,538 |
| | Scenario 1 | $385,737 | N/A | N/A | $385,737 |
| | Scenario 2 | $327,129 | N/A | $1,623,773 | $1,950,902 |
| | Scenario 3 | $327,129 | N/A | $1,623,773 | $1,950,902 |
| **Total Greenfield** | **Baseline** | **$21,026,834** | **$14,291,980** | **N/A** | **$35,318,814** |
| | **Scenario 1** | **$19,164,486** | **$9,475,866** | **N/A** | **$28,640,352** |
| | **Scenario 2** | **$15,964,468** | **$9,475,866** | **$30,519,997** | **$55,960,331** |
| | **Scenario 3** | **$15,964,468** | **$9,475,866** | **$30,519,997** | **$55,960,331** |

**Figure 5-11 Summary of Trunk Capital and Operational NPV for Greenfield Development**




### 5.6.4 CUSTOMER COST COMPARISON

The cost to householders is an important issue to consider when assessing scenarios which ultimately must be paid for by the residents of a new development. An initial assessment of the change in cost burden on the Single Family Residential dwelling was undertaken to review the impact. Obviously the situation would be different for all households, however an example of a home built in 2012 was reviewed. The review is summarised in Table 5-32 and takes account of the major costs and benefits for the home owner. This calculation is undertaken for a period up to 2036 and does not consider the headworks or rates impact as these are considered separately.

**Table 5-32 Direct Cost of Scenarios to SFR Customers (not including Headworks and Usage Charges)**

| Scenario | Rainwater Tank | | Potable Water | Recycled Water | Sewer | Annual Water Savings | Annual Hot Water Savings | Total NPV |
|---|---|---|---|---|---|---|---|---|
| | Capital Cost | Annual O&M | | | | | | |
| Baseline | 0 | 0 | $2,800 | 0 | $3,630 | 0 | 0 | **$6,430** |
| Scenario 1 | $3,000 | $60 | $2,800 | 0 | $2,640 | $81 | $47 | **$7,872** |
| Scenario 2 | $3,000 | $60 | $1,880 | $2,800 | $2,640 | $88 | $47 | **$6,196** |
| Scenario 3 | $3,000 | $60 | $1,880 | $2,800 | $2,640 | $149 | $47 | **$9,188** |

Based on this assessment the adoption of rainwater tanks (Scenario 1) or dual reticulation (Scenario 2) alone results in a minimal increase in the direct cost to the household in the longer term. However, the cost to the customer of adopting both recycled water and rainwater tanks (Scenario 3) is increased by around 50% over the baseline costs. This is primarily due to the higher up front costs and the lower relative savings of this scenario.

### 5.6.5 COUNCIL COST COMPARISON

Costs to Council relate to the set up costs for programs and the on-going costs of compliance. For recycled water to be delivered to households Council would be required to develop a Recycled Water Management Plan which includes comprehensive monitoring and compliance testing regimes to reduce the risk of cross contamination in the potable system. For rainwater tanks a similar, but less complex or onerous system of compliance is necessary.

In addition, operation, maintenance and depreciation of assets must be funded for the recycled water system. These costs would normally be passed on to residents and businesses through annual rates. Options available for Council include:

- Recover all costs through user pays charging for the use of recycled water.
- Recover costs through an increase in the sewerage charge levied on the whole community. This recognises that removing nutrients from the waterways is a community responsibility that should be paid for by all rather than a small section of the community.
- Combination of the above, taking account of the benefits that the householder gains in terms on reduced water bills. For example the treatment costs may be spread over the whole community and the balance could be paid by the user.

Broadly estimated cost of recycled water is summarised in Table 5-33.

**Table 5-33 Estimated Cost to Council of Recycled Water Management**

| Cost Description | Estimated Cost |
|---|---|
| **Recycled Water** | |
| Management Plan | $150,000 |
| Compliance Testing | $50 /property/annum |
| **Rainwater Tanks** | |
| Management Plan | $30,000 |
| Compliance Testing | $30 /property/annum |

### 5.6.6 ENVIRONMENTAL COMPARISON

Based on the assessment of environmental impacts in Section 5.5, the following conclusions are evident:

- Scenarios 2 and 3 (recycled water) will reduce the discharge to the waterways by approximately 10 -12 % over the baseline forecast. Nutrient discharge will provide a similar level of reduction.

- Although it appears that Scenario 4 (Indirect Potable Reuse) will provide a reduction of 75% of the dry weather flow to the rivers, the level of nutrient reduction will be significantly less. This is due to the fact that the Reverse Osmosis brine needs to be discharged to the rivers. The brine contains the majority of the nutrients that are present. In essence the concentration of nutrients will be increased and this may have a more detrimental impact than the present discharge.
- Greenhouse gases for all options are essentially neutral as the additional energy usage for the recycled water and rainwater systems are offset by the savings in hot water generation.

## 5.7 ADDITIONAL ASSESSMENT OF COBAKI LAKES DEVELOPMENT OPTIONS

Additional assessment of options was undertaken as an addendum to the report. The assessment considered the option of a stand alone decentralised option instead of centralised treatment at the Banora Point STP. Two options were reviewed as follows:

- Option 1 – Centralised Treatment at Banora Point STP. Under this option, sewage would be transferred to the existing Banora Point STP for treatment to Class A+ standard and then returned to the Cobaki Lakes development area for reuse. It would be proposed that the recycled water woul be used on external areas and
- Option 2 – Cobaki Lakes Treatment Facility. This option involves the construction of a sewage treatment plant at the southern end of the Cobaki Lakes development. A Class A+ water recycling facility would be constructed for use in the development residential and commercial sectors with the major end uses being landscaping, toilets and open space irrigation. Sewage from Bilambil Heights would also be treated at this facility. It is proposed that there would be no discharge from the site to the existing sewerage system.

For both options it was necessary to consider the collection and treatment of both the Cobaki Lakes and Bilambil Heights developments as either of these developments will trigger a requirement to upgrade the sewerage system between Cobaki Creek and the Banora Point STP.

Based on assessment of the two options for provision of recycled water to the Cobaki lakes development it is evident that Option 2, with a treatment plant located at the development is significantly lower in cost than a centralised system with treatment at Banora Point. Option 2 is approximately $5.1 m or 17% lower in NPV than Option 1. The major reasons for the difference in NPV are as follows:

- The Cobaki STP is constructed in 2 stages rather than a single large stage at Banora Point.
- Costs of transferring raw sewage and recycled water to and from the STP are greatly reduced.

Any decision to adopt one of these options must however take account of the additional costs for the implementation of the recycled water scheme. These costs relate to the development of education program, billing systems, testing and compliance and reporting. On the other hand there are savings related to the reduction in water use resulting from substitution of existing potable end uses with recycled water.

On the balance, costs of provision of recycled water to customers in the development will be higher than that of potable water. The benefits to the environment do need to be considered. Nutrient mass loads discharged to the Tweed River will be lowered as a result of the approach.

Obviously it will be necessary to gain State Government approval for a discharge to either Cobaki Creek or further downstream. If such a license is not granted, storage will be required on site with a dry weather capacity connection to the existing sewerage system at SPS 2052. The costs of such a connection were not included in the assessment.

It was concluded that although the capital and operating costs of the decentralised treatment option are lower than the option of treating all water at Banora Point, the overall cost of providing recycled water are substantially higher than for potable water. The overall cost to the community is higher than for potable water and these costs would need to be passed on through the price of recycled water. These higher costs are however balanced in some way by the reduction in nutrients and greenhouse gas generation for the business as usual option of centralised sewage treatment without recycling.

Council should therefore consider a local scheme to recycle water should the developer propose this approach. A detailed assessment of the impact on developer charges and rates should however be undertaken should a formal proposal be submitted.

# 6. OPTIONS ASSESSMENT FOR BROWNFIELD AREAS

## 6.1 OVERVIEW

An assessment was undertaken to identify and analyse the costs and benefits of implementing demand management measures in the existing or 'brownfield' areas of Tweed Shire. This section of the report outlines the development of integrated water scenarios, the assessment of water forecasts and the costs and benefits of available options.

## 6.2 DEMAND MANAGEMENT OPTIONS ASSESSMENT

### 6.2.1 SCENARIO DEFINITION

For the brownfield areas of the shire, four scenarios were developed in conjunction with council representatives. These scenarios comprise a range of water efficiency measures, source substitution and water loss management options. The scenarios are defined as follows:

- Scenario 1 – BASIX with a Rainwater Tank serving external, cold water for washing machines and toilets combined with the WELS Program.
- Scenario 2 – BASIX with a Rainwater Tank serving external, cold water for washing machines and toilets combined with the WELS Program and a Loss Management Program.
- Scenario 3 – Selected Demand Management Options including a range of measures to reduce water demand in the residential sector.
- Scenario 4 – Enhanced Demand Management Options including Scenario 3 measures plus Non Residential sector measures.

Each of the above scenarios reflects the current legislative requirements for new residential dwellings in NSW according to the Building Sustainability Index (BASIX). All scenarios consider the installation of water efficient fixtures including showerheads, taps and dual flush toilets. In accordance with BASIX these fixtures are required to be rated at 3 Stars or higher. Furthermore, a 5 kL rainwater tank servicing external uses, cold water for washing machine and toilets has been assumed to be connected to fulfil the BASIX requirements. The sizing of the rainwater was undertaken in Section 5.3.1 of this report.

Besides the water savings generated through BASIX, additional savings from residential and non-residential measures such as educational programs, residential audit programs, residential end use specific rebates and retrofit programs, the national water efficiency labelling and standards (WELS) scheme and the influence of future pricing paths have been considered.

### 6.2.2 SCENARIO 1 – BASIX / WELS PROGRAM

Scenario 1 reflects the current legislative requirements for new residential developments in NSW according to the Building Sustainable Index (BASIX) and the national Water Efficiency Labelling and Standards (WELS) scheme. This scenario mandates the installation of water efficient fixtures as discussed above, including a 5 kL rainwater tank.

The WELS program was introduced in 2005 by the Federal Government to encourage the purchase and installation of water efficient appliances and fixtures. This scenario enhances the market share of water efficient showerheads, washing machines and dishwashers.

### 6.2.3 SCENARIO 2 – BASIX/WELS PROGRAM AND LEAKAGE MANAGEMENT

Scenario 2 extends Scenario 1 to include a Loss Management Strategy with an aim to reduce the current losses to below 10% by 2010. Section 6.2.3.1 discusses Tweed Shire's current approach to water loss management in accordance to their Water Loss Management Program (WLMP), while Section 6.2.3.2 investigates the Active Leakage Management options that have been assessed in this scenario, such as the implementation of District Metering Areas (DMAs) and Pressure Management Areas (PMAs) to monitor and reduce losses.

#### 6.2.3.1 CURRENT APPROACH TO WATER LOSS MANAGEMENT

Based on documents provided by TSC the current loss management strategy follows the framework provided by the state government sponsored Water Loss Management Program (WLMP). The current strategy includes the following activities to reduce leakage:

- Pipe Replacement Program: To upgrade poorly performing and aging pipes.
- Customer Service System: To improve the response times for reporting and actioning water breaks.
- Meters on Water Standpipes: To enforce the use of metered standpipes to accurately record the volume of water taken from the system by water carters.
- Water Meter Replacement Program: To replace all domestic water meters every 10 years to achieve the accuracy required by the Australian Standard.

Although these actions are essential to reduce the level of NRW, the program does not currently include any elements of active leakage management, such as pressure management or leakage detection and repair. Based on the current approach it is not likely that the NRW target of 10% set under the IWCM Concept Study and adopted by Council will be met.

#### 6.2.3.2 ACTIVE LEAKAGE MANAGEMENT OPTIONS

In accordance with the recommendations of the WBI (refer to Section 4.2.4.2), a range of active leakage reduction activities are required to reduce water losses to below 10%. Costs and benefits of these active leakage reduction options are assessed as part of this study.

The key assumptions and adopted cost rates are also listed below (based on data provided by TSC and recent information from leakage reduction program in South East Queensland):

- Active Leakage Detection and Repair:
    - Number of bursts in existing system: 0.4/km
    - Cost for leakage inspection: $209/km
    - Repair costs: 1,880 per leak

  - Percentage reduction in avoidable losses on repair: 75%
  - Life span for loss reduction: 3 years
- Pressure Management Areas (PMA)
  - Number of service connections per PMA: 1,500
  - Number of PMAs: 13
  - Cost for the PMA establishment: $150,000 per PMA
  - Operation and Maintenance Cost: $15,000 /annum
  - Percentage of system covered by Pressure Management: 60%
  - Percentage of reduction in pressure in PMA: 20% (50m to 40m head)
- District Metering Area (DMA)
  - Number of service connections per DMA: 1,500
  - Number of DMAs: 7
  - Cost for the DMA establishment: $50,000 per DMA
  - Operation and Maintenance Cost: $15,000 /annum

By applying the above cost rates and assumptions, the current water losses percentage (13.6%) could be reduced to 9.6% in 2011 if the WLMP actions are implemented from 2008. An annual water saving of 320 ML/a or 0.88 ML/d could be achieved by 2011. The capital cost to implement the active leakage program is estimated to be approximately $2.8m, with a on-going operation and maintenance cost of $0.3 to $0.5m /a.

### 6.2.4 SCENARIO 3 – SELECTED DEMAND MANAGEMENT OPTIONS

Scenario 3 is a further extension of Scenario 2 but including a suite of demand management initiatives, such as residential retrofits, rebates for water efficient fixtures and a residential audit program, designed to develop long term reductions in water use.

Table 6-1 summarises the demand management measures available for Scenario 3, and details key assumptions for each.

**Table 6-1 Overview of Possible Demand Management Options for Brownfield Areas**

| Program | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| **WELS Program** | | | |
| Water efficient showerheads | All residential dwellings | Increased sale of efficient showerheads by 5% | 15 % savings of current shower demand |
| Water efficient washing machines | | Increased sale of efficient washing machines by 7% | 30% savings of original household washing machine demand |
| Water efficient dishwashers | | Increased sale of efficient dishwashers by 2% | 20% savings of original dishwasher demand |
| **Education** | | | |
| Behavioural changes and awareness | All single and multi-family residential dwellings | 100% of residential accounts | 1% savings for all internal end uses and 2% of external end uses |

| Program | Target Sector | Take up Rate | Water Savings |
|---|---|---|---|
| Landscape Use Efficiency Awards | Existing residential dwellings | 10 % of residential accounts | 10% of external and irrigation demand |
| **BASIX Efficient Fixture Requirements** | | | |
| Water efficient taps (minimum 3 Star) | All new single and multi-family residential dwellings | 100 % of new residential accounts | 20 % savings of current demand for taps and sinks |
| Water efficient shower heads (minimum 3 Star) | | 100 % of new residential accounts | 15 % savings of current shower demand |
| Water efficient dual flush toilet (minimum 3 Star) | | 100 % of new residential accounts | 40 % savings current existing toilet demand |
| **BASIX Source Substitution (Rainwater Tanks)** | | | |
| 5kL Rainwater Tank | All new single and multi-family residential dwellings | 100 % of new residential accounts | Connected to external taps, toilet and cold water laundry. |
| **Loss Management Program** | | | |
| Leakage detection and Pressure Reduction Program | Non Revenue Water | Savings achieved over 3 years and maintained | Reduction of NRW from 13.6 % to below 10 % of production |
| **Residential Audit Program** | | | |
| Council Subsidised Voluntary Residential Efficiency Audit | Existing residential dwellings | 10 % of existing single and multi-family dwellings (3,200 by 2036) | 5% savings for all internal end uses and 10% of external end uses |
| **Residential Retrofit Service** | | | |
| Council Subsidised Voluntary Residential Retrofit Service | Existing residential dwellings | 25 % of existing single and multi-family residential dwellings (7,400 retrofits by 2011) | Program targeting the retrofit of water inefficient showerheads and taps to 3 Star or better. 10 % savings of current demand for taps and a 15 % savings of current shower demand |
| **Residential End Use Specific Rebate Program** | | | |
| Washing Machine Rebate | Existing residential dwellings | 10 % of existing single and multi-family residential dwellings (3,200 rebates by 2011) | 30 % saving from the current demand for washing machines |
| Showerhead Rebate | | 15 % of existing single and multi-family residential dwellings (4,600 rebates by 2011) | 15 % savings of current shower demand |
| Rainwater Tank Rebate | | 10 % of existing single family residential dwellings (1,800 rebates by 2011) | Yielding 80 % of current external demands |

An assessment of the water savings and annualised costs of the individual measures described above was undertaken and the results are provided in Table 6-2.

**Table 6-2 Individual Measures - Water Savings and Annualised Cost**

| Measure Description | Annual Potable Water Savings (ML/a) | | | Annualised Cost ($/kL) |
|---|---|---|---|---|
| | 2016 | 2036 | Avg. | |
| BASIX Fixtures and WELS | 219 | 532 | 290 | $0.02 |
| BASIX - Internal/External Rainwater Tank (5 kL) | 827 | 2,611 | 1,277 | $4.42 |
| Inclining Block Tariff | 33 | 60 | 36 | $0.04 |
| Residential Education Program | 76 | 73 | 70 | $0.88 |
| Landscape Use Efficiency Awards | 62 | 71 | 57 | $1.17 |
| Residential Rebate Program - Showerheads | 29 | 10 | 20 | $0.51 |
| Residential Rebate Program - Washing Machines | 16 | 4 | 11 | $14.23 |
| Residential Rebate Program - Rainwater Tanks | 91 | 104 | 85 | $4.64 |
| Pressure and Leakage Management Program | 532 | 813 | 556 | $0.94 |
| Residential Retrofit | 77 | 65 | 68 | $1.34 |
| Residential Audit Program | 54 | 64 | 50 | $1.56 |
| **Total** | **1,900** | **3,993** | **2,328** | |

Based on the results of the above assessment the majority of the proposed demand management measures assessed are likely to be cost effective. The exceptions were the rebate programs for rainwater tanks and washing machines, which were not included in the program.

It is noted that the majority of water savings result from two programs – BASIX with rainwater tanks for infill development and the loss reduction program.

#### 6.2.5 SCENARIO 4 – FULL SUITE OF DEMAND MANAGEMENT OPTIONS WITH ENHANCED NON RESIDENTIAL EFFICIENCIES

Scenario 4 utilises the demand management options developed for Scenario 3, and includes a 10% reduction in demand for all existing and new non residential accounts to be achieved by 2010. It is assumed that this level of demand reduction could be achieved through the introduction of programs such as business audit program and demand management plans for high water users as well as education and possible rebate programs designed to encourage the retrofit of water efficient fixtures e.g. spray rinse valves or waterless urinals. The non-residential efficiency will be subject to further assessment in the next stage of the Demand Management Program.

## 6.3 REVISED DEMAND FORECAST – BROWNFIELD AREAS

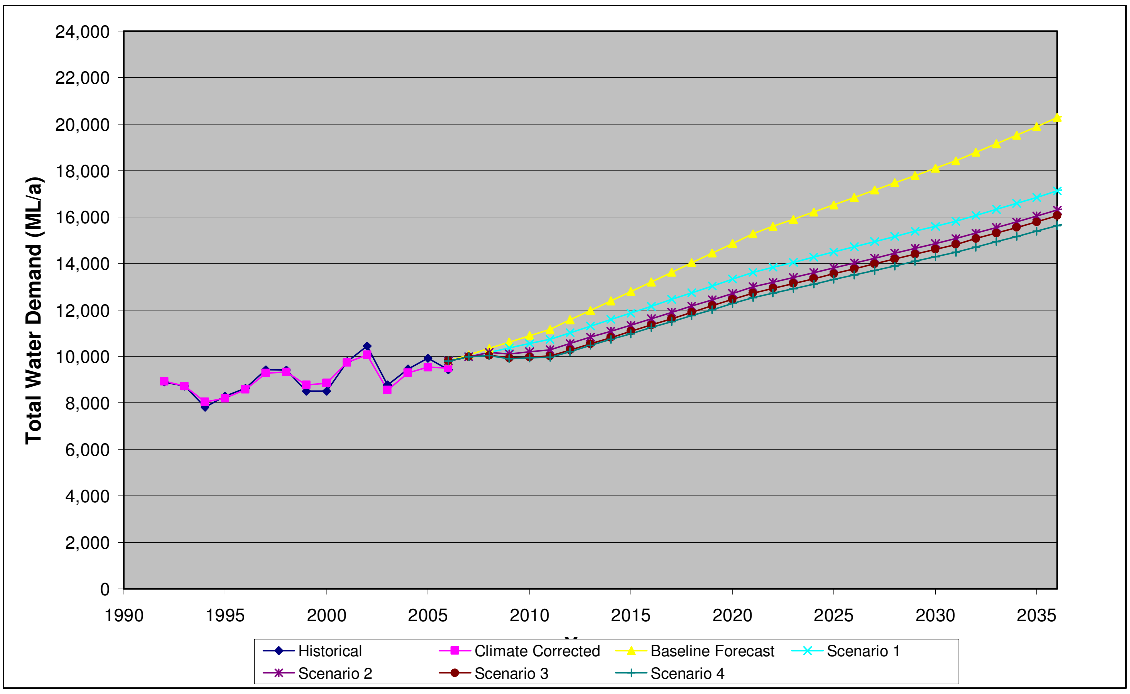
A summary of the future water demand management outcomes for the brownfield areas of Tweed Shire, based on the assessment of demand for each brownfield scenario is provided in the following figures and tables. The assessment indicated that on an annual basis the following savings can be achieved in 2036:

- Scenario 1 will save approximately 16% over the baseline.
- Scenario 2 will save approximately 20% over the baseline.
- Scenario 3 will save approximately 21% over the baseline.
- Scenario 4 will save approximately 23% over the baseline.

### Table 6-3 Total Annual Water Demand Forecast – Brownfield Areas Only

| Brownfield Scenario | Annual Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Baseline Forecast | 9,804 | 11,160 | 13,207 | 15,278 | 16,840 | 18,425 | 20,280 |
| Scenario 1 – BASIX / WELS | 9,804 | 10,737 | 12,158 | 13,618 | 14,716 | 15,827 | 17,129 |
| Scenario 2 - BASIX /WELS and Loss Management Program | 9,804 | 10,293 | 11,620 | 12,990 | 14,024 | 15,073 | 16,304 |
| Scenario 3 – Scenario 2 plus Active Demand Management Options | 9,804 | 10,014 | 11,353 | 12,731 | 13,770 | 14,822 | 16,053 |
| Scenario 4 – Scenario 3 plus Non Residential Demand Management | 9,804 | 9,970 | 11,236 | 12,536 | 13,505 | 14,485 | 15,635 |

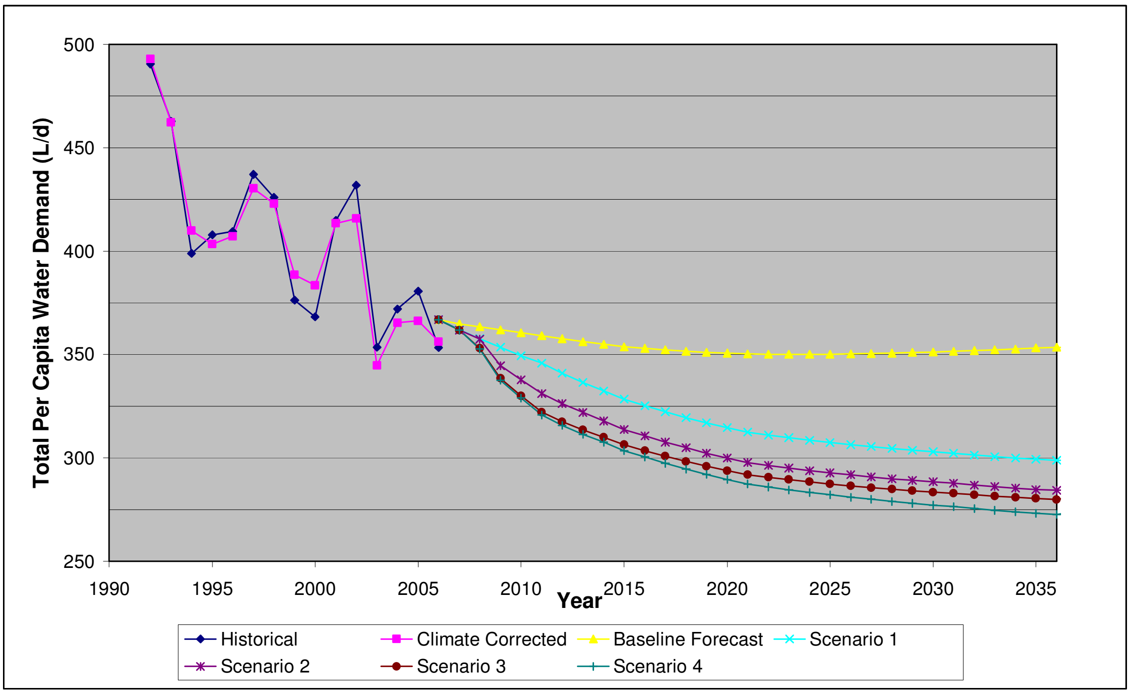
### Figure 6-1 Total Water Demand Forecast – Brownfield Areas Only




### Table 6-4 Total Per Capita Water Demand Forecast – Brownfield Areas Only

| Brownfield Scenario | Per Capita Demand (L/person/day) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Baseline Forecast | 367 | 359 | 353 | 350 | 350 | 352 | 354 |
| Scenario 1 – BASIX / WELS | 367 | 346 | 325 | 312 | 306 | 302 | 299 |
| Scenario 2 - BASIX /WELS and Loss Management Program | 367 | 331 | 311 | 298 | 292 | 288 | 284 |
| Scenario 3 – Scenario 2 plus Active Demand Management Options | 367 | 322 | 303 | 292 | 286 | 283 | 280 |
| Scenario 4 – Scenario 3 plus Non Residential Demand Management | 367 | 321 | 300 | 287 | 281 | 276 | 273 |

## Figure 6-2 Total Per Capita Water Demand Forecast – Brownfield Areas Only




A summary of the savings from the various scenarios is given in Table 6-5 to Table 6-8 and graphically in Figure 6-3 to Figure 6-6.

## Table 6-5 Sectoral Annual Water Demand Forecast – Scenario 1 – Brownfield Areas

| Sector | Annual Water Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Single Family Existing | 4,635 | 4,523 | 4,409 | 4,325 | 4,260 | 4,209 | 4,186 |
| Single Family Greenfield | 0 | 172 | 581 | 995 | 1,342 | 1,688 | 2,068 |
| Single Family Infill | 0 | 65 | 109 | 156 | 188 | 221 | 258 |
| Multi-Family Existing | 1,781 | 1,724 | 1,662 | 1,599 | 1,544 | 1,497 | 1,464 |
| Multi-Family Greenfield | 0 | 102 | 317 | 534 | 709 | 881 | 1,071 |
| Multi-Family Infill | 0 | 229 | 383 | 551 | 662 | 775 | 904 |
| Commercial | 1,400 | 1,641 | 1,991 | 2,336 | 2,589 | 2,838 | 3,123 |
| Industrial | 67 | 71 | 75 | 79 | 83 | 87 | 91 |
| Irrigation | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Public | 464 | 544 | 660 | 774 | 858 | 941 | 1,035 |
| Bulk Sales | 181 | 182 | 184 | 185 | 187 | 188 | 189 |
| Non Revenue Water | 1,274 | 1,482 | 1,784 | 2,080 | 2,292 | 2,499 | 2,735 |
| **Total** | **9,804** | **10,737** | **12,158** | **13,618** | **14,716** | **15,827** | **17,129** |

**Table 6-6 Sectoral Annual Water Demand Forecast – Scenario 2 – Brownfield Areas**

| Sector | Annual Water Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Single Family Existing | 4,635 | 4,523 | 4,409 | 4,325 | 4,260 | 4,209 | 4,186 |
| Single Family Greenfield | 0 | 172 | 581 | 995 | 1,342 | 1,688 | 2,068 |
| Single Family Infill | 0 | 65 | 109 | 156 | 188 | 221 | 258 |
| Multi-Family Existing | 1,781 | 1,724 | 1,662 | 1,599 | 1,544 | 1,497 | 1,464 |
| Multi-Family Greenfield | 0 | 102 | 317 | 534 | 709 | 881 | 1,071 |
| Multi-Family Infill | 0 | 229 | 383 | 551 | 662 | 775 | 904 |
| Commercial | 1,400 | 1,641 | 1,991 | 2,336 | 2,589 | 2,838 | 3,123 |
| Industrial | 67 | 71 | 75 | 79 | 83 | 87 | 91 |
| Irrigation | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Public | 464 | 544 | 660 | 774 | 858 | 941 | 1,035 |
| Bulk Sales | 181 | 182 | 184 | 185 | 187 | 188 | 189 |
| Non Revenue Water | 1,274 | 1,037 | 1,245 | 1,452 | 1,600 | 1,745 | 1,910 |
| **Total** | **9,804** | **10,293** | **11,620** | **12,990** | **14,024** | **15,073** | **16,304** |

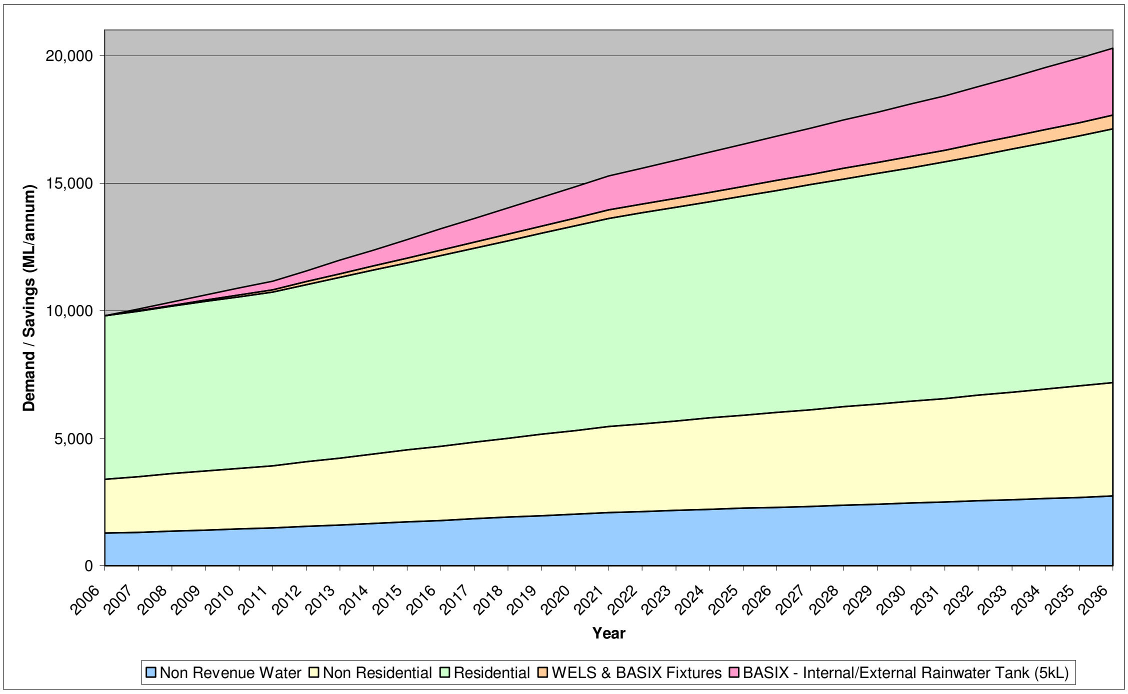
**Table 6-7 Sectoral Annual Water Demand Forecast – Scenario 3 – Brownfield Areas**

| Sector | Annual Water Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Single Family Existing | 4,635 | 4,316 | 4,207 | 4,128 | 4,065 | 4,017 | 3,994 |
| Single Family Greenfield | 0 | 172 | 579 | 992 | 1,337 | 1,683 | 2,062 |
| Single Family Infill | 0 | 64 | 108 | 156 | 188 | 220 | 257 |
| Multi-Family Existing | 1,781 | 1,655 | 1,602 | 1,542 | 1,491 | 1,446 | 1,414 |
| Multi-Family Greenfield | 0 | 102 | 317 | 534 | 708 | 880 | 1,070 |
| Multi-Family Infill | 0 | 228 | 383 | 550 | 661 | 774 | 903 |
| Commercial | 1,400 | 1,641 | 1,991 | 2,336 | 2,589 | 2,838 | 3,123 |
| Industrial | 67 | 71 | 75 | 79 | 83 | 87 | 91 |
| Irrigation | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Public | 464 | 544 | 660 | 774 | 858 | 941 | 1,035 |
| Bulk Sales | 181 | 182 | 184 | 185 | 187 | 188 | 189 |
| Non Revenue Water | 1,274 | 1,037 | 1,245 | 1,452 | 1,600 | 1,745 | 1,910 |
| **Total** | **9,804** | **10,014** | **11,353** | **12,731** | **13,770** | **14,822** | **16,053** |

