WaterPlan 2050

OPTIONS REPORT FOR THE
LONG TERM WATER SUPPLY STRATEGY

Gosford City Council Central Coast · Central Coast · Wyong Shire Council

Gosford/Wyong Councils' Water Authority

JULY 2007

OPTIONS REPORT

Summary and Process Overview

WaterPlan 2050 - Long Term Water Supply Strategy for the Central Coast has been prepared by the Gosford/Wyong Councils' Water Authority (GWCWA). The objective of *WaterPlan 2050* is to develop a sustainable long-term water supply for the Central Coast that:

a is safe and reliable;

b meets community needs;

c ensures the supply and use of water is efficient and affordable;

d improves and protects the health of our rivers and streams and general environment;

e involves the community in the development and selection of the proposed options;

f ensures the proposed measures are realistic and achievable.

While the State Government announced in November 2006 that a new 450,000 million litre (ML) dam would be built at Tillegra in the Hunter, this does not mean that the Central Coast water future is automatically secured. The principal role for Tillegra Dam is to provide a secure water supply for the Hunter. This new dam would also help to ensure the security of water transfers between Hunter Water and the Central Coast in the longer term when the current agreement expires.

Tillegra Dam is unlikely to be built until at least 2013. Therefore to assist with drought recovery, work is still required on a number of other options for the Central Coast water supply and this needs to be carried out now. *WaterPlan 2050* contains the building blocks for the Central Coast's long-term water supply system. It identifies a number of options for securing the system and making it a more diverse and robust scheme into the future.

The options are in addition to the existing system and the many drought contingency measures that the Councils have introduced to manage the current drought. GWCWA has obtained extensive additional information and reports to help manage the drought in recent years and this information has contributed to the development of *WaterPlan 2050*. Improved hydrological studies and systems analysis during the current drought has further enhanced the available information. Illustrated below are the supply options considered:

Option Number	Description
1	Regional Tillegra Dam
2	Upper Wyong River to Mangrove Creek Dam transfer system
3	Mangrove Creek Weir to Mangrove Creek Dam transfer system
4	Second lower Wyong Off-river Storage (Toobys Creek Dam)
5	MacDonald River to Mangrove Creek Dam transfer system
6	Lower Wyong River to Mangrove Creek Dam transfer system
7	20 ML/d permanent desalination plant at Toukley
8	Large scale retrofit of rainwater tanks on existing houses
 9a 9b	Environmental flow substitution 10 ML/d at lower Wyong River Weir 20 ML/d at lower Wyong River Weir
	Indirect potable reuse

Option Number	Description
10a	10 ML/d to Mardi Dam
10b	20 ML/d to Mardi Dam
10c	10 ML/d to Mooney Dam

Some options can be combined to form a number of potential water supply schemes for consideration. All of the schemes include reuse (where practical) and ongoing demand management.

GWCWA understands that future generations may have access to new technology or approaches to securing our water supply and may face different challenges, so it has developed a staged approach. The GWCWA needs to consider a combination of options to gain early benefit for our system and maintain the greatest flexibility and opportunity for the future.

Whatever approach is taken, however, we are reminded that our water supply system will evolve over time. Current options may be implemented progressively; and new (yet unavailable) options may be added in the future. It is important that the approach be flexible, as it needs to respond to climate change, regulatory change, changes in user trends and new technology.

The community has been involved in the development of *WaterPlan 2050* through a number of forums including the Community Liaison and IWCM Project Reference Groups. The preliminary working draft of *WaterPlan 2050* was placed on public exhibition in December 2006. The community were invited to make submissions and 57 submissions were received.

The submissions were reviewed at a joint workshop involving Gosford and Wyong Councillors. The workshop developed a recommended strategy for the Central Coast water supply based on the following key objectives:

a delivering early benefits by further improving the existing water supply system and gradually easing water restrictions;

b continuing to change the way people value and use water; and

c maintaining flexibility and opportunities for future generations so they can effectively meet their water needs.

No single action, by itself, is considered the ideal solution. Rather, it is proposed that a mix of actions be implemented over time, so we can adapt and respond to circumstances as they continue to change and evolve. *WaterPlan 2050 Summary* (May 2007) presented the outcomes from the workshop, which included:

a using water efficiently;

b enhancing the existing water supply scheme;

c accessing additional sources of water.

The *Summary* was placed on public exhibition seeking further public comment of the Councillor's resolution.

The Recommended Strategy

The recommended strategy developed at the joint workshop has three aspects:

a using water efficiently;

b enhancing the existing water supply;

c accessing additional sources of water.

Using water efficiently

All strategies in *WaterPlan 2050* are based on water conservation and supply substitution with recycled water and stormwater. The details of the water conservation and local reuse initiatives are outlined in the IWCM strategies prepared by Gosford and Wyong Councils.

However, water conservation and local reuse initiatives are not sufficient on their own to provide a secure supply for the Central Coast necessitating an augmentation of the headworks.

Enhancing the existing water supply system

To enhance the existing system and increase the secure yield, it is proposed to build a 21 kilometre underground pipeline linking Mardi and Mangrove Creek Dams together with two new pumping stations. One pumping station will enable water to be transferred between the two dams and the other will increase water extractions from Wyong River. It is estimated the new pipeline and pumping stations could be completed by the end of 2010 at cost of $80 million.

The new transfer system is considered to provide the quickest drought recovery time when compared with other possible options. The aim is to get the region's total dam storage levels up to a level whereby water restrictions could be eased.

The key benefits of this project include:

a Harvesting more water for town uses from Wyong River and Ourimbah Creek during medium and high flows (temporarily stored in Mardi Dam before being pumped through to Mangrove Creek Dam).

b Increased storage levels in Mangrove Creek Dam by using excess water from Wyong River and Ourimbah Creek;

c Enhanced environmental flows in Wyong River during low and medium streamflows; and

d Good integration with current and future elements of the Central Coast water supply.

When required, spillway gates can be installed on Mangrove Creek Dam to increase its storage capacity from 190,000 million litres to 230,000 million litres (ML).

Accessing additional sources of water

Any strategy that extends to the year 2050 must be both flexible and adaptable. The proposed *WaterPlan 2050* strategy is based on a staged approach to increase the overall water resources to ensure that supply always exceeds demand.

There are several demand and supply side risks facing the Central Coast water supply, which could affect the timing for staging the options; these are:

a failure to achieve the predicted water savings through water conservation and recycling projects;

b growth exceeding the population predictions;

c changes in the water access licence affecting the ability to extract water from the surface water sources;

d climate change reducing natural streamflows; and

e Hunter Water inability to transfer water in the longer term without affecting its security of supply.

As a risk management measure, the pre-construction activities for the next stage will be well advanced to reduce the lead-time for future implementation. There are currently four potential second stage augmentation options, which will compliment the proposed lower Wyong River – Mangrove Creek Dam transfer system namely:

a Tillegra Dam (Option 1);

b permanent desalination (Option 7);

c environmental flow substitution (Option 9); and

d indirect potable reuse (Option 10).

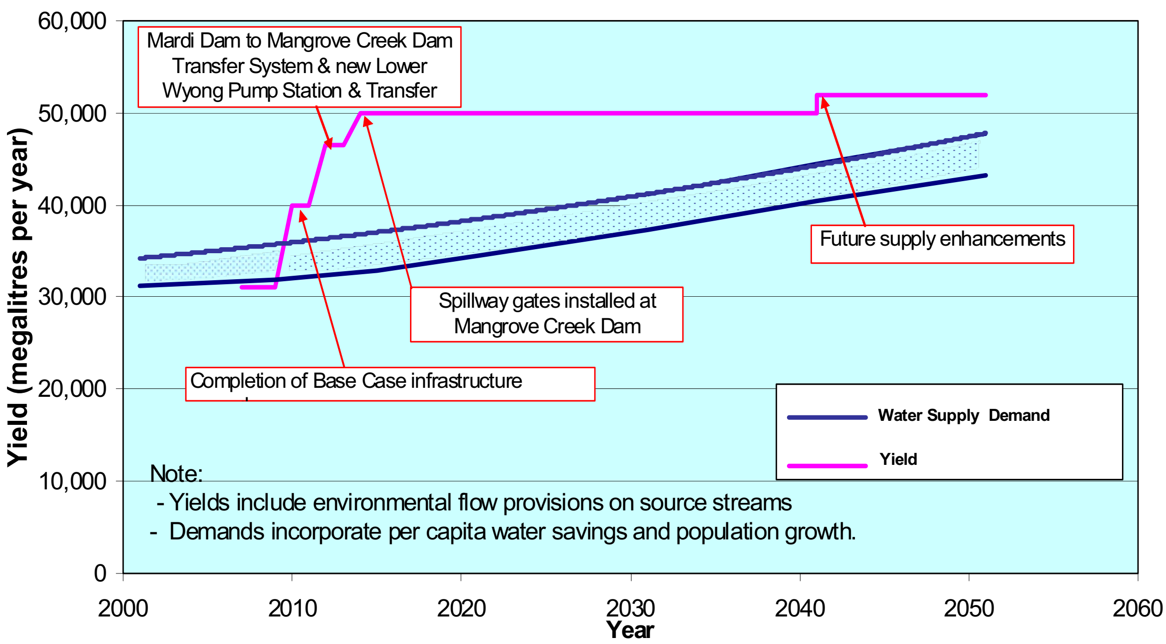
Continuing investigations and environmental assessments are required to develop these options and reflect future changes in policy, guidelines and technology developments.

Implementation

The proposed augmentation works will be staged to ensure that supply exceeds demand for the period 2007 to 2050. The red line in Figure S1 indicates the increase in yield with each stage of the augmentation. The timing for each stage can be read off the horizontal axis and in this case based on the best-case scenario.

The estimated annual demand is represented by a blue band. The band represents the possible range in demands between average and dry years. From the year 2011 onwards, the safe yield of the augmented water supply system supply exceeds demand. The timing for the future supply enhancement could be brought forward significantly if one or more of the risk events occur.

Figure S1: Staged Water Supply Increases



Further Information

WaterPlan 2050 is available on-line at the following websites:

www.gwcwater.nsw.gov.au (Gosford/Wyong Councils' Water Authority)
www.gosford.nsw.gov.au (Gosford City Council)
www.wyong.nsw.gov.au (Wyong Shire Council)

Printed copies are also available at all Council libraries and customer service centres in the Gosford City and Wyong Shire areas. Additional copies are available from Gosford and Wyong Councils on request.

Foreword

The Central Coast is renowned for its beaches and estuaries, coastal lakes and rivers. These natural features attract a large number of visitors and permanent settlers from the Sydney Metropolitan and country areas. This has resulted in net migration to the Central Coast making it one of the highest growth centres in New South Wales.

WaterPlan 2050 – Long Term Water Supply Strategy charts our course towards a sustainable and secure water system for the Central Coast up until the year 2050. *WaterPlan 2050* has as its foundation, the conservation of drinking water. Many of the demand management and water efficiency measures introduced by Gosford and Wyong Councils, both prior to and during the current drought, are incorporated in the long-term strategy.

The greatest challenge in developing the plan has been to maintain the balance between providing sustainable water services for a growing community while protecting the health of the environment including the rivers, coastal lakes and estuaries.

WaterPlan 2050 is prepared in the context of an Integrated Water Cycle Management (IWCM) and together with two other documents: Gosford Sub Plan and Wyong Sub Plan make up the IWCM Central Coast Strategy. These documents are linked via an IWCM linking document: “WaterPlan 2050 – IWCM Strategy for the Central Coast”, which is issued separately. The IWCM strategy aligns with the Department of Water and Energy (DWE) guidelines for the development of IWCM strategy, for use by NSW water utilities as part of the Best Practice Management Guidelines.