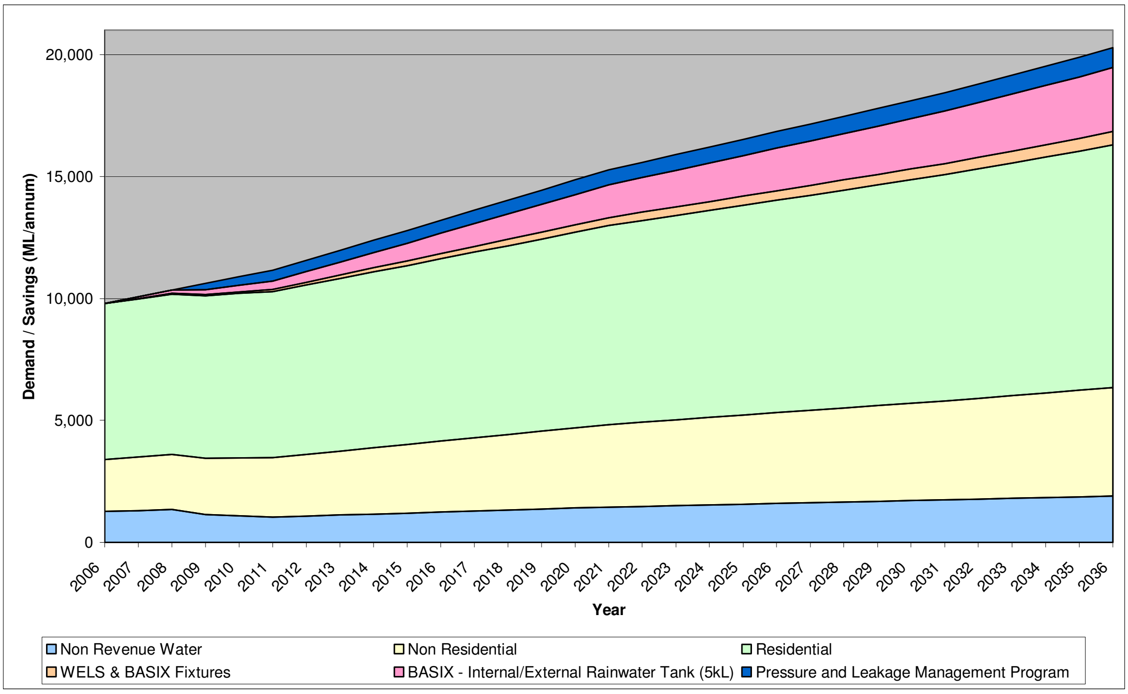
**Table 6-8 Sectoral Annual Water Demand Forecast – Scenario 4 – Brownfield Areas**

| Sector | Annual Water Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Single Family Existing | 4,635 | 4,316 | 4,207 | 4,128 | 4,065 | 4,017 | 3,994 |
| Single Family Greenfield | 0 | 172 | 579 | 992 | 1,337 | 1,683 | 2,062 |
| Single Family Infill | 0 | 64 | 108 | 156 | 188 | 220 | 257 |
| Multi-Family Existing | 1,781 | 1,655 | 1,602 | 1,542 | 1,491 | 1,446 | 1,414 |
| Multi-Family Greenfield | 0 | 102 | 317 | 534 | 708 | 880 | 1,070 |
| Multi-Family Infill | 0 | 228 | 383 | 550 | 661 | 774 | 903 |
| Commercial | 1,400 | 1,610 | 1,907 | 2,196 | 2,399 | 2,596 | 2,823 |
| Industrial | 67 | 70 | 73 | 76 | 78 | 81 | 85 |
| Irrigation | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| Public | 464 | 534 | 632 | 728 | 795 | 861 | 936 |
| Bulk Sales | 181 | 181 | 181 | 180 | 180 | 179 | 178 |
| Non Revenue Water | 1,274 | 1,037 | 1,245 | 1,452 | 1,600 | 1,745 | 1,910 |
| **Total** | **9,804** | **9,970** | **11,236** | **12,536** | **13,505** | **14,485** | **15,635** |

**Figure 6-3 Water Demand Profile – Scenario 1 – Brownfield Areas**



## Figure 6-4 Water Demand Profile – Scenario 2 – Brownfield Areas




## Figure 6-5 Water Demand Profile – Scenario 3 – Brownfield Areas

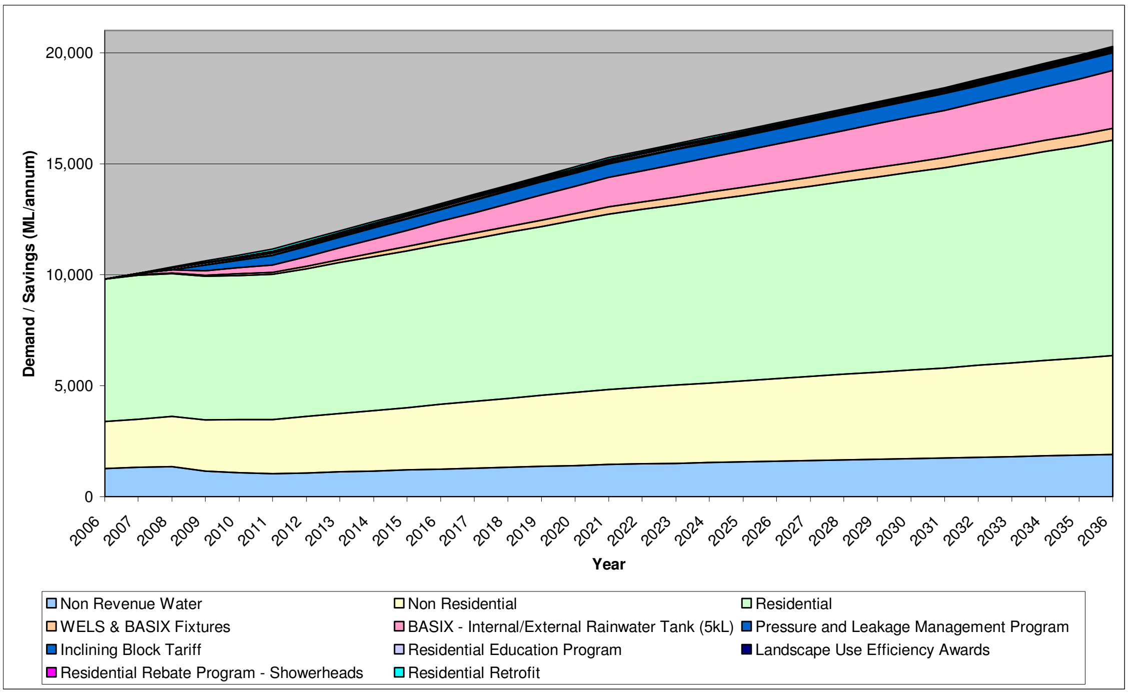
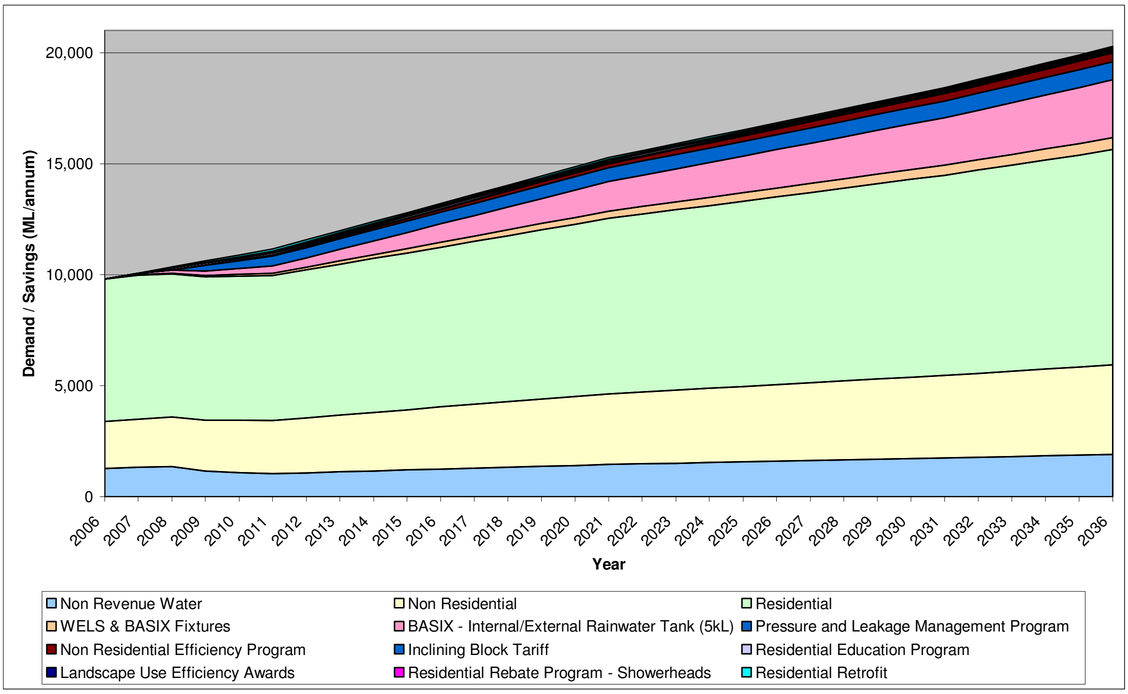


**Figure 6-6 Water Demand Profile – Scenario 4 – Brownfield Areas**




## 6.4 PROGRAM COSTS

An overall cost assessment was undertaken for each of the four scenarios for the brownfield area. A summary of the assessment is provided in the tables below. The total NPV contained costs for the following elements:

- Council Capital Costs – assumed to be capital costs of works to council. In the case of brownfield development, costs do not include impact on infrastructure such as dams and other infrastructure.
- Customer Capital Costs – assumed to be the costs related to provision of rainwater tanks and other fixtures and fittings.
- Council Operational Costs – assumed to be the on-going cost of maintaining programs and for compliance testing and inspections.
- Customer Operational Costs – assumed to be the costs of operating a rainwater tank as well as the benefits of lower energy costs from hot water savings.

**Table 6-9 Individual Demand Measurement Results – Scenario 1 – Brownfield Areas**

| Measure Description | Net Present Value of Forecast Expenditure | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | | Total NPV | Annualised Cost ($/kL) |
| | Council NPV | Customer NPV | Total Capital NPV | Council NPV | Customer NPV | Total OPEX NPV | | |
| BASIX Fixtures and WELS | $0 | $72,120 | $72,120 | $0 | $0 | $0 | **$72,120** | **$0.02** |
| BASIX - Internal/External Rainwater Tank (5kL) | $0 | $56,241,488 | $56,241,488 | $1,947,303 | $11,858,863 | $13,806,166 | **$70,047,654** | **$4.42** |
| **Total** | **$0** | **$56,313,608** | **$56,313,608** | **$1,947,303** | **$11,858,863** | **$13,806,166** | **$70,119,774** | **$3.60** |

### Table 6-10 Individual Demand Measurement Results – Scenario 2 – Brownfield Areas

| Measure Description | Net Present Value of Forecast Expenditure | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | | Total NPV | Annualised Cost ($/kL) |
| | Council NPV | Customer NPV | Total Capital NPV | Council NPV | Customer NPV | Total OPEX NPV | | |
| BASIX Fixtures and WELS | $0 | $72,120 | $72,120 | $0 | $0 | $0 | **$72,120** | **$0.02** |
| BASIX - Internal/External Rainwater Tank (5kL) | $0 | $56,241,488 | $56,241,488 | $1,947,303 | $11,858,863 | $13,806,166 | **$70,047,654** | **$4.42** |
| Pressure and Leakage Management Program | $2,887,978 | $0 | $2,887,978 | $3,568,283 | $0 | $3,568,283 | **$6,456,261** | **$0.94** |
| **Total** | **$2,887,978** | **$56,313,608** | **$59,201,586** | **$5,515,586** | **$11,858,863** | **$17,374,449** | **$76,576,035** | **$2.91** |

### Table 6-11 Individual Demand Measurement Results – Scenario 3 – Brownfield Areas

| Measure Description | Net Present Value of Forecast Expenditure | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | | Total NPV | Annualised Cost ($/kL) |
| | Council NPV | Customer NPV | Total Capital NPV | Council NPV | Customer NPV | Total OPEX NPV | | |
| BASIX Fixtures and WELS | $0 | $72,120 | $72,120 | $0 | $0 | $0 | $72,120 | **$0.02** |
| BASIX - Internal/External Rainwater Tank (5kL) | $0 | $56,241,488 | $56,241,488 | $1,947,303 | $11,858,863 | $13,806,166 | $70,047,654 | **$4.42** |
| Inclining Block Tariff | $17,469 | $0 | $17,469 | $0 | $0 | $0 | $17,469 | **$0.04** |
| Residential Education Program | $344,032 | $0 | $344,032 | $415,891 | $0 | $415,891 | $759,923 | **$0.88** |
| Landscape Use Efficiency Awards | $88,123 | $679,807 | $767,930 | $53,005 | $0 | $53,005 | $820,935 | **$1.17** |
| Residential Rebate Program - Showerheads | $29 | $10 | $20 | $1 | $0 | wu cap | $0 | **$0.51** |
| Pressure and Leakage Management Program | $2,887,978 | $0 | $2,887,978 | $3,568,283 | $0 | $3,568,283 | $6,456,261 | **$0.94** |
| Residential Retrofit | $963,009 | $156,408 | $1,119,416 | $0 | $0 | $0 | $1,119,416 | **$1.34** |
| **Total** | **$4,300,640** | **$57,149,832** | **$61,450,453** | **$5,984,483** | **$11,858,863** | **$17,843,345** | **$79,293,779** | **$2.69** |

# 7. PREFERRED OPTION ASSESSMENT

## 7.1 APPROACH

A Triple Bottom Line (TBL) assessment of the scenarios was undertaken utilising a Multi Criteria Assessment (MCA) approach that was based on broad issues identified through the issues assessment in the TSC Concept Study and discussions with TSC.

This section of the report outlines the results to the preliminary TBL assessment undertaken by MWH. The assessment should be tested against the stakeholder group to confirm and finalise the preferred option.

The following TBL assessment criteria were adopted for the study:

- Environmental
  - Minimise Greenhouse Gas Emissions
  - Minimise Pollutants Entering Waterways
  - Minimise Extractions From Rivers
- Social
  - Accepted by Community
  - Secures Water Supply
  - Enhances Service Levels
- Economic
  - Whole of Life Cost
  - Impact on Rates

## 7.2 GREENFIELD DEVELOPMENT PROGRAM

### 7.2.1 TBL ASSESSMENT

The TBL assessment was undertaken for each of individual development. Each development may have higher greenhouse gases or a significantly higher cost of infrastructure compared to another development. A summary of the Assessment is provided in Table 7-1.

## Table 7-1 Triple Bottom Line Assessment of Development Scenarios

| Development | Scenario | Description | Minimise Greenhouse Gas Emissions | Minimise Pollutants Entering Waterways | Minimise Extractions From Rivers | Enviro Average Score | Accepted by Community | Secures Water Supply | Enhances Service Levels | Social Average Score | Whole of Life Cost | Impact on Rates | Economic Average Score | Total Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cobaki Lakes | Scenario 1 | Basix + Rainwater Tank | 4 | 2 | 3 | 3.00 | 5 | 3 | 3 | 3.67 | 5 | 4 | 4.50 | 11.17 |
| | Scenario 2 | Basix + Recycled Water | 4 | 4 | 4 | 4.00 | 3 | 4 | 2 | 3.00 | 4 | 2 | 3.00 | 10.00 |
| | Scenario 3 | Basix + Rainwater Tank +Recycled Water | 3 | 5 | 5 | 4.33 | 4 | 5 | 1 | 3.33 | 2 | 2 | 2.00 | 9.67 |
| | Scenario 4 | Indirect Potabel Reuse and Rainwater Tanks | 2 | 2 | 5 | 3.00 | 1 | 4 | 2 | 2.33 | 1 | 1 | 1.00 | 6.33 |
| | Scenario 5 | BASIX with Fourth Pipe Recycling System | 3 | 3 | 5 | 3.67 | 4 | 3 | 2 | 3.00 | 2 | 2 | 2.00 | 8.67 |
| Bilambil Heights | Scenario 1 | Basix + Rainwater Tank | 3 | 2 | 2 | 2.33 | 5 | 3 | 3 | 3.67 | 5 | 4 | 4.50 | 10.50 |
| | Scenario 2 | Basix + Recycled Water | 2 | 3 | 3 | 2.67 | 3 | 4 | 2 | 3.00 | 4 | 2 | 3.00 | 8.67 |
| | Scenario 3 | Basix + Rainwater Tank +Recycled Water | 2 | 4 | 4 | 3.33 | 4 | 3 | 1 | 2.67 | 1 | 2 | 1.50 | 7.50 |
| | Scenario 4 | Indirect Potabel Reuse and Rainwater Tanks | 2 | 2 | 4 | 2.67 | 1 | 4 | 2 | 2.33 | 1 | 1 | 1.00 | 6.00 |
| | Scenario 5 | BASIX with Fourth Pipe Recycling System | 3 | 3 | 5 | 3.67 | 4 | 3 | 2 | 3.00 | 2 | 2 | 2.00 | 8.67 |
| Terranora Area A | Scenario 1 | Basix + Rainwater Tank | 4 | 2 | 2 | 2.67 | 5 | 2 | 3 | 3.33 | 5 | 4 | 4.50 | 10.50 |
| | Scenario 2 | Basix + Recycled Water | 4 | 3 | 3 | 3.33 | 3 | 3 | 2 | 2.67 | 4 | 2 | 3.00 | 9.00 |
| | Scenario 3 | Basix + Rainwater Tank +Recycled Water | 3 | 4 | 4 | 3.67 | 4 | 4 | 1 | 3.00 | 1 | 2 | 1.50 | 8.17 |
| | Scenario 4 | Indirect Potabel Reuse and Rainwater Tanks | 2 | 2 | 4 | 2.67 | 1 | 4 | 2 | 2.33 | 1 | 1 | 1.00 | 6.00 |
| | Scenario 5 | BASIX with Fourth Pipe Recycling System | 3 | 3 | 5 | 3.67 | 4 | 3 | 2 | 3.00 | 2 | 2 | 2.00 | 8.67 |
| West Kingscliff | Scenario 1 | Basix + Rainwater Tank | 4 | 2 | 2 | 2.67 | 5 | 2 | 3 | 3.33 | 5 | 4 | 4.50 | 10.50 |
| | Scenario 2 | Basix + Recycled Water | 4 | 3 | 3 | 3.33 | 3 | 3 | 2 | 2.67 | 4 | 2 | 3.00 | 9.00 |
| | Scenario 3 | Basix + Rainwater Tank +Recycled Water | 4 | 4 | 4 | 4.00 | 4 | 3 | 1 | 2.67 | 3 | 2 | 2.50 | 9.17 |
| | Scenario 4 | Indirect Potabel Reuse and Rainwater Tanks | 2 | 2 | 4 | 2.67 | 1 | 4 | 2 | 2.33 | 1 | 1 | 1.00 | 6.00 |
| | Scenario 5 | BASIX with Fourth Pipe Recycling System | 3 | 3 | 5 | 3.67 | 4 | 3 | 2 | 3.00 | 2 | 2 | 2.00 | 8.67 |
| Kings Forest | Scenario 1 | Basix + Rainwater Tank | 4 | 2 | 3 | 3.00 | 5 | 3 | 3 | 3.67 | 5 | 4 | 4.50 | 11.17 |
| | Scenario 2 | Basix + Recycled Water | 3 | 4 | 4 | 3.67 | 3 | 4 | 2 | 3.00 | 4 | 2 | 3.00 | 9.67 |
| | Scenario 3 | Basix + Rainwater Tank +Recycled Water | 3 | 5 | 5 | 4.33 | 4 | 5 | 1 | 3.33 | 2 | 2 | 2.00 | 9.67 |
| | Scenario 4 | Indirect Potabel Reuse and Rainwater Tanks | 2 | 2 | 4 | 2.67 | 1 | 4 | 2 | 2.33 | 1 | 1 | 1.00 | 6.00 |
| | Scenario 5 | BASIX with Fourth Pipe Recycling System | 3 | 3 | 5 | 3.67 | 4 | 3 | 2 | 3.00 | 2 | 2 | 2.00 | 8.67 |

### 7.2.2 PREFERRED SCENARIO – GREENFIELD AREAS

Based on the Triple Bottom Line assessment of the development scenarios it is evident that the preferred option is Scenario 1, comprising the implementation of BASIX (efficient showerheads and taps, dual flush toilets) together with rainwater tanks (5 kL for Single Family Residential dwellings) to service external, toilet flushing and cold water to washing machines.

The major reasons for the selection of Greenfield Scenario 1 are as follows:

- Scenario 1 has the lowest costs to the community. The majority of the capital cost and on-going costs are the responsibility of the householder. Council will need to have a management plan including regular inspections to ensure that health and water quality aspects are addressed through regular maintenance.
- Scenario 1 has the best return on investment with savings of 34 to 38% of the baseline demand forecasts. This compares to around 42% for Scenario 2 (recycled water) and 61% for Scenario 3 (rainwater tanks and recycled water). However due to the high costs of developing a dual reticulation system the cost of water saved for the higher water saving options is very high.
- From an environmental perspective Scenario 1 is not the highest performer, due to the fact that Scenarios 2 and 3 reduce return effluent flows to the waterways by more than 10%. Rainwater tanks will however have a modest impact on urban runoff in the greenfield areas as part of an overall Water Sensitive Urban Design solution.
- Scenario 1 will have a broad community acceptance compared to Scenarios 2 and 3. Although there has been significant support for recycled water in Pimpama Coomera, there are local and regional water management drivers that do not exist in Tweed Shire.

Adoption of Scenario 1 does not come without risk. The wide scale use of rainwater tanks in urban areas is only starting to occur in Australia, therefore the level of yield from the tanks is not guaranteed. Achievement of the yield of around 80 kL/d will not be achieved without education on the part of council as well as the implementation of a regular program of inspection.

An exception to the preferred scenario is the West Kingscliff development. Due to the proximity of the development to the sewage treatment plant the cost of return flows to the area are low compared to the other developments. There are however risks as the actual use for recycled water in this development are unknown. Currently the proposal is to develop service industry, which does not generally have a high water use. Therefore it would be recommended that recycled water in the form of dual reticulation be considered further at the development application stage.

Assessment of the recycled water scenarios undertaken in this report was based on the use of centralised treatment facilities aimed at aligning with Tweed Shire's current business, and to provide economies of scale with respect to the treatment plants and staff. An alternative would be to develop a water mining plant at or near the major developments. For example a plant could be constructed at Cobaki Lakes, Terranora or Kings Forest to service local development. However the reduced cost of recycled water trunk mains and pumping would need to be offset against the additional cost of treating dry weather flow to a standard suitable for membrane treatment. No savings would be achieved through the sewerage collection system as the wet weather flows would be passed through to the centralised treatment plants. The additional on-going costs of staff resources to operate decentralised plants would also impact on the costs.

Considering the above issues it is recommended that:

- For the Cobaki Lakes, Bilambil Heights, Terranora and Kings Forest developments council adopts Scenario 1
- For West Kingscliff, recycled water be made available if there is a sufficient level of end use in the industrial land uses.

## 7.3 BROWNFIELD AREAS PROGRAM

### 7.3.1 TBL ASSESSMENT

A TBL assessment was undertaken for each of scenarios for the brownfield areas. The assessment is summarised in Table 7-2.

### 7.3.2 PREFERRED SOLUTION

Based on the Triple Bottom Line assessment of the brownfield scenarios it is evident that the preferred option is Scenario 4, comprising the implementation of BASIX with 5,000 L rainwater tanks, the implementation of a pressure and leakage management program, the implementation of demand management measures for both the residential and non-residential sectors. The major reasons for the selection of this scenario are the following:

- Scenario 3 has the highest savings potential at the lowest cost per kL saved to the community as a whole. This cost is however higher than the marginal cost of potable water due mainly to the overall cost of rainwater tanks. Scenario 4 includes water savings from a non-residential program that has not been evaluated, but is expected to result in savings of around 10% at a similar cost to the residential program.
- The majority of the capital cost and on-going costs are the responsibility of the householder. Council will need a management plan including regular inspections to ensure that health and water quality aspects are addressed through regular maintenance.
- From an environmental perspective Scenario 4 is the best performer, with reductions in river extractions due to the additional reductions in demand.
- Scenario 4 would have broad community acceptance as it involves all sectors of the community and council contributing to achieve a water reduction target.

## Table 7-2 Triple Bottom Line Assessment of Development Scenarios

| Scenario | Description | Minimise Greenhouse Gas Emissions | Minimise Pollutants Entering Waterways | Minimise Extractions From Rivers | Average Environmental Score | Accepted by Community | Secures Water Supply | Enhances Service Levels | Average Social Score | Whole of Life Cost | Impact on Rates | Average Economic Score | Total Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | BASIX Fixtures and WELS and Rainwater Tank | 4 | 2 | 3 | 3.00 | 5 | 3 | 3 | 3.67 | 5 | 4 | 4.50 | **11.17** |
| Scenario 2 | BASIX Fixtures and WELS, Rainwater Tank and Pressure and Leakage Management Program | 4 | 2 | 3 | 3.00 | 5 | 3.5 | 4 | 4.17 | 5 | 4 | 4.50 | **11.67** |
| Scenario 3 | Scenario 2 plus Selected Residential Demand Management Options | 5 | 3 | 4 | 4.00 | 4 | 4 | 4 | 4.00 | 4 | 3 | 3.50 | **11.50** |
| Scenario 4 | Scenario 3 plus Non Residential Demand Management Options | 5 | 3 | 4 | 4.00 | 4 | 4.5 | 4.5 | 4.33 | 4 | 3 | 3.50 | **11.83** |

Adoption of Scenario 4 does not come without risk. The wide scale use of rainwater tanks in urban areas is only starting to occur in Australia, therefore the level of yield from the tanks is not guaranteed. Achievement of the yield of around 80 kL/d will not be possible without community education and a regular program of inspection.

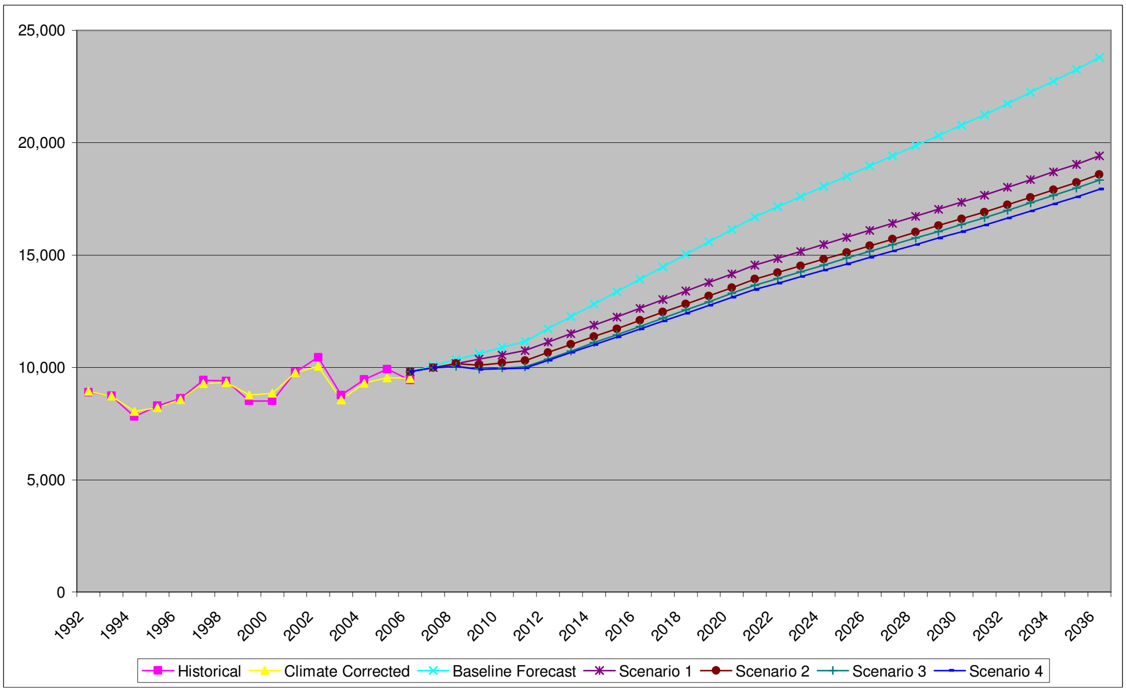
Considering the above issues it is recommended that:

- Scenario 4 is adopted for the Tweed Shire brownfield areas, with a key focus on developing an extensive active leakage control and pressure management program.
- Rainwater tank education programs be developed, focussed on the correct use and maintenance including a regular program of inspections.
- An on-going communication and education program be adopted as part of the preferred program to ensure that savings are maintained in future.
- The inclining block tariff structure be maintained and enhanced to provide a price signal for high users.
- Options for a non-residential demand management program be considered further.

## 7.4 OVERALL DEMAND FORECASTS

Demand forecasts for areas served by the Bray Park system were developed assuming the adoption of Scenario 1 for all Greenfield Areas. The figures and tables below outline the future water demand management outcomes for the whole of the Tweed Shire for the combination of Greenfield Scenario 1 and the range of Brownfield Scenarios.

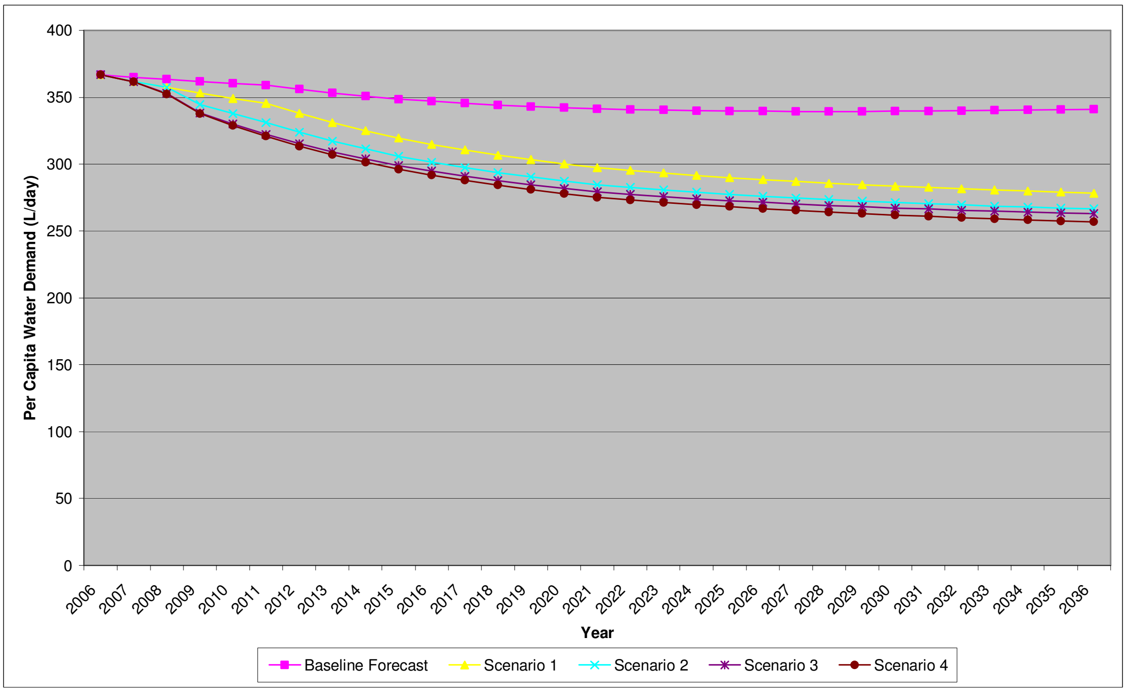
**Figure 7-1 Overall Tweed Shire Annual Water Demand Forecast**



### Table 7-3 Total Annual Water Demand Forecast – Tweed Shire

| Scenario | Total Annual Demand (ML/a) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Baseline Forecast | 9,804 | 11,160 | 13,922 | 16,699 | 18,960 | 21,239 | 23,796 |
| G/F Scenario 1 plus B/F Scenario 1 | 9,804 | 10,737 | 12,629 | 14,545 | 16,103 | 17,666 | 19,421 |
| G/F Scenario 1 plus B/F Scenario 2 | 9,804 | 10,293 | 12,091 | 13,918 | 15,411 | 16,912 | 18,595 |
| G/F Scenario 1 plus B/F Scenario 3 | 9,804 | 10,014 | 11,824 | 13,658 | 15,157 | 16,660 | 18,345 |
| G/F Scenario 1 plus B/F Scenario 4 | 9,804 | 9,970 | 11,707 | 13,463 | 14,892 | 16,324 | 17,926 |

### Figure 7-2 Total Per Capita Water Demand Forecast – Tweed Shire




### Table 7-4 Total Per Capita Water Demand Forecast – Tweed Shire

| Scenario | Total Per Capita Demand (L/person/d) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | 2036 |
| Baseline Forecast | 367 | 359 | 347 | 341 | 340 | 340 | 341 |
| G/F Scenario 1 plus B/F Scenario 1 | 367 | 345 | 315 | 297 | 288 | 283 | 278 |
| G/F Scenario 1 plus B/F Scenario 2 | 367 | 331 | 301 | 285 | 276 | 270 | 266 |
| G/F Scenario 1 plus B/F Scenario 3 | 367 | 322 | 295 | 279 | 271 | 266 | 263 |
| G/F Scenario 1 plus B/F Scenario 4 | 367 | 321 | 292 | 275 | 267 | 261 | 257 |

# 8. CONCLUSIONS AND RECOMMENDATIONS

## 8.1 CONCLUSIONS

The following conclusions can be drawn from the assessment of options for the Tweed Shire Demand Management Strategy:

1. The current population of the Tweed Shire that is served by the Bray Park Water Treatment Plant is estimated to be 73,185.
2. Population served by Brays Park WTP is expected to grow to 157,048 by 2036, mostly due to the development of large greenfield areas and the redevelopment and infill development of the Tweed Heads area.
3. Occupancy rates are expected to fall between 2006 and 2036. For single family residences the rate will fall from 2.8 to 2.5 persons/dwelling, and for multi family dwellings from 1.95 to 1.7 persons/dwelling.
4. The average per capita usage in Tweed Shire is 370 L/person/day (including losses), which is a fall from pre-drought (2002) demands.
5. Average residential use for 2004/5 was 231 kL/household/annum. Although this was higher than recent figures for some northern NSW coastal centres it is not known whether these centres were drought affected. Based on comparisons with South East Queensland studies this demand is substantially lower than demand in adjacent local government areas.
6. The Baseline demand case for the whole shire, taking account of the natural replacement rate for fittings and fixtures, indicates that the demand in 2036 will be approximately 23, 800 ML/annum.
7. Five integrated water cycle scenarios were developed for the major greenfield development areas of Cobaki Lakes, Bilambil Heights, Terranora Area A, West Kingscliff and Kings Forest. The scenarios reviewed were:
   - Scenario 1 – Implementation of BASIX including a rainwater tank
   - Scenario 2 – Implementation of BASIX together with recycled water for external and toilet use.
   - Scenario 3 – Implementation of BASIX with a rainwater tank and recycled water.
   - Scenario 4 – Indirect potable reuse and rainwater tanks for new development.
   - Scenario 5 – Scenario 3 with a separation of the greywater and blackwater systems (not taken forward to detailed assessment).
8. Each of these assessed scenarios included the use of Reduced Infiltration Gravity Sewers (RIGS).
9. The results of the assessment of Greenfield Scenarios 1, 2 and 3 is summarised as follows:
   - Rainwater tanks would need to be 5 kL in size and would save around 80 kL/a for the average household.