To support the overall planning strategy, Gosford and Wyong Councils have each prepared a separate Integrated Water Cycle Management (IWCM) strategy for each Council area, which identifies opportunities to use recycled water or stormwater for purposes that currently use potable water. The opportunities to reduce surface water extractions from local rivers by substituting with recycled water and stormwater shall be used as these become available. The outcomes from the IWCM strategies align with the long-term bulk water supply goals and capabilities as set in Water Plan 2050.

The NSW Government has also introduced measures to improve the design of new homes to reduce the demand for power and water (Building and Sustainability Index or BASIX) and to improve the labelling of water use appliance in the homes with a 5 star rating system (Water Efficiency Labelling and Standards Scheme). In the longer term, minimum efficiency standards are likely to be a permanent requirement for the water use appliances.

The community has demonstrated a strong commitment to water conservation during the current drought, and the Central Coast is already one of the most water efficient communities in New South Wales as demonstrated by average annual residential water usage (kL per property).Both Councils continue to work with the NSW Government to balance the community requirements for drinking water, with improvements in environmental flows – in the Wyong River, Ourimbah Creek and Mangrove Creeks – in accordance with the *Water Management Act 2000.*

WaterPlan 2050 seeks to balance the short-term actions required to manage the current drought with the longer-term needs for a sustainable water supply. The *Plan* proposes staged implementation to address uncertainties such as future population growth and water demands, climatic change and technological developments. The planned staging of actions allows for adaptive management and decision making to achieve cost-effective (over time) sustainable water supplies and healthy rivers.

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Abbreviations

A	Annual
ADWF	Average Dry Weather Flows
ADWG	2004 Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
BASIX	Building and Sustainability Index
C	NPV Capital
CAPEX	Capital Expenditure (costs)
CBD	Central Business District
CLG	Community Liaison Group
CMA	Catchment Management Authority
CO^2	Carbon Dioxide
CTP	Cease to Pump
D	Day
DA	Development Application
DCP	Development Control Plan
DWE	Department of Water and Energy formerly Department of Energy, Utilities & Sustainability
DIPNR	Department of Infrastructure Planning & Natural Resource
DNR	Department of Natural Resources
DECC	Department of Environment and Climate Change formerly Department of Environment and Conservation
EFS	Environmental Flow Substitution
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning & Assessment Act
ET	Equivalent Tenement
FDM	Fixed Demand Model
GL	gigalitres = 1 billion litres
GWCWA	Gosford / Wyong Councils' Water Authority
HACCP	Hazard Assessment & Critical Control Point
IPART	Independent Pricing and Review Tribunal
IPR	Indirect Potable Reuse
IRR	Internal Rate of Return
IWCM	Integrated Water Cycle Management

Abbreviations

kL	kilolitre = 1,000 litres
km	kilometres
kV	kilovolts
LCP	Least Cost Planning
L/d	Litres per day
LEP	Local Environment Plans
LGA	Local Government Area
MCA	Multi Criteria Analysis
MCD	Mangrove Creek Dam
ML	megalitre = 10^6 or 1,000,000 litres (1,000 kL)
NABERS	National Australia Built Environment Rating System
NCP	National Competition Policy
NPV	Net present Value
OPEX	Operation & Maintenance Expenditure (costs)
Pc	Per Capita
Plan	*WaterPlan 2050*
RL	Height above Australian Datum
RO	Reverse Osmosis
RWT	Rainwater Tanks
SCA	Sydney Catchment Authority
SEPP	State Environmental Planning Policies
SMEC	Snowy Mountain Engineering Corporation
SWRO	Salt Water Reverse Osmosis
UAW	Unaccounted for Water
WELS	Water Efficiency Labelling & Standards Scheme
WMA	Water Management Act
WMP	Water Management Plan
WSP	Water Sharing Plan
WSUD	Water Sensitive Urban Design
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant

1. Introduction

The Central Coast water supply is provided by Gosford City Council and Wyong Shire Council. The Councils have jointly invested in the water supply headworks, which include major water storages, treatment facilities and transfer systems. The Gosford/Wyong Councils' Water Authority (GWCWA) was established by the Councils to undertake the long term planning for the joint headworks.

The GWCWA developed *WaterPlan 2050* to ensure that the growing population of the Central Coast has sufficient water to meet its needs for the next 50 years without compromising the health of our rivers and lakes.

WaterPlan 2050 is prepared in the context of an Integrated Water Cycle Management (IWCM) and together with two other documents: Gosford IWCM Sub Plan and Wyong IWCM Sub Plan make up the IWCM Central Coast Strategy. These documents are linked via an IWCM linking document: "*WaterPlan* 2050 – IWCM Strategy for the Central Coast", which is issued separately. The IWCM strategy aligns with the Department of Water and Energy (DWE) guidelines for the development of IWCM strategy, for use by NSW water utilities as part of the Best Practice Management Guidelines.

The Central Coast is experiencing the worst drought on record, which has highlighted the need for a clear long-term strategy to ensure a safe, secure and sustainable water supply for the Central Coast.

WaterPlan 2050 considers a broad range of options to supply, save and/or substitute water. A key challenge is determining the timing and sequence of options to deliver the best economic, environmental and social outcomes for the community. The options raised in this report have been investigated and identified as having the best prospects of delivering cost effective and sustainable water supply solutions for the Central Coast, in both the short and long term.

To achieve a sustainable and secure water future, *WaterPlan 2050* weighs up short-term actions required to manage the current drought on the Central Coast within a longer-term context. The *Plan* must be sufficiently flexible to address uncertainties regarding:

a future population and growth patterns;

b catchment, water resources and urban supply issues;

c effectiveness of demand management on water requirements;

d potential to substitute supply with recycled water and stormwater;

e changes in legislative and policy issues set by the NSW Government;

f ability of hydrologic studies to predict the secure yield of supply in a time of climate change;

g changing legislative requirements to provide for environmental flows in the rivers; and

h new technology providing innovative solutions.

In evaluating options and considering the best mix of options in formulating a preferred strategic *Plan*, GWCWA has had regard to:

a increasing the efficient use of water throughout the community;

b optimising the use of the existing infrastructure;

c recycling water or stormwater, where practical;

d minimising the risk of water shortages by diversifying sources of supply;

e improving the health of our rivers and coastal lakes; and

f options that support recovery from the drought.

A risk management approach, in conjunction with and adaptive management framework, has been used to assist in the development of the preferred strategy under *WaterPlan 2050.*

Risk assessment and pro-active management are appropriate tools to deal with the rapidly changing environment currently facing Gosford and Wyong Councils. Risk assessment identifies the risks, possible solutions and monitors the outcomes.

An adaptive management framework will provide opportunities for *WaterPlan 2050* to incorporate new technologies and innovations as they are developed.

Ongoing monitoring and review of the performance of the system is essential to facilitate regular periodic review of the *Plan*, its achievements and the need for further action and possible changes. The *Plan* will be subject to review at 5-yearly intervals.

WaterPlan 2050 is designed to secure the long-term water supply for the Central Coast. The *Plan* addresses the bulk water supply issues including the impact of environmental flows on surface water extractions, potential for water savings to reduce demand and the reuse of recycled water and stormwater. The *Plan* seeks to optimise the existing water supply scheme with the development of additional bulk water sources of supply, such as surface water sources, desalination, the use of recycled water for environmental flow substitution and indirect potable reuse, and transfers of water between Hunter Water Corporation and the Central Coast.

To support this goal, Gosford and Wyong Councils have each prepared separate IWCM strategy Sub Plans, which focus on the specific water needs, uses and opportunities present within the urban areas of each local government area.

IWCM is a tool by which water utilities (i.e. Councils) can manage local water systems in harmony with regional water systems, aiming to maximise benefits to the community and the environment. It involves integrating the planning and management of water supply, sewerage and stormwater functions, to ensure that water is used optimally for urban development within the catchments and national water quality objectives are met.

The IWCM strategies will include for each local government area:

a water quality objectives;

b forecast water demands (for different demand management scenarios);

c opportunities for local recycled water use;

d opportunities for local stormwater reuse;

e development planning issues, including Water Sensitive Urban Design (WSUD);

f impacts on wastewater treatment capacity;

g local environmental outcomes (eg. water quality, greenhouse emission reductions);

h specific inputs required for *WaterPlan 2050* (demands, costs, etc).

The relationship of *WaterPlan 2050* and the IWCM strategies is illustrated in Figure 1.1. *WaterPlan 2050* has made a broad assessment of potential water savings that could be achieved from water conservation and recycling.

The IWCM strategies have evaluated the water savings that can be achieved through a comprehensive range of actions and these have been grouped into scenarios. All the scenarios either match or exceed the water savings assumed in *WaterPlan 2050*.

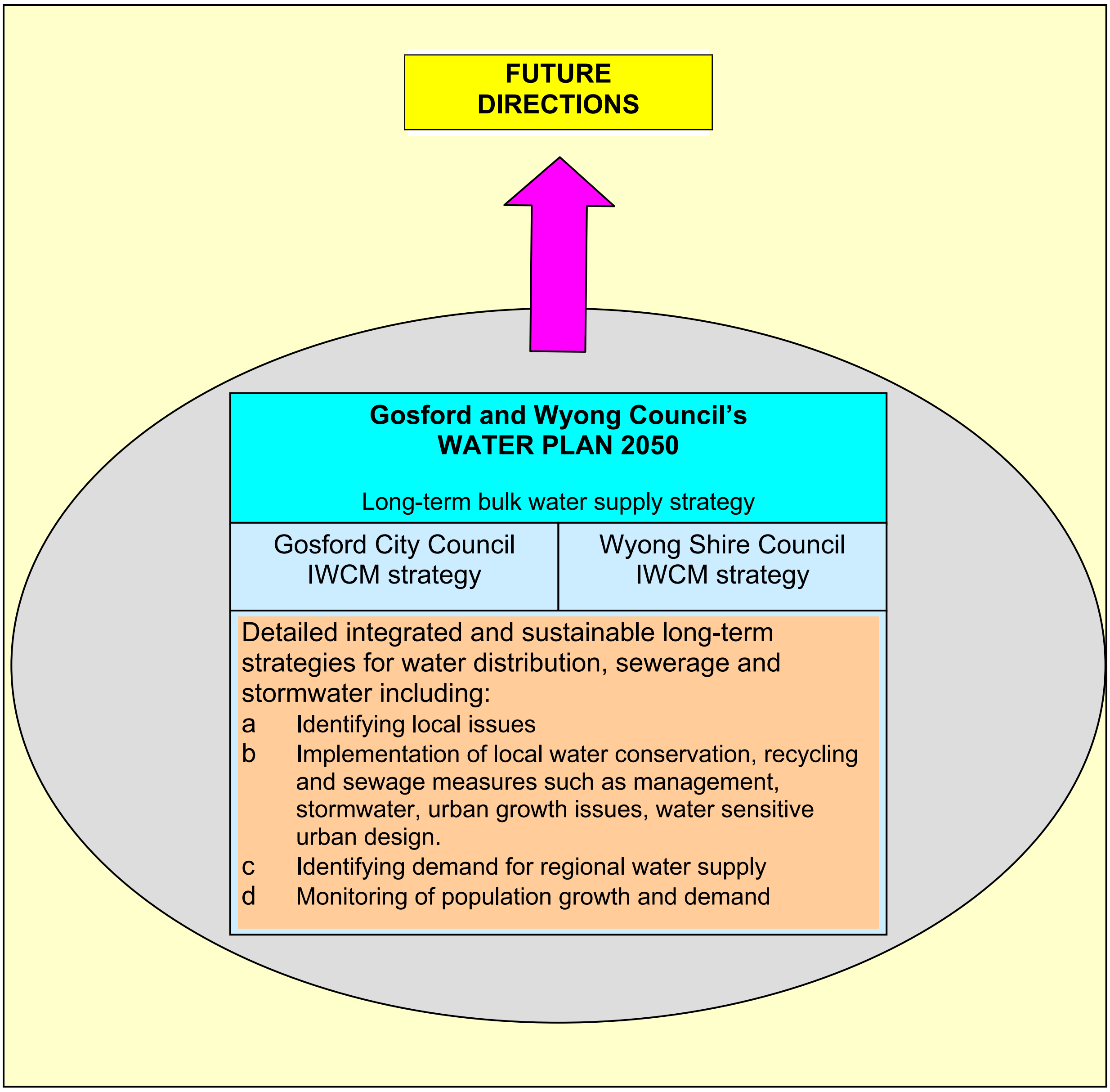

Figure 1-1. Relationship of *WaterPlan 2050* to the IWCM strategy

2. Central Coast's Existing Water Supply Scheme

2.1 Background

Until 1975, Gosford and Wyong had separate water supply schemes. Gosford's scheme was based on Mangrove Creek Weir and Mooney Dam, which is located on the upper reaches of Mooney Mooney Creek. Water could be transferred from Mangrove Creek Weir or Mooney Dam to the Somersby Water Treatment Plant (WTP), before distribution through the Kariong reservoirs to the Gosford community.