- Reduction of potable water use was determined to be approximately 36%, 42% and 61% for Scenarios 1, 2 and 3 respectively for all greenfield developments except West Kingscliff. Reductions for individual areas varied slightly dependent on the sectoral distribution.
- Water savings for West Kingscliff are lower than the other greenfield areas as this development is non-residential and the external water savings are lower. The actual savings will depend on the available end uses of water in the development.
- Scenario 1 has the lowest costs to the community. The majority of the capital cost and on-going costs are the responsibility of the householder.
- Scenario 1 has the best return on investment with savings of 34 to 38% of the baseline demand forecasts. This scenario also has the lowest cost per kilolitre of savings.
- The cost of the recycled water scenarios is significantly higher than Scenario 1 due to the high cost of providing a third pipe network and establishing membrane treatment.
- From an environmental perspective Scenarios 2 and 3 reduce return effluent flows to the waterways by more than 10%. Scenario 1 will have a modest impact on urban water quality through the reduction of pollutants to waterways.

10. Additional work indicated that a dual reticulation scheme for Cobaki Lakes would be more cost beneficial if the treatment plant was located close to the development. This option should be further pursued should the developer propose a dual reticulation solution.
11. The assessment of Scenario 4 (Indirect Potable Reuse) indicated that:
    - By 2036 a total volume of 28 ML/d or 10,220 ML/a could be provided.
    - The total NPV for implementation of the IPR scheme alone would be of the order of $184m.
12. Four future demand scenarios were developed and assessed for the brownfield areas of Tweed Shire. The scenarios reviewed were:
    - Scenario 1 – Implementation of BASIX including a rainwater tank (5,000 L for detached dwellings).
    - Scenario 2 – An extension of Scenario 1 with an extensive active leakage control and pressure management program.
    - Scenario 3 – An extension of Scenario 2, including the implementation of selected demand management measures, including education programs, residential audit programs, a retrofit service and rebate scheme.
    - Scenario 4 – Scenario 3 with an assumed enhanced non residential efficiency saving of 10%.
13. The results of the assessment for the brownfield areas are summarised as follows:
    - Rainwater tanks would need to be 5,000 L in size and would save around 80 kL/a for the average household if connected internally to toilets, cold water laundry and external taps.

- Reduction of potable water use was determined to be approximately 16 %, 20%, 21% and 23% for Scenarios 1, 2, 3 and 4 respectively for the brownfield areas with Tweed Shire.
- Scenario 3 has the highest savings potential at the lowest cost per kL saved to the community as a whole. This cost is however higher than the marginal cost of potable water due mainly to the overall cost of rainwater tanks. Scenario 4 includes water savings from a non-residential program that has not been evaluated, but is expected to result in savings of around 10% at a similar cost to the residential program.
- The majority of the capital cost and on-going costs are the responsibility of the householder. Council will need a management plan including regular inspections to ensure that health and water quality aspects are addressed through regular maintenance.
- From an environmental perspective Scenario 4 is the best performer, with reductions in river extractions due to the additional reductions in demand.
- Scenario 4 would have broad community acceptance as it involves all sectors of the community and council contributing to achieve a water reduction target.

## 8.2 RECOMMENDATIONS

Based on the assessment of options in this report it is recommended that:

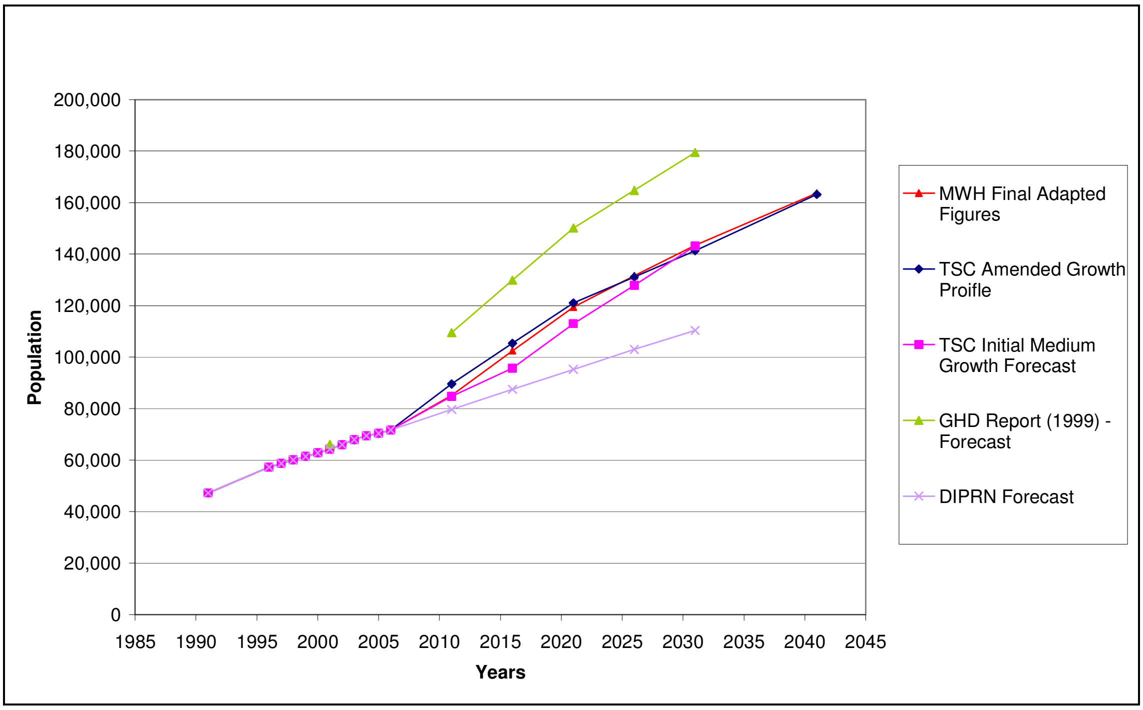
1. Brownfield Scenario 4 be adopted for the Tweed Shire existing and infill development areas, with a key focus on developing an extensive active leakage control and pressure management program.
2. Greenfield Scenario 1 be adopted for the Cobaki Lakes, Bilambil Heights, Terranora and Kings Forest developments. This will include the adoption of BASIX with 5,000 L rainwater tanks (minimum of 160 $m^2$ roof area) connected to external uses, toilet flushing and cold water to washing machines. In addition new dwellings will have dual flush toilets as well as 3 star showerheads and taps.
3. For West Kingscliff, recycled water be made available to future industrial land use areas where demand is identified.
4. Rainwater tank education programs be developed, focused on the correct use and maintenance including a regular program of inspections.
5. An on-going communication and education program be developed as part of the preferred program to ensure that savings are maintained in future.
6. The inclining block tariff structure be maintained and enhanced to provide a price signal for high users.
7. Options for a non-residential demand management program be considered further.
8. A review be undertaken of the potable water design standards based on the demand assessment undertaken in this report. A regular assessment should then be undertaken to review the adopted design standards.

APPENDIX A

# GREENFIELD POPULATION FORECASTS

The following figure depicts the historical and future serviced population forecasts developed over the past 10 years for regional and infrastructure planning in Tweed Shire.

**Figure A1 Tweed Shire – Historic and Future Serviced Population Forecast**




The table below summarises the anticipated population for the various areas of Tweed Shire and shows the distribution of Infill and Greenfield sites for the proposed new greenfield development areas. The information was provided by TSC and was adapted by MWH to match the predicted lot development of the new growth areas new and expected persons per account estimations.

**Table A1 Future Growth and Development Distribution by Suburb / Development Area**

| Locality | 2001 | 2011 | 2021 | 2031 | 2041 | Infill | Greenfield |
|---|---|---|---|---|---|---|---|
| Tweed Heads | 6,853 | 7,800 | 8,000 | 8,000 | 8,000 | 100% | 0% |
| Tweed Heads New Infill | - | 2,000 | 4,000 | 6,000 | 10,000 | 100% | 0% |
| Tweed Heads West | 7,673 | 8,400 | 8,664 | 8,719 | 8,719 | 100% | 0% |
| Tweed Heads South & Banora Pt | 16,771 | 19,098 | 21,424 | 23,751 | 26,077 | 30% | 70% |
| Bilambil Heights | 2,395 | 2,498 | 2,601 | 2,705 | 2,808 | 30% | 70% |
| Bilambil & Piggabeen | 907 | 1,110 | 1,314 | 1,517 | 1,720 | 0% | 100% |
| Cobaki | - | 1,000 | 6,000 | 10,000 | 11,040 | 0% | 100% |
| Highlands Estate | 29 | 625 | 625 | 625 | 625 | 0% | 100% |
| McAllisters | - | - | - | 2,110 | 2,110 | 0% | 100% |
| Adjacent to Terranora Resort | 244 | 250 | 1,500 | 3,010 | 3,010 | 0% | 100% |
| Terranora Resort | - | - | 1,600 | 3,564 | 3,564 | 0% | 100% |
| Terranora Rural | 2,209 | 2,836 | 3,463 | 4,090 | 4,717 | 0% | 100% |
| Area E | - | - | 2,000 | 2,000 | 2,000 | 0% | 100% |
| Fingal | 626 | 784 | 960 | 1,176 | 1,176 | 100% | 0% |

| Locality | 2001 | 2011 | 2021 | 2031 | 2041 | Infill | Greenfield |
|---|---|---|---|---|---|---|---|
| Chinderah | 1,794 | 2,243 | 2,754 | 2,754 | 2,754 | 100% | 0% |
| Kingscliff | 5,049 | 5,270 | 5,270 | 5,270 | 5,322 | 100% | 0% |
| West Kingscliff | - | - | 1,400 | 2,800 | 2,800 | 0% | 100% |
| Cudgen Village | 579 | 656 | 733 | 811 | 888 | 50% | 50% |
| Rest of Rural A | 907 | 1,122 | 1,122 | 1,122 | 1,122 | 0% | 100% |
| Kings Forest | - | - | 5,000 | 5,000 | 11,500 | 0% | 100% |
| Casuarina | - | 4,500 | 5,000 | 5,000 | 5,000 | 100% | 0% |
| Lot 490 & Sea Side City | - | - | 2,500 | 2,500 | 2,500 | 0% | 100% |
| Salt | - | 2,000 | 2,500 | 2,500 | 2,500 | 100% | 0% |
| Cabarita | 2,621 | 3,301 | 3,981 | 4,662 | 5,342 | 70% | 30% |
| Hastings Pt | 722 | 877 | 1,031 | 1,185 | 1,339 | 100% | 0% |
| Pottsville | 2,137 | 2,664 | 3,248 | 3,959 | 3,959 | 100% | 0% |
| Pottsville Waters | 1,271 | 1,350 | 1,400 | 1,500 | 1,500 | 100% | 0% |
| Black Rocks | - | 1,000 | 1,280 | 1,280 | 1,280 | 0% | 100% |
| Tanglewood | 98 | 100 | 1,200 | 1,200 | 1,200 | 0% | 100% |
| Koala Beach | 98 | 2,600 | 2,800 | 2,800 | 2,800 | 0% | 100% |
| Seabreeze | - | 1,800 | 2,000 | 2,000 | 2,000 | 0% | 100% |
| Dunloe Park | - | - | - | - | 5,000 | 0% | 100% |
| Cowel Park | 73 | 90 | 105 | 120 | 120 | 0% | 100% |
| Burringbar Area | 1,244 | 1,510 | 1,775 | 2,040 | 2,305 | 0% | 100% |
| Rural North West | 196 | 272 | 348 | 424 | 500 | 0% | 100% |
| Tumbulgum | 414 | 503 | 591 | 679 | 767 | 50% | 50% |
| Wardrop Valley | 2,236 | 2,876 | 3,516 | 4,156 | 4,796 | 0% | 100% |
| Murwillumbah | 7,246 | 8,191 | 9,051 | 10,001 | 10,001 | 0% | 100% |
| Condong | 231 | 253 | 275 | 297 | 319 | 100% | 0% |
| **Total Population** | **64,624** | **89,577** | **121,030** | **141,325** | **163,180** | | |

APPENDIX B

# HISTORICAL WATER RESTRICTIONS AND WATER CHARGES

A summary of the historical water restrictions and pricing regimes was provided by TSC and is summarised in the tables below.

**Table B1 Overview of Historical Water Restriction**

| Bray Park System | | |
|---|---|---|
| Start | Finish | Level of Restriction |
| 28/10/2002 | | DAM CAPACITY 50 % - LEVEL 1 RESTRICTIONS |
| 18/11/2002 | | DAM CAPACITY 45 % - LEVEL 2 RESTRICTIONS |
| 5/02/2003 | | DAM CAPACITY 35 % - LEVEL 3 RESTRICTIONS |
| | 27/02/2003 | ALL RESTRICTIONS LIFTED |

**Table B2** ***Overview of Water Usage Pricing Structure***

| | TARIFF FOR RESIDENTIAL CUSTOMERS | COMPONENT IN ANNUAL CHARGES: RESIDENTIAL | LAND VALUE COMPONENT IN ANNUAL CHARGES: NON-RESIDENTIAL | WATER USAGE CHARGES BELOW | WATER USAGE CHARGES | WATER USAGE CHARGES ABOVE | WATER USAGE CHARGES | MINIUMUM ANNUAL RESIDENTIAL CHARGE | DEVELOPER CHARGE |
|---|---|---|---|---|---|---|---|---|---|
| **Year** | | **Y/N** | **Y/N** | **kL** | **$/KL** | **kL** | **$** | **$** | **$/ ET** |
| **1991** | ALLOWANCE | YES | YES | 371 | 0 | 371 | 0.69 | 256 | 2100 |
| **1992** | ALLOWANCE | YES | YES | 371 | 0 | 371 | 0.69 | 256 | 2750 |
| **1993** | ALLOWANCE | YES | YES | 369 | 0 | 369 | 0.71 | 262 | 2750 |
| **1994** | ALLOWANCE | YES | YES | 186 | 0 | 186 | 0.73 | 136 | 2900 |
| **1995** | ALLOWANCE | YES | YES | 370 | 0 | 370 | 0.75 | 278 | 2900 |
| **1996** | ALLOWANCE | YES | YES | 368 | 0 | 368 | 0.77 | 284 | 3230 |
| **1997** | ALLOWANCE | YES | YES | 360 | 0 | 360 | 0.77 | 277 | 3230 |
| **1998** | ALLOWANCE | YES | YES | 265 | 0 | 265 | 0.7 | 212 | 3310 |
| **1999** | ALLOWANCE | NO | NO | 250 | 0 | 250 | 0.72 | 215 | 3350 |
| **2000** | ALLOWANCE | NO | NO | 250 | 0 | 250 | 0.72 | 215 | 3480 |
| **2001** | ALLOWANCE | NO | NO | 250 | 0 | 250 | 0.73 | 220 | 3590 |
| **2002** | 2 PART | NO | NO | 250 | 0 | 250 | 0.75 | 226 | 3840 |
| **2003** | 2 PART | NO | NO | 0 | 0 | 0 | 0.6 | 105 | 4000 |
| **2004** | 2 PART | NO | NO | 0 | 0 | 0 | 0.62 | 106 | 4110 |
| **2005** | 2 PART | NO | NO | 0 | 0 | 0 | 0.68 | 106 | 4325 |
| **2006** | 2 PART | NO | NO | 0 | 0 | 0 | 0.82 | 90 | Varies |
| **2007** | | | | | | | 1.04 | 95 | |
| **2008** | | | | | | | 1.21 | 97 | |

APPENDIX C

# END USE BREAKDOWN – BASELINE SCENARIO FOR WHOLE SHIRE

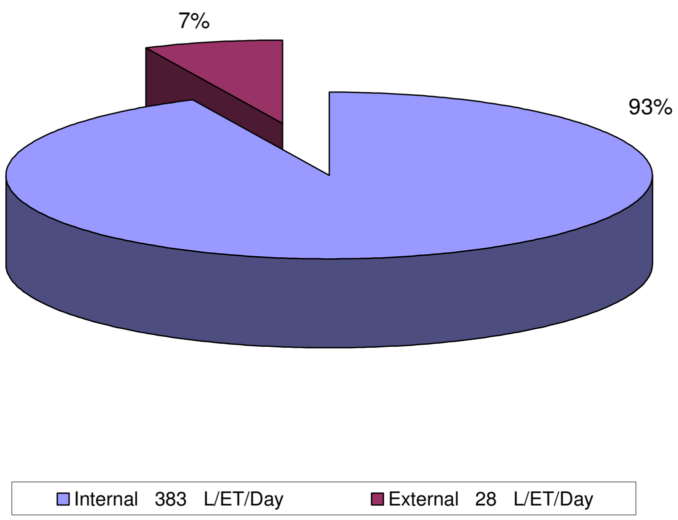
Additional information relating to the adopted end use breakdown demand, as discussed in Section 4.3 is provided in the tables below.

Table C1 provides detailed volumes for the specific end-use demands for MFR in the baseline year of 2007, whereas Figures C1 and C2 depict the results for MFR.

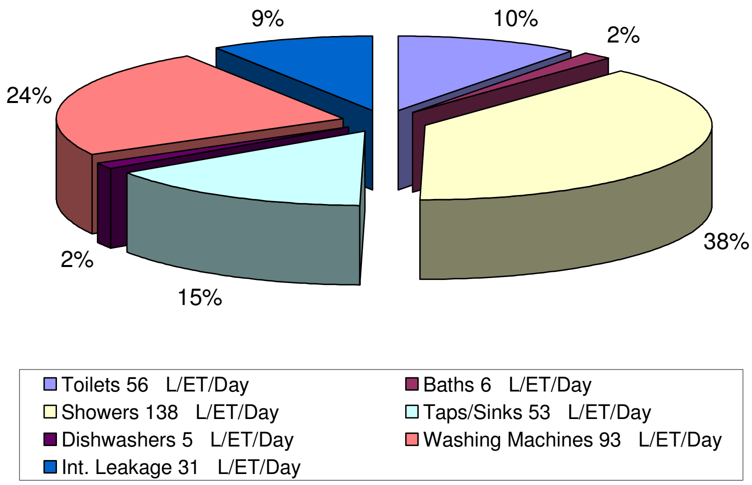
**Table C1 Baseline Summary 2007 – Internal/ External End-Use Breakdown**

| Customer Sector | Internal Breakdown (L/ Account/ Day) | | | | | | | Total Usage (L/ ET/ Day) | |
|---|---|---|---|---|---|---|---|---|---|
| | Toilet | Shower | Laundry | Bath | Dishwasher | Taps | Leakage | Internal | Externa |
| SFR | 81 | 198 | 134 | 9 | 8 | 76 | 45 | 549 | 161 |
| New SFR | 50 | 188 | 118 | 9 | 8 | 76 | 45 | 493 | 161 |
| MFR | 56 | 138 | 93 | 6 | 5 | 53 | 31 | 383 | 28 |
| New MFR | 35 | 131 | 82 | 6 | 5 | 53 | 31 | 343 | 28 |
| COM | Each non-residential sector has their own specific end uses used in the study, e.g. Industrial Process, Tourist Kitchen Spray, and Public Toilets. | | | | | | | | |
| IND | | | | | | | | | |
| PUB | | | | | | | | | |
| BS | | | | | | | | | |

**Figure C1 Existing Multi-Family – Internal/ External Consumption**



## Figure C2 Existing Multi-Family – Internal Consumption Breakdown



APPENDIX D

# SUMMARY OF SCENARIO ASSUMPTIONS

| Scenario | Programme / Measures | Customer Sector | Penetration | Water Savings | Utility Cost per Account | Customer Unit Cost | Fixed Setup Cost | Setup Cost per Account | Admin Cost – Mark-up (% per participant) | Admin Cost - Fixed | Administration Cost- Per Account ($ per participant) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **WELS & BASIX Fixture Programme** | | | | | | | | | | | |
| BASIX | Water Efficient Taps/ Sinks | All Residential | 100% of all new residential accounts | 20% of Taps/ Sinks End-Use | | | | | | | |
| BASIX | Water Efficient Showerheads | All Residential | 80% of all new residential accounts | See Fixture Details | | | | | | | |
| WELS | Water Efficient Dishwashers | All Residential | 5% of all new and existing accounts | 20% of Dishwasher End-Use | | | | | | | |
| WELS | Water Efficient Washing Machines | All Residential | Refer to Market Share ( 7% increased sale) | 30% of WM End-Use | | | | | | | |
| **Education** | | | | | | | | | | | |
| BASIX & All Demand Management | Behavioural Changes and Awareness | All Residential | 100% of all new residential accounts | 1% of all indoor and 2% of outdoor use | $2 | $0 | $0 | $1 | 0% | $50,000 – split between 5 growth areas | $2 |
| BASIX & All Demand Management | Non-Residential – Management Training | All Non-Residential | 80% of commercial, public and irrigation | 10% of external and internal irrigation | $0 | $0 | $0 | $5 | 10% | $50,000 – split between 5 growth areas | $0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rainwater Tanks** | | | | | | | | | | | |
| Scenario 1 | 5kL Rainwater Tank connected to Indoor (Toilet/ WM) and Outdoor | All Residential | 100% of all new residential accounts | 66% (SFR), 80% (MFR) of connected end uses | $0 | SFR - $3,000 plus maintenance , proportional for MFR | $0 | $0.00 | 0% | $10,000 | $10 |
| Scenario3 | 5kL Rainwater Tank connected to Indoor (Shower/ WM) only | All Residential | 100% of all residential accounts | 67% (SFR), 47% (MFR) of connected end uses | $0 | SFR - $,3000 plus maintenance , proportional for MFR | $0 | $0.00 | 0% | $10,000 | $10 |
| **Recycled Water** | | | | | | | | | | | |
| Scenario 2 and Scenario 3 | RCW for Outdoor and Toilet - Residential | All Residential | 100% of all residential accounts | 100% of potable water saving for external and toilet demand | $3500 per account plus$ 75 Annual O&M costs | $0 | Combined Cost of Recycle Plant and RCW Distribution System | $0 | $0 | $75 | $0 |
| | | All Non-Residential | 100% of all non- residential accounts | | | $0 | | $0 | $0 | $75 | $0 |
| **Non-Residential Demand Management** | | | | | | | | | | | |
| BASIX & All Demand Management | Water Management Plan for new non-residential developments | All Non-Residential | 100% of all non- residential accounts | 20% of total demand | $0 | $0 | $0 | $0 | 10% | $10,000 split between 5 growth areas | $25 |

APPENDIX E

# RESIDENTIAL END USE BREAKDOWN FOR NEW GROWTH AREAS

The following tables and figures provide an overview about the end use breakdowns for the two residential sectors from the proposed start year 2012 up to 2036, when development of the new growth areas has been fully completed. It is assumed that new water efficient fixtures according to BASIX have been installed.

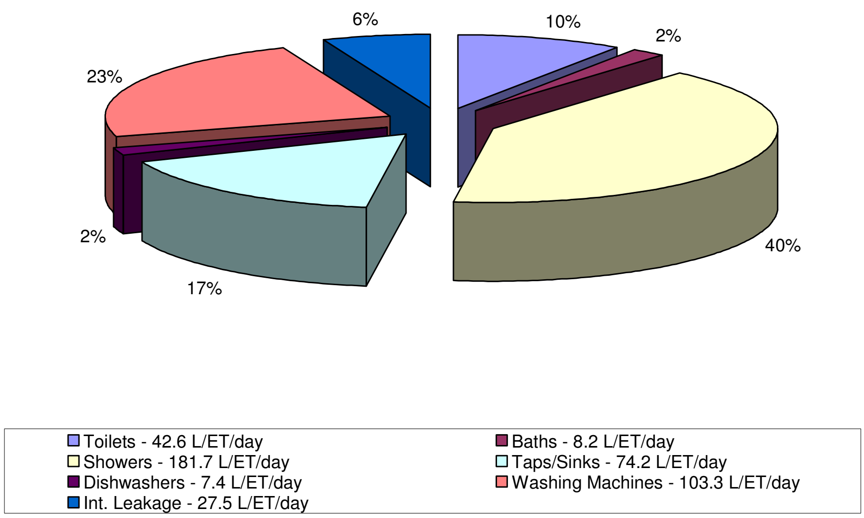
**Table E1 Singe Residential End Use Breakdown**

| | | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|---|
| SFR PPA | PPA | 2.74 | 2.69 | 2.64 | 2.59 | 2.54 | 2.5 |
| Toilets | L/ET/day | 42.6 | 41.7 | 40.8 | 39.9 | 38.9 | 38.0 |
| Baths | L/ET/day | 8.2 | 8.5 | 8.8 | 9.2 | 9.5 | 9.8 |
| Showers | L/ET/day | 180 | 175 | 171 | 166 | 162 | 158 |
| Taps/Sinks | L/ET/day | 73.5 | 72.8 | 71.5 | 70.2 | 68.8 | 67.5 |
| Dishwashers | L/ET/day | 7.3 | 7.6 | 7.9 | 8.2 | 8.5 | 8.8 |
| Washing Machines | L/ET/day | 102 | 100 | 97 | 94 | 91 | 89 |
| Int. Leakage | L/ET/day | 27.2 | 27.4 | 27.5 | 27.5 | 27.5 | 27.5 |
| Irrigation | L/ET/day | 155 | 163 | 170 | 176 | 182 | 189 |
| Other | L/ET/day | 29.1 | 30.5 | 31.8 | 33.0 | 34.2 | 35.4 |
| Ext Leakage | L/ET/day | 9.7 | 9.8 | 9.9 | 9.8 | 9.8 | 9.8 |
| **Total** | **L/ET/day** | **635** | **636** | **635** | **633** | **632** | **632** |

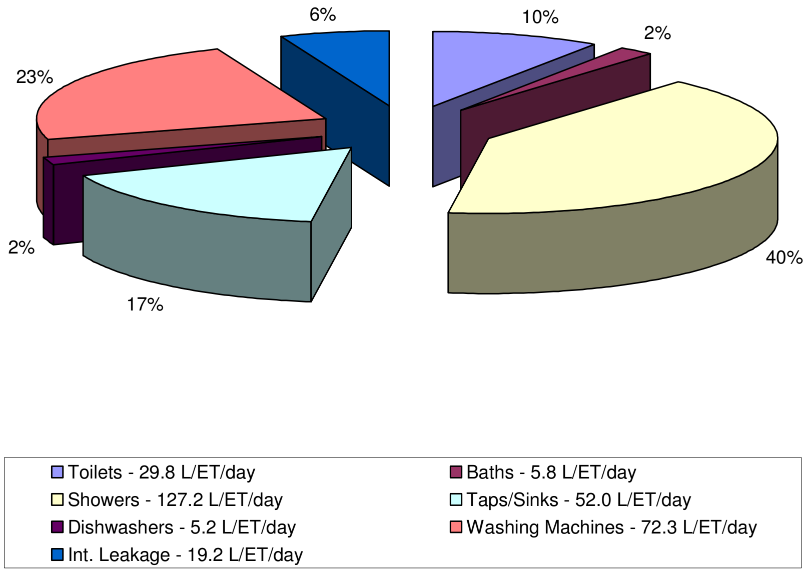
**Table E2 MFR Residential End Use Breakdown**

| | | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|---|
| MFR PPA | PPA | 1.92 | 1.89 | 1.84 | 1.79 | 1.74 | 1.70 |
| Toilets | L/ET/day | 29.8 | 29.4 | 28.5 | 27.6 | 26.7 | 25.8 |
| Baths | L/ET/day | 5.7 | 5.9 | 6.2 | 6.4 | 6.6 | 6.9 |
| Showers | L/ET/day | 126 | 123 | 119 | 115 | 111 | 107 |
| Taps/Sinks | L/ET/day | 51.4 | 51.2 | 49.9 | 48.6 | 47.2 | 45.9 |
| Dishwashers | L/ET/day | 5.1 | 5.3 | 5.5 | 5.7 | 5.9 | 6.1 |
| Washing Machines | L/ET/day | 71.6 | 70.1 | 67.4 | 64.8 | 62.6 | 60.6 |
| Int. Leakage | L/ET/day | 19.1 | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 |
| Irrigation | L/ET/day | 39.5 | 41.4 | 43.1 | 44.8 | 46.4 | 48.0 |
| Other | L/ET/day | 7.4 | 7.8 | 8.1 | 8.4 | 8.7 | 9.0 |
| Ext Leakage | L/ET/day | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| **Total** | **L/ET/day** | **358** | **356** | **349** | **343** | **337** | **331** |

## Figure E1 Internal End Use Breakdown – New SFR Developments in 2012




## Figure E2 Internal End Use Breakdown – New MFR Developments in 2012



APPENDIX F

# DETAILED DEMAND FORECAST RESULTS – GREENFIELD DEVELOPMENT AREAS

In addition to the summarised results of the demand management analysis, further information is provided in this appendix for the total sectoral water demand breakdown and the multi-residential (MFR) demand profile.

**Table F1 Total Sectoral Annual Water Demand Forecast – Scenario 1 – Combined Greenfield Development Areas**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 57.0 | 282 | 558 | 828 | 1,093 | 1,360 |
| Multi-Family Greenfield | 23.9 | 118 | 230 | 337 | 440 | 541 |
| Commercial | 0.1 | 7.2 | 16.0 | 25.0 | 34.0 | 44.8 |
| Industrial | 0.4 | 2.0 | 4.0 | 6.1 | 8.1 | 10.1 |
| Irrigation | 1.7 | 8.6 | 18.4 | 28.6 | 39.4 | 50.8 |
| Public | 3.7 | 18.6 | 37.5 | 56.6 | 75.9 | 95.5 |
| **Total** | **87** | **436** | **865** | **1,281** | **1,690** | **2,103** |

**Table F2 Sectoral Annual Water Demand Forecast – Scenario 2 – Combined Greenfield Development Areas**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 57.4 | 281 | 549 | 805 | 1,052 | 1,297 |
| Multi-Family Greenfield | 28.1 | 138 | 268 | 390 | 506 | 620 |
| Commercial | 0.1 | 4.2 | 9.3 | 14.5 | 19.5 | 25.6 |
| Industrial | 0.4 | 2.0 | 4.0 | 6.1 | 8.1 | 10.1 |
| Irrigation | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Public | 1.7 | 8.7 | 17.4 | 26.0 | 34.7 | 43.4 |
| **Total** | **88** | **434** | **848** | **1,242** | **1,621** | **1,996** |

**Table F3 Sectoral Annual Water Demand Forecast – Scenario 3 – Combined Greenfield Development Areas**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 32.7 | 161 | 316 | 466 | 611 | 756 |
| Multi-Family Greenfield | 18.7 | 92 | 180 | 263 | 342 | 421 |
| Commercial | 0.1 | 4.2 | 9.3 | 14.5 | 19.5 | 25.6 |
| Industrial | 0.4 | 2.0 | 4.0 | 6.1 | 8.1 | 10.1 |
| Irrigation | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Public | 1.7 | 8.7 | 17.4 | 26.0 | 34.7 | 43.4 |
| **Total** | **54** | **268** | **527** | **776** | **1,016** | **1,256** |

**Table F4 Residential Demand (L/Person/Day) including SFR and MFR for Combined Greenfield Development Areas**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 219 | 221 | 224 | 228 | 232 | 237 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 147 | 148 | 149 | 150 | 152 | 153 |
| Scenario 2 - BASIX with Dual Reticulation | 155 | 155 | 155 | 154 | 154 | 154 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 93 | 94 | 94 | 94 | 94 | 95 |

The following tables and figures summarise the water demand forecast for a new multi-residential dwelling under the different scenarios. Results for SFR are given in the main report (Section 5.3).