Wyong's water supply scheme was based on a weir and pumping station on the lower Wyong River which transferred water to Mardi Dam (an off river storage). Mardi Dam provided the balancing storage and drought security. Water from Mardi Dam was treated (disinfected) and distributed to the Wyong community.

In 1975, Gosford and Wyong Councils resolved to augment and integrate their water supply schemes. The joint scheme developed was based on harvesting water from Wyong River and Mangrove, Mooney Mooney and Ourimbah Creeks with the key element being a major new water storage dam (190,000 ML) on Mangrove Creek. Mangrove Creek Dam was commissioned in 1980.

2.2 1985 Headworks Strategy

In 1985, Gosford and Wyong Councils, with funding assistance from the NSW Government, adopted a three-stage joint water supply scheme to serve both Gosford City and Wyong Shire. The stages would be implemented as water demands dictated. The key elements of the three-stage strategy are as follows:

Stage A

1. The retention of Mooney Dam, Mardi Dam and weirs on Mangrove Creek and lower Wyong River;
2. The construction of a weir on Ourimbah Creek with a pumping station and pipeline connection to Mardi Dam;

   Note: There are two weirs on Ourimbah Creek – a lower weir at the tidal limit, and the upper weir referred to above that was constructed as part of the water supply system. Any reference to Ourimbah Creek Weir in relation to the water supply is to the upper weir.
3. The construction of a tunnel from Mangrove Creek Dam to upper Wyong River (Boomerang Creek Tunnel);
4. Construction of a pipeline from Wyong to Gosford (Gosford–Wyong transfer system).
5. The construction of a low weir on the upper Wyong River at the junction with Bunning Creek and the provision of a 1000 ML/d pumping station delivering flood waters to Mangrove Creek Dam through Boomerang Creek Tunnel.

Stage B

6. Construction of a 700 ML/d pumping station on the lower Wyong River Weir (replacing the 72 ML/d pumping station) and pipeline delivering raw water to Mardi Dam;
7. Construction of a 20 km x 1,650 mm diameter pipeline from the Bunning Creek end of Boomerang Creek Tunnel to Mardi Dam with direct linkage to Mardi WTP.

Stage C

8. Construction of a 54 km x 900 mm diameter pipeline with two inline 130 ML/d booster pumping stations connecting Kanwal reservoir to the Hunter Water system.

In conjunction with the scheme development, treatment plants at Mardi (capacity 100 ML/d) and Somersby (capacity 160 ML/d) would be retained. Additional capacity would be provided at Mardi, as required to meet future needs, potentially up to 600 ML/d.

Stage-A works were designed to increase system yield and improve operational flexibility. Stage B works were planned to maximise potential extractions from Wyong River particularly during high flows and transfer these to Mangrove Creek Dam.

Stage C (connection to Hunter Water) would enable the transfer of water in non-peak demand periods from the Hunter Water system to the Central Coast water supply when storage in Mangrove Creek Dam fell below 85% capacity.

The calculated secure yield of the Central Coast water supply using the data and modelling available at the time is presented in Table 2.1.

Table 2.1 1985 Estimates of Secure Yield of Central Coast Water Supply

Completed Stage	Secure Yield (ML/a)	Population Served
A1, A2, A3 & A4	47,000	250,000
A5, B6 & B7	70,000	330,000
C8	106,000	450,000

2.3 The Existing Water Supply System

2.3.1 Implementation of the 1985 Headworks Strategy

Stages A1 to A4 of the adopted 1985 strategy were completed in the late 1980's, and represent the existing system (refer *Report on Investigations for Water Supply to the Gosford Wyong Region*[1]).

Stage A5 was deferred because the demand on the system has been lower than predicted (33,000 ML/a, as at May 2007) due to:

a lower population growth than was predicted in 1985;

b a progressive reduction in average annual residential and total consumption of water; and,

c lower peak day water demands than were predicted.

Stage B work has also been deferred because the demand on the system has been lower than predicted and Mangrove Creek Dam filled rapidly to over 70% during significant wet weather events during the late 1980s and 1990.

The 7-year drought commencing 1935 was the critical drought used in modelling and system analysis of the schemes and options investigated in 1985. This was the worst drought on record at the time.

The current drought, dating from 1993 is now the worst on record, with below average rainfall occurring in 13 of the 15 years (up to and including 2006 – refer Section 2.3.5). It has led to a drawdown of Mangrove Creek Dam to less than 13% (January 2007) and has advanced the need to reappraise the 1985 Headworks Strategy.

2.3.2 Interim Upgrade Works

The GWCWA has adopted the following interim upgrade works to improve the performance of the existing headworks:

a upgrading the existing lower Wyong River pumping station by improving the intake pipe work and providing an additional transfer main. This work will increase the transfer capacity from 72 to 125 ML/d. The programmed completion date is February 2008;

b constructing a new transfer system from Mardi Dam to Mardi WTP increasing the capacity from 100 ML/d (existing) to 240 ML/d. The programmed completion date is June 2009;

c constructing a new 160 ML/d, Mardi high lift pumping station that will enable water transfers from Wyong (via Tuggerah No. 2 reservoir) to Gosford via the Gosford/Wyong trunk main. The programmed completion date is June 2009;

d raising the storage capacity of Mardi Dam from 7,400 ML to 8,800 ML. The programmed completion date is February 2009; and

e upgrading Mooney Dam pumping station to 60 ML/d. It is proposed to undertake this upgrade when there is sufficient total storage to enable the pump station to be off-line during construction.

2.3.3 Drought Contingency Works

The Central Coast is currently experiencing the worst drought since records began in 1896. This has resulted in the system storage declining to approximately 13% of capacity (January 2007). The GWCWA, and Gosford and Wyong Councils have prepared and are implementing a drought contingency plan to maintain supply. The plan includes:

a Water saving measures including:

  i introduction of water restrictions, first introduced February 2002, with Level 4 restrictions being introduced in October 2006;

  ii residential retrofit program, installing water efficient devices into households;

  iii rebate program for rainwater tanks;

  iv rebate program for water efficient washing machines;

  v preparation and implementation of Water Management Plans by medium to large consumers to ensure water is used efficiently and not wasted; and

  vi leakage reduction programs in the Councils' distributions systems.

b Development of groundwater sources (production bores) for town water purposes.

c Development of additional water sources such as groundwater, recycled water and stormwater for the irrigation (non-potable) of parks and sporting facilities.

d Partial closure of the outlet valve on upper Ourimbah weir reducing environmental releases downstream and increasing water supply extractions.

e Construction of a temporary weir and 12 ML/d transfer system between Porters Creek and lower Wyong River.

f Constructing a 33 ML/d transfer system between Morisset and Warnervale to enable the two-way transfer of water between Hunter Water and the Central Coast.

g Connecting the rising main from Mangrove Creek Weir to Mooney Dam to enable the transfers of surplus water to Mooney Dam for storage.

h Funding with Hunter Water, the Balickera pre-treatment plant designed to reduce nutrient levels in flood flows extracted from the Williams River and stored in Grahamstown storage. Currently the nutrient levels are monitored and flood transfers only occur when the nutrient levels are low to reduce the risks of algal blooms in Grahamstown storage.

i Funding with Hunter Water, the upgrading of Balickera pumping station to 2000 ML/d capacity, provision of 7 km of trunk main north of Morisset and a groundwater investigation of the North Stockton and Tomago sand beds.

The last four drought contingency measures are permanent, and will result in the improvement of the long-term performance of the Central Coast water supply headworks.

In addition, there are a number of other drought contingency measures being planned, for introduction if necessary, including the installation of temporary desalination plants on the coast.

2.3.4 The *Base Case* for Future Augmentations

The existing system (Section 2.3.1), interim upgrade works (Section 2.3.2) together with the permanent drought contingency measures (Section 2.3.3) are referred to as the *Base Case* for future augmentations in subsequent Sections of this report.

2.3.5 Mangrove Creek Dam Storage Behaviour

Under average climatic conditions, a significant proportion of the Central Coast water requirements are met by extracting run of river flows from the weirs on Wyong River, Ourimbah Creek, Lower Mangrove Creek and water captured by the small dam on Mooney Mooney Creek. During low rainfall periods with depressed streamflows, streamflows are supplemented by releases from Mangrove Creek Dam to Wyong River and Mangrove Creek.

Because of the extended period of low rainfall since the early 1990s, streamflows on the Central Coast have decreased necessitating releases from Mangrove Creek Dam. The runoff from the catchment of Mangrove Creek Dam, particularly during this extended low rainfall period, has not been sufficient to refill or maintain the storage (refer Figure 2.2).

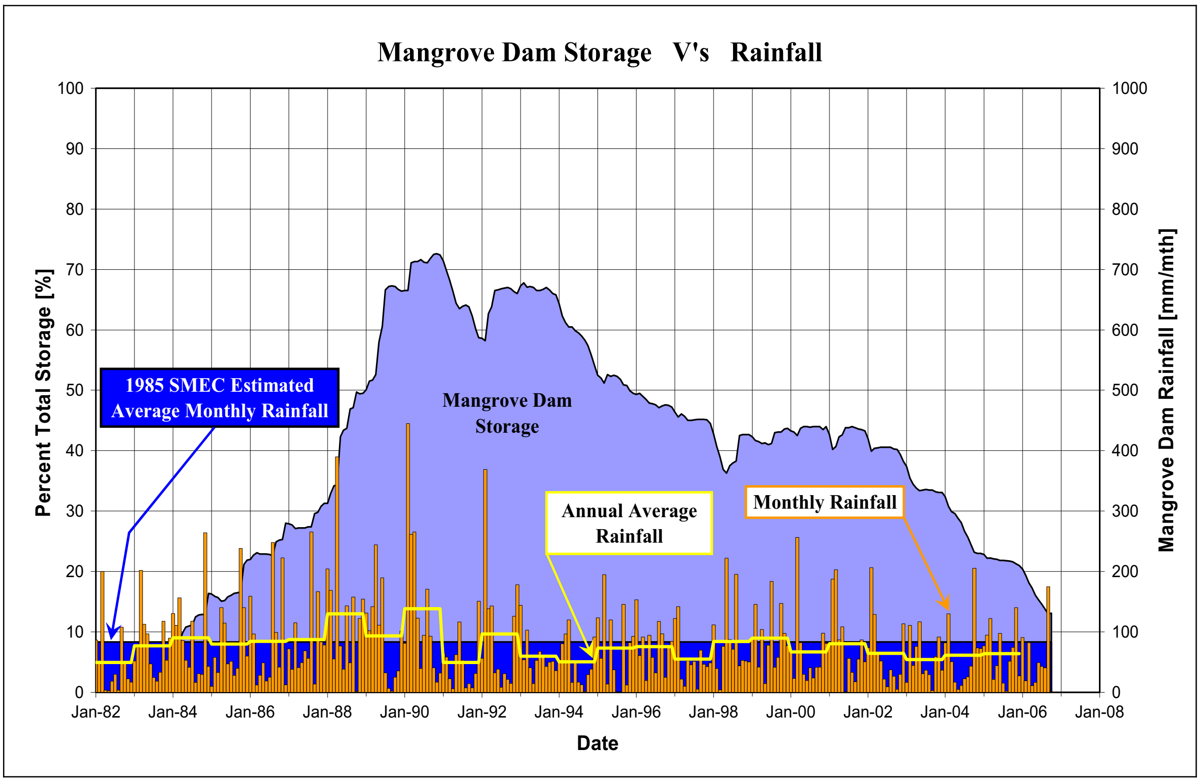

Figure 2-1 Mangrove Creek Dam Storage Behaviour

While Mangrove Creek Dam has a large storage capacity of 190,000 ML, its catchment area is relatively small (approximately 101 km^2). From the graph in Figure 2-1, it can been seen that the Dam filled rapidly in the wet period from 1988 to 1991 but the incidence of high rainfall is variable with intervals between major events sometimes exceeding 10 years.