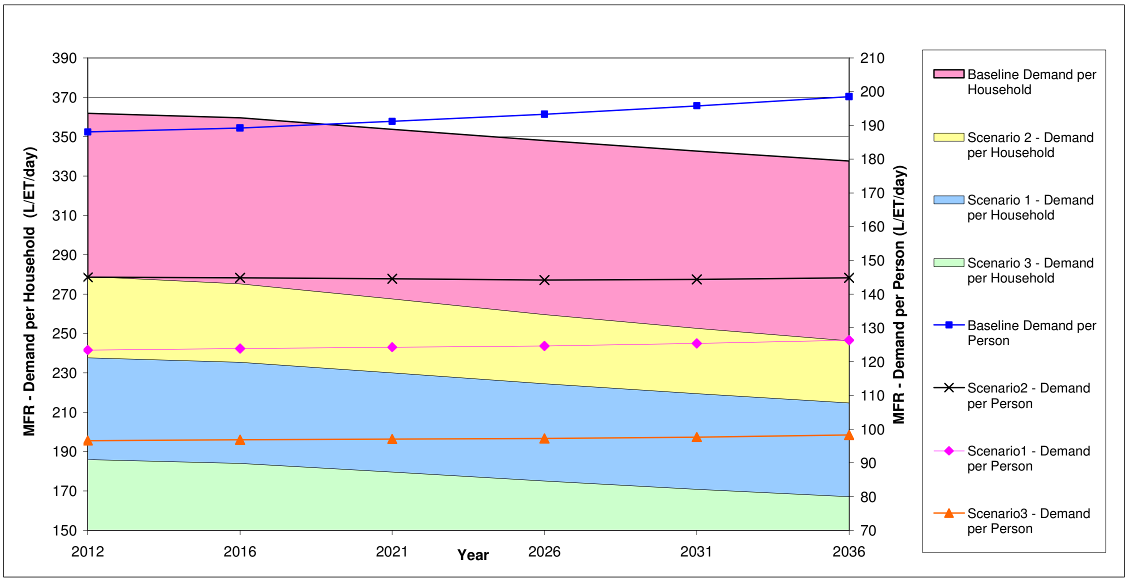
**Table F5 MFR Demand per Account (L/ET/Day)**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 362 | 360 | 354 | 348 | 343 | 338 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 238 | 235 | 230 | 224 | 219 | 215 |
| Scenario 2 - BASIX with Dual Reticulation | 279 | 275 | 267 | 260 | 253 | 246 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 186 | 184 | 180 | 175 | 171 | 167 |

**Table F6 MFR Demand per Person (L/EP/Day)**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 188 | 189 | 191 | 193 | 196 | 199 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 123 | 124 | 124 | 125 | 125 | 126 |
| Scenario 2 - BASIX with Dual Reticulation | 145 | 145 | 145 | 144 | 144 | 145 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 97 | 97 | 97 | 97 | 98 | 98 |

**Figure F1 Demand Forecast - Multi-Family Residential Dwelling**



APPENDIX G

# SCENARIO DEMAND FORECASTS - BILAMBIL HEIGHTS

The following figures and tables summarise the future water demand management outcomes for Bilambil Heights.

**Table G1 Total Annual Water Demand Forecast – Bilambil Heights**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 29 | 143 | 285 | 425 | 564 | 705 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 19 | 91 | 178 | 267 | 353 | 440 |
| Scenario 2 - BASIX with Dual Reticulation | 19 | 88 | 172 | 254 | 334 | 412 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 12 | 58 | 114 | 170 | 225 | 279 |

**Figure G1 Total Water Demand Forecast – Bilambil Heights**

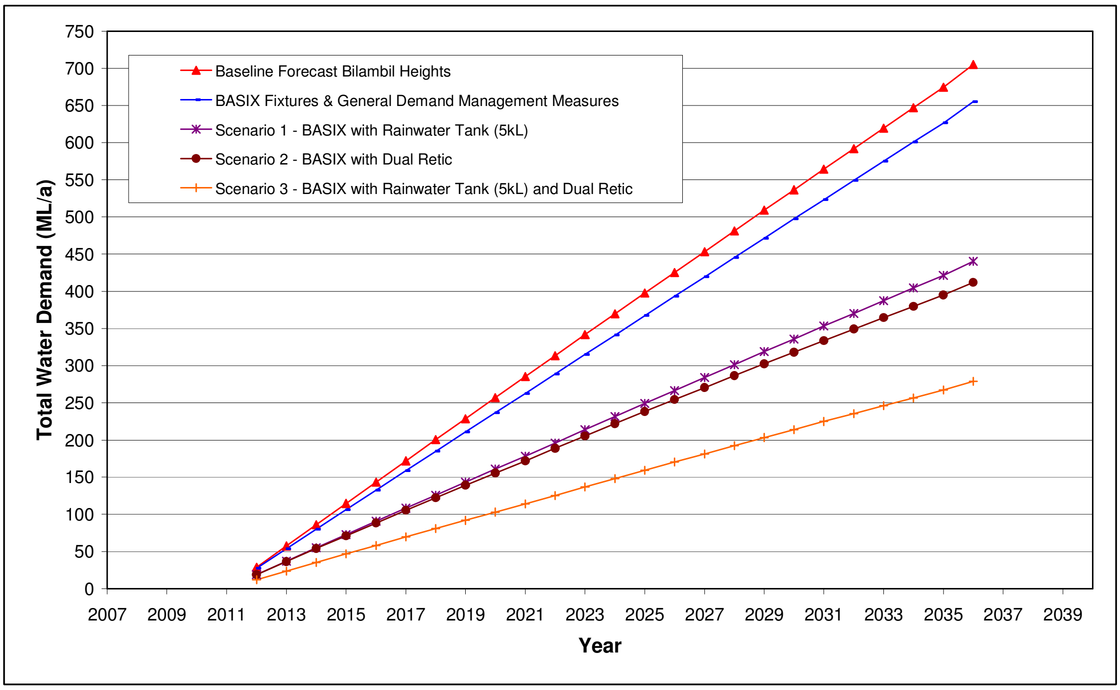
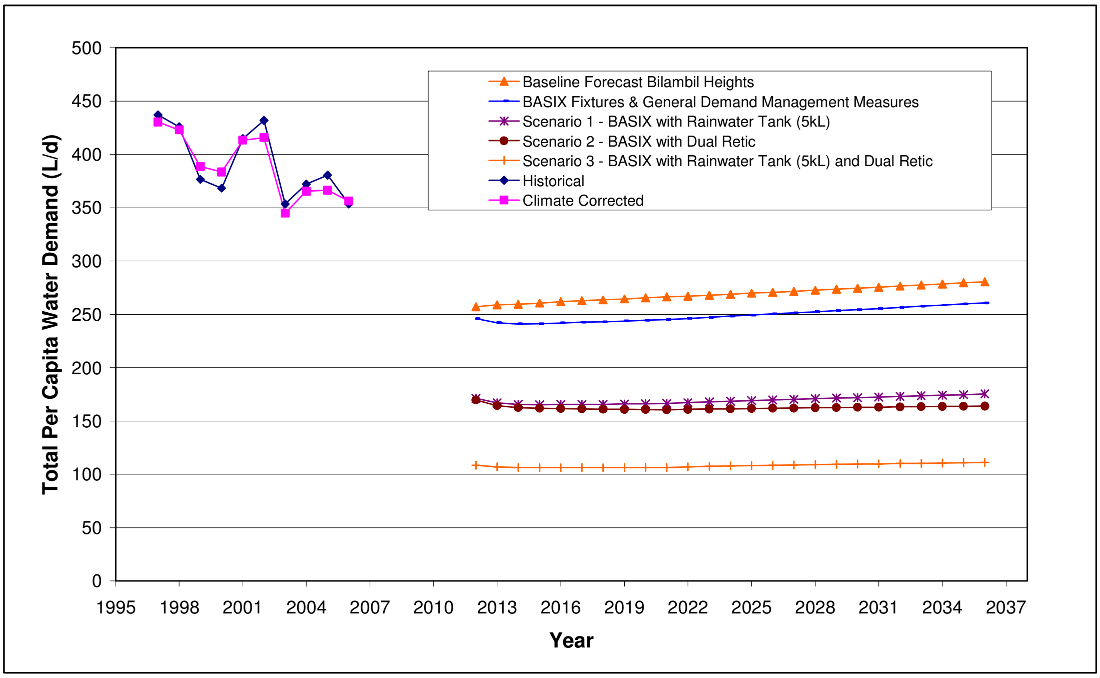



**Table G2 Total Per Capita Water Demand Forecast – Bilambil Heights**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 257 | 262 | 266 | 271 | 275 | 281 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 171 | 165 | 166 | 170 | 172 | 175 |
| Scenario 2 - BASIX with Dual Reticulation | 170 | 161 | 160 | 162 | 163 | 164 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 108 | 106 | 106 | 108 | 110 | 111 |

### Figure G2 Total Per Capita Water Demand Forecast – Bilambil Heights




### Table G3 Sectoral Annual Water Demand Forecast – Scenario 1 – Bilambil Heights

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 10.9 | 54 | 107 | 158 | 209 | 260 |
| Multi-Family Greenfield | 5.3 | 26 | 51 | 75 | 98 | 121 |
| Commercial | 0.14 | 1.76 | 3.85 | 5.82 | 7.95 | 10 |
| Industrial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Irrigation | 0.35 | 1.80 | 3.85 | 6.01 | 8.28 | 11 |
| Public | 0.76 | 3.85 | 7.76 | 12 | 16 | 20 |
| **Total** | **18** | **88** | **174** | **257** | **339** | **422** |

### Table G4 Sectoral Annual Water Demand Forecast – Scenario 2 – Bilambil Heights

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 11.0 | 54 | 105 | 154 | 201 | 248 |
| Multi-Family Greenfield | 6.3 | 31 | 60 | 87 | 113 | 139 |
| Commercial | 0.1 | 1 | 2 | 3 | 5 | 6 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Public | 0.4 | 2 | 4 | 5 | 7 | 9 |
| **Total** | **18** | **87** | **171** | **250** | **326** | **402** |

### Table G5 Sectoral Annual Water Demand Forecast – Scenario 3 – Bilambil Heights

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 6.2 | 31 | 60 | 89 | 117 | 145 |
| Multi-Family Greenfield | 4.2 | 21 | 40 | 59 | 76 | 94 |
| Commercial | 0.1 | 1 | 2 | 3 | 5 | 6 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Public | 0.4 | 2 | 4 | 5 | 7 | 9 |
| **Total** | **11** | **54** | **107** | **157** | **205** | **253** |

### Table G6 Individual Demand Measurement Results – Scenario 1 – Bilambil Heights

| Summaries NPV Costs Scenario 1 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $6,758,617 | $2,228,714 | $8,987,331 | | | $94,224 |
| Sewer (without RIGS) | $2,083,593 | $4,687,894 | $6,771,487 | | | $326,014 |
| Rainwater Tanks | $- | $3,882,050 | $3,882,050 | $261,742 | $1,120,803 | $1,382,545 |
| Recycled Water | $- | $- | $- | $- | $- | $- |
| **Total** | **$8,842,210** | **$10,798,658** | **$19,640,868** | **$261,742** | **$1,120,803** | **$1,802,784** |

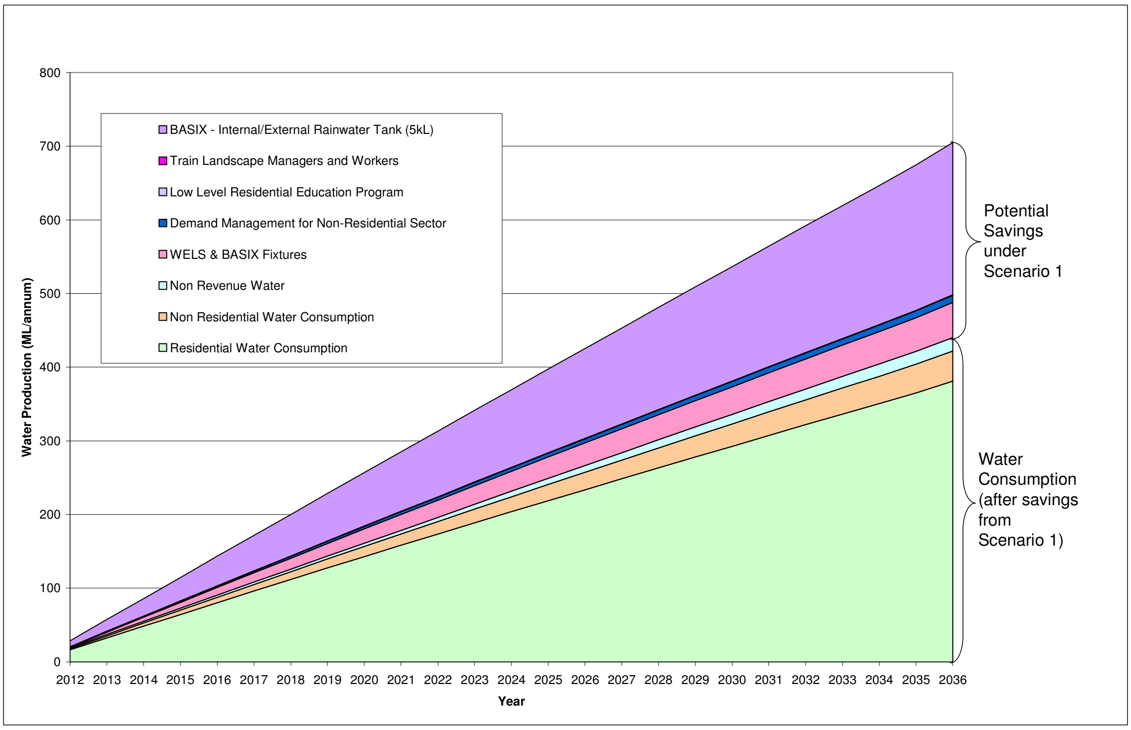
### Table G7 Individual Demand Measurement Results – Scenario 2 – Bilambil Heights

| Summaries NPV Costs Scenario 2 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $5,751,826 | $1,444,822 | $7,196,648 | | | $94,224 |
| Sewer (without RIGS) | $2,083,593 | $4,687,894 | $6,771,487 | | | $326,014 |
| Rainwater Tanks | $0 | $0 | $0 | $0 | $0 | $0 |
| Recycled Water | $9,104,504 | $2,820,652 | $11,925,156 | $1,084,085 | $0 | $1,084,085 |
| **Total** | **$16,939,923** | **$8,953,368** | **$25,893,291** | **$1,084,085** | **$0** | **$1,504,324** |

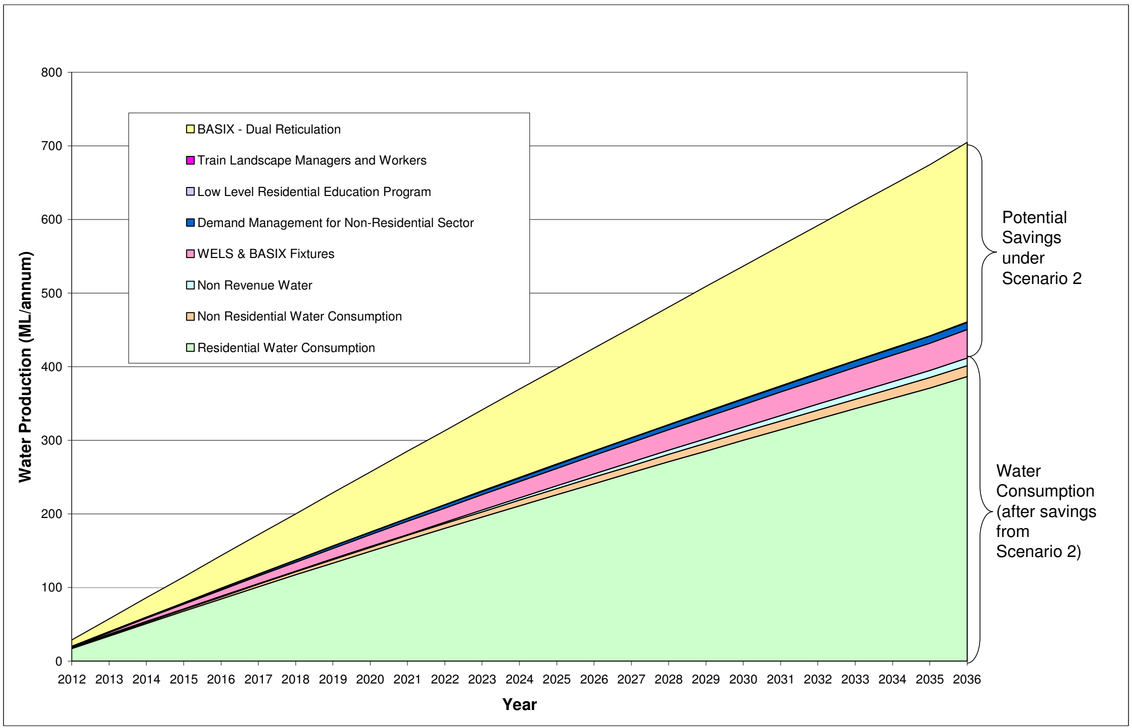
### Table G8 Individual Demand Measurement Results – Scenario 3 – Bilambil Heights

| Summaries NPV Costs Scenario 3 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $5,751,826 | $1,444,822 | $7,196,648 | | | $52,335 |
| Sewer (without RIGS) | $2,083,593 | $4,687,894 | $6,771,487 | | | $326,014 |
| Rainwater Tanks | $0 | $3,882,050 | $3,882,050 | $261,742 | $1,120,803 | $1,382,545 |
| Recycled Water | $9,104,504 | $2,820,652 | $11,925,156 | $1,084,085 | $0 | $1,084,085 |
| **Total** | **$16,939,923** | **$12,835,418** | **$29,775,341** | **$1,345,828** | **$1,120,803** | **$2,844,980** |

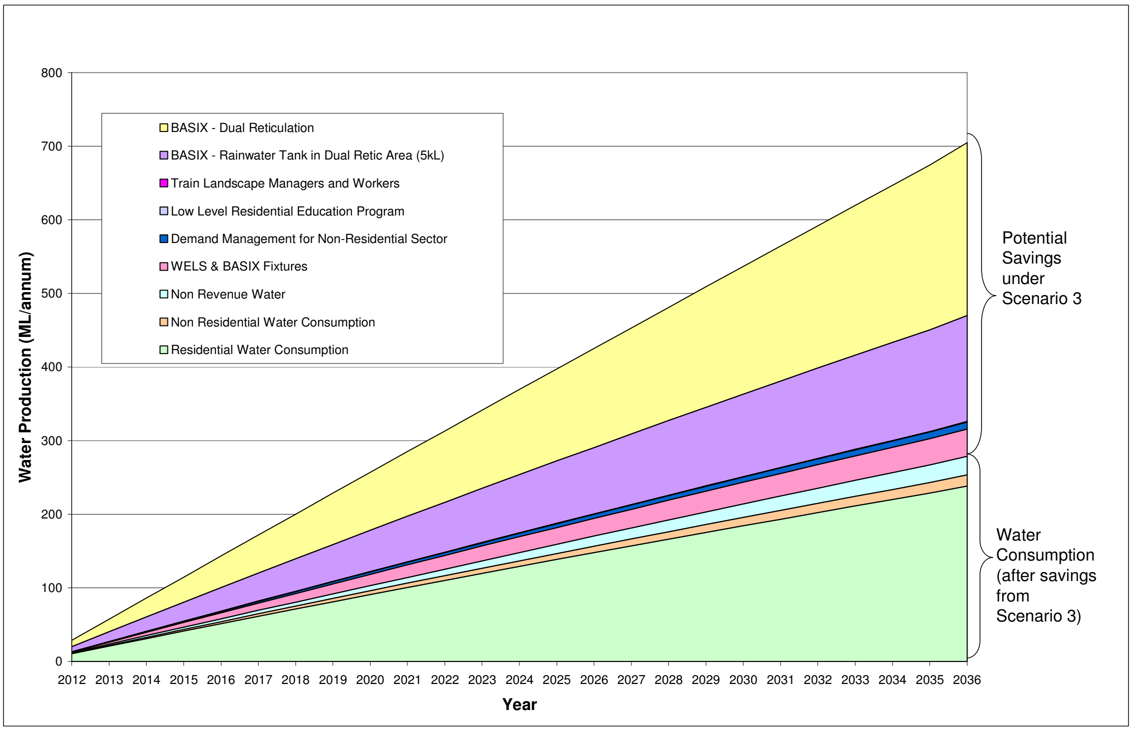
## Figure G3 Water Demand Profile – Scenario 1 – Bilambil Heights



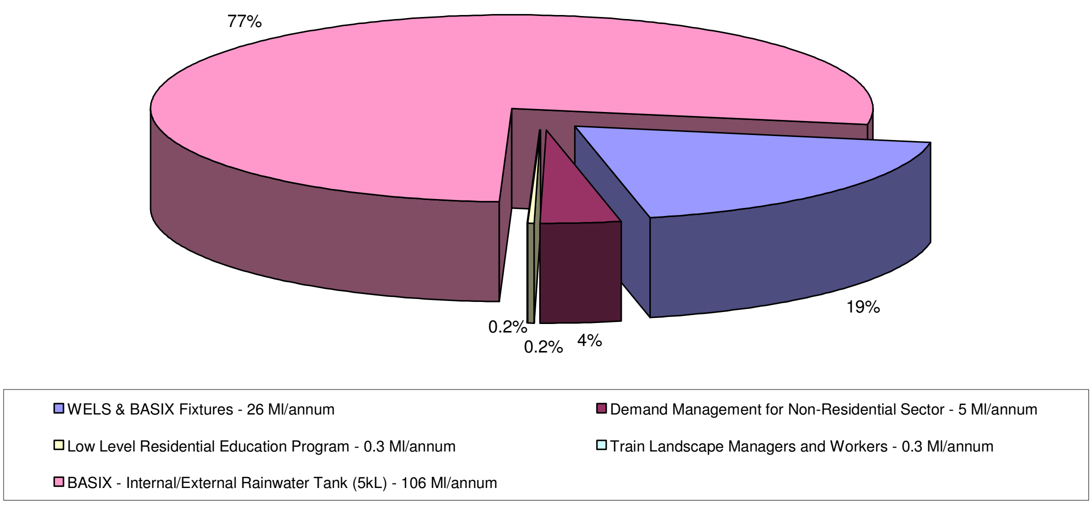

## Figure G4 Water Demand Profile – Scenario 2 – Bilambil Heights



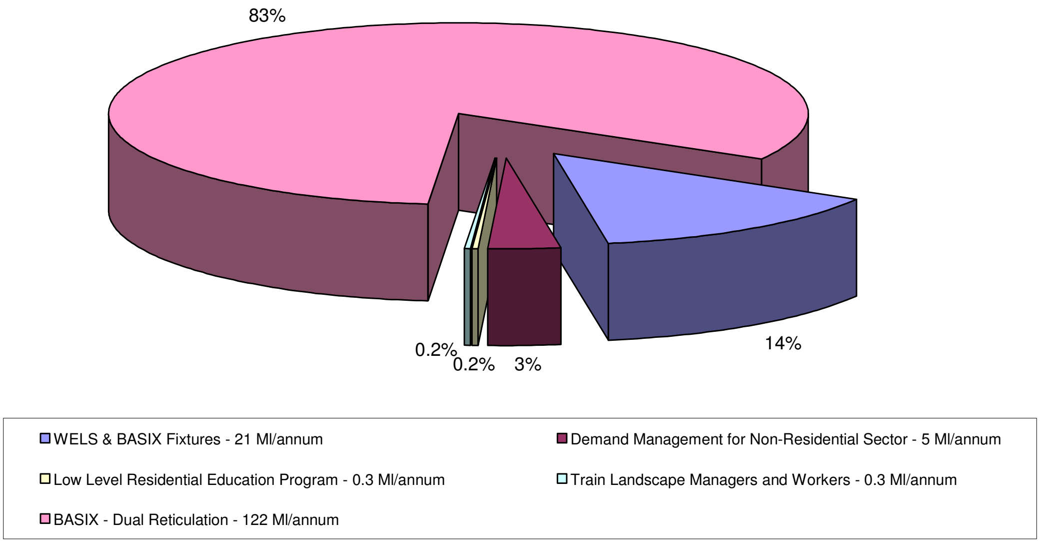
## Figure G5 Water Demand Profile – Scenario 3 – Bilambil Heights



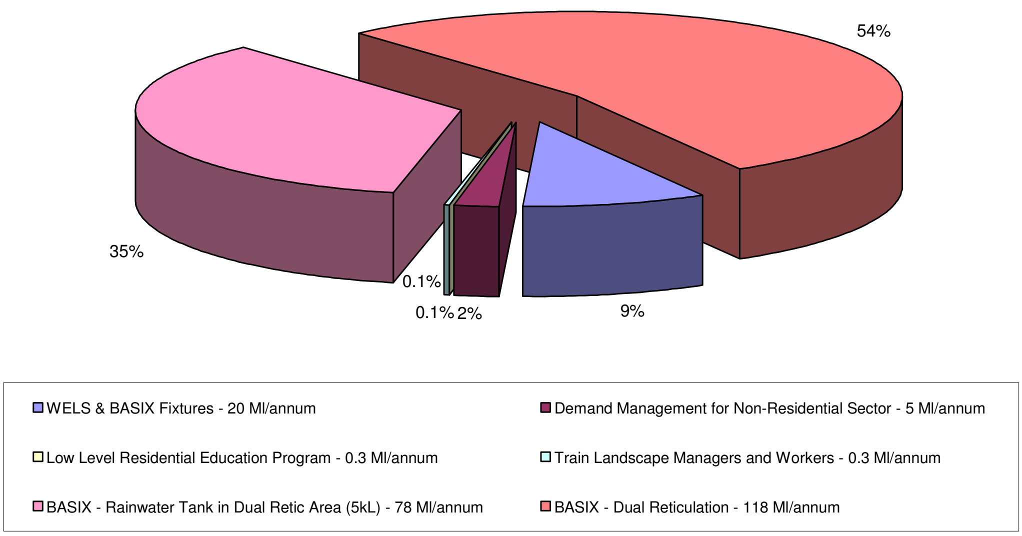

## Figure G6 Average Water Savings by Component – Scenario 1 – Bilambil Heights



## Figure G7 Average Water Savings by Component – Scenario 2 – Bilambil Heights




## Figure G8 Average Water Savings by Component – Scenario 3 – Bilambil Heights



APPENDIX H

# SCENARIO DEMAND FORECASTS - COBAKI LAKES

The figures and tables below outline the future water demand management outcomes for Cobaki Lakes.

**Table H1 Total Annual Water Demand Forecast – Cobaki Lakes**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 43 | 214 | 426 | 636 | 844 | 1054 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 29 | 138 | 271 | 405 | 536 | 669 |
| Scenario 2 - BASIX with Dual Reticulation | 28 | 133 | 257 | 380 | 498 | 615 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 18 | 86 | 167 | 249 | 329 | 407 |

**Figure H1 Total Water Demand Forecast – Bilambil Heights**

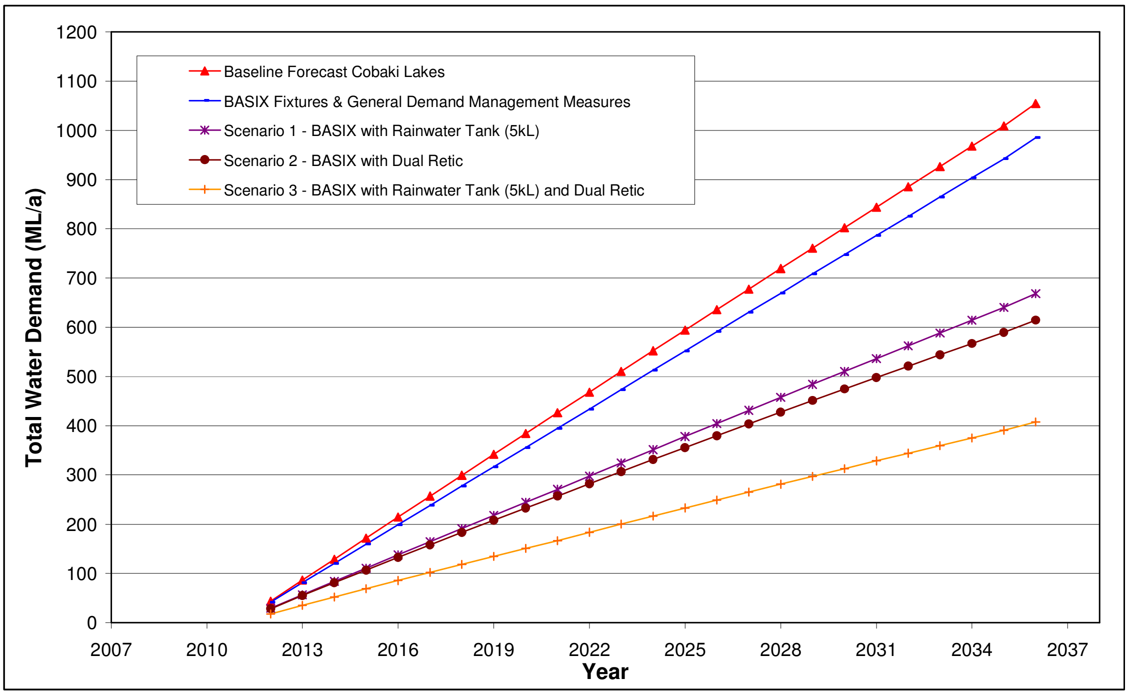



**Table H2 Total Per Capita Water Demand Forecast – Cobaki Lakes**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 256 | 258 | 262 | 266 | 271 | 276 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 173 | 165 | 166 | 169 | 172 | 175 |
| Scenario 2 - BASIX with Dual Reticulation | 168 | 160 | 158 | 159 | 160 | 161 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 105 | 103 | 103 | 104 | 106 | 107 |

**Figure H2 Total Per Capita Water Demand Forecast – Cobaki Lakes**

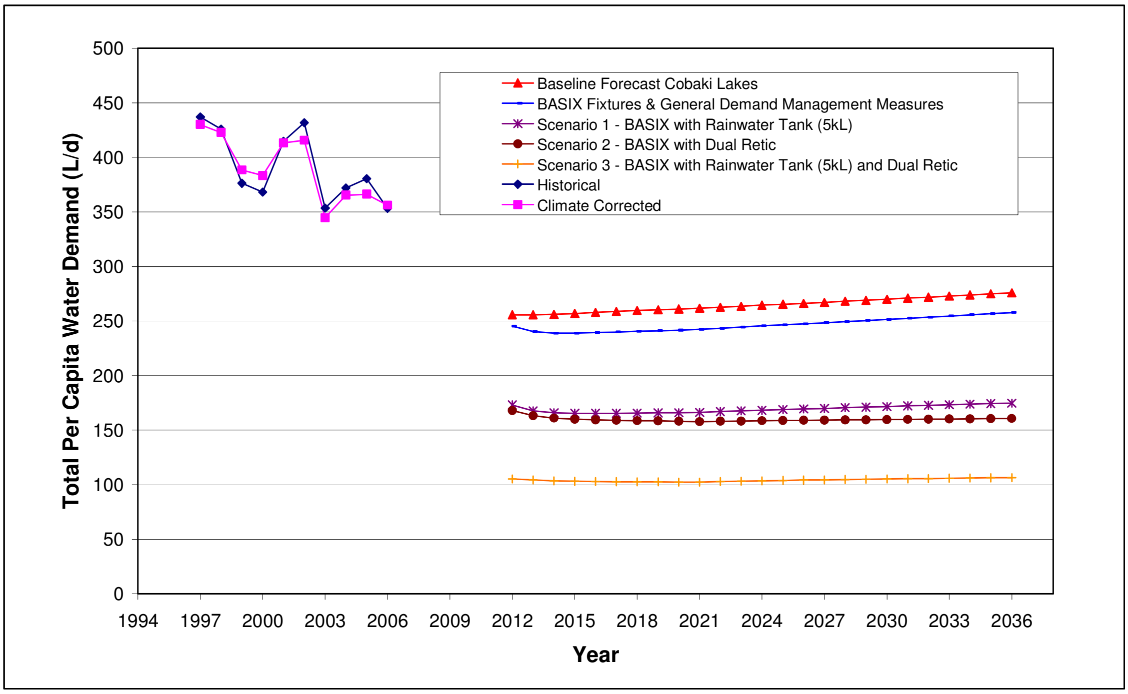



**Table H3 Sectoral Annual Water Demand Forecast – Scenario 1 – Cobaki Lakes**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 19.0 | 94 | 186 | 277 | 366 | 455 |
| Multi-Family Greenfield | 6.7 | 33 | 64 | 94 | 122 | 151 |
| Commercial | 0.29 | 1.35 | 2.73 | 4.12 | 5.68 | 7 |
| Industrial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Irrigation | 0.48 | 2.46 | 5.27 | 8.23 | 11.33 | 15 |
| Public | 0.55 | 2.80 | 5.64 | 9 | 11 | 14 |
| **Total** | **27** | **134** | **264** | **391** | **516** | **642** |

**Table H4 Sectoral Annual Water Demand Forecast – Scenario 2 – Cobaki Lakes**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 18.6 | 91 | 178 | 260 | 340 | 419 |
| Multi-Family Greenfield | 7.8 | 38 | 75 | 109 | 141 | 173 |
| Commercial | 0.2 | 1 | 2 | 2 | 3 | 4 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 1 | 1 | 1 |
| Public | 0.3 | 2 | 3 | 4 | 5 | 7 |
| **Total** | **27** | **132** | **257** | **376** | **490** | **603** |

### Table H5 Sectoral Annual Water Demand Forecast – Scenario 3 – Cobaki Lakes

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 10.6 | 52 | 102 | 151 | 198 | 244 |
| Multi-Family Greenfield | 5.2 | 26 | 50 | 73 | 95 | 117 |
| Commercial | 0.2 | 1 | 2 | 2 | 3 | 4 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 1 | 1 | 1 |
| Public | 0.3 | 2 | 3 | 4 | 5 | 7 |
| **Total** | **16** | **80** | **157** | **231** | **302** | **373** |

### Table H6 Individual Demand Measurement Results – Scenario 1 – Cobaki Lakes

| Summaries NPV Costs Scenario 1 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $6,958,788 | $3,555,230 | $10,514,018 | | | $281,669 |
| Sewer (without RIGS) | $2,988,190 | $6,932,191 | $9,920,381 | | | $423,885 |
| Rainwater Tanks | $0 | $5,891,597 | $5,891,597 | $331,282 | $1,701,050 | $2,032,332 |
| Recycled Water | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | **$9,946,978** | **$16,379,018** | **$26,325,996** | **$331,282** | **$1,701,050** | **$2,737,886** |