The current drought, dating from 1993, is now the worst on record, with below average rainfall occurring in 13 of the 15 years (up to and including 2006). Average rainfall was experienced in 1998 and slightly above average in 1999. In effect, the Central Coast has, to date, experienced two-7 year droughts back-to-back.

This has resulted in average streamflows in our four river and creeks being reduced by approximately 50% over the past 15 years compared to the long-term average over the past 100 years – down from an annual average of 177,000 ML to 83,000 ML (refer Figure 2-2).

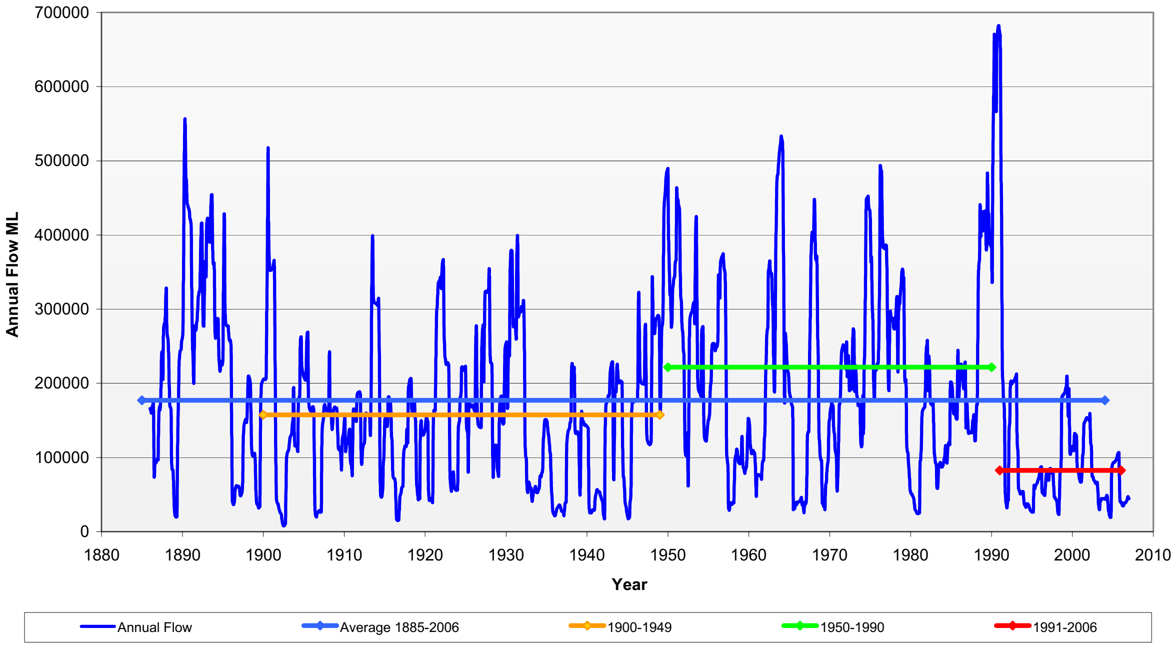

Figure 2-2 Central Coast Streamflows

Mangrove Creek Dam was originally designed to operate in conjunction with transfers from the upper Wyong River (refer Section 2.2). As Mangrove Creek Dam provides the primary storage for drought security, there is a need to review the options to facilitate recovery of the Dam. These options fall into two broad categories namely:

a transfers from adjoining surface water sources; and

b development of alternative water sources (such as rainwater tanks and desalination) which can reduce demand on the existing water supply and the need for releases from Mangrove Creek Dam.

3. Operating Background

Section 3 provides an overview of the key relevant legislation and policy requirements that must be considered when planning an augmentation of a town water supply. There are other legislative requirements that must also be addressed when implementing the preferred strategy. These will not be addressed in this report as they predominantly involve detailed construction issues, which do not significantly influence the strategic direction.

Gosford and Wyong Councils are "water supply authorities" as defined in the *Water Management Act 2000*. The functions of a water supply authority include the construction, operation and maintenance of water management works. The water management works comprise the water supply and sewerage infrastructure in each Council's area of operation.

GWCWA is the structure established by agreement between Gosford and Wyong Councils to provide overall planning for the Joint Water Supply Scheme (JWS) owned and operated by the Councils.

The major Central Coast water supply headworks covered by the agreement include:

a In Wyong Shire - Boomerang Creek Tunnel, lower Wyong River Weir and pumping station, Mardi Dam, Ourimbah Creek Weir and pumping station, Mardi WTP, Tuggerah 2 reservoir and all interconnecting pipelines; and

b In Gosford City - Mangrove Creek Dam, Mangrove Creek Weir and pumping station, Mooney Dam, Somersby WTP, Kariong 1 and 2 reservoirs and all interconnecting pipelines.

3.1 Water Management Act 2000

The *Water Management Act 2000* (*WM Act*) provides the legislative framework for water resource management in New South Wales. The provisions that are relevant to the Councils' water supply businesses are:

a the preparation and gazettal of Water Sharing Plans (Section 3.1.1);

b the issuing of local water utility water licences with access conditions (Section 3.1.2); and

c governance issues relating to water supply authorities (Section 3.1.3).

These provisions are discussed in more detail below.

3.1.1 Water Sharing Plans

The DECC (formerly Department of Environment) has published a policy document *NSW environmental objectives for water quality and river flow*[2] designed to improve the health of NSW Rivers.

The WM *Act* has consolidated the legislation governing water management under the one Act and incorporated DECC policy directions. Under previous legislation, there were no specific allocations of water to the environment or clear rules for establishing priority for the provision of water to different users.

The *WM Act* specified the preparation of Water Sharing Plans (WSP) for all water sources (rivers and groundwater) as the mechanism to achieve these outcomes. The initial WSPs covering approximately 80 percent of water extracted in New South Wales were prepared by Water Management Committees, which included community representation.

The access conditions developed in the WSPs were incorporated into water licences issued under the *WM Act* to each entitlement holder. Under this procedure, a WSP has been prepared covering Ourimbah Creek, Jilliby Jilliby Creek and the Kulnura Mangrove Mountain Groundwater System.

In 2005, the *WM Act* was amended to permit the development of macro WSPs. These are broader scale plans to cover most of the remaining water sources in NSW, including many of the unregulated coastal rivers and groundwater sources. A Central Coast macro WSP is currently under preparation that will cover the remaining Central Coast water sources i.e. Mangrove Creek, Mooney Mooney Creek and Wyong River.

The macro plans are prepared by classifying sub-catchments according to their social, economic and ecological values. A standard set of water sharing rules are developed and extended across catchments with similar classification.

WSPs are required to:

a share water between all water users and the environment;

b improve the health of the rivers;

c provide security of access for all water users;

d meet social and economic needs of regional communities; and

e facilitate water trading.

These plans are currently being developed by the Department of Natural Resources (DNR). The Minister for Natural Resources approves the final plans with the agreement of the Minister for the Environment. Once gazetted, WSPs are to remain in force for ten years. On expiry of the ten-year plan, a new plan is developed based on adaptive management principles.

The WSP for each water source contains requirements for environmental flows, extractions and trading rules. Water licences issued under the *WM Act* on completion of the WSP include access conditions designed to protect the river ecology and share the water between all water users.

The existing water licences issued under the *Water Administration Act 1912* specify current access rules for Wyong River, Mangrove Creek Dam and Mangrove Creek at the weir, and Mooney Dam. The introduction of WSPs under the *WM Act* and associated environmental flow rules are likely to alter significantly the access conditions applying to streamflow extractions and may affect long-term security of the water supply.

Development of additional infrastructure will be required to offset reduced access to low flows upon which the existing system relies. It is current State Government policy that under WSPs, existing access arrangements for town water supplies will not be impacted until necessary supply system infrastructure has been provided.

Section 8 examines the hydrology of the Central Coast water supply and quantifies the impact of possible access conditions on the security of supply.

3.1.2 Water Access Licence Conditions

Under the *WM Act,* Councils are issued with local water utility water licences for town water supply purposes. Gosford and Wyong have been jointly issued with a town water entitlement of 47 Giga-litres per annum (GL/a) which corresponds to the system yield for Stage A1 to A4 works (refer Table 2.1). The *WM Act* provides for 5-yearly adjustments to the entitlement to account for population growth and associated commercial activities.

The ability to extract the full entitlement is dependent on the access conditions in the water licence. The access conditions are normally developed in the WSP. Access conditions restricting extraction of water during low river flows and limitations in the medium and high flow range will have a significant impact on system yield.

In the case of regional water supplies drawing from a number of water sources with highly variable flows, the determination of access conditions and entitlement from each source is complex. From the GWCWA perspective, the conditions must enable flexible operation of the water supply system to facilitate access to good quality water and to maximise the yield of the supply in a cost effective way.

3.1.3 Governance

The *WM Act* sets out the regulatory requirements for Water Supply Authorities, which are designed to demonstrate compliance with National Competition Policy (NCP). The NSW Government adopted a Best Practice Management approach, which satisfies the NCP requirements.

Consistent with the NSW Government's approach, the Department of Energy and Water (DEW) formerly the Department of Energy, Utilities and Sustainability published the *Best-Practice Management of Water Supply and Sewerage Guidelines*[3] in May 2004. The *Guidelines* include six criteria of which three are relevant to *WaterPlan 2050*:

a demand management;

b drought management; and

c integrated water cycle management.

The Gosford and Wyong Councils have individually prepared and implemented demand management and drought management plans for their respective areas of operation and are currently developing individual IWCM strategies (refer Section 1.0)

WaterPlan 2050 currently incorporates the outcomes of the Councils' demand management and drought management plans, and will ensure consistency with actions and goals of the IWCM Sub Plans of both Councils.

3.2 Environmental Planning and Assessment Act

3.2.1 Central Coast Regional Strategy

The NSW Department of Planning has published a *Draft Central Coast Regional Strategy*[4] seeking public comment. This 25-year regional development strategy foreshadows an additional 64,250 people to be living in the region by 2031. It is estimated that up to 36,000 new dwellings will be required with around 78% of new homes located within existing centres and urban areas and 22% in new estates.

The *Draft Central Coast Regional Strategy* has reduced the predicted population due to concern about the security of the water supply. The strategy *allows targets to be revised if long term planning for water supply shows that additional population can be supported.*

WaterPlan 2050 is based on a 50-year planning horizon designed to support a population of up to approximately 460,000 and the associated commercial and industrial development (refer Section 6.2).

3.2.2 Planning Controls

All development proposals in NSW must be assessed to ensure they comply with the relevant planning controls and, according to the nature and scale, that they are environmentally and socially sustainable. State, regional and local plans and policies indicate what level of assessment is required and who is responsible for the assessment (the Council, an accredited private professional or the Minister for Planning).

The development assessment system in New South Wales is set out in Part 4 and 5 of the *Environmental Planning and Assessment Act 1979 (EP&A Act).* The *EP&A Act* ensures that members of the public can participate in decisions that will shape their community's future.

Water supply and sewerage infrastructure generally requires development consent to permit construction. An environmental assessment is undertaken to determine the significance of the proposal on the environment and community. For projects with significant impact, an Environmental Impact Statement (EIS) is prepared and submitted to the consent authority, which is generally the Council in whose area the development occurs.

The Minister for Planning is the determining (consent) authority for the following:

a designated developments (which includes most sewerage treatment works, larger sewerage systems and release/recycling works);

b State Significant Developments; and

c SEPP Major Projects under Part 3A of the *Environmental Planning and Assessment Act 1979*.

NSW Planning has prepared a draft *State Environmental Planning Policy (Infrastructure) 2006* which outlines the planning processes for considering classes of public infrastructure and particular infrastructure projects. It defines the environmental assessment and approval process including identification of developments that are assessed under Part 5 of the *EP&A Act.*

Water and sewerage projects generally comprise a mixture of Part 4 and Part 5 matters. Under the proposed definition in the draft SEPP, all water supply facilities will become Part 5 matters removing the need for local government development consent.

This will assist a water authority to construct works in areas where the local government does not support its proposals. It has been used by Sydney Water and Sydney Catchment Authority to fast track works identified in the *2006 Metropolitan Water Plan*[5].

Hunter Water may use these provisions to fast track the proposed development of Tillegra Dam. The provisions do not eliminate the need for detailed environmental and engineering studies, preparation of an Environmental Impact Statement and determination by the Minister for Planning.

3.2.3 Building and Sustainability Index

The Building and Sustainability Index (BASIX) is an initiative of NSW Department of Planning to encourage better design of dwellings and to reduce power and water consumption per dwelling by 25% and 40% respectively relative to Sydney's pre-BASIX demands. The legislative basis for BASIX is the *Environmental Planning and Assessment Regulations 2000.*

BASIX replaces requirements in Councils' Development Control Plan (DCP) for installation of water efficient appliances, including rainwater tanks in new homes. BASIX is a web-based tool that enables individuals to calculate the net savings of a number of conservation measures to achieve the specified reduction in power and water use.

BASIX initially targeted new residential dwellings in Metropolitan Sydney. As of October 2006, BASIX includes all residential alterations and additions throughout NSW (in addition to all new residential single detached and low to high-rise dwellings in NSW).

With commercial office space, the NSW Government has introduced a star rating for energy efficiency for all new buildings and a minimum standard for all buildings leased by Government agencies. This initiative is being expanded to include water efficiency.

This has effectively set a new benchmark for office developments and most major developers are now seeking to exceed the minimum requirements.

3.2.4 Councils' Development Control Plans

Both Councils are revising their DCP's to integrate development within the water cycle (as part of the IWCM initiatives) and to improve water efficiency, water quality and provide for alternative water supplies.

3.3 Water Efficiency Labelling and Standards Scheme (New South Wales) Act 2005

The *Water Efficiency Labelling and Standards Scheme*, commonly referred to as WELS, is a national initiative of the Commonwealth, States and Territories Governments. WELS requires certain water-use appliances to display labels at the point of sale, which provide information on the performance and water efficiency of the appliance. The Scheme may also establish a minimum standard for water-use appliances. This means that appliances not meeting the standard cannot be sold.

Water-use appliances that are currently subject to WELS are:

a clothes washing machine;

b dishwashers;

c flow controllers;

d toilet (lavatory) equipment;

e showers;

f tap equipment intended for use over a kitchen sink, bathroom basin, laundry trough or ablution trough; and

g urinal equipment.

The full potential of the Scheme will only occur if minimum efficiency standards are established. The impact of minimum standards will take some time to be effective as the existing stock of appliances are discarded and replaced.

3.4 Public Health Act 1991

NSW Health is responsible under the *Public Health Act 1991* for monitoring and managing public health and improving public health through regulation, education and promotion. NSW Health monitors all water supply schemes against the requirements of the *2004 Australian Drinking Water Guidelines*[6] (ADWG). The Minister for Health has powers to issue orders and direct public authorities to take action to prevent public health risks in town water supplies.

NSW Health also plays a key role in setting water compliance criteria for town water and recycled water.

3.5 Local Government Act 1993

As a consent authority, a Council approves proposed new developments and modifications to existing developments, and may set conditions on approvals following advice and referrals from other agencies and bodies. Council's approval is required for specific water, sewerage and stormwater infrastructure that are defined in Part 4 of the *EP&A Act.*

3.6 Other Legislation

The GWCWA and the Councils have to comply with various other State and Federal legislation for the future development and operation of the Central Coast water supply. These are mentioned in this report where they are relevant to the particular action or activity under discussion.

4. Approach

4.1 WaterPlan 2050 - Objectives

4.1.1 Objectives Generally

WaterPlan 2050 is a strategic plan that aims to deliver a sustainable and secure water supply for the Central Coast. The *Plan* has the flexibility to cater for uncertainties such as future regulatory and policy changes, population growth, water demands, supply side options, climate change and technology development, and mitigate its impacts.

The Plan needs to address the uncertainties such as future regulatory and policy changes, population growth, water demands, supply-side options, climate change and technology development, within a flexible and adaptive management framework.

The objective of *WaterPlan 2050* is to ensure a sustainable long-term water supply for the Central Coast that:

a is safe, reliable, affordable and secure (Section 4.1.2) that:

b meets the levels of service agreed with the community; and

c leads to rapid recovery of Mangrove Creek Dam storage;

d encourages and promotes efficient use of water (Section 4.1.3);

e improves and protects the health of our rivers and streams and general environment (Section 4.1.4);

f involves the community in the development and selection of the proposed options (Section 4.1.5); and

g ensures that the proposed measures in the *Plan* could be adapted to future needs, and can be implemented (Sections 4.1.5 & 4.1.6).

Each of the objectives contains a number of critical issues that must be addressed in a structured way to facilitate analysis of issues and the selection of the preferred measures as part of and overall strategy. The objectives and relevant key issues are discussed in detail below.

4.1.2 A Safe, Reliable and Secure Water Supply

A safe water supply is designed to protect the health of its customers and prevent outbreaks of water borne diseases. In Australia, the *2004 Australian Drinking Water Guidelines* set out a strategy to maintain drinking water quality and the protection of public health by the adoption of a preventative management approach that encompasses all steps in water production from catchment to consumers. It is commonly referred to as a multiple barrier approach. Each authority must analyse the risks to its system, and identify and implement strategies to manage the risks.

On the Central Coast, this approach covers protection of the water supply catchments, management of water quality in the storages, water treatment plants and distribution system.

Supply disruption is avoided and reliability can be achieved for short-term events (eg. loss of power, pipeline failure) by providing a degree of redundancy in the headworks (such as standby pumps), ring or dual mains and additional reservoir capacity to maintain supply. It can also be maintained through the timely replacement of poorly performing assets as programmed in the Asset Management Plan.

Reliability for longer-term events (such as droughts) can be achieved by interlinking schemes, providing greater headworks capacity and flexibility, and by diversifying the sources of supply.

A secure water supply should be designed to withstand extended periods of low rainfall and other climate change related occurrences like floods, extreme storms, extended low runoff, more frequent bushfires, etc. Security is generally defined in terms of drought security criteria, which specify the frequency, duration and intensity of water restrictions. This approach recognizes that it is generally uneconomic to design a headworks system that could provide unrestricted supply at all times.

The security of supply can be increased from both ends (supply and demand). Diversifying the sources of supply (particularly with non-rainfall dependent options such as recycled water and desalination) and the geographical diversity of surface water sources by inter-linking catchments and schemes is a strategic approach, i.e. the Hunter transfer system. This can be further supplemented by promoting water conservation measures.

Gosford and Wyong Councils have agreed the levels of service required to meet the communities' expectations. These incorporate many of the features outlined above. While these levels of service are met at the consumers' tap, the headworks must be able to meet the overall performance requirements for the system.

A unique feature of the existing Central Coast water supply is the system constraints to increasing storage levels in Mangrove Creek Dam. The Dam is reliant on runoff from its own relatively small catchment. Storage recovery under the worst-case scenario may take many years to occur and it is a pre-condition for lifting water restrictions. The augmentation options, which lead to a more rapid storage recovery, are beneficial.

4.1.3 Encourage and Promote Efficient use of Water, and an Affordable Water Supply

The increasing competition for water to meet the growing demands of urban and rural communities means that there is an onus on the Councils and community to ensure that water is managed in a careful and responsible manner. The NSW Government has provided the regulatory and policy framework for water management in NSW. The implementation of this framework at a catchment level is through the Water Sharing Plan (WSP) process, which is designed to protect the health of rivers and share the available water between water users.

In an urban context, the community is expected to conserve water where practical. The intention is to maintain the quality of life while eliminating unnecessary losses and wastage through the system. Recent initiatives such as the Councils' residential retrofit program, changes to the planning requirements to reduce water use and wastage by better design of new homes (BASIX, refer Section 3.2.3) and use of water efficient appliances and fixtures (WELS, refer Section 3.3) are all low impact measures for improving water efficiency. IWCM strategies are a comprehensive approach to achieve water savings and supply substitution with recycled water.

The affordability of a scheme is reflected in the water rates paid by the community and developer contributions levied on new developments. It is desirable to select the least cost measures that still meet the broad range of objectives. However, least cost is not the only criteria used in evaluating the best strategy for a water supply. IWCM has adopted the triple bottom line (TBL) assessment framework and all options and solutions presented in the Gosford and Wyong Sub Plans (which feeds into this document) were evaluated using a similar methodology.

4.1.4 Protection of Our Environment and Rivers

Gosford and Wyong Councils have implemented a number of measures to improve the health of rivers and creeks on the Central Coast as a result of environmental assessments, experience and community feedback. These include:

a provision of fish ways at lower Wyong River Weir and the two weirs on Ourimbah Creek;

b provision of environmental flows on Ourimbah Creek Weir; and

c provision of flow releases from Mangrove Creek Dam and Mooney Dam.

The Central Coast macro WSP currently being prepared by the DNR (refer Section 3.1.1) will provide for environmental flows in Wyong River, Mangrove Creek and Mooney Mooney Creek. A key element underlying any development proposals under *WaterPlan 2050* will be the staged implementation of environmental flows for Wyong River.

The water supply catchment areas are currently zoned by the two Councils in their respective Local Environment Plans (LEP). The Councils are planning to strengthen the planning controls for the protection of the water supply catchments by including a common catchment policy in the new LEP. Good catchment management is essential to managing risks to and protecting water quality (refer ADWG).

Planning controls need to address the management and control of high-risk developments in water catchments (and aquifer intake areas) and issues of long-term incremental development, including urban, agricultural and general industry development, to ensure that they will not impact on water resources. On-site waste treatment and disposal systems need to be located, designed, operated and monitored so that there is minimal risk to the water supply.

Community awareness programs have also been developed to promote the protection of water quality eg Streambank Rehabilitation Program in water supply catchments. State agencies have also prepared Rivercare plans for many streams (eg Wyong River, Ourimbah Creek, Toobys Creek, Jilliby Jilliby Creek) and funded implementation of natural resource management projects by landholders.

Councils need to continue to encourage best practice catchment and riparian zone management by landholders.

Protection of the environment also covers the short and long-term impacts of the construction of pipelines, pumping stations and storages, and the operation of the system, which includes energy consumption and associated green house gas production. This is particularly relevant when considering high-energy options such as desalination.

4.1.5 Community Involvement

An integral part of developing *WaterPlan 2050* has been community and stakeholder input. The *WaterPlan 2050* preferred strategy has been prepared taking into account input from a broad range of sources and consultations, including the establishment of a Community Liaison Group, community presentations, various surveys, input from individuals, forums and feedback related to a wide range of water related communications.