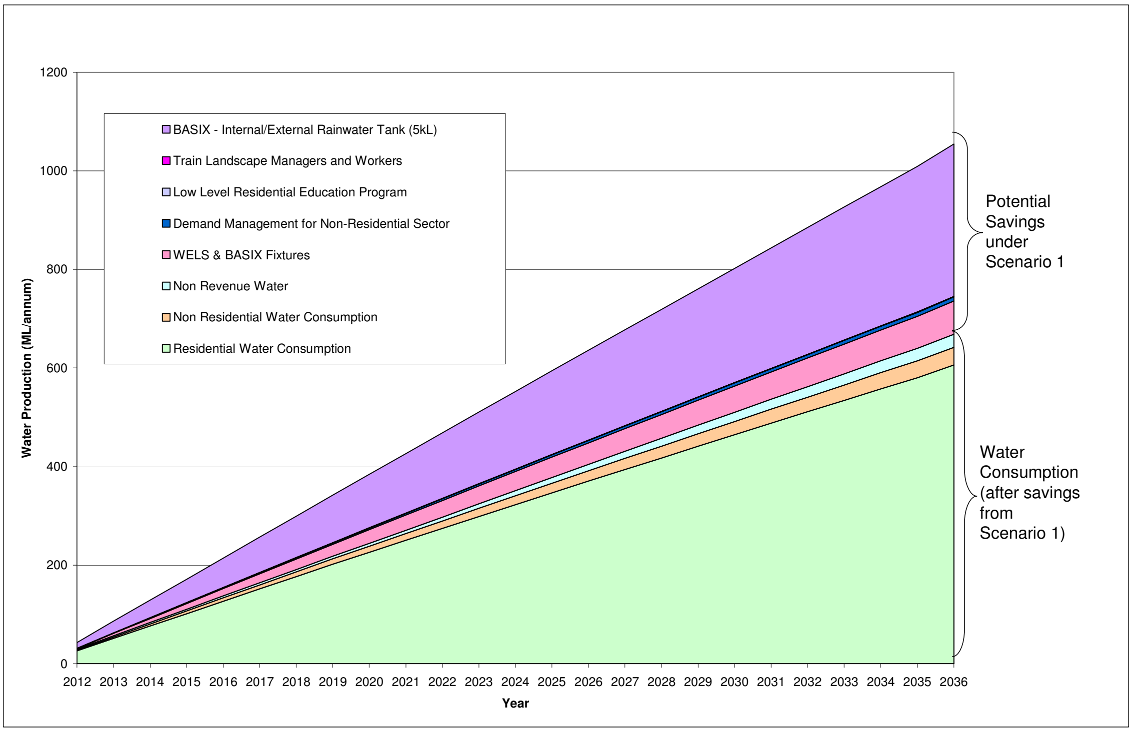
### Table H7 Individual Demand Measurement Results – Scenario 2 – Cobaki Lakes

| Summaries NPV Costs Scenario 2 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $5,693,579 | $2,304,770 | $7,998,349 | | | $260,245 |
| Sewer (without RIGS) | $2,988,190 | $6,932,191 | $9,920,381 | | | $423,885 |
| Rainwater Tanks | $0 | $0 | $0 | $0 | $0 | $0 |
| Recycled Water | $11,801,071 | $4,499,485 | $16,300,556 | $1,632,713 | $0 | $1,632,713 |
| **Total** | **$20,482,840** | **$13,736,446** | **$34,219,285** | **$1,632,713** | **$0** | **$2,316,843** |

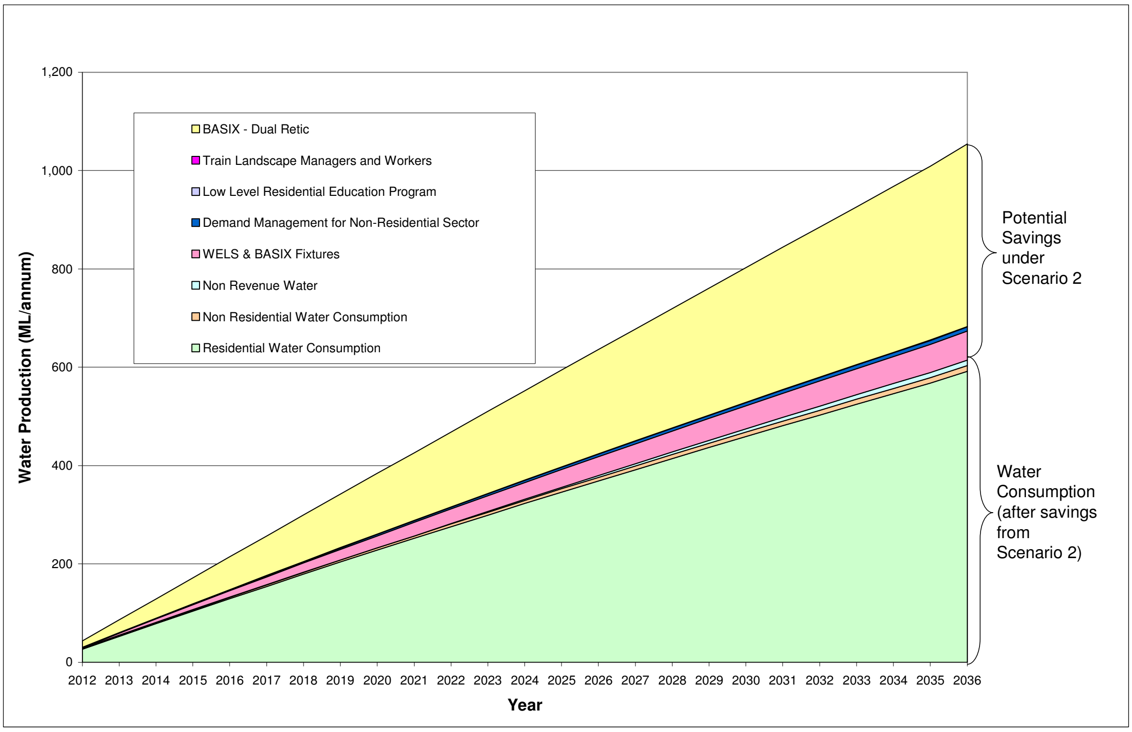
### Table H8 Individual Demand Measurement Results – Scenario 3 – Cobaki Lakes

| Summaries NPV Costs Scenario 3 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $5,693,579 | $2,304,770 | $7,998,349 | | | $170,187 |
| Sewer (without RIGS) | $2,988,190 | $6,932,191 | $9,920,381 | | | $423,885 |
| Rainwater Tanks | $0 | $5,891,597 | $5,891,597 | $331,282 | $1,701,050 | $2,032,332 |
| Recycled Water | $11,801,071 | $4,499,485 | $16,300,556 | $1,632,713 | $0 | $1,632,713 |
| **Total** | **$20,482,840** | **$19,628,043** | **$40,110,883** | **$1,963,995** | **$1,701,050** | **$4,259,118** |

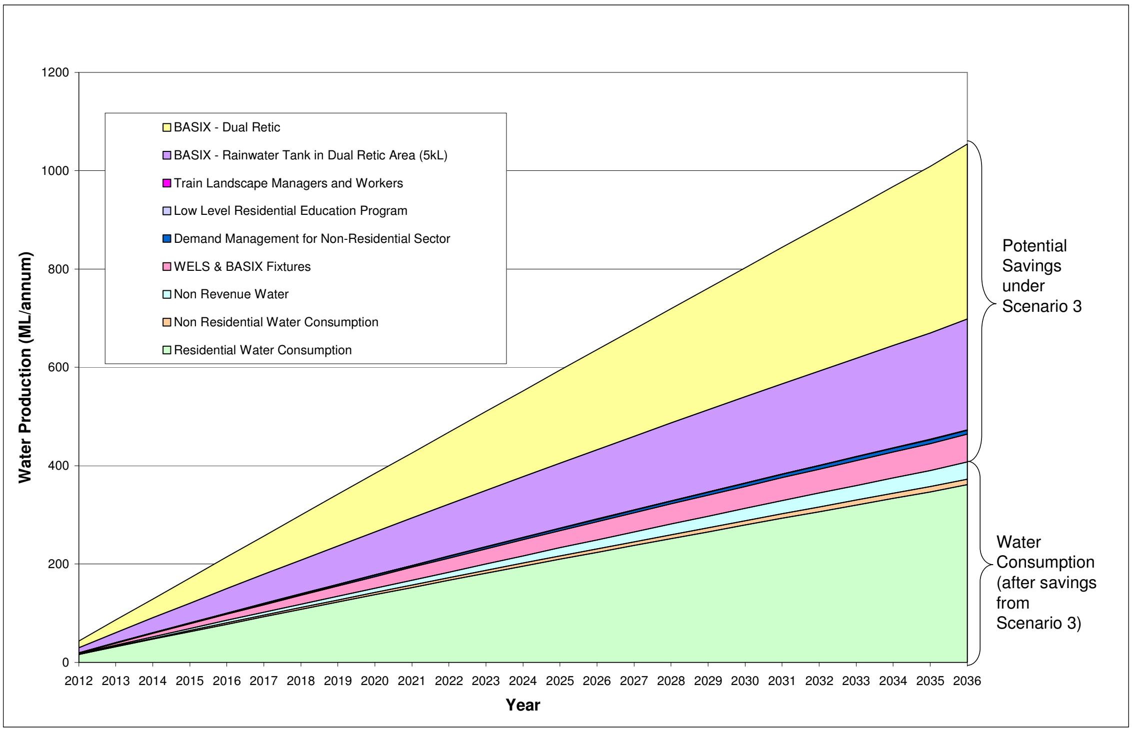
## Figure H3 Water Demand Profile – Scenario 1 – Cobaki Lakes



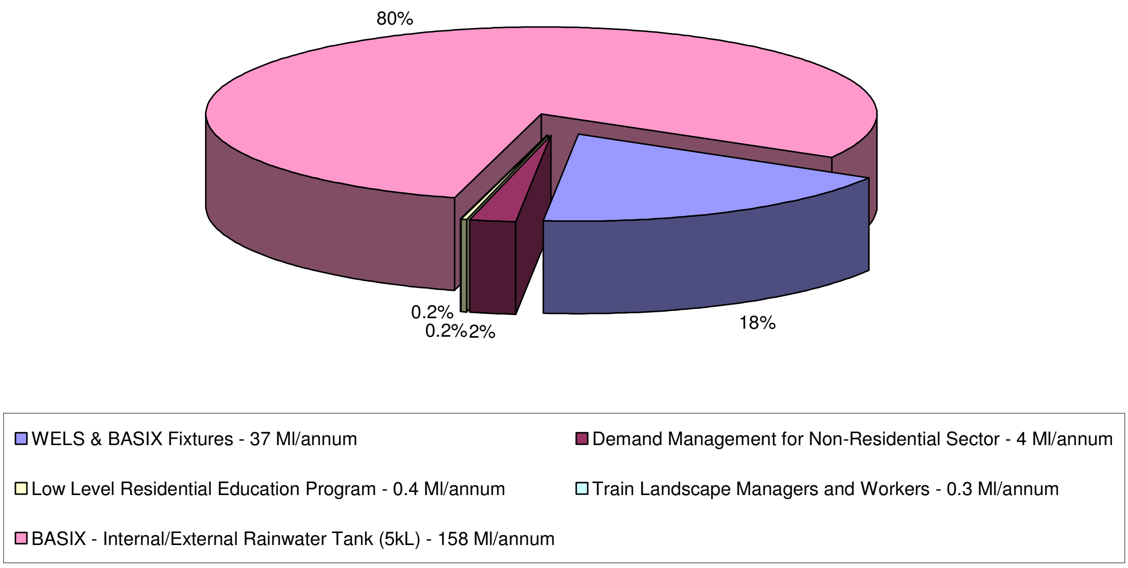

## Figure H4 Water Demand Profile – Scenario 2 – Cobaki Lakes



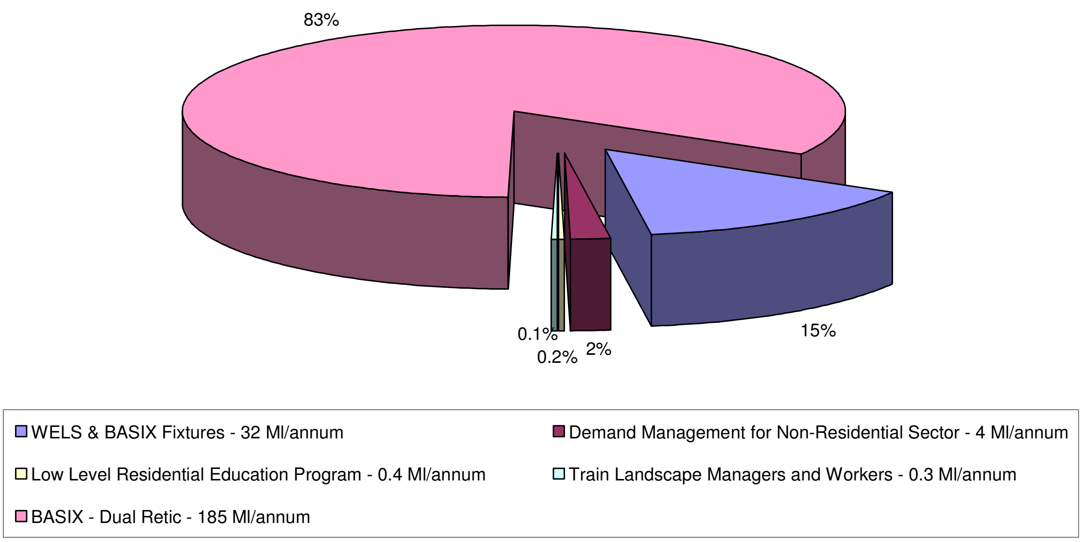
## Figure H5 Water Demand Profile – Scenario 3 – Cobaki Lakes



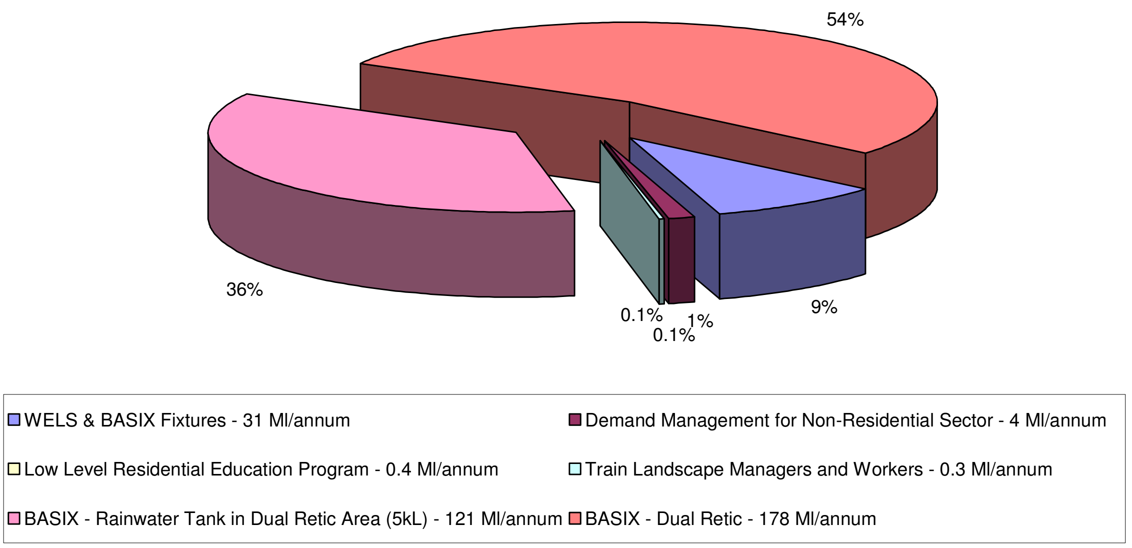

## Figure H6 Average Water Savings by Components – Scenario 1 – Cobaki Lakes



## Figure H7 Average Water Savings by Components – Scenario 2 – Cobaki Lakes




## Figure H8 Average Water Savings by Components – Scenario 3 – Cobaki Lakes



APPENDIX I

# SCENARIO DEMAND FORECASTS - KINGS FOREST

The figures and tables below outline the future water demand management outcomes for Kings Forest.

**Table I1 Total Annual Water Demand Forecast – Kings Forest**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 45 | 223 | 443 | 661 | 877 | 1096 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 30 | 143 | 281 | 420 | 557 | 695 |
| Scenario 2 - BASIX with Dual Reticulation | 30 | 138 | 267 | 395 | 518 | 639 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 19 | 89 | 173 | 259 | 342 | 424 |

**Figure I1 Total Water Demand Forecast – Kings Forest**

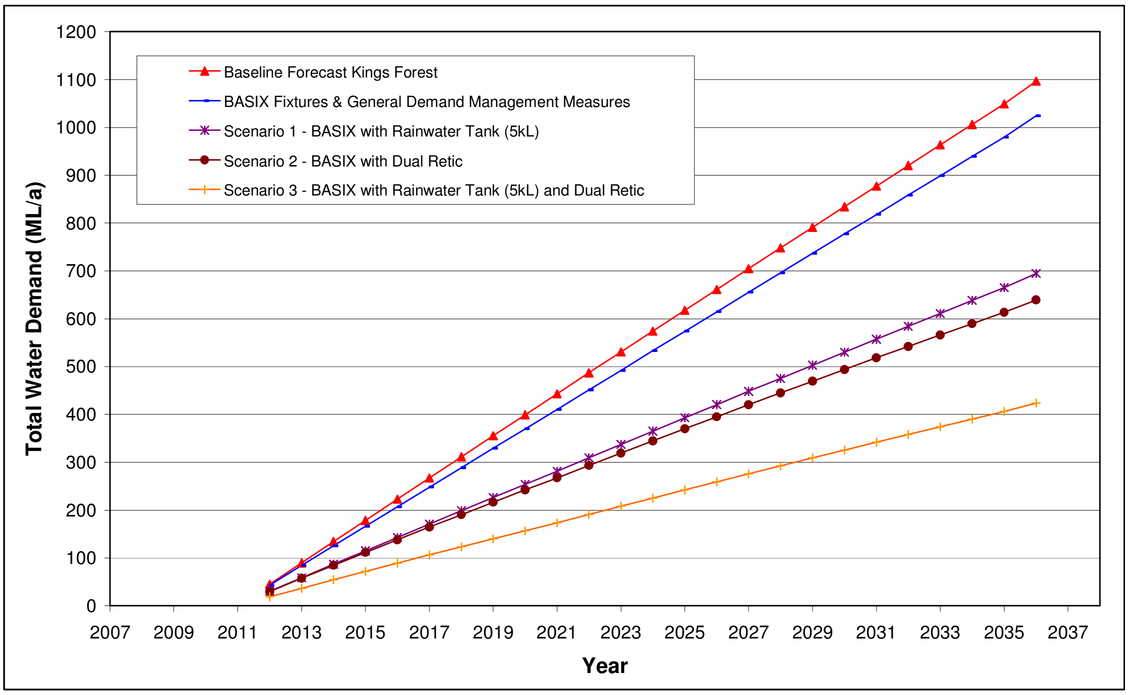
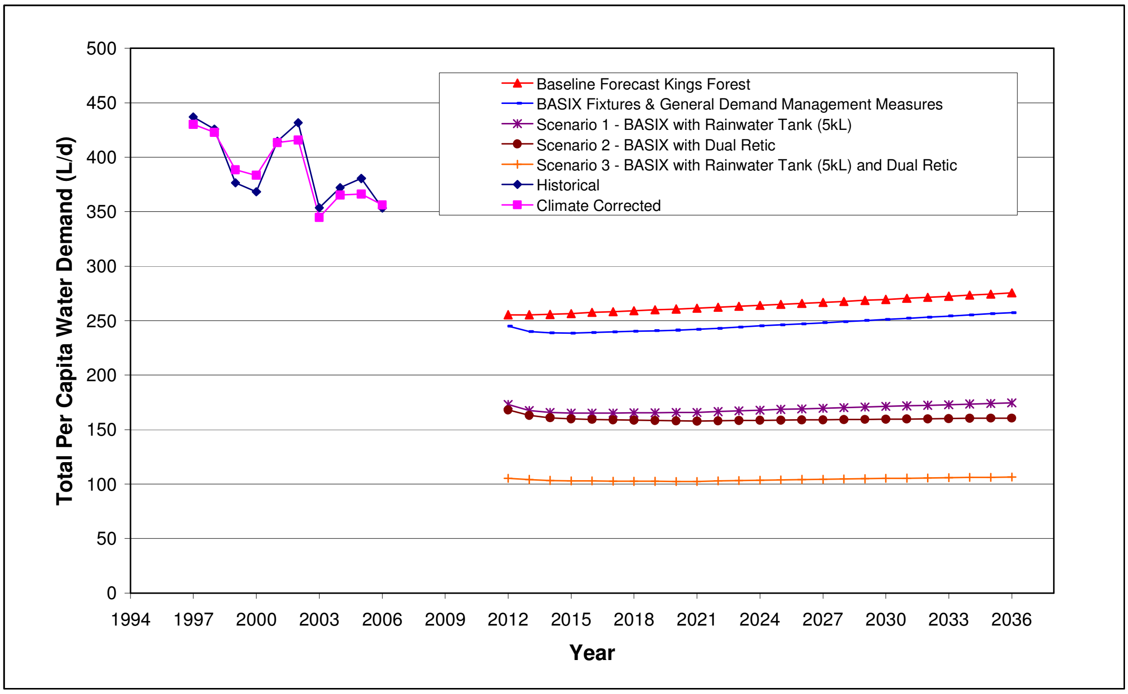



**Table I2 Total Per Capita Water Demand Forecast – Kings Forest**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 255 | 258 | 261 | 266 | 271 | 275 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 173 | 165 | 166 | 169 | 172 | 174 |
| Scenario 2 - BASIX with Dual Reticulation | 168 | 159 | 158 | 159 | 160 | 161 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 105 | 103 | 102 | 104 | 105 | 106 |

## Figure I2 Total Per Capita Water Demand Forecast – Kings Forest




## Table I3 Sectoral Annual Water Demand Forecast – Scenario 1 – Kings Forest

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 19.8 | 98 | 194 | 288 | 381 | 474 |
| Multi-Family Greenfield | 6.9 | 34 | 67 | 98 | 127 | 157 |
| Commercial | 0.29 | 1.33 | 2.67 | 4.04 | 5.56 | 7 |
| Industrial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Irrigation | 0.48 | 2.46 | 5.27 | 8.23 | 11.33 | 15 |
| Public | 0.55 | 2.80 | 5.64 | 9 | 11 | 14 |
| **Total** | **28** | **139** | **275** | **407** | **536** | **667** |

## Table I4 Sectoral Annual Water Demand Forecast – Scenario 2 – Kings Forest

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 19.3 | 94 | 185 | 271 | 354 | 437 |
| Multi-Family Greenfield | 8.1 | 40 | 78 | 113 | 147 | 180 |
| Commercial | 0.2 | 1 | 2 | 2 | 3 | 4 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 1 | 1 | 1 |
| Public | 0.3 | 2 | 3 | 4 | 5 | 7 |
| **Total** | **28** | **137** | **268** | **391** | **510** | **628** |

## Table I5 Sectoral Annual Water Demand Forecast – Scenario 3 – Kings Forest

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 11.0 | 54 | 106 | 157 | 206 | 255 |
| Multi-Family Greenfield | 5.4 | 27 | 52 | 76 | 99 | 122 |
| Commercial | 0.2 | 1 | 2 | 2 | 3 | 4 |
| Industrial | 0.0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 0.0 | 0 | 0 | 1 | 1 | 1 |
| Public | 0.3 | 2 | 3 | 4 | 5 | 7 |
| **Total** | **17** | **84** | **164** | **240** | **314** | **388** |

## Table I6 Individual Demand Measurement Results – Scenario 1 – Kings Forest

| Summaries NPV Costs Scenario 1 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $3,862,947 | $3,703,364 | $7,566,312 | | | $233,686 |
| Sewer (without RIGS) | $3,089,988 | $7,221,032 | $10,311,020 | | | $280,470 |
| Rainwater Tanks | $0 | $6,137,080 | $6,137,080 | $340,230 | $1,771,928 | $2,112,157 |
| Recycled Water | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | **$6,952,936** | **$17,061,477** | **$24,014,412** | **$340,230** | **$1,771,928** | **$2,626,313** |

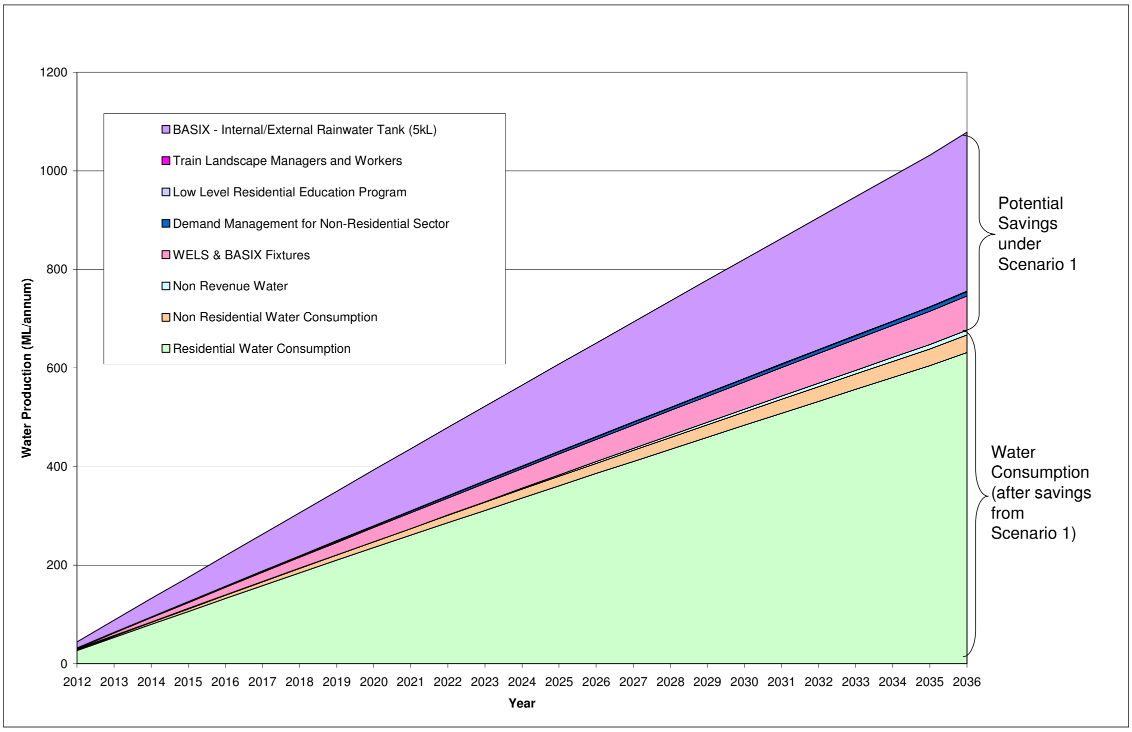
## Table I7 Individual Demand Measurement Results – Scenario 2 – Kings Forest

| Summaries NPV Costs Scenario 2 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $3,353,111 | $2,400,802 | $5,753,913 | | | $225,947 |
| Sewer (without RIGS) | $3,089,988 | $7,221,032 | $10,311,020 | | | $280,470 |
| Rainwater Tanks | $0 | $0 | $0 | $0 | $0 | $0 |
| Recycled Water | $11,219,344 | $4,686,964 | $15,906,307 | $2,309,009 | $0 | $2,309,009 |
| **Total** | **$17,662,443** | **$14,308,797** | **$31,971,240** | **$2,309,009** | **$0** | **$2,815,426** |

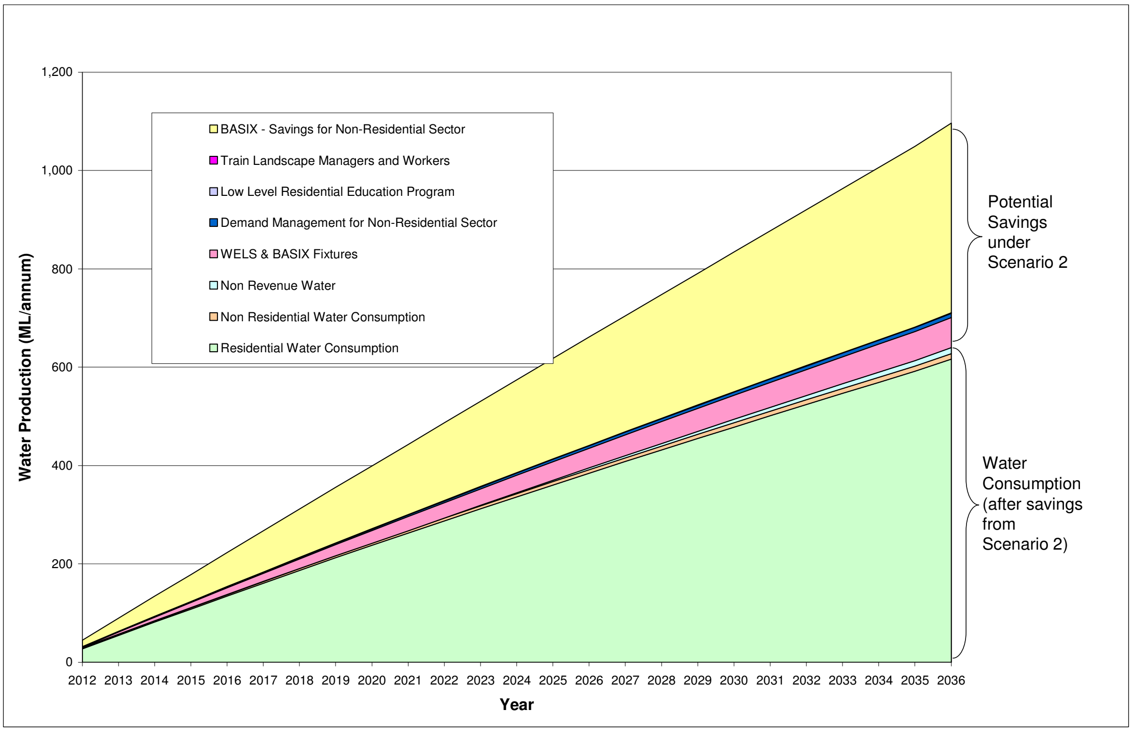
## Table I8 Individual Demand Measurement Results – Scenario 3 – Kings Forest

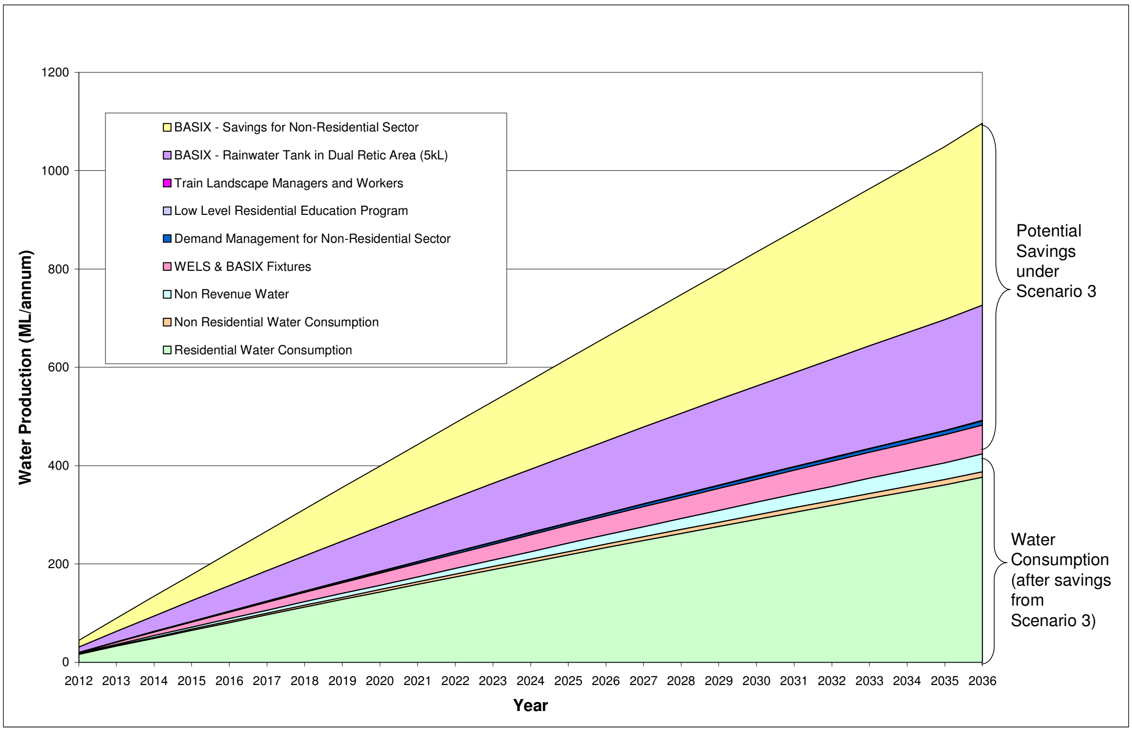
| Summaries NPV Costs Scenario 3 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $3,353,111 | $2,400,802 | $5,753,913 | | | $147,666 |
| Sewer (without RIGS) | $3,089,988 | $7,221,032 | $10,311,020 | | | $280,470 |
| Rainwater Tanks | $0 | $6,137,080 | $6,137,080 | $340,230 | $1,771,928 | $2,112,157 |
| Recycled Water | $11,219,344 | $4,686,964 | $15,906,307 | $2,309,009 | $0 | $2,309,009 |
| **Total** | **$17,662,443** | **$20,445,878** | **$38,108,320** | **$2,649,239** | **$1,771,928** | **$4,849,302** |

## Figure I3 Water Demand Profile – Scenario 1 – Kings Forest

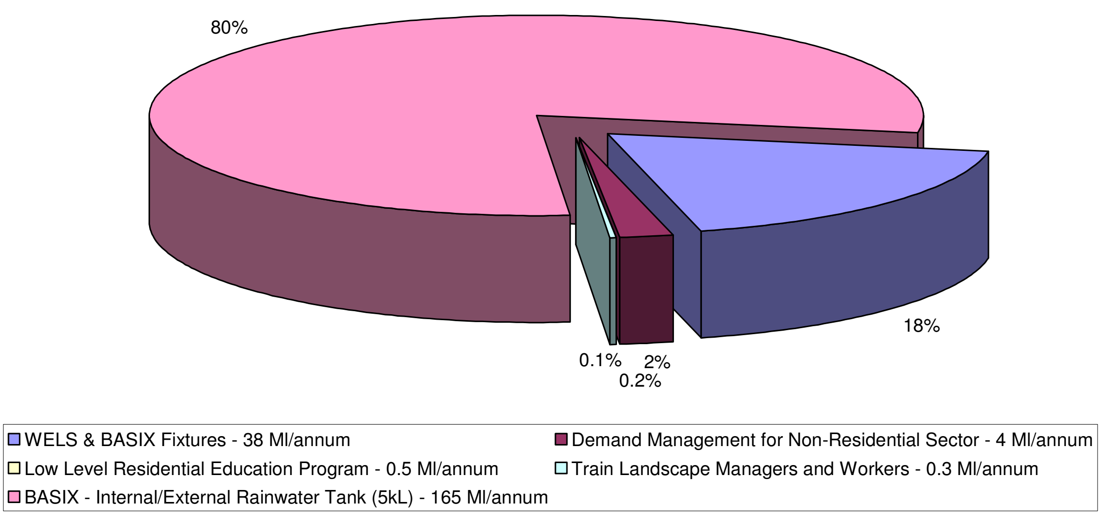



## Figure I4 Water Demand Profile – Scenario 2 – Kings Forest

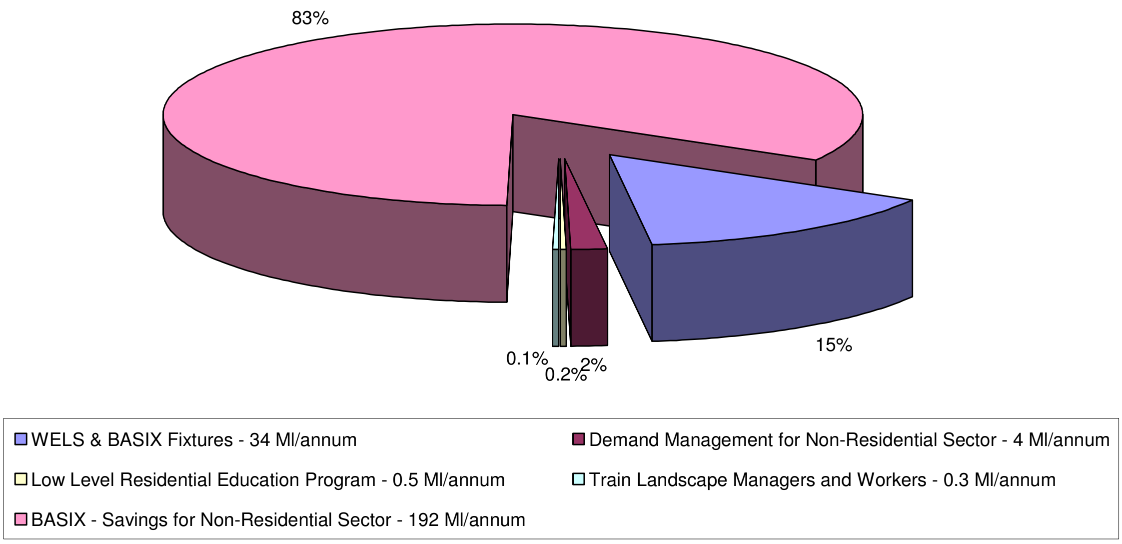




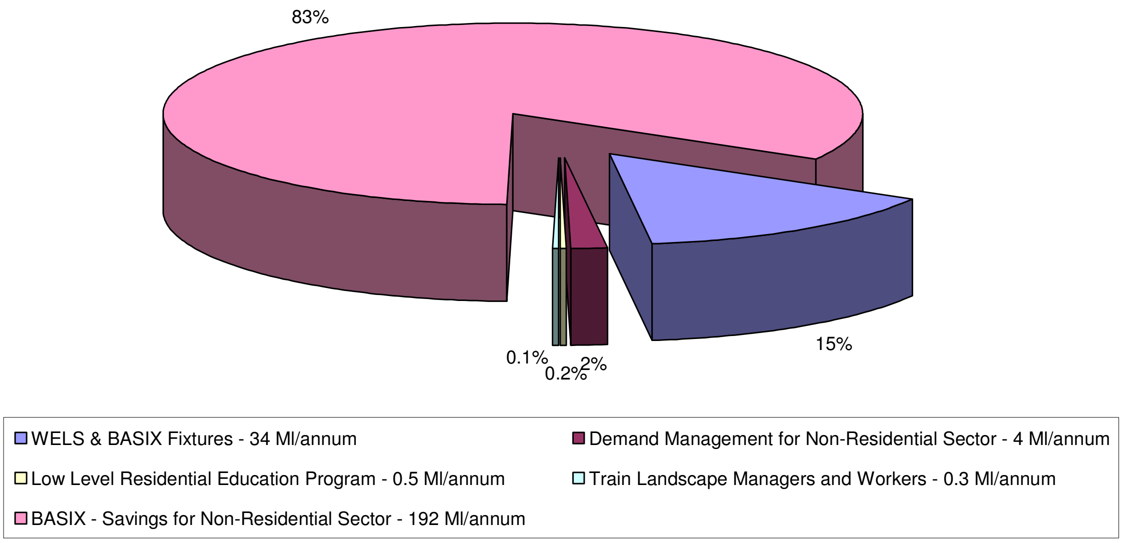

## Figure I6 Average Water Savings by Component – Scenario 1 – Kings Forest



## Figure I7  Average Water Savings by Component – Scenario 2 – Kings Forest




## Figure I8  Average Water Savings by Component – Scenario 3 – Kings Forest



APPENDIX J

# SCENARIO DEMAND FORECASTS - TERRANORA AREA A

The figures and tables below outline the future water demand management outcomes for Terranora Area A.

**Table J1 Total Annual Water Demand Forecast – Terranora**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 15 | 75 | 149 | 224 | 298 | 373 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 10 | 50 | 99 | 148 | 197 | 246 |
| Scenario 2 - BASIX with Dual Reticulation | 9 | 43 | 83 | 123 | 162 | 200 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 6 | 28 | 55 | 82 | 109 | 135 |

**Figure J1 Total Water Demand Forecast – Terranora**

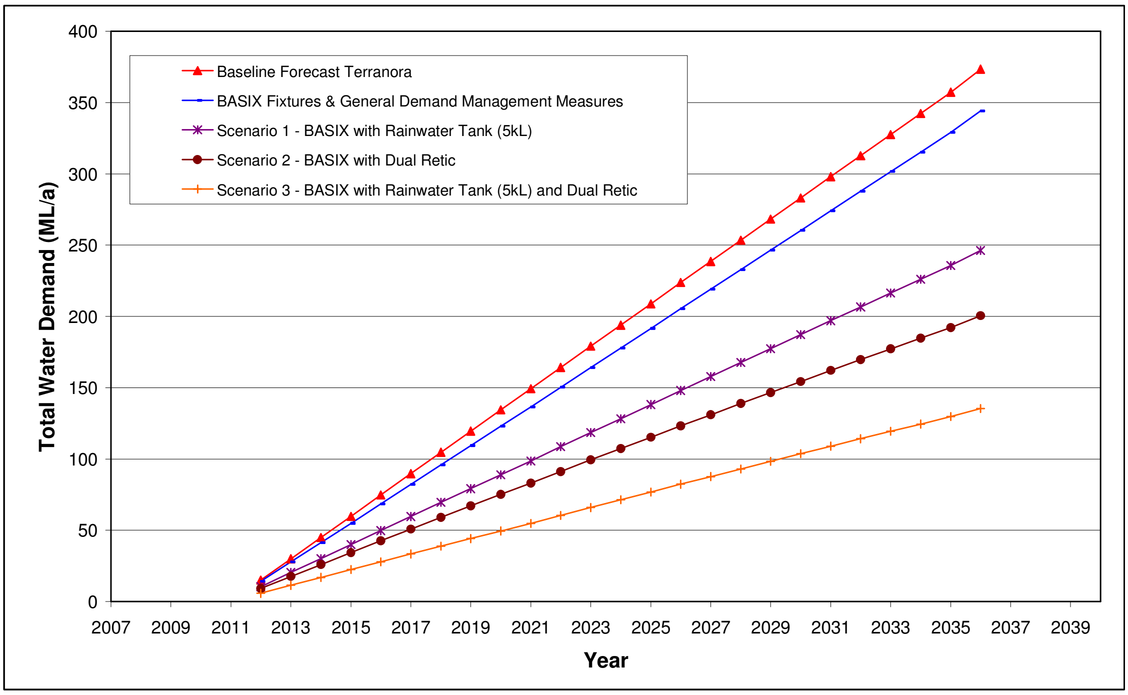



**Table J2 Total Per Capita Water Demand Forecast – Terranora**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 303 | 309 | 314 | 320 | 327 | 333 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 211 | 205 | 208 | 212 | 216 | 220 |
| Scenario 2 - BASIX with Dual Reticulation | 184 | 176 | 175 | 176 | 178 | 179 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 117 | 115 | 115 | 118 | 119 | 121 |

**Figure J2 Total Per Capita Water Demand Forecast – Terranora**

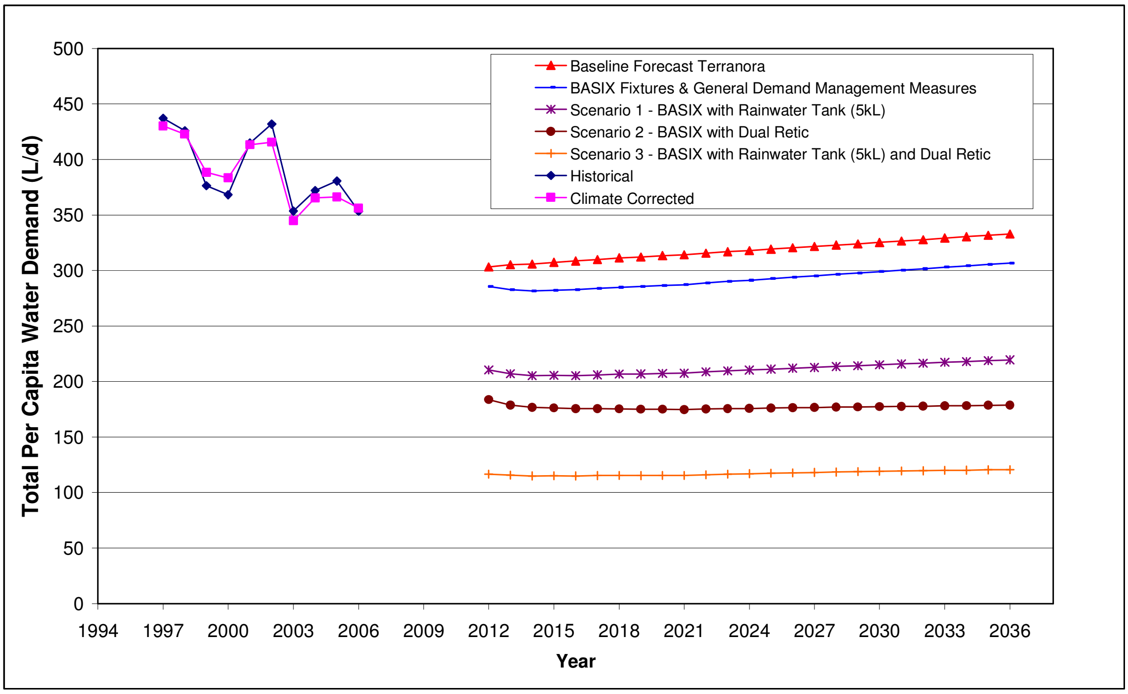



**Table J3 Sectoral Annual Water Demand Forecast – Scenario 1 – Terranora**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 7.3 | 36 | 72 | 106 | 141 | 175 |
| Multi-Family Greenfield | 0.6 | 3.0 | 5.9 | 8.6 | 11.3 | 13.9 |
| Commercial | 0.00 | 0.3 | 0.8 | 1.4 | 1.8 | 2.3 |
| Industrial | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Irrigation | 0.22 | 1.2 | 2.5 | 3.8 | 5.3 | 6.8 |
| Public | 1.42 | 7.2 | 14.6 | 22.0 | 29.6 | 37.2 |
| **Total** | **10** | **48** | **95** | **142** | **189** | **235** |

**Table J4 Sectoral Annual Water Demand Forecast – Scenario 2 – Terranora**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 7.1 | 35 | 68 | 100 | 131 | 161 |
| Multi-Family Greenfield | 0.7 | 3.5 | 6.9 | 10.0 | 13.0 | 15.9 |
| Commercial | 0.0 | 0.2 | 0.4 | 0.8 | 1.1 | 1.3 |
| Industrial | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Irrigation | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Public | 0.7 | 3.4 | 6.8 | 10.1 | 13.5 | 16.9 |
| **Total** | **9** | **42** | **82** | **121** | **158** | **195** |

**Table J5 Sectoral Annual Water Demand Forecast – Scenario 3 – Terranora**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 4.1 | 20 | 39 | 58 | 76 | 94 |
| Multi-Family Greenfield | 0.5 | 2.4 | 4.6 | 6.7 | 8.8 | 11 |
| Commercial | 0.0 | 0.2 | 0.4 | 0.8 | 1.1 | 1.3 |
| Industrial | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Irrigation | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| Public | 0.7 | 3.4 | 6.8 | 10 | 14 | 17 |
| **Total** | **5** | **26** | **51** | **76** | **99** | **123** |

**Table J6 Individual Demand Measurement Results – Scenario 1 – Terranora**

| Summaries NPV Costs Scenario 1 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $1,198,397 | $1,194,568 | $2,392,965 | | | $94,224 |
| Sewer (without RIGS) | $1,314,095 | $1,855,805 | $3,169,900 | | | $62,756 |
| Rainwater Tanks | $0 | $1,718,536 | $1,718,536 | $174,047 | $496,241 | $670,288 |
| Recycled Water | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | **$2,512,492** | **$4,768,909** | **$7,281,400** | **$174,047** | **$496,241** | **$827,268** |

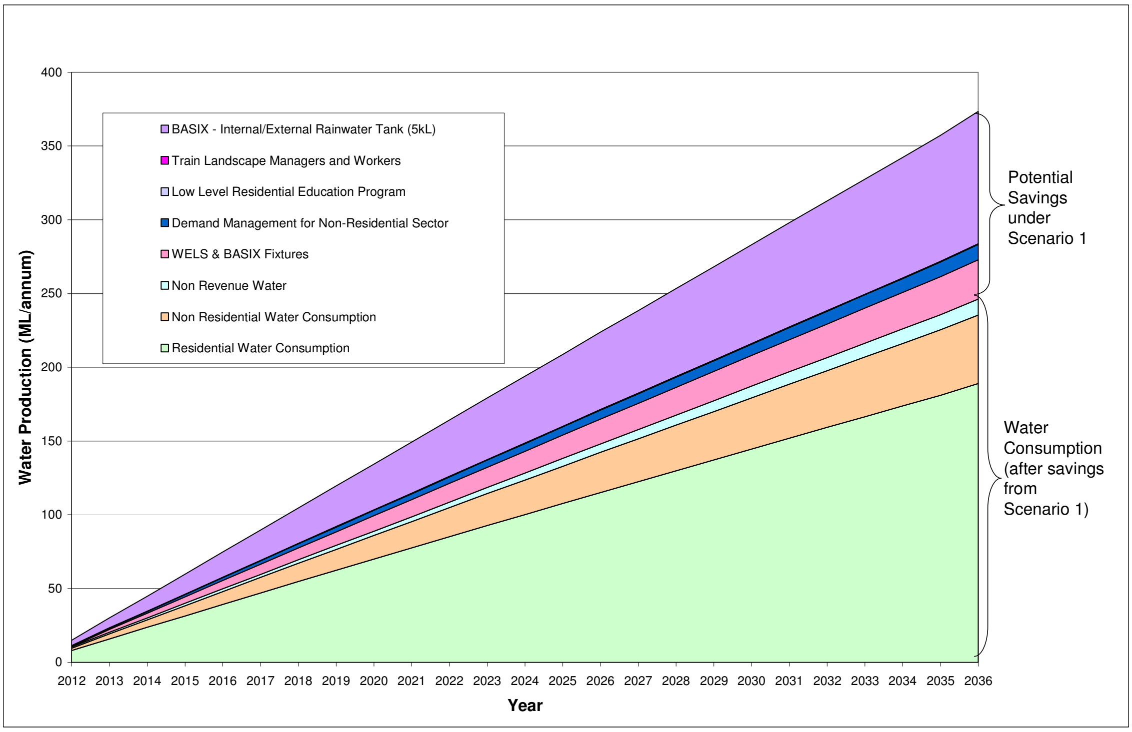
**Table J7 Individual Demand Measurement Results – Scenario 2 – Terranora**

| Summaries NPV Costs Scenario 2 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $838,822 | $774,409 | $1,613,232 | | | $78,674 |
| Sewer (without RIGS) | $1,314,095 | $1,855,805 | $3,169,900 | | | $62,756 |
| Rainwater Tanks | $0 | $0 | $0 | $0 | $0 | $0 |
| Recycled Water | $5,170,410 | $1,511,840 | $6,682,251 | $555,685 | $0 | $555,685 |
| **Total** | **$7,323,327** | **$4,142,055** | **$11,465,382** | **$555,685** | **$0** | **$697,115** |

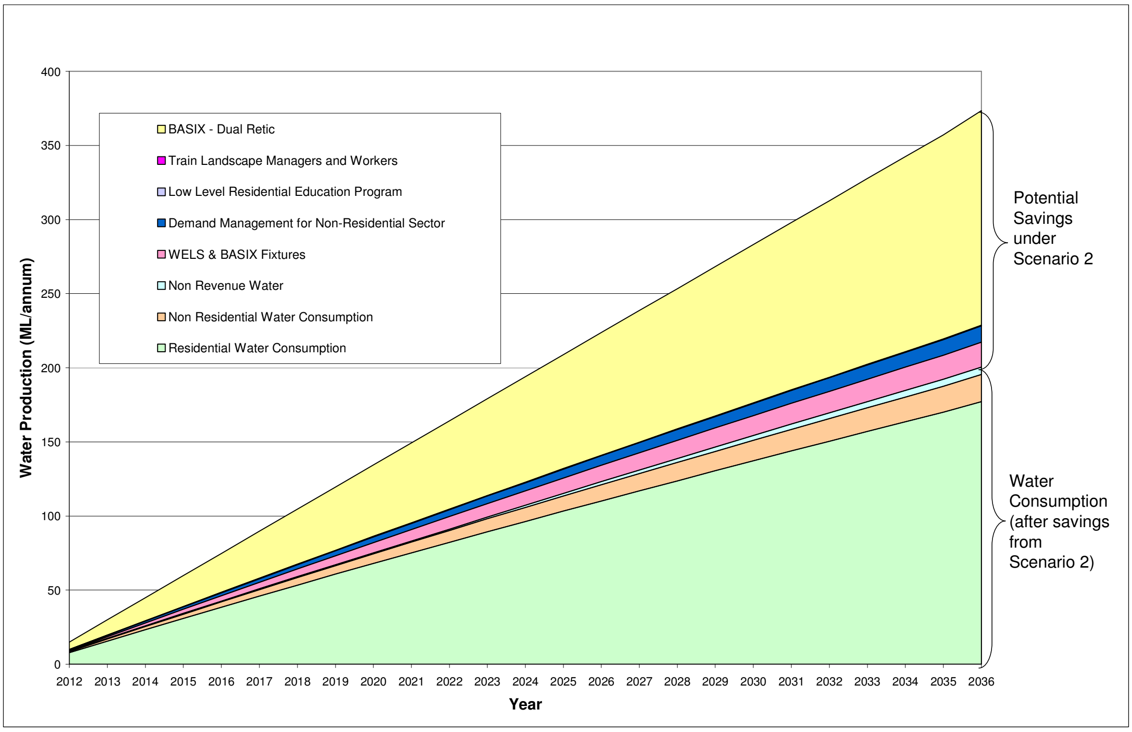
**Table J8 Individual Demand Measurement Results – Scenario 3 – Terranora**

| Summaries NPV Costs Scenario 3 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $838,822 | $774,409 | $1,613,232 | | | $52,335 |
| Sewer (without RIGS) | $1,314,095 | $1,855,805 | $3,169,900 | | | $62,756 |
| Rainwater Tanks | $0 | $1,718,536 | $1,718,536 | $174,047 | $496,241 | $670,288 |
| Recycled Water | $5,170,410 | $1,511,840 | $6,682,251 | $555,685 | $0 | $555,685 |
| **Total** | **$7,323,327** | **$5,860,591** | **$13,183,918** | **$729,731** | **$496,241** | **$1,341,063** |

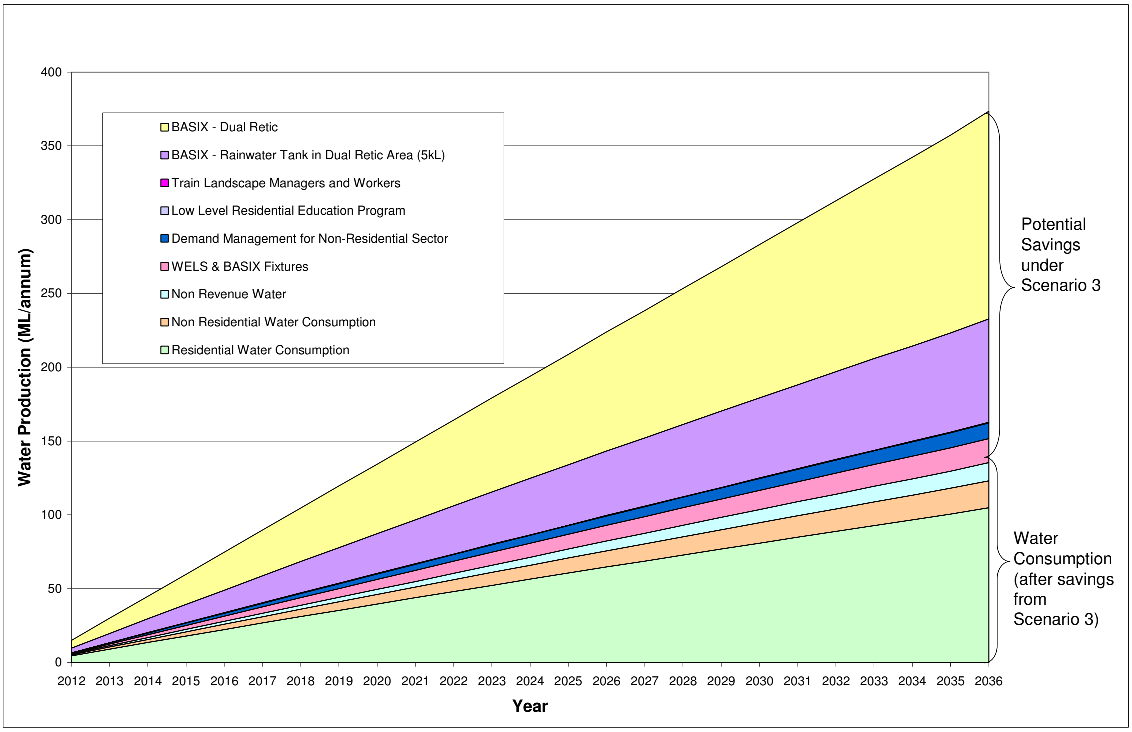
## Figure J3 Water Demand Profile – Scenario 1 – Terranora




## Figure J4 Water Demand Profile – Scenario 2 – Terranora



## Figure J5 Water Demand Profile – Scenario 3 – Terranora




## Figure J6 Average Water Savings by Component – Scenario 1 – Terranora

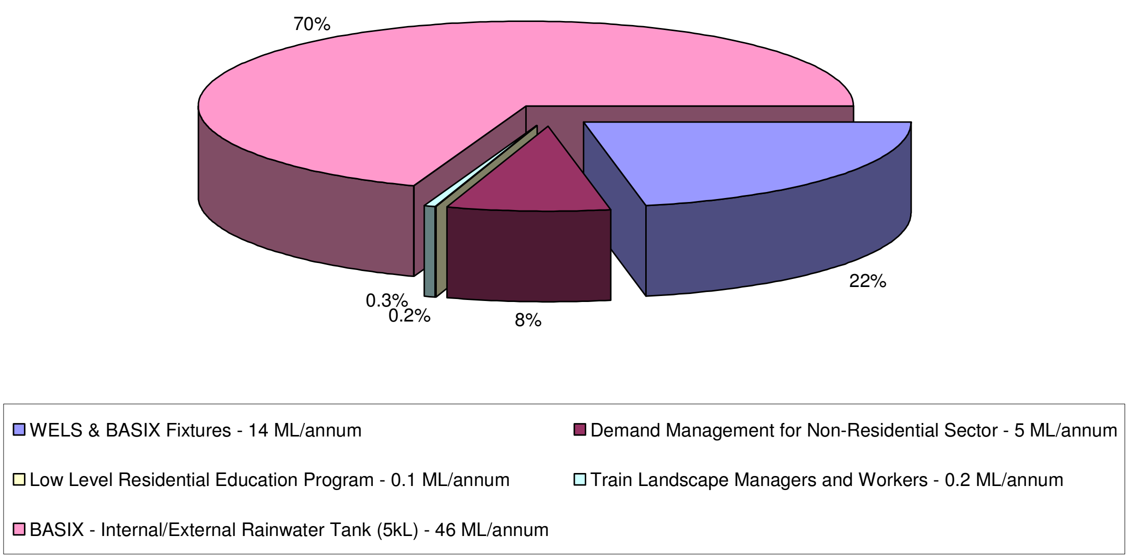


**Figure J7 Average Water Savings by Component – Scenario 2 – Terranora**

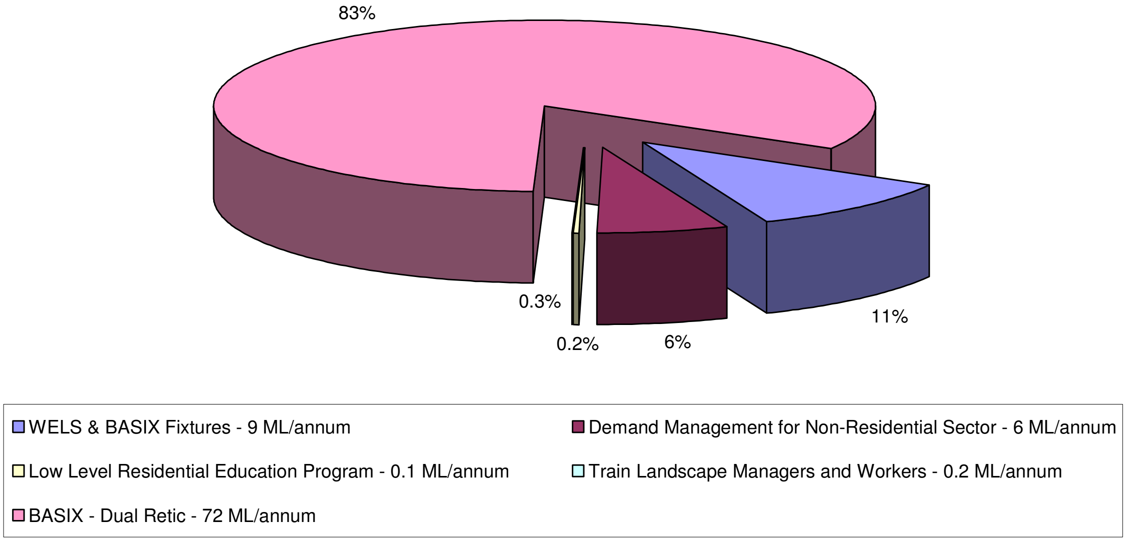
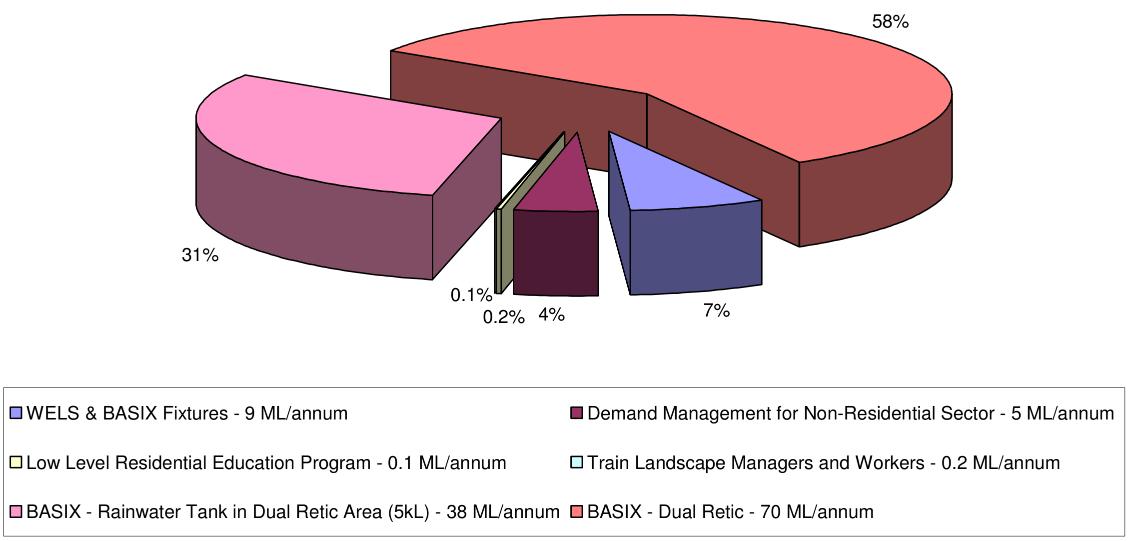



**Figure J8 Average Water Savings by Component – Scenario 3 – Terranora**



APPENDIX K

# SCENARIO DEMAND FORECASTS - WEST KINGSCLIFF

The figures and tables below outline the future water demand management outcomes for West Kingscliff.