The Councils and the GWCWA websites continue to provide information to the public on the water supply planning process. The Councils have completed a number of surveys with the community to gauge preferences on the both long-term water supply planning and drought contingency measures. A number of public meetings, presentations and focus group workshops have been held.

WaterPlan 2050 Community Liaison Group (CLG) was established to provide focused input to the development of Water Plan 2050. The CLG consisted of community members, representatives from local environment groups, State Government departments and the two Councils. The CLG held ten meetings over a twelve month period from July 2004 to July 2005 with minutes and a final report prepared to consolidate the advice (*Community Liaison Group for the Central Coast WaterPlan 2050 – Report to Gosford and Wyong Councils' Joint Water Authority, November 2005* [16].

The *WaterPlan 2050 Preliminary Working Draft (December 2006)* was subject to public consultation from December 2006 to February 2007. Fifty-seven submissions were received from fifty-four respondents (refer to Section – 14 - Community Consultation).

The IWCM process promotes formal consultation of all stakeholders through the Project Reference Group (PRG). The PRG's role in the context of WP2050 is delivered by the CLG. The community has also been involved in the development of the IWCM strategies (called Sub Plans) for Gosford and Wyong Councils. These Plans identify opportunities for integrated management of water supply and services including reuse of recycled water and stormwater. In particular, the IWCM workshops engaged the PRG whose membership included some of the members from the *WaterPlan 2050 CLG*.

Community responses and inputs from public consultation have been taken into consideration in the completion of this *WaterPlan 2050*. The need for continual gains in water efficiency, reuse, long-term sustainability, affordability and long-term supply security are key themes that have emerged from these inputs. The build and non-build elements and options presented in the preferred *WaterPlan 2050* strategy have been developed to achieve goals consistent with these themes.

The community has also been invited to comment on the *WaterPlan 2050 Summary*, which was developed at a joint workshop of Gosford and Wyong Councillors in May 2007, and includes a preferred strategy.

4.1.6 Implementation of Measures

Ongoing review of changing community needs, regulatory regime and other circumstances is part of the long-term implementation of this strategy.

A number of the measures proposed will require NSW Government regulatory approval and the support of the community to implement. Failure to obtain timely regulatory approvals or community support generally leads to long delays and an escalation in the cost of the project.

It is essential that this plan is aligned to the policy direction of NSW Government and promotes community engagement and ownership in order to minimise delay.

It is always prudent to anticipate any potential issues especially those relating to the environment at an early stage in order to mitigate if not eliminate any adverse impacts. Proceeding with unresolved environmental issues not only leads to extensive delays but also projects a negative image of the project to the community.

4.2 Challenges for the Central Coast Water Supply

Since the 1985 Headworks Strategy was adopted, there have been several significant changes, which have affected the original proposals under the adopted 1985 Headworks strategy; these are:

a a significant reduction in per capita water consumption due to improved demand management measures and changes in community attitude, thus enabling the deferment and refinement of previously identified augmentation works;

b NSW Government policies to protect the health of NSW rivers(in particular *NSW Environmental objectives for water quality and river flows*[3]) will affect the sharing of water between users and the environment;

c the *NSW Weirs Policy*[7] which sets strict guidelines for approval of new or expanded weirs - *"An increase in town water supply for the purposes of meeting projected population demand cannot be a justification to approve a proposal to build a new or expand an existing weir, if environmentally friendlier alternatives to meeting that demand exist, which are also economically feasible",*

d enacting the *WM Act* with the requirement to prepare Water Sharing Plans (WSPs) for all surface water and groundwater sources. This will change the GWCWA priority and access to surface and groundwater sources;

e revision of the catchment hydrology based on rainfall and streamflow data obtained during the current 2000-2007 drought;

f potential for global climate change to affect rainfall and reduce streamflows while simultaneously increasing water demand due to warmer and/or drier conditions;

g changes in technology that may offer viable alternatives to traditional river-based extractions (eg. reverse osmosis technology that reduces the cost of desalination and treatment of reclaimed water);

h more rigorous assessment process compared to 1985;

i changes in community awareness, attitude and acceptance of alternative water supply sources; and

j revisions in estimation methodology for stream flows and run-off.

These changes have been considered and addressed in development of *WaterPlan 2050* through:

a A review of long-term water needs and demand management programs and initiatives (Sections 5 and 6);

b Ensuring our water sources remain sustainable and do not compromise river health (Sections 7 and 8);

c Examination of alternative water sources and technologies in the light of advances made in the last 20 years (Section 9);

The major changes affecting the 1985 water supply strategy for the Central Coast highlight the need for *WaterPlan 2050* to be flexible and adaptable to meet similar changing and emergent circumstances in the future. It has to be able to address a range of future issues such as possible regulatory and policy changes, changes in population growth and associated water demands, supply-side options, climate change and technology development.

4.3 Managing Current and Future Risks

A risk-management approach is seen today as the most effective way to manage complex decision making where there is a high degree of uncertainty.

A risk management approach involves identifying and managing the risks in a proactive way, rather than simply reacting when problems arise. The first step is to look systematically at all the risks that are likely to affect the long-term planning of the water supply. Once the risks are identified, the next step is to estimate the likelihood that the event will occur and the consequence if it does (how likely is it that something happens, and how serious the effects will it be if it does). This allows planners to rank the risks and develop priorities as to the management strategies that could eliminate or control the likelihood of the risks or the severity of its consequences.

As the risks in a long-term strategy occur over time, there is a need to regularly monitor the strategy, reassess the risks at regular intervals, and use adaptive management to achieve environmentally sustainable cost effective solutions.

The key requirement of a long-term strategy is to ensure the secure yield exceeds the annual demand. To achieve this outcome, a staged program of augmentation works, in combination with demand management strategies, is developed and implemented to meet the growth in water demand.

Any staged program of works must be flexible to adapt to policy and regulatory changes, new technology, changes in climate and water demands (as highlighted in Section 4.2) by either advancing or deferring augmentations, developing new measures or reprioritising the alternative measures based on the new circumstances.

5. Saving Water

Best practice demand management is essential for ensuring that water supply meets demand in the Central Coast. This entails efficient management and use of water resources. Cost effective demand management measures can deliver significant environmental and social benefits and help minimise customer water supply bills through reduced wastage, lower capital and operating costs.

A permanent reduction in demand achieved through demand management serves the same purpose as an increase in supply capacity. In many cases, demand management actions have proven to be more cost effective than increasing supply capacity.

A key part of managing demand is to understand how, when and where water is used. A demand management program therefore requires metering of all customers supplied, together with rigorous demand analysis.

Measures that should be examined as part of a demand management program include:

a active intervention – appropriate retrofit, rebate and building code programs;

b water pricing reform; and

c community education.

While recycling of reclaimed water (treated effluent) and stormwater are frequently considered demand management measures, the large-scale measures identified in *WaterPlan 2050* are considered alternative sources of supply to substitute or replace potable water for some uses. Local recycling schemes such as Gosford CBD reuse scheme are addressed in each Council's IWCM Sub Plan. The Gosford and Wyong Sub Plans detail demand management actions to achieve jointly 15 % reduction in consumption by 2050.

The Central Coast water supply system services approximately 300,000 people through a distribution system made up of over 2000 km of pipeline. The average unrestricted daily consumption is approximately 90 mega litres a day (ML/d) or 33,000 mega litres per annum (ML/a).

The percentage of water consumption by customer category is set out in Figure 5-1. State and local government, commercial and industrial demand consumes approximately 22 percent of the annual supply. Residential demand is typically around 68 percent, with system leakage and un-metered use (known as Unaccounted for Water or UAW) representing the remaining 10 percent of annual supply.

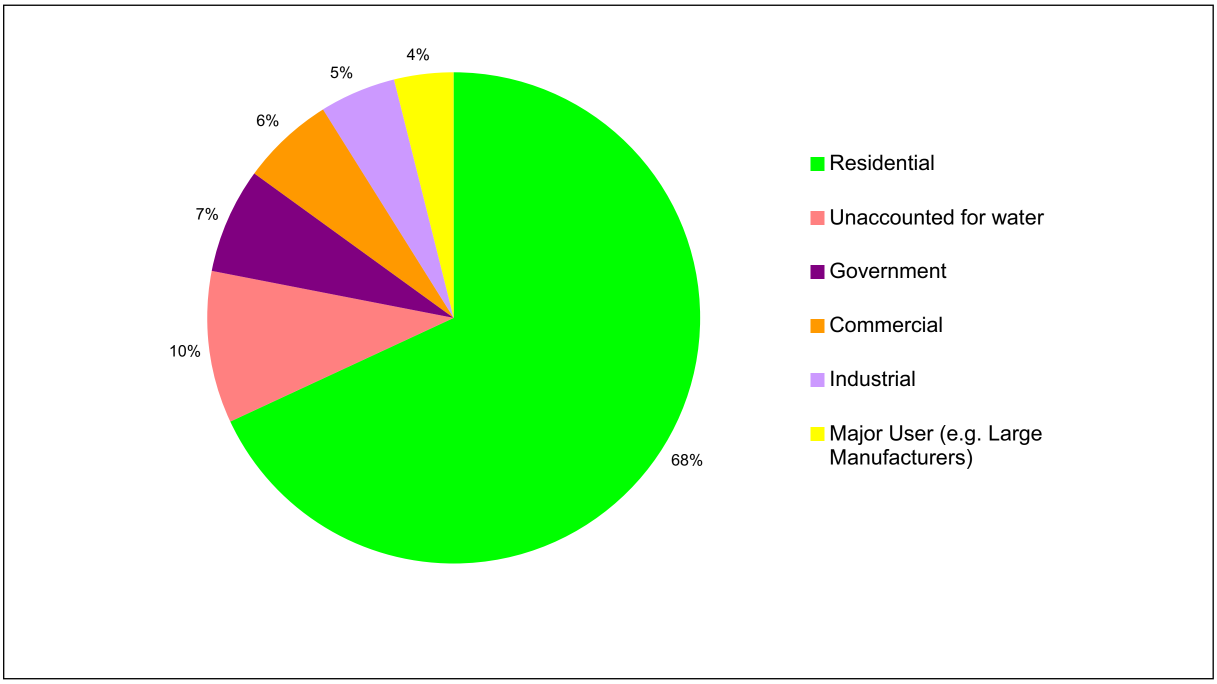

Figure 5-1 Water Consumption by Customer Category on the Central Coast

5.1 Government Consumers

The Department of Housing, Department of Education, and Gosford and Wyong Councils are major government consumers of water on the Central Coast.

The Department of Housing manages public housing on the Central Coast. The Department is introducing user-pays pricing for public housing and the Councils are currently negotiating a jointly funded retrofit program installing water efficient appliances in the approximately 4,000 Department houses on the Central Coast.

The Department of Education manages schools and higher education facilities on the Central Coast. The Councils have established water demand-management programs for schools, such as providing rainwater tanks and the *Water Saving in Schools* program. These programs aim to achieve town water savings and incorporate the water projects into the schools educational curriculum. Twenty-five schools have participated in these programs to date. There are opportunities for further water conservation initiatives such as retrofitting school toilet blocks, improving the efficiency of irrigation systems on sporting facilities and leakage detection.

Gosford and Wyong Councils are also major consumers supplying all Council facilities including Council Chambers and depots, libraries, child care centres, sporting complexes, surf life saving clubs, beaches, parks and gardens. The Councils are undertaking the following demand management measures:

a installing water efficient appliances in Council buildings and facilities;

b installing rainwater and grey-water systems to Council buildings and facilities; and

c undertaking a number of recycled water, groundwater and stormwater harvesting projects to replace town water, e.g. for the irrigation of sporting complexes, parks, gardens and golf courses.

5.2 Commercial Consumers

5.2.1 Existing Commercial Buildings

While water efficient appliances can be installed during construction of new buildings at relatively low additional cost, the cost to install water efficient appliances in existing commercial buildings (offices and shopping centres) can be relatively high.