**Table K1 Total Annual Water Demand Forecast – West Kingscliff**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 12 | 59 | 118 | 175 | 231 | 286 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 8 | 39 | 77 | 115 | 152 | 189 |
| Scenario 2 - BASIX with Dual Reticulation | 8 | 40 | 77 | 113 | 148 | 182 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 6 | 29 | 57 | 85 | 111 | 137 |

**Figure K1 Total Water Demand Forecast – West Kingscliff**

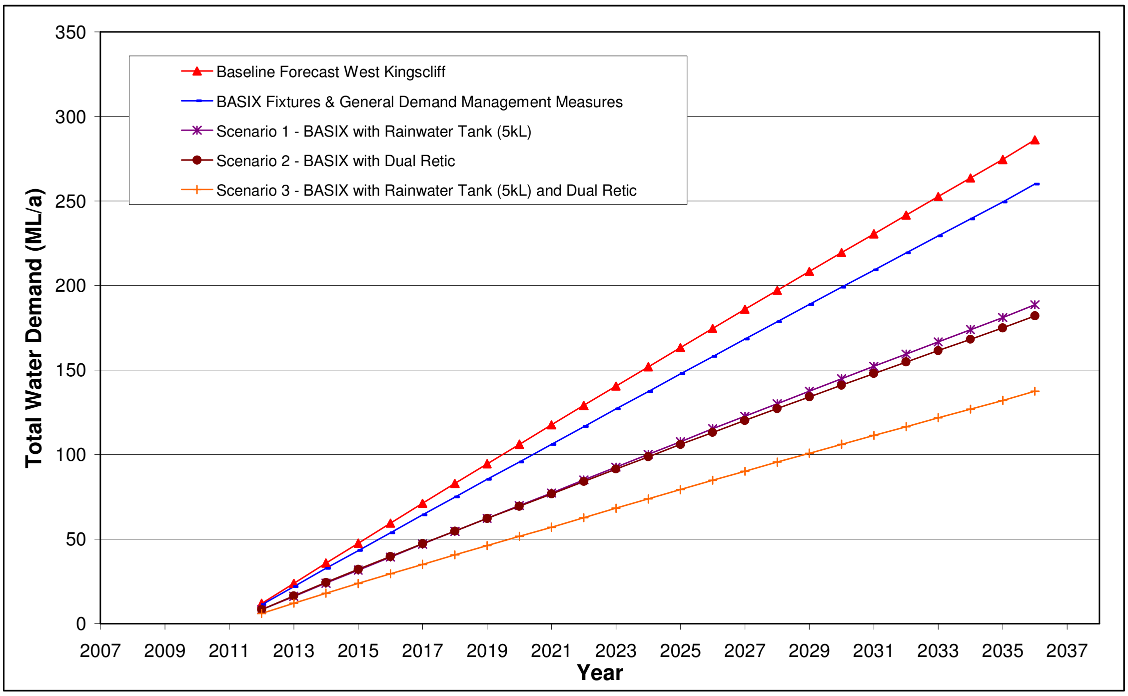



**Table K2 Total Per Capita Water Demand Forecast – West Kingscliff**

| Scenario | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Baseline Forecast New Growth Areas | 272 | 274 | 278 | 283 | 287 | 292 |
| Scenario 1 - BASIX with Rainwater Tank (5kL) | 189 | 182 | 183 | 186 | 190 | 192 |
| Scenario 2 - BASIX with Dual Reticulation | 190 | 183 | 182 | 183 | 184 | 186 |
| Scenario 3 - BASIX with Rainwater Tank (5kL) and Dual Reticulation | 137 | 136 | 135 | 137 | 139 | 140 |

**Figure K2 Total Per Capita Water Demand Forecast – West Kingscliff**

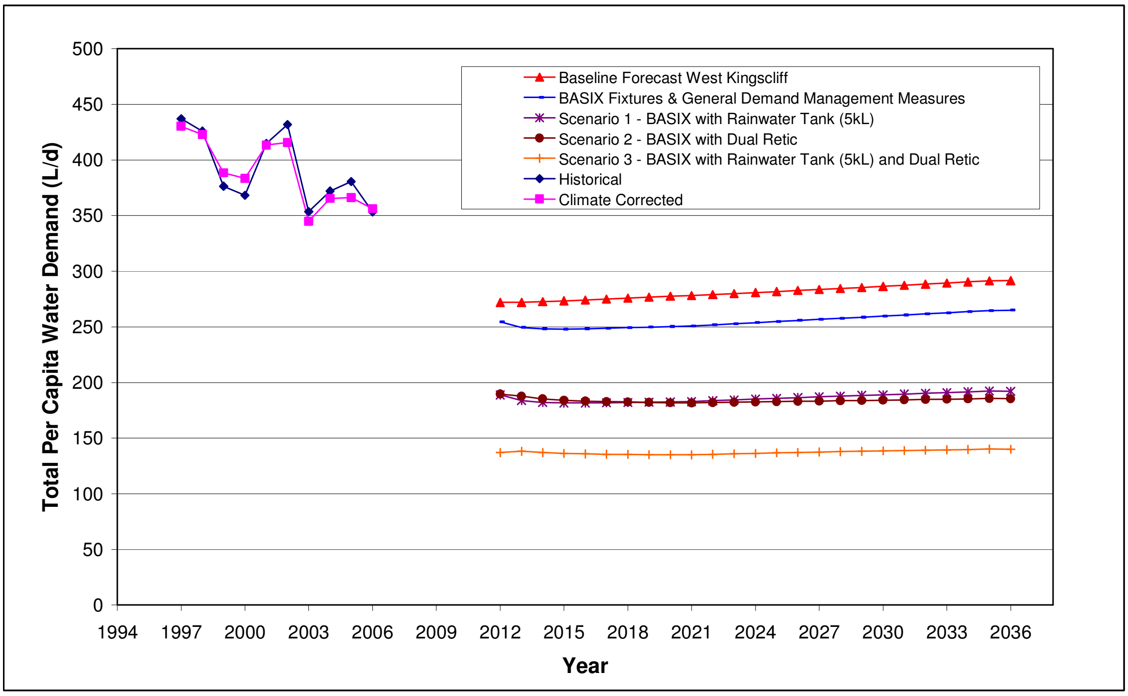



**Table K3 Sectoral Annual Water Demand Forecast – Scenario 1 – Kings Forest**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 1.4 | 7 | 14 | 21 | 27 | 34 |
| Multi-Family Greenfield | 4.4 | 22 | 42 | 62 | 80 | 99 |
| Commercial | 0.72 | 3.68 | 7.42 | 11.21 | 15.03 | 18 |
| Industrial | 0.40 | 2.03 | 4.04 | 6.05 | 8.07 | 10.08 |
| Irrigation | 0.13 | 0.70 | 1.49 | 2.32 | 3.20 | 4 |
| Public | 0.38 | 1.92 | 3.88 | 6 | 8 | 10 |
| **Total** | **7** | **37** | **73** | **108** | **142** | **176** |

**Table K4 Sectoral Annual Water Demand Forecast – Scenario 2 – West Kingscliff**

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 1.4 | 7 | 13 | 20 | 26 | 31 |
| Multi-Family Greenfield | 5.1 | 25 | 49 | 71 | 93 | 114 |
| Commercial | 0.4 | 2 | 5 | 7 | 9 | 11 |
| Industrial | 0.4 | 2 | 4 | 6 | 8 | 10 |
| Irrigation | 0.00 | 0.11 | 0.13 | 0.14 | 0.15 | 0.16 |
| Public | 0.2 | 1 | 2 | 3 | 4 | 5 |
| **Total** | **8** | **38** | **73** | **107** | **139** | **170** |

### Table K5 Sectoral Annual Water Demand Forecast – Scenario 3 – West Kingscliff

| Sector | 2012 | 2016 | 2021 | 2026 | 2031 | 2036 |
|---|---|---|---|---|---|---|
| Single Family Greenfield | 0.8 | 4 | 8 | 11 | 15 | 18 |
| Multi-Family Greenfield | 3.4 | 17 | 33 | 48 | 63 | 77 |
| Commercial | 0.4 | 2 | 5 | 7 | 9 | 11 |
| Industrial | 0.4 | 2 | 4 | 6 | 8 | 10 |
| Irrigation | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| Public | 0.2 | 1 | 2 | 3 | 4 | 5 |
| **Total** | **5** | **26** | **51** | **75** | **98** | **121** |

### Table K6 Individual Demand Measurement Results – Scenario 1 – West Kingscliff

| Summaries NPV Costs Scenario 1 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $385,737 | $611,722 | $997,459 | | | $79,853 |
| Sewer (without RIGS) | N/A | N/A | N/A | N/A | N/A | N/A |
| Rainwater Tanks | $0 | $1,533,826 | $1,533,826 | $182,662 | $442,740 | $625,402 |
| Recycled Water | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | **$385,737** | **$2,145,549** | **$2,531,285** | **$182,662** | **$442,740** | **$705,255** |

### Table K7 Individual Demand Measurement Results – Scenario 2 – West Kingscliff

| Summaries NPV Costs Scenario 2 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $327,129 | $396,565 | $723,694 | | | $78,692 |
| Sewer (without RIGS) | N/A | N/A | N/A | N/A | N/A | N/A |
| Rainwater Tanks | $0 | $0 | $0 | $0 | $0 | $0 |
| Recycled Water | $2,128,435 | $774,194 | $2,902,628 | $538,777 | $0 | $538,777 |
| **Total** | **$2,455,564** | **$1,170,758** | **$3,626,322** | **$538,777** | **$0** | **$617,469** |

### Table K8 Individual Demand Measurement Results – Scenario 3 – West Kingscliff

| Summaries NPV Costs Scenario 3 | Net Present Value of Forecast Expenditure | | | | | |
|---|---|---|---|---|---|---|
| | CAPEX | | | OPEX | | |
| | NPV - Authority | NPV - Customer | Total NPV | NPV - Authority | NPV - Customer | Total NPV |
| Potable Water | $327,129 | $396,565 | $723,694 | | | $58,839 |
| Sewer (without RIGS) | N/A | N/A | N/A | N/A | N/A | N/A |
| Rainwater Tanks | $0 | $1,533,826 | $1,533,826 | $182,662 | $442,740 | $625,402 |
| Recycled Water | $2,128,435 | $774,194 | $2,902,628 | $538,777 | $0 | $538,777 |
| **Total** | **$2,455,564** | **$2,704,585** | **$5,160,148** | **$721,439** | **$442,740** | **$1,223,018** |

Figure K3  Water Demand Profile – Scenario 1 – West Kingscliff

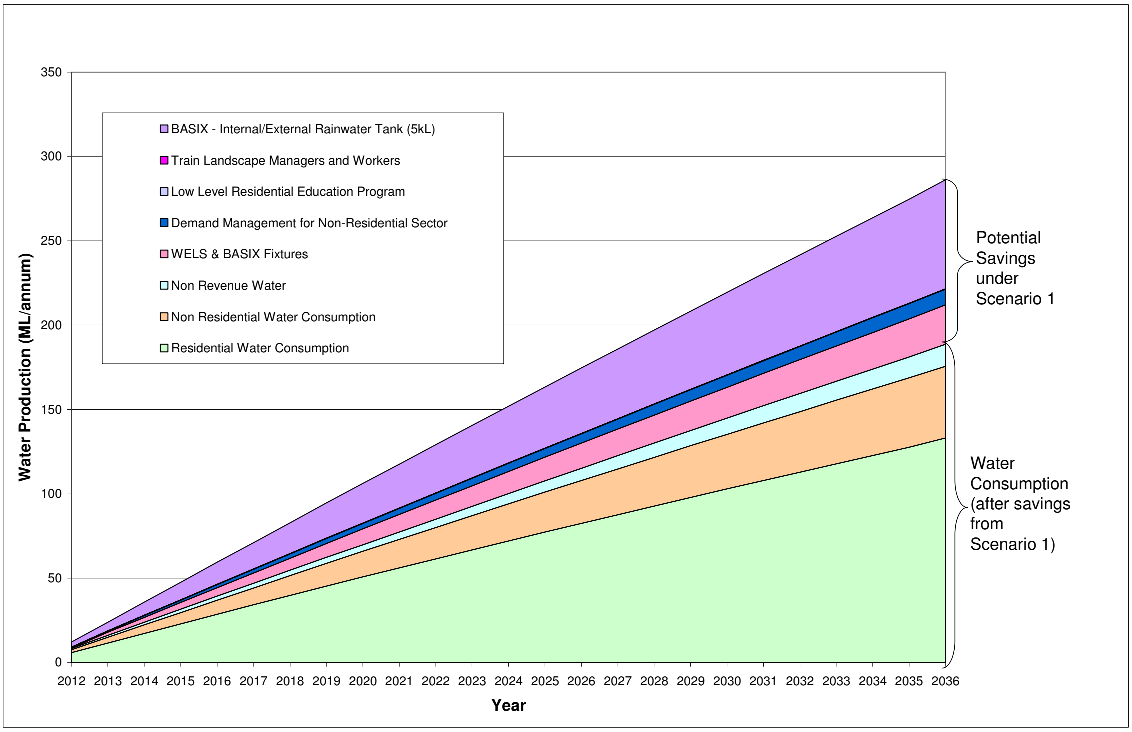



Figure K4  Water Demand Profile – Scenario 2 – West Kingscliff

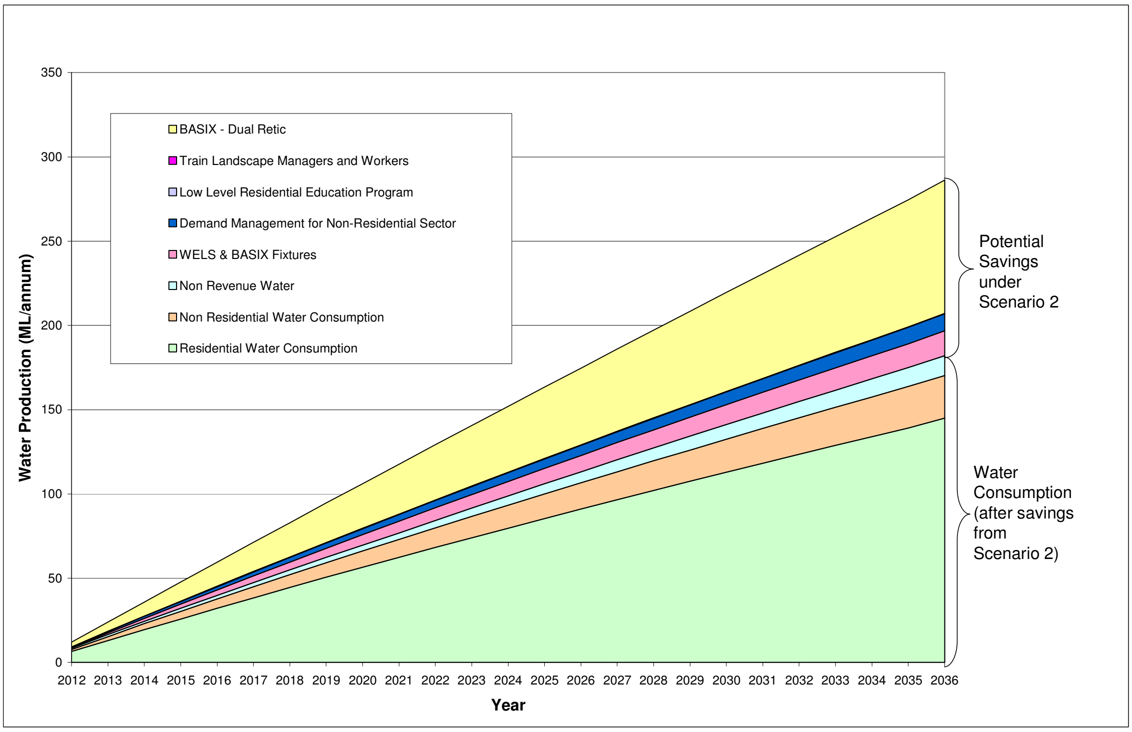


Figure K5  Water Demand Profile – Scenario 3 – West Kingscliff

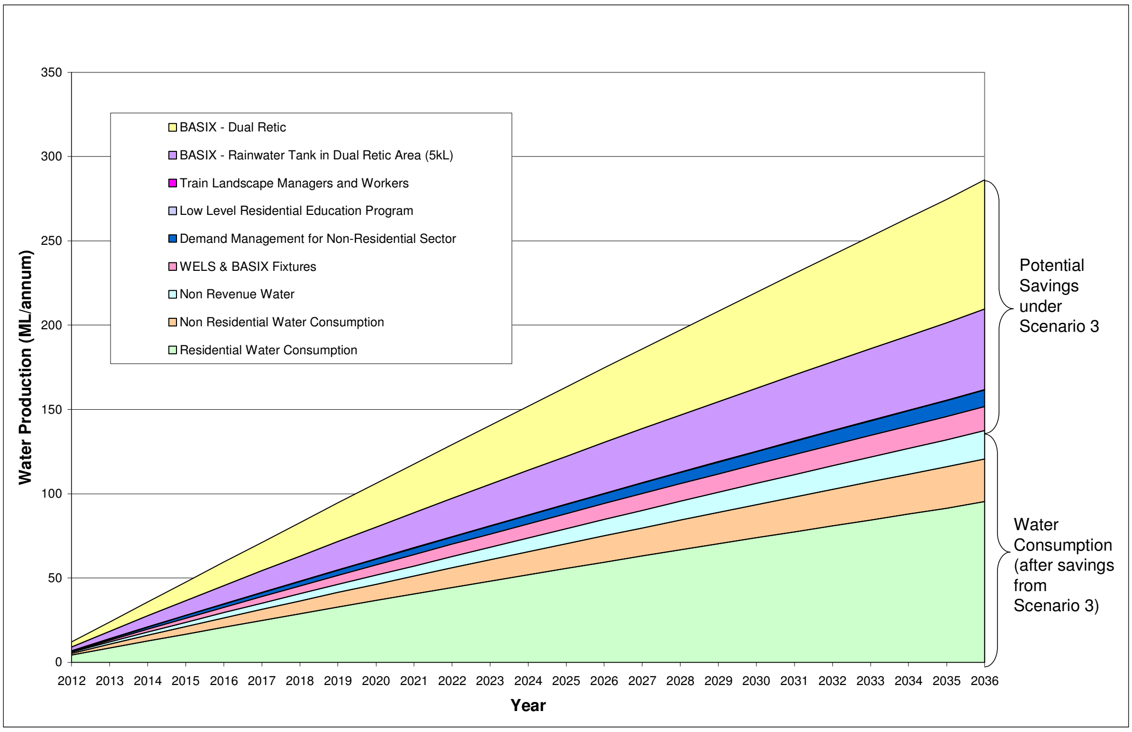



Figure K6  Average Water Savings by Component – Scenario 1 – West Kingscliff

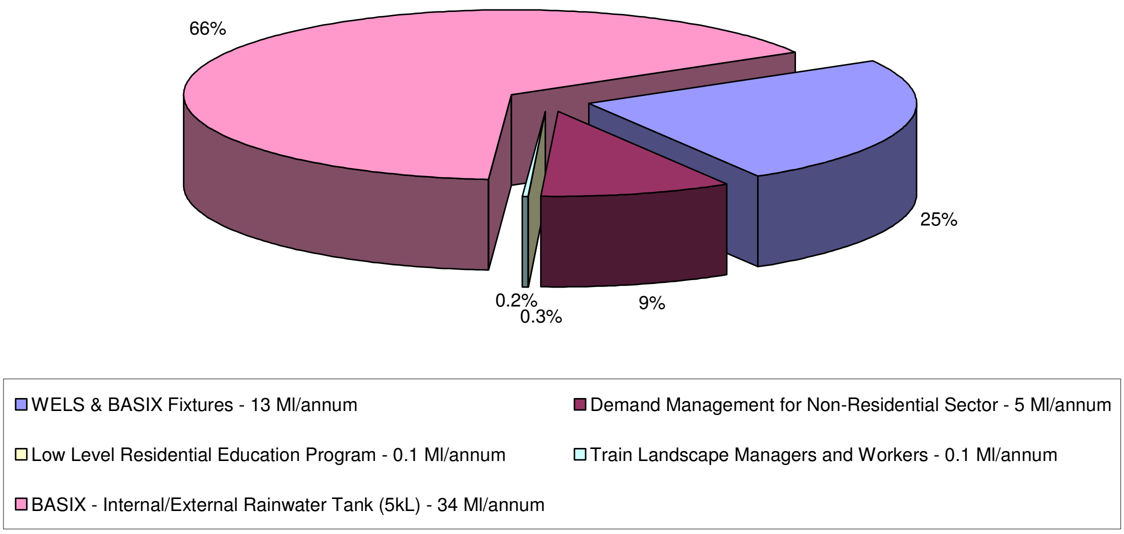


**Figure K7 Average Water Savings by Component – Scenario 2 – West Kingscliff**

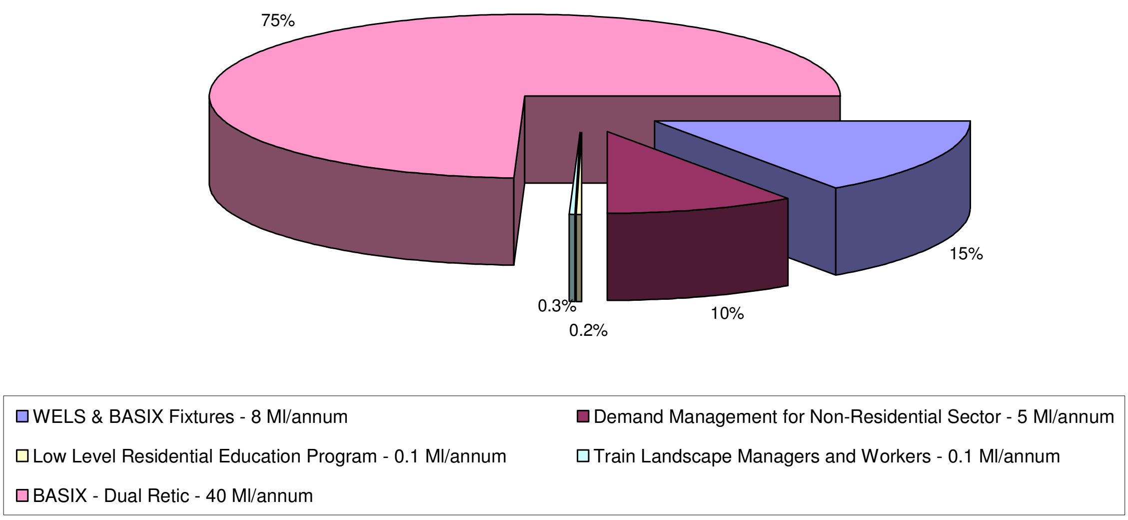
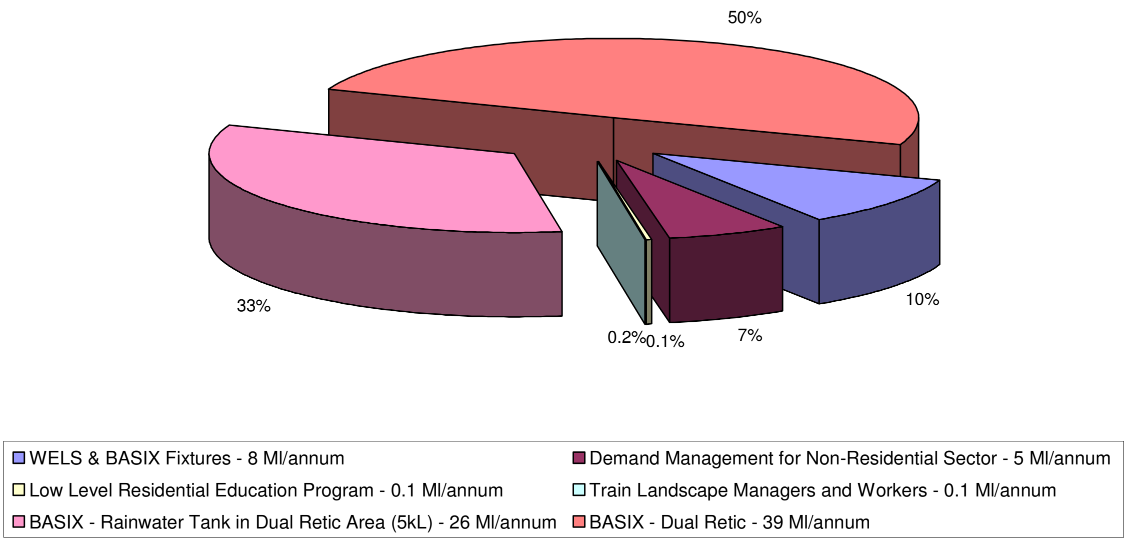



**Figure K8 Average Water Savings by Component – Scenario 3 – West Kingscliff**

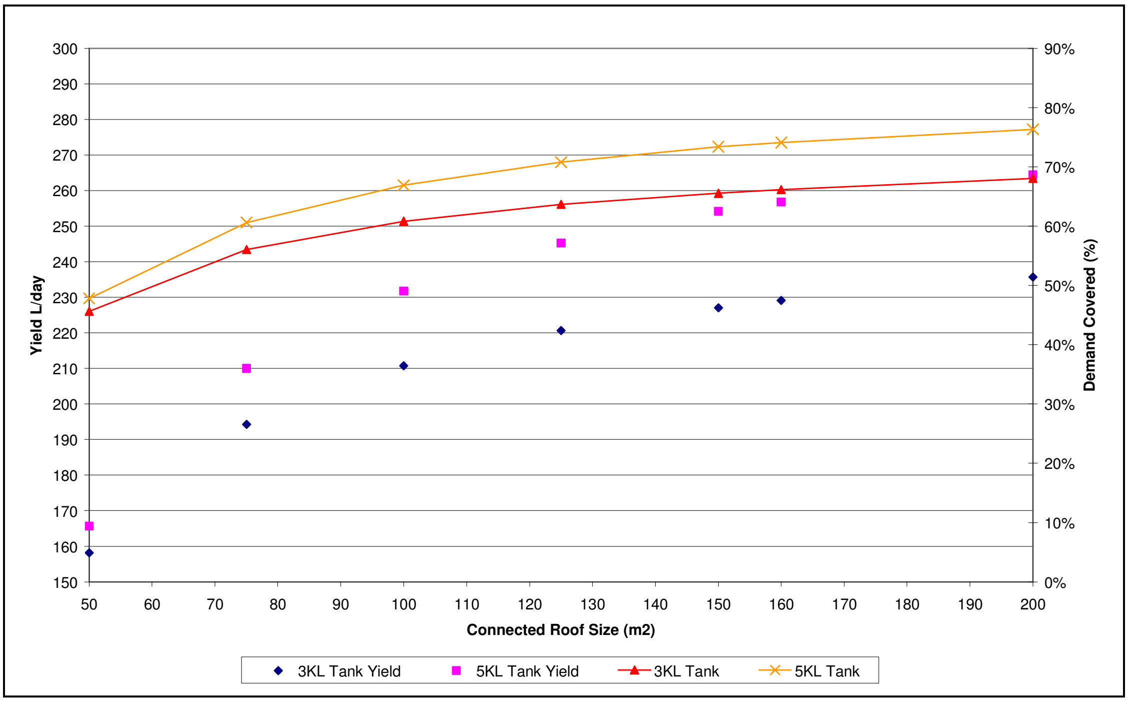


APPENDIX L

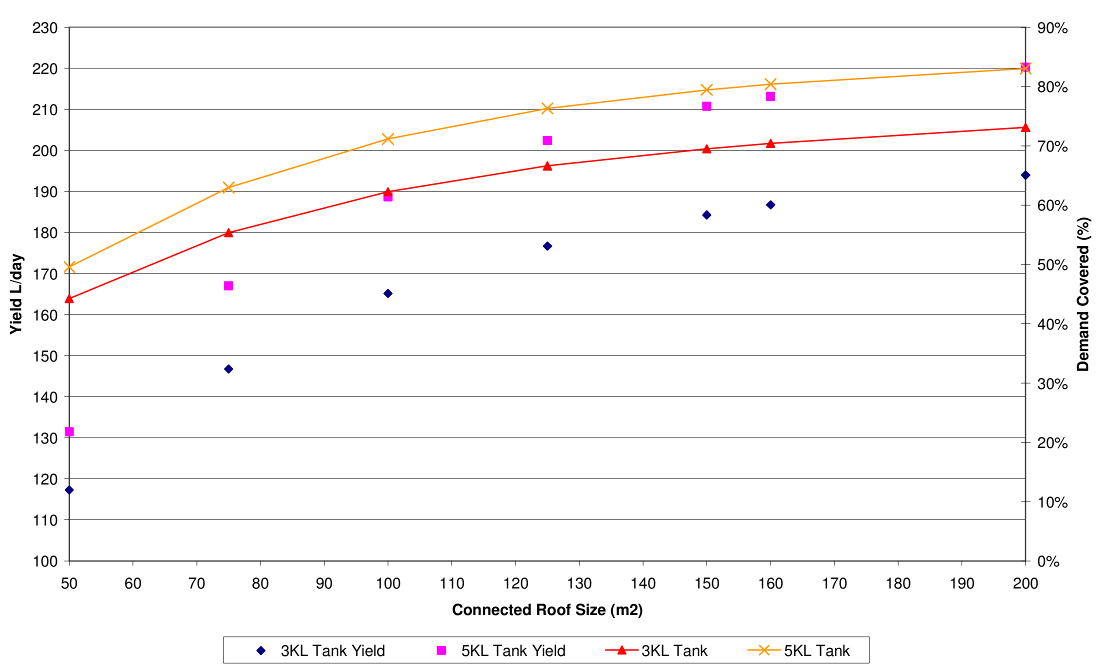
# RAINWATER TANK YIELD ASSESSMENT

The simulation of rainwater tanks has been undertaken using a probabilistic demand model. The probabilistic model simulates the climate-drive and random aspects of both water demand and rainfall over a large number of "virtual" properties. The simulation was undertaken for two rainwater tank sizes (i.e. 3 kL and 5 kL tanks), a variety of roof sizes and connected end uses. The first assessment study analysed the potential tank yield for all external end uses and toilet demand over time for a singe family residential property. In the second assessment study the potential yield of a rainwater tank connected to internal end uses for shower and washing machine was determined. The results of the analyses in terms of average daily yield and the percentage reduction in residential potable demand for the connected end-uses are shown in the figures below. The results suggest that a reasonably small tank (e.g. 3 kL or 5 kL) could provide significant reductions in demand. For the overall demand management scenarios a 5 kL tank has been chosen.

**Figure L1 Rainwater Tank Yield – Connected to all external end-uses and toilet – Scenario 1**

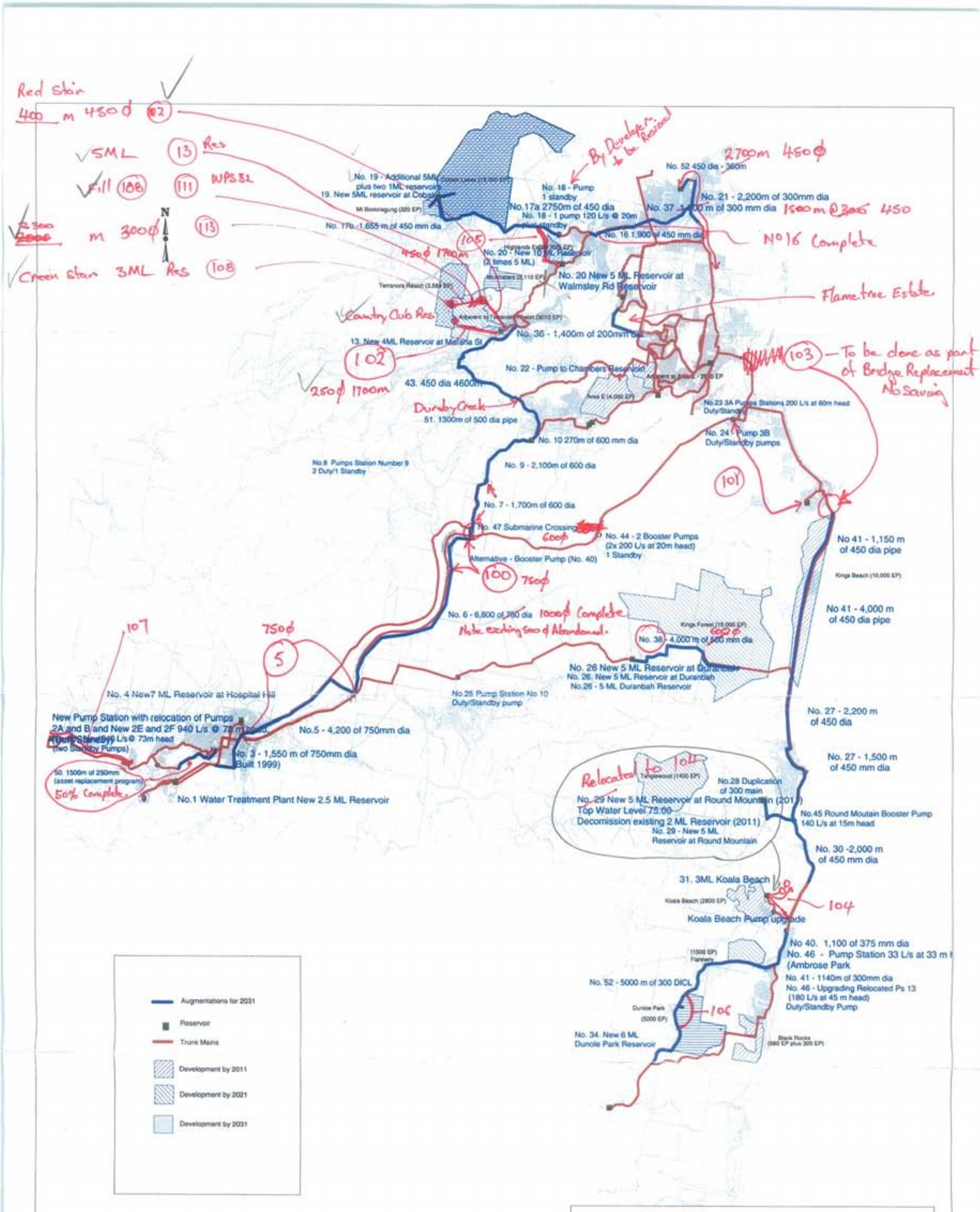


## Figure L2 Rainwater Tank Yield – Connected to Shower and Washing Machine – Scenario 3



APPENDIX M

# POTABLE WATER INFRASTRUCTURE PLAN




scale: 1:100,000

GHD

**Figure 6.1**
**Augmentations required by 2031**
**3DMD - Maximum pump hours 23 hours**
**Network Analysis for Tweed Shire Council**

g:\411\15251\mapinfo\watercad\mapall.wor

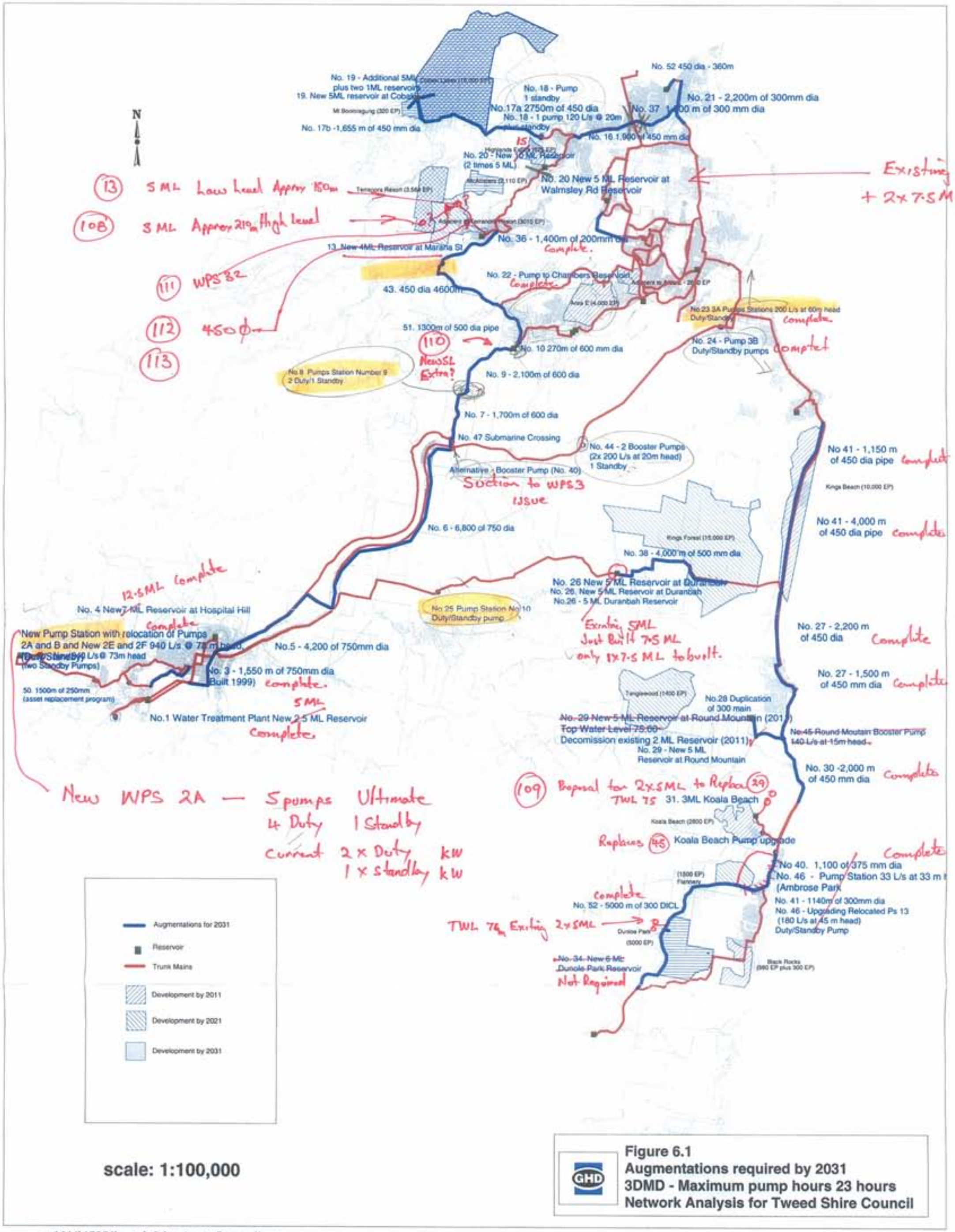
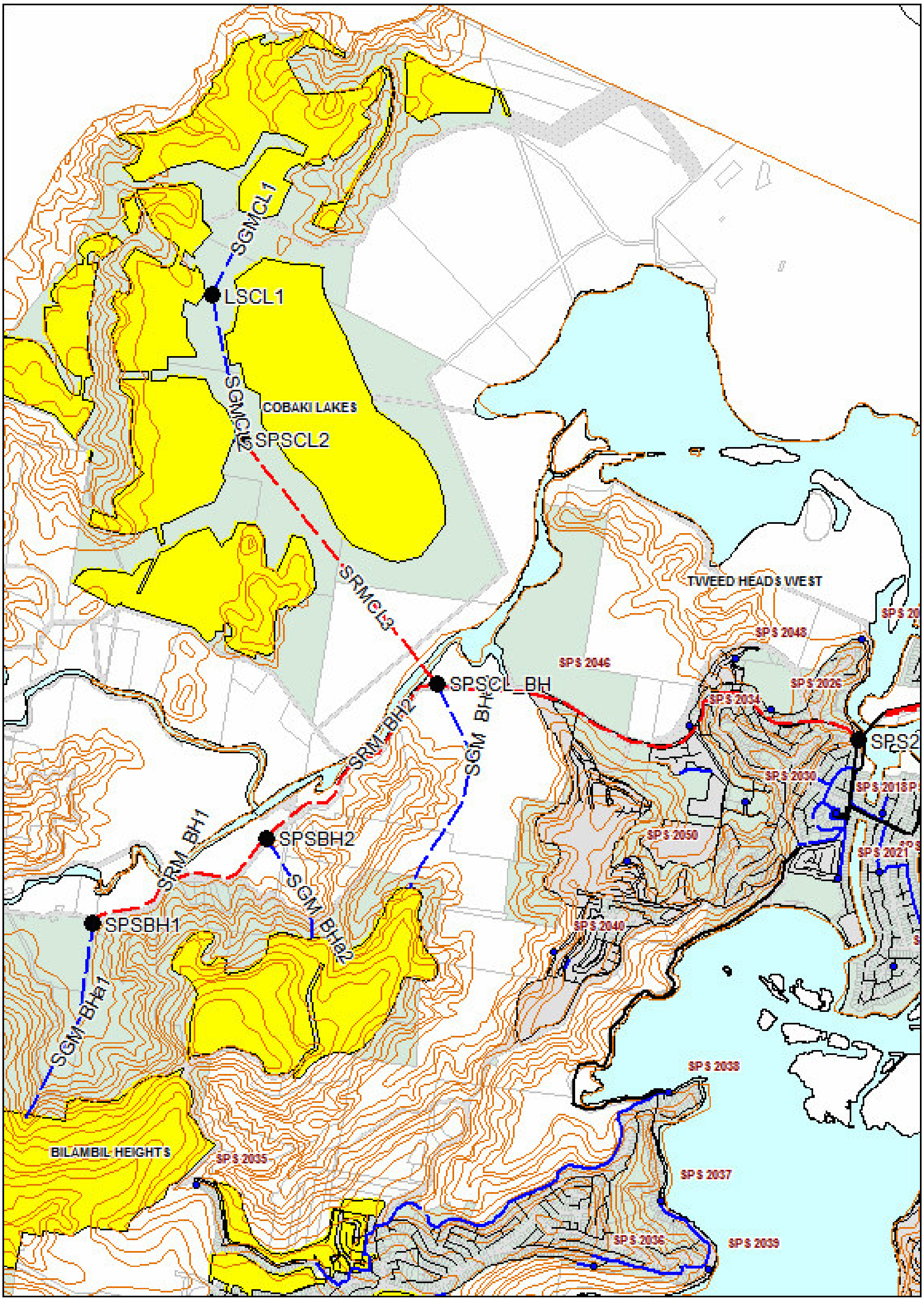


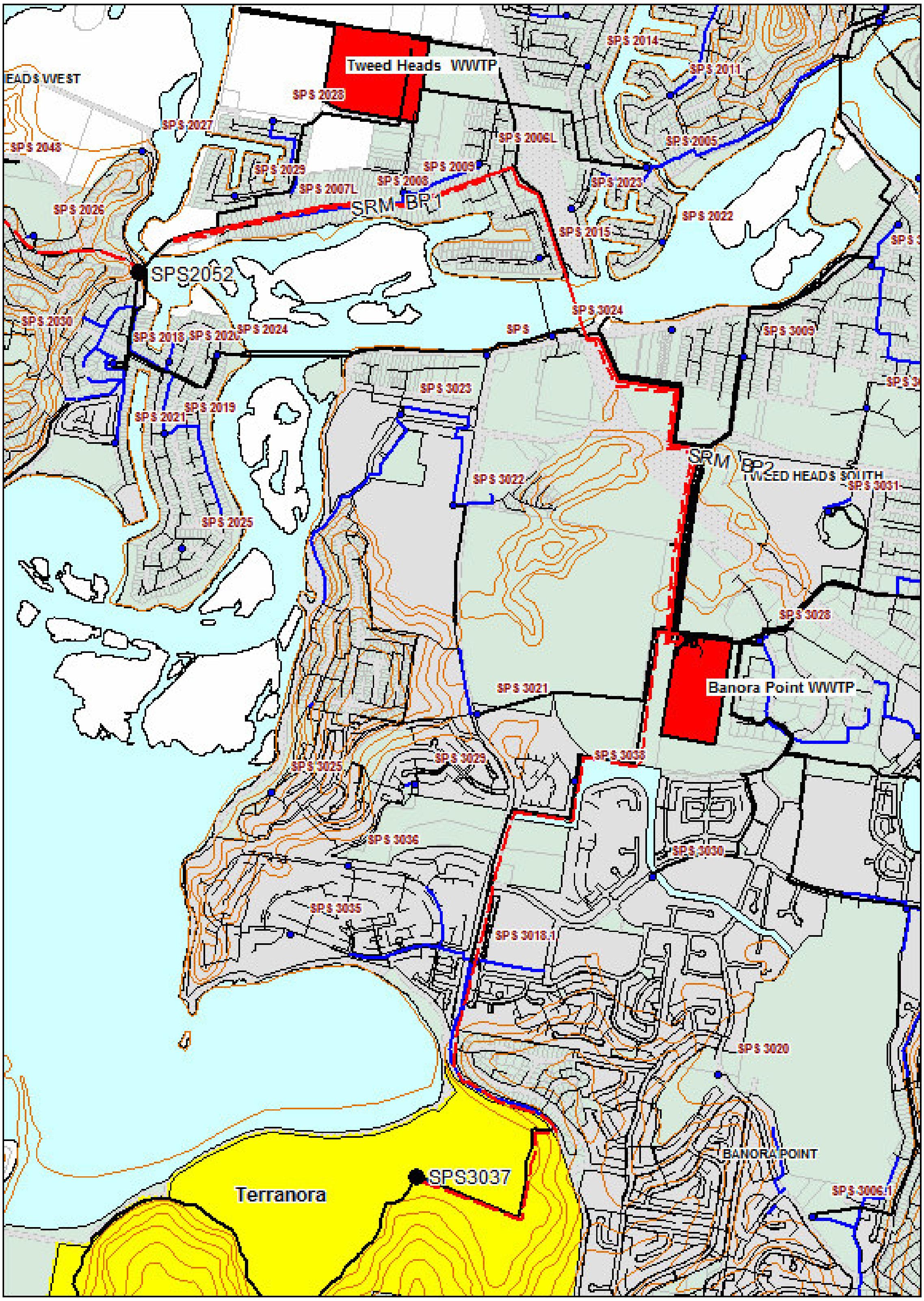

Figure 6.1
Augmentations required by 2031
3DMD - Maximum pump hours 23 hours
Network Analysis for Tweed Shire Council

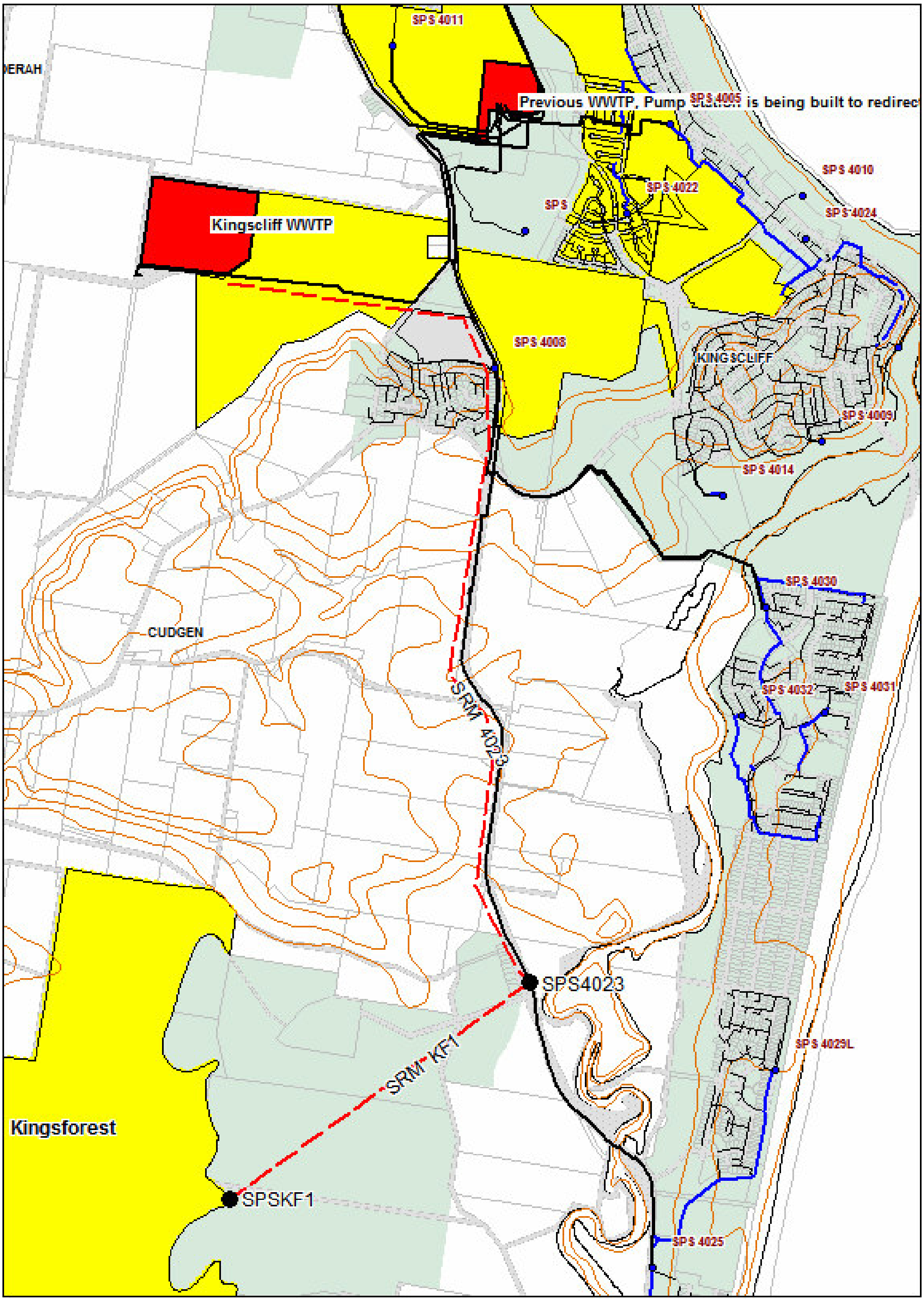
g:\411\15251\mapinfo\watercad\mapall.wor

APPENDIX N

# SEWER INFRASTRUCTURE PLANS


SGMCL1
LSCL1
SGMCL2
COBAKI LAKES
SPSCL2
SRMCL3
TWEED HEADS WEST
SPS 2048
SPS 2046
SPSCL_BH
SPS 2026
SPS 2034
SPS2
SRM_BH2
SGM_BH
SPS 2030
SPS 2018
SPS 2050
SPS 2021
SRM_BH1
SPSBH2
SGM_BH2
SPSBH1
SPS 2040
SGM_BH1
SPS 2038
BILAMBIL HEIGHTS
SPS 2035
SPS 2037
SPS 2036
SPS 2039

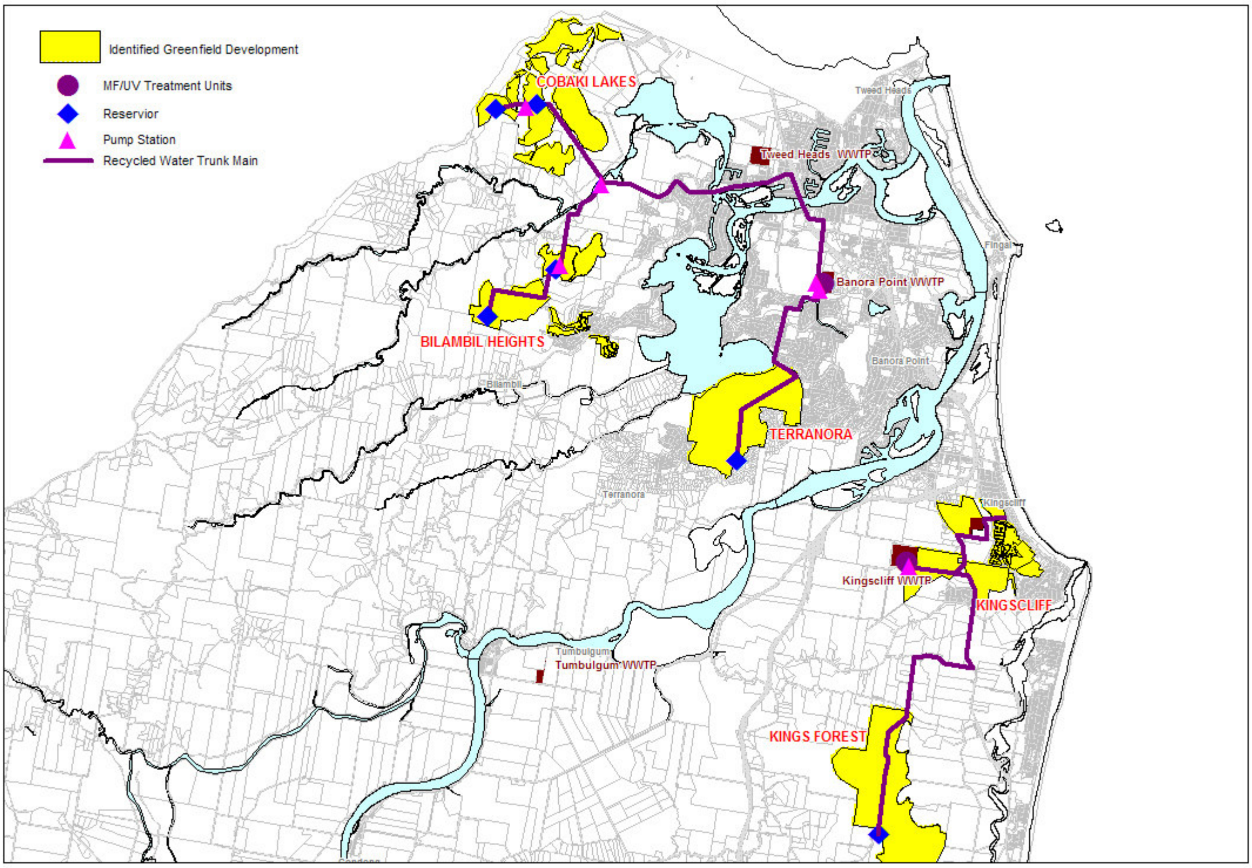

Tweed Heads WWTP
SPS 2014
SPS 2011
EADS WEST
SPS 2028
SPS 2027
SPS 2048
SPS 2006L
SPS 2005
SPS 2029
SPS 2009
SPS 2007L
SPS 2008
SPS 2023
SRM BP1
SPS 2026
SPS 2022
SPS 2015
SPS2052
SPS 2030
SPS 3024
SPS 2018
SPS 2020
SPS 2024
SPS
SPS 3009
SPS 3023
SPS 2019
SPS 2021
SRM BP2
TWEED HEADS SOUTH
SPS 3022
SPS 3031
SPS 2025
SPS 3028
Banora Point WWTP
SPS 3021
SPS 3038
SPS 3029
SPS 3025
SPS 3036
SPS 3030
SPS 3035
SPS 3018.1
SPS 3020
BANORA POINT
Terranora
SPS3037
SPS 3006.1



SPS 4011
ERAH
Previous WWTP, Pump Station SPS 4005 is being built to redirect
SPS 4010
SPS 4022
SPS
SPS 4024
Kingscliff WWTP
SPS 4008
KINGSCLIFF
SPS 4009
SPS 4014
SPS 4030
CUDGEN
SPS 4032
SPS 4031
SRM 4023
SPS4023
SRM KF1
SPS 4029L
Kingsforest
SPSKF1
SPS 4025

APPENDIX O

# RECYCLED WATER INFRASTRUCTURE PLAN


Identified Greenfield Development
MF/UV Treatment Units
Reservior
Pump Station
Recycled Water Trunk Main
COBAKI LAKES
Tweed Heads WWTP
Banora Point WWTP
BILAMBIL HEIGHTS
TERRANORA
Kingscliff WWTP
KINGSCLIFF
Tumbulgum WWTP
KINGS FOREST

APPENDIX P

# REVIEW OF OPTIONS FOR COBAKI LAKES

MWH Ref:

07 November 2007

Mr Robert Seibert
Department of Commerce
Lismore NSW

Dear Robert

# Addendum to Demand Management Strategy Report - Assessment of Options For Cobaki Lakes Development

Further to your request we have assessed options for the development of a integrated water solution for the Cobaki Lakes development. The assessment is an addendum to the Demand Management report and considers the option of a stand alone decentralised option instead of centralised treatment at the Banora Point STP.

Details of the assessment are outlined in the discussion below.

## 1. Outline of Options

Two options were reviewed as follows:

- Option 1 – Centralised Treatment at Banora Point STP. Under this option, sewage would be transferred to the existing Banora Point STP for treatment to Class A+ standard and then returned to the Cobaki Lakes development area for reuse. It would be proposed that the recycled water woul be used on external areas and
- Option 2 – Cobaki Lakes Treatment Facility. This option involves the construction of a sewage treatment plant at the southern end of the Cobaki Lakes development. A Class A+ water recycling facility would be constructed for use in the development residential and commercial sectors with the major end uses being landscaping, toilets and open space irrigation. Sewage from Bilambil Heights would also be treated at this facility. It is proposed that there would be no discharge from the site to the existing sewerage system.

For both options it was necessary to consider the collection and treatment of both the Cobaki Lakes and Bilambil Heights developments as either of these developments will trigger a requirement to upgrade the sewerage system between Cobaki Creek and the Banora Point STP.

The estimated EP served for Cobaki Lakes is 10,822 EP and for Bilambil Heights is 7,273 EP, giving a total population served of 18,095 EP.

## 2. Option 1 – Infrastructure and Cost Estimate

Option 1 was based on work undertaken in the Demand Management Strategy. Sewage is transferred to the Banora Point STP and treated prior to being further treated in a micro-filtration plant to a Class A+ standard, for use on landscaping and for toilet flushing. However due to the high cost and significant level of greenhouse gases generated through the high pumping head, recycling at the Bilambil Heights development was rejected. Therefore it was necessary to revise the costs of the recycling system including the treatment plant and the return main.

The infrastructure capacity was revised taking account of the lower return flow. Required infrastructure is summarised in Table 8-1.

**Table 8-1 : Option 1 - Summary of Required Recycled Water Infrastructure**

| Item | Description | Capacity Required | Quantity |
|---|---|---|---|
| 1 | Water Treatment Plant and Balancing Storage | 2.4 ML/day | 1 |
| 2 | Cobaki Lakes Reservoir | 5 ML | 1 |
| 3 | Cobaki Lakes HL Reservoir | 2 ML | 1 |
| 4 | Banora Point PS | 40 kW, 33 L/s @ 81 m | 1 |
| 5 | Cobaki lakes HL PS | 10 kW, 12 L/s @ 50 m | 1 |
| 6 | Main from STP to Cobaki Reservoir | 250 mm | 9,350 m |
| 7 | Main from Cobaki to HL | 150 mm | 500 m |

An estimate of cost was undertaken based on similar assumptions outlined in Section 5.4 of the Demand Management Strategy report. Estimates of capital works are provided in Table 8-2.

**Table 8-2 : Option 1 - Summary of Recycled Water Infrastructure Costs**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Trunk Mains | $5,419,150 | $3,616,521 |
| 2 | Reservoirs | $1,877,594 | $1,253,030 |
| 3 | Pumping Stations | $413,156 | $275,724 |
| 4 | MF/UV Treatment Plant | $6,240,000 | $3,549,137 |
| | **Capital Cost Totals** | **$13,949,900** | **$8,694,411** |

An estimate was made of the operations cost of the recycled water treatment plant and pumping costs from the plant to the Cobaki Lakes development. A summary of the costs are given in Table 8-3. It is noticed that the treatment opex includes for operators, membrane replacement, chemicals and energy. Distribution opex only includes for the energy costs related to the transfer to the Cobaki reservoirs.

**Table 8-3 : Option 1 – Summary of Recycled Water Operational Costs**

| Item | Description | NPV to 2036 |
|---|---|---|
| 1 | Treatment Opex @ $0.30/kL | $414,139 |
| 2 | Distribution Opex (Energy only) | $46,367 |
| | **Total Opex NPV** | **$460,506** |

Costs of the sewerage collection were assessed as part of the Demand Management Strategy Report. The infrastructure required for the transfer of sewage from the Cobaki Lakes and Bilambil Heights developments includes the construction of regional pumping stations as well as rising mains from Cobaki Creek along Kennedy Drive to the Banora Point STP.

The capital and operating costs for the provision of sewerage collection infrastructure summarised in Table 8-4.

**Table 8-4 : Option 1 – Summary of Sewerage Collection System Costs (Cobaki Creek PS to Banora Point STP)**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Capital Cost | $7,758,696 | $5,177,839 |
| 2 | Opex (Energy only) | | $228,720 |
| | **Total Sewerage System NPV** | | $5,406,559 |

In addition to the cost of sewerage collection infrastructure, consideration needs to be given to the impact of the developments on the Banora Point STP. It is proposed to upgrade this plant before 2010 from 62,000 to 80,000 EP. This upgrade will not be sufficient to service the ultimate capacity of the Cobaki Lakes and Bilambil Heights developments and a further upgrade of around 18,000 EP will be required. It is estimated that the timing of this work will need to be around 2015. It is estimated that the upgrade would cost $27m. Operation costs also need to be considered as part of the assessment. A summary of the STP costs are provided in Table 8-5.

**Table 8-5 : Option 1 – Summary of Sewerage Treatment Costs (Banora Point STP)**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Capital Cost | $27,000,000 | $15,714,246 |
| | **Total Sewerage System NPV** | | **$15,714,246** |

A summary of the costs related to Option 1 is provided in Table 8-6.

**Table 8-6 : Option 1 – Summary of Costs**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Recycled Water Capital Cost | $13,949,900 | $8,694,411 |
| 2 | Recycled Water Opex Cost | | $460,506 |
| 3 | Sewerage Collection Capital Cost | $7,758,696 | $5,177,839 |
| 4 | Sewerage Collection Opex Cost | | $228,720 |
| 5 | Sewerage Treatment Capital Cost | $27,000,000 | $15,714,246 |
| 6 | Sewerage Treatment Opex Cost | | $0 |
| | **Total Capital Cost** | **$48,708,596** | |
| | **Total NPV** | | **$30,275,722** |

## 3. Option 2 – Infrastructure and Cost Estimate

Option 2 involves the construction of a sewage treatment plant in the southern area of the Cobaki Lakes development near to Cobaki Creek. Sewage from both Cobaki Lakes and Bilambil Heights will be treated at the proposed STP, to achieve the benefits of reduced capital works in transport infrastructure back to Banora Point STP. The exact location of the STP would be determined by the developer depending on distances to residential areas, flood plain limits and other constraints.

The guiding principle of this option is to reuse the dry weather flow within the development for residential external irrigation, toilet flushing and for open space irrigation of parks and other open space. Wet weather flows would be discharged at an approved location. Class A+ recycled water would be supplied back to reservoirs within the system. During off peak periods recycled water would be transferred to ponds at either the treatment plant or possibly a golf course. During peak periods all recycled water would be utilised for the residential area and major open space areas such as the golf course would be irrigated from the storage ponds.

The recycled water scheme from Option 1 was reviewed and pipe diameters revised between the STP and the storage reservoirs. A summary of the required infrastructure is given in Table 8-7 and shown in Figure 1.

**Table 8-7 : Option 2 - Summary of Required Recycled Water Infrastructure**

| Item | Description | Capacity Required | Quantity |
|---|---|---|---|
| 1 | Treatment Plant and Balancing Storage | 2.4 ML/day | 1 |
| 2 | Cobaki Lakes Reservoir | 5 ML | 1 |
| 3 | Cobaki Lakes HL Reservoir | 2 ML | 1 |
| 4 | Banora Point PS | 40 KW, 33 L/s @ 76 m | 1 |
| 5 | Cobaki lakes HL PS | 10 kW, 12 L/s @ 50 m | 1 |
| 6 | Main from STP to Cobaki Reservoir | 200 mm | 2,100 m |
| 7 | Main from Cobaki to HL | 150 mm | 500 m |

A summary of the capital costs and associated NPV is given in Table 8-8. Based on this assessment a saving of approximately $4.27m in capital costs is evident over Option 1 due to the shorter rising main.

**Table 8-8 : Option 2 - Summary of Recycled Water Infrastructure Costs**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Trunk Mains | $1,150,100 | $767,530 |
| 2 | Reservoirs | $1,877,594 | $1,253,030 |
| 3 | Pumping Stations | $413,156 | $275,724 |
| 4 | MF/UV Treatment Plant | $6,240,000 | $3,549,137 |
| | **Capital Cost Totals** | **$9,680,850** | **$5,845,420** |

The operations cost of the recycled water treatment plant is assumed to be the same as for a centralised plant. Additional costs for having two STPs in lieu of the single plant at Banora are accounted for in the overall STP operations and maintenance costs discussed below.

Sewerage system collection infrastructure for Option 2 will be met entirely by the developers of the Cobaki Lakes and Bilambil Heights developments. The connection point for both developers will be the Cobaki STP. Therefore operational costs of the sewerage transfer costs are not required to be accounted for as the Option 1 costs were only for the transfer from Cobaki Creek PS to the Banora Point STP, i.e. the difference between the options.

One of the major cost issues with Option 2 is the operation costs of an additional STP at Cobaki Lakes. As discussed above, such plant will require staffing for operations and maintenance as well as higher costs for operation of a biosolids handling facility. The estimated costs of the plant operation will include a full time operator, and 1 crew of 2 staff involved in operations and maintenance. The annual cost of staffing is estimated to be $288,000 / annum (including 20% on-costs). This is in addition to the normal operating costs related to energy and chemicals.

The STP is assumed to be constructed in two 9,000 EP stages at a total cost of $30m. Stage 1 would cost around $17m and Stage 2 around $13m.

A summary of the costs of the STP is given in Table 8-9.

**Table 8-9 : Option 2 – Summary of Sewerage Treatment Costs (Banora Point STP)**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Capital Cost | $30,000,000 | $17,266,991 |
| 2 | Opex | | $1,549,467 |
| | **Total Sewerage System NPV** | | **$18,816,458** |

A summary of the costs related to Option 1 is provided in Table 8-6.

**Table 8-10 : Option 2 – Summary of Costs**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Recycled Water Capital Cost | $9,680,850 | $5,845,420 |
| 2 | Recycled Water Opex Cost | | $460,506 |
| 3 | Sewerage Collection Capital Cost | $0 | $0 |
| 4 | Sewerage Collection Opex Cost | | $0 |
| 5 | Sewerage Treatment Capital Cost | $33,000,000 | $17,266,991 |
| 6 | Sewerage Treatment Opex Cost | | $1,549,467 |
| | **Total Capital Cost** | **$42,680,850** | |
| | **Total NPV** | | **$25,122,384** |

### 4. Water Supply Savings

For the two options considered as part of this assessment, the use of recycled water for the external use and toilet flushing will reduce the reliance on potable water from the Tweed Shire water supply system, including dams, treatment and transfer. Based on the assessment of scenarios outlined in the Demand Management Strategy Report, the reduction in peak day demand would be 2.3 ML/d compared to the current demands. In addition a reduction of average annual demand of around 60% will occur assuming that rainwater tanks will be installed together with dual reticulation.

Estimates of the savings which may accrue from the reduction in annual potable water demand have not been calculated for Cobaki Lakes alone. However based on the previous cost assessment it is not likely that the avoided costs would be greater than an NPV cost of around $3m.

### 5. Other Costs to Council

Implementation of a recycled water scheme to supply residences and businesses has a range of associated costs relating to inspection, education, metering and billing, on-going compliance testing and reporting. Although these costs will be met by the users as part of the pricing structure for recycled water it is worth noting that the cost are substantial. Additional costs are estimated as follows:

- Set-up costs for recycled water program (i.e. educational program): $500,000
- Annual field and laboratory test: $50/ customer

Table 11 summarises the estimated set-up and annual compliance costs for dual reticulation for the new residential developments in Cobaki Lakes.

**Table-8-11 Estimated Set-up and Compliance Costs**

| Item | Description | Estimated Cost | NPV to 2036 |
|---|---|---|---|
| 1 | Set up and Compliance Costs | $5,899,462 | $1,929,740 |

### 6. Comparison of Costs

Based on the assessment of the options as outlined above a summary of estimated costs is provided in the table below.

**Table 8-12 : Summary of Costs**

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| **Option 1 – Treatment at Banora Point STP** | | | |
| 1 | Sewerage Collection and Treatment | $34,758,696 | $21,120,805 |
| 2 | Recycled Water Treatment and Distribution | $13,949,900 | $9,154,917 |
| | **Total Costs - Option 1** | **$48,708,596** | **$30,275,722** |

| Item | Description | Estimated Capital Cost | NPV to 2036 |
|---|---|---|---|
| **Option 2 – Treatment at Cobaki Lakes STP** | | | |
| 1 | Sewerage Collection and Treatment | $33,000,000 | $18,816,458 |
| 2 | Recycled Water Treatment and Distribution | $9,680,850 | $6,305,926 |
| | **Total Costs - Option 2** | **$42,680,850** | **$25,122,384** |
| | **Difference (Option 1 – Option 2)** | **$6,027,746** | **$5,153,338** |

It is noted that if recycled water is to be implemented in Cobaki Lakes a range of other costs will need to be taken into account. These are discussed above and are summarised as follows:

- Savings in the potable water system are estimated at this stage at an NPV of $3m.
- Additional costs related to the provision of the recycled water reticulation system need to be considered even if these costs are passed on to purchasers of land in the development.
- Additional costs of the operations and maintenance of two water systems in the development will be applicable however have not been estimated for this report.
- Additional costs to council of inspection, education, metering and billing, on-going compliance testing and reporting need to be considered. This is estimated as an initial set up cost of around $0.5m and an NPV of $1.9m. These costs will be passed through to developer in inspection costs and to customers in the water price.

## 7. Discussion of Options

Based on assessment of the two options for provision of recycled water to the Cobaki lakes development it is evident that Option 2, with a treatment plant located at the development is significantly lower in cost than a centralised system with treatment at Banora Point. Option 2 is approximately $5.1 m or 17% lower in NPV than Option 1. The major reasons for the difference in NPV are as follows:

- The Cobaki STP is constructed in 2 stages rather than a single large stage at Banora Point.
- Costs of transferring raw sewage and recycled water to and from the STP are greatly reduced.

Any decision to adopt one of these options must however take account of the additional costs for the implementation of the recycled water scheme. These costs relate to the development of education program, billing systems, testing and compliance and reporting. On the other hand there are savings related to the reduction in water use resulting from substitution of existing potable end uses with recycled water.

On the balance, costs of provision of recycled water to customers in the development will be higher than that of potable water. The benefits to the environment do need to be considered. Nutrient mass loads discharged to the Tweed River will be lowered as a result of the approach.

Obviously it will be necessary to gain State Government approval for a discharge to either Cobaki Creek or further downstream. If such a license is not granted, storage will be required on site with a dry weather capacity connection to the existing sewerage system at SPS 2052. The costs of such a connection are not included in this assessment.

## 8. Conclusions

In conclusion, it is noted that although the capital and operating costs of the decentralised treatment option are lower than the option of treating all water at Banora Point, the overall cost of providing recycled water are substantially higher than for potable water. The overall cost to the community is higher than for potable and this will be evident in price of housing and in the price of recycled water following implementation.

These higher costs are however balanced in some way by the reduction in nutrients and greenhouse gas generation for the business as usual option of centralised sewage treatment without recycling.

**MWH Australia Pty Ltd**