Owners of existing buildings can utilise the Councils' subsidised retrofit program to install cost effective water efficient appliances. In the case of existing shopping centres, there is potential for assistance to be made available to install individual meters on larger consumers such as restaurants and take away food outlets.

As part of the water-restrictions currently in place, all customers with demands greater than 3.5 ML/a, are required to prepare a Water Management Plan (WMP). As part of WMP preparation, the customer is required to examine water needs and uses, alternative water sources and options and the efficiency of water use, and to develop and implement water saving measures and practices where appropriate and economic. The Councils review each WMP and audit implementation by the customer.

5.2.2 New Commercial Buildings

The NSW Government has launched the national water rating system, which encourages commercial office building owners and tenants to improve their energy and water use. The National Australian Built Environment Rating Systems (NABERS) water-rating tool uses a star rating system to measure the sustainability of water use in buildings. This enables owners and tenants to benchmark their water consumption performance as a first step to saving water.

Some of the nation's biggest commercial property owners including Investa Property Group, Colonial First State, Stockland and AMP have already indicated they would use the system to rate their buildings.

In new commercial shopping centres where there is a mix of tenants, the building owner will also be required to install water efficient appliances throughout the complex and individually meter and charge each tenant based on water usage. This will ensure that higher water users, such as restaurants and take away food outlets, will receive appropriate pricing signals and will be paying directly for their water use.

5.3 Industrial Consumers

Industry uses approximately 9 percent of the Central Coast's annual water consumption with the major users using approximately 4 percent.

The major users have participated in a water audit program with specific water saving opportunities being identified. In the case of Vales Point power station, this has led to the development of a water recycling scheme to replace as much of the water consumption at the power station as practically possible.

Similar requirements apply to industrial consumers as for commercial regarding preparation of WMPs. Indications are that this will reduce industrial water consumption by up to 20 percent.

While the preparation of WMPs is currently treated as a drought management measure, it is intended to include 5-yearly reviews as part of the ongoing demand management program.

The Councils may also require the submission of a WMP as part of the development application for new industries to ensure water efficient process equipment and appliances are installed at the time of construction.

5.4 Residential Consumers

When unrestricted, approximately 70% of residential water use is indoors and 30% is used outdoors, principally for garden watering. The assessed proportions to particular end-uses are set out in Figure 5-2. The major opportunities for saving water in the home include toilet flushing, showers, laundry and garden watering which, in total, represent about 82 percent of residential use.

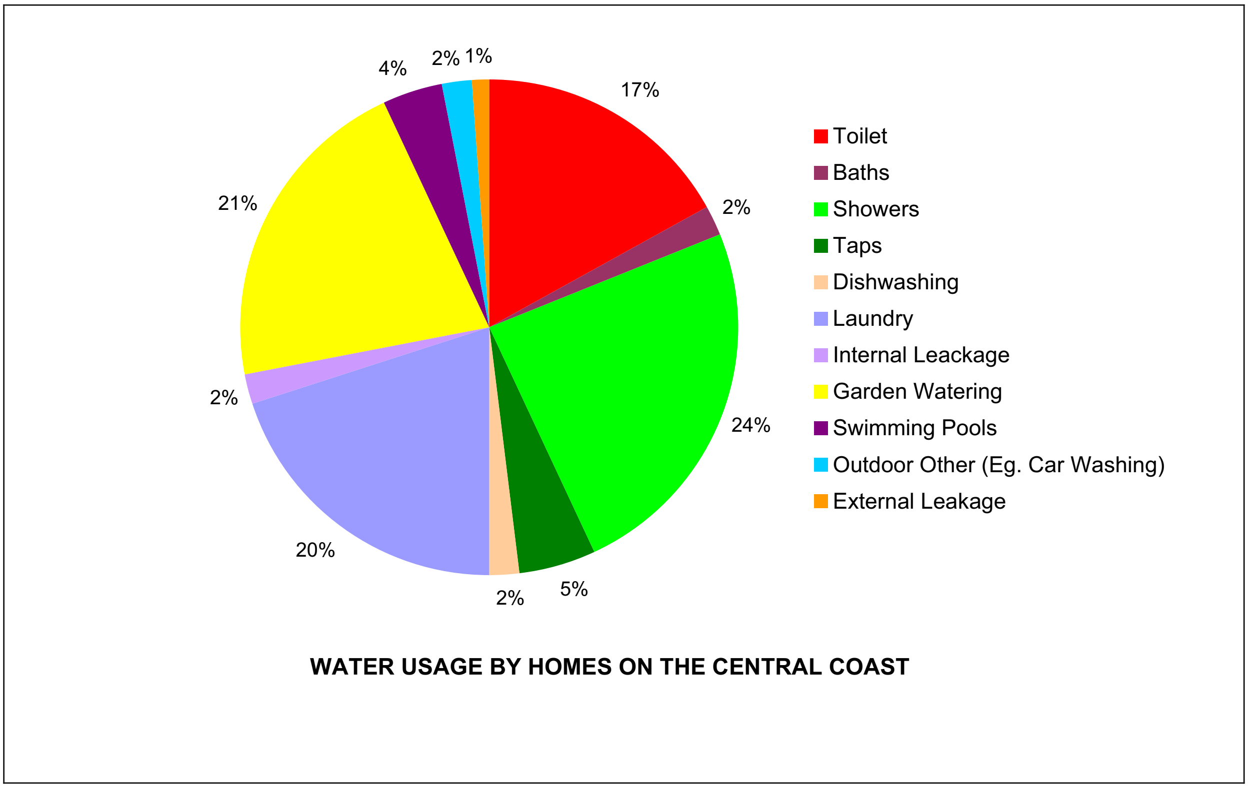

Figure 5-2 Typical Water Use in Homes on the Central Coast

Note: Most of the items discussed below were also further analysed in the Gosford and Wyong Sub Plans using the DWE 'Decision Support System' (DSS) model to assess the costs and benefits that they will provide.

5.4.1 Community Information and Education Programs

Gosford and Wyong Councils have funded a range of educational programs concerning ways to save water. These campaigns have improved community awareness of the issues and greatly improved the success of water saving programs and regulations.

In 2004/05, both Councils were placed on the list of best performing water authorities in NSW with average residential water consumption in the lowest 20th percentile.

Programs implemented to date include forums, displays, water expos community presentations and a series of web-based education documents entitled *Save Our Water. Save Our Water* documents include I*n Your Garden, On Your Lawn, In Your Pool, Outside and Inside.*

The sustainable Water Cycle Futures project will provide an ongoing community information and consultation forum, to communicate *WaterPlan* 2050 and IWCM Gosford and Wyong Sub Plans as parts of the bigger strategy Central Coast IWCM Strategy: WP2050.

5.4.2 Labelling and Performance Standards

To ensure residential consumers have information about the water efficiency of the appliances and fixtures they purchase, the Commonwealth, State and Territory Governments have established a national labelling scheme – *Water Efficiency Labelling and Standards* (WELS) scheme. Manufacturers and retailers are required to display a label indicating their level of water efficiency on appliances such as toilets, showerheads, clothes washers and dishwashers manufactured or imported into Australia after 1 July 2006.

A timetable to introduce minimum standards for household appliances (similar to that applied to dual flush toilets in 2005) is likely to be agreed shortly between the Governments. The introduction of minimum standards will lead to the progressive replacement of existing appliances as they reach the end of their lives and will achieve considerable water savings over time.

Similarly, the Government together with industry associations have developed a *Smart Water Mark* for household gardens including plant selection, garden design and irrigation equipment.

5.4.3 Residential Retrofit Program for Water-Conscious Householders

The Councils propose to continue to support householders who wish to install devices, which will assist them to save water in their bathrooms, kitchens and laundries. The program implemented during the drought has been very successful with over 8,500 refit kits being installed between 2004 and December 2007. However with the uptake significantly reducing (less than 10 kits/month) it is considered that the market has been effectively saturated. It is intended that a subsidised Retrofit Program will continue to be available for existing dwellings served by the Central Coast water supply system.

For an average family using electricity for water heating, the retrofit kit saves approximately $20 per year in water charges (or approximately 8% of the annual usage charge) and around $35 per year in electricity charges resulting in an average pay back period of less than one year to the householder.

5.4.4 Rainwater Tank Rebates

Gosford and Wyong Councils provide a rebate to install rainwater tanks to existing houses connected to the reticulated water supply. The rebates are on a sliding scale subject to the size of the tank. An additional rebate of $300 to $500 (depending on the nature of the connection) is provided to homeowners connecting the tank to the internal plumbing to supply the laundry and/or toilet.

The rebate does not apply to new homes or extensions, which are required to comply with the requirements of BASIX, or for development applications submitted after January 1, 2003 in Wyong Shire Council or October 1, 2003 in Gosford City Council, which were subject to Councils' water efficiency DCPs.

5.4.5 Washing Machine Rebates

Gosford and Wyong Councils provide a $200 rebate for the purchase of new washing machines with a 4-star or above water rating under WELS (refer Section 3.3) effective for 2006/7 and 2007/8 financial years. A 4-star washing machine uses 10.3 L/kg of washing compared with 30 L/kg for a 1 star and 21 L/kg for a 2-star machine.

Currently, washing machines rated 4-star or above make up only 4% of the market. The rebate will provide an incentive for the householder to purchase the more efficient machines resulting in the saving of approximately 26 KL per year of water or approximately $30 in water bills per year, per household, relative to an average top loading machine.

As the adoption of minimum standards nationally will involve an extensive consultation period with manufacturers, importers and retailers of appliances, agreement of Commonwealth, State and Territory Governments, and a transition period to reduce outdated stock, the introduction of minimum national standards is unlikely to occur before July 2010.

5.4.6 Reducing Water Wastage

As approximately 40% of water applied to gardens during the heat of the day is lost to evaporation, the Councils are considering the introduction of permanent water saving conditions on water use to reduce unnecessary wastage. The conditions may include:

a restricting garden watering between 10 am and 4 pm;

b banning the hosing down of paths without a permit; and

c the mandatory use of trigger hoses for car washing.

Currently the Water Management (Water Supply Authorities) Regulation 2004 only permit the application of water restrictions in times of drought or emergency.

It is proposed that water conservation conditions be introduced when the current restrictions are lifted subject to the Water Management (Water Supply Authorities) Regulation 2004 being amended.

5.4.7 Sustainability & New Homes

The introduction of BASIX (refer Section 3.2.3) to improve the design of new homes (including house alterations and additions, and low to high-rise residential developments) will achieve significant reductions in water and energy use – the water usage reduction is estimated at 40% relative to Sydney's pre-BASIX demands.

For individual homes on existing subdivisions, the use of rainwater tanks in conjunction with water efficient appliances will achieve the saving objective. In new "green field" development areas, a recycled water supply (third pipe) may be more cost effective though would not offer the reduction in stormwater loads which rainwater tanks provide. The Gosford and Wyong Sub Plans address different combinations of measures and provide a TBL evaluation for the different measures.

5.4.8 Metering of Multi-Unit Developments

Many of the recently constructed multi-unit strata developments and residential community estates do not have separate metering for each dwelling. A single water meter records the site usage and the charges are then divided and allocated equally using the number of dwelling units on the site. In this situation, there is no effective pricing signal or incentive for an individual to conserve water.

The principal argument against individual metering has been the difficulty gaining access to secure estates and high-rise buildings to read the meters. With remote sensing meters and meter reading equipment now available, the additional cost per dwelling is approximately $500. Sydney Water is currently undertaking a trial of metering individual homes in multiple unit developments and the results of this trial may be applied to the Central Coast.

In the interim, the Councils will require all future housing estates and multi-unit developments to install plumbing to facilitate the future installation of meters on individual homes or units.

In selected redevelopment sites, the Councils will require a third pipe to be installed in the building for recycled water for use in toilets, air conditioning units and washing machines.

5.5 System Operations & Water Losses

All water supply systems are subject to operational water needs and losses that are not directly measured, commonly referred to as Unaccounted for Water or UAW.

By its nature, the annual volume of UAW is difficult to quantify UAW on the Central Coast typically accounts for approximately 10% of total water demand. The UAW in Wyong Council's area of operation has been measured at 8%, a relatively low figure. As a result, Wyong Shire Council was recently (2005 and 2006) included in the list of best performing water utilities in NSW in a survey conducted by DWE.

The major contributions to UAW in the Gosford and Wyong water supply systems and activities in managing and reducing losses are discussed below.

5.5.1 Leakage

As with all water supply systems, leakage can be through main breaks, cracked pipes, leaking joints, faulty hydrants and valves. The leakage on the Central Coast has been estimated at 5.6% of total supply, which is a relatively low loss rate. Many water supplies suffer from leakage rates of more than 10%.

The Councils in an effort to reduce water losses across the water distribution system have also been pursuing a number of programs that address leakage and losses including:

a water mains replacement/rehabilitation;

b pressure management; and

c leak detection and repair.

The Councils have developed water mains renewal/rehabilitation programs based on risk assessment procedures. Renewals are prioritised on:

a risk of failure (probability and consequence);

b financial benefit/cost analysis;

c customer impacts;

d levels of service; and

e environmental impacts.

The pressures in certain areas of Gosford distribution system are being reduced resulting in lower leakage and water consumption. The pressure management program is based on the insertion of pressure reduction valves and zoning of the water distribution into smaller areas to tailor pressure to customer needs.

The Councils are undertaking an active leak detection program which:

a reduces real water losses by repairing identified leaks;

b reduces water losses from service connections by informing customers of their obligation to conserve water; and

c identifies leak-prone areas as a target for managing pressure to limit leakage.

The Councils are installing additional bulk water meters on their distribution mains to facilitate tracking of water usage and attributing losses to specific localities. This, in combination with visual checking for leaks and regular surveys of pipelines, will ensure ongoing high performance in managing and reducing leakage and other losses.

The Councils also progressively replace all customer water meters older than 10 years, which reduces metering inaccuracies. It has been found in a number of other water supply systems that accurate metering has registered (on average), additional per tenement consumption of approximately 33 KL/a.

5.5.2 Operational Uses

Water is used water for various system operational needs such as regular mains flushing and reservoir cleaning programs. During the current drought, these programs have been curtailed to some extent to essential needs.

5.5.3 Fire Fighting

Water drawn from hydrants for fire fighting purposes is not metered and is highly variable.

The Councils are investigating the feasibility of requiring detector check meter/backflow prevention devices for assessing fire service water-consumption.

5.5.4 Un-metered

Ignoring a small number of illegal tapings, only a small proportion of water users remain un-metered, primarily Councils usage in some parks and garden. The Councils have/are installing meters on all Councils' facilities, sporting fields, parks and gardens where water is supplied from the distribution system.

The individual business units in Councils, such as Open Space and Recreation, will in future be billed for their water usage, which should encourage better water management and accountability by each user group.

5.6 Water Pricing

The existing two-part tariff incorporating a service or availability charge and an appropriate water usage charge per kL based on the long-term marginal cost of water sends a strong pricing signal to consumers. This approach currently represents industry "Best Practice", but is being reviewed in response to the current drought in many parts of Australia. For example, in addition to an access charge, Sydney Water has recently introduced a 2-tiered usage price: Tier 1 @ $1.264/kL for 1.096 kL/d (400 kL/a), and Tier 2 @ $1.634/kL over 1.096 kL/d.

At the request of Independent Pricing and Review Tribunal (IPART), the Councils are investigating the potential of *stepped* pricing to encourage further water conservation.

5.7 Cost Effectiveness of Water Saving Measures

The cost effectiveness of residential water savings measures can be assessed using a technique called least cost planning (LCP). Least cost planning estimates the net present value (NPV) for the capital, operating and maintenance cost of a water saving measure, reduced to $ per kL saved for the total volume of water saved over the lifetime of the measure. The IWCM strategies include the levelised costs of the individual measures in Table 5.1. The Gosford and Wyong Sub Plans provide further details on results of cost effectiveness analysis for all water savings measures.

5.8 Risks to Achieving Water Savings

Several factors may prevent target water savings from being achieved. Demand management measures could potentially interact and the resultant net savings could be less than the sum of the individual measures. The planned 15% reduction in per capita demand (refer Section 6.4) are based on the measures in Table 5.1**.** This is however similar to the 2020 target adopted for Brisbane and Sydney when the pro-rata commercial and industrial demands are considered.

Failure to implement individual metering of homes in community estates and multi–unit strata developments and individual businesses in commercial shopping centres will reduce the effectiveness of the overall demand management program, as these activities are a rapidly growing segment of the market.

Until minimum national standards are implemented for water efficient devices, the effectiveness of WELS is limited by the voluntary nature of purchasing new water efficient appliances.

The proposed savings are considered achievable, and monitoring will be necessary to provide feedback on the achievement or otherwise of these savings as part of the risk management strategy. In the unlikely event that these savings are not being realised, then GWCWA will need to consider other strategies to deal with any resulting water supply-demand imbalance.

Table 5.1 Summary of Water Saving Measures

	DESCRIPTION
	State & Local Government
a	Retrofit public housing with water efficient appliances.
b	Retrofit schools, TAFEs and universities with water efficient appliances, upgrade irrigation facilities and implement leak detection programs.
c	Meter all remaining Council facilities.
d	Preparation of water management plans for facilities consuming more than 3.5 ML/a (not limited to times of water restrictions).
	Commercial
a	Introduction of water cycle DCP on new office developments.
b	Individual metering of commercial businesses in new shopping centres.
c	Retrofit existing office building with water efficient appliances.
d	Retrofit existing commercial buildings with water efficient appliances and selective metering of larger consumers
e	Preparation of water management plans for facilities consuming more than 3.5 ML/a. (not limited to times of water restrictions)
	Industry
a	Preparation of water management plans on existing industries using 3.5 ML/d or more on a five yearly basis.
b	Preparations and implementation of water management plans on new developments.
	Distribution System losses
a	Installation of bulk meters in Wyong
b	Water mains replacement program
c	Water mains renewals
d	Pressure management
e	Active leak detection program
	Residential & Multi-Unit Developments
a	Community education.
b	Labelling and performance standards.
c	Residential retrofit program.
d	Rainwater tank rebate.
e	Washing machine rebate.
f	Residential outdoor assessment.
g	Reduce water wastage (external use conditions).
h	Water pricing review.
i	Provision for individual metering for new multi-unit developments.
j	Recycled water provisions in selected new multi-unit developments.

6. Future Water Demands

6.1 Introduction

Future water demands are a product of the per capita demand, population and associated government, commercial and industrial demands and UAW. The per capita demand is expected to decline over the next fifty years as water efficiency measures and new planning rules are implemented on the Central Coast. This decrease will, however be offset by a growing population.

6.2 Population growth

Gosford and Wyong Councils have prepared population forecasts for their respective areas of operation utilising data from various sources such as the Australian Bureau of Statistics, Planning NSW and internal Council sources. Internal Council forecasts indicate a serviced population of approximately 463,800 by the year 2051.

Planning NSW has also prepared population forecasts for the Central Coast out to the year 2031. NSW Planning released the *Draft Central Coast Regional Strategy 2006* in September 2006. This draft strategy provisionally reduced the population forecasts (to approximately 380,000 in 2031) pending development of a long-term water supply strategy which can support the original population forecasts. NSW Planning has also released the Transport and Population Data Centre estimates for the Central Coast

The results of these forecasts are set out in Table 6.1 and illustrated in **Error! Reference source not found.**. The future serviced population (i.e. served by town water) has been calculated assuming the current proportion of serviced population to total population.

Table 6.1 Predicted Populations for the Central Coast from 2001 to 2051

Year	LGA Population Projections			***Serviced Population***
	Department of Planning Draft Central Coast Regional Strategy September 2006	**Department of Planning Transport & Population Data Centre April 2007**	**Councils Projections**	
2001	296,260	296,260	296,260	*285,200*
2011	-	331,653	330,530	*318,960*
2021	-	369,525	368,000	*355,120*
2031	380,250	404,626	405,540	*391,340*
2041			443,070	*427,570*
2051			*480,000*	*463,800*

There is limited difference between the population projections (up to the year 2031) developed by the Department of Planning's Transport and Population Data Centre and Council's forecast . As the Department of Planning has provided forecasts only out to the year 2031 Council's population forecasts have been adopted for calculating future water demands for 2050.

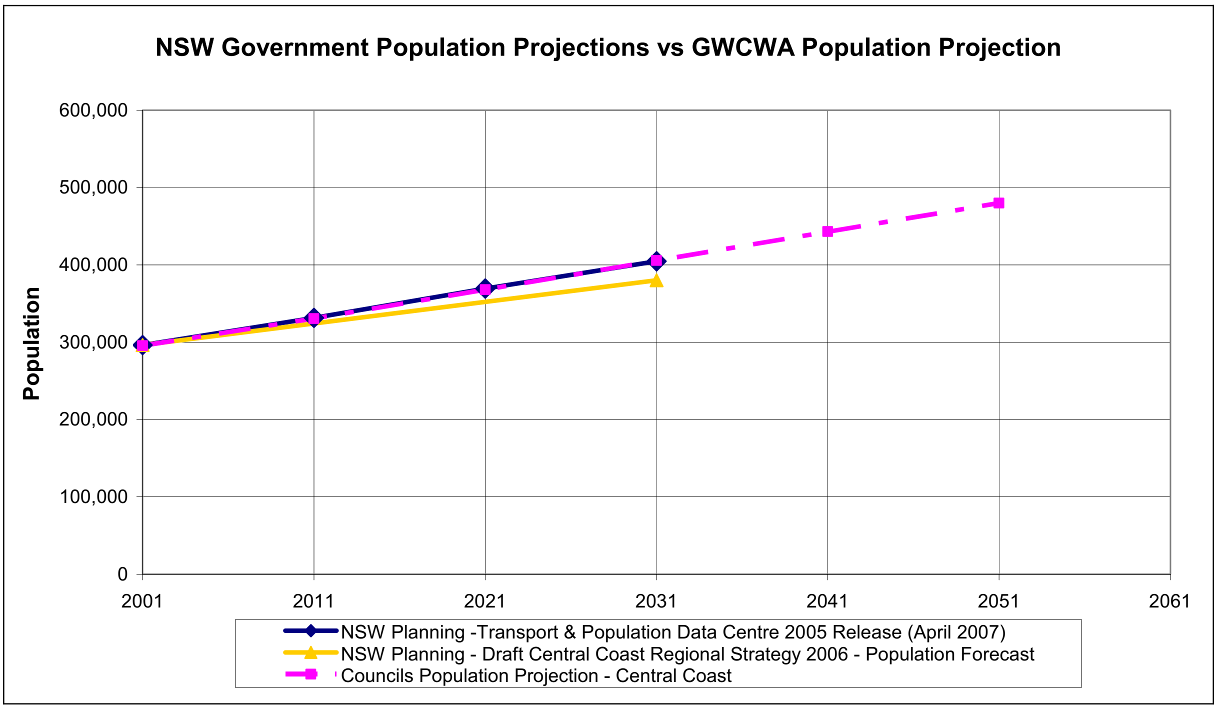

Figure 6-1 Comparison of Department of Planning and Councils' Population Projections

6.3 Equivalent tenements

As the major customer base for most utilities is residential dwellings with a service connection, utilities frequently express the demand based on the average tenement demand. Using this methodology, one residential service equals one equivalent tenement (1 ET). Demands are expressed as an equivalent number of residential tenements. For example, a factory could be assessed as having water demands equivalent to 5000 residential properties i.e. 5000 ET.

Predicted residential tenements (ET) have been based on a constant occupancy ratio of 2.6 over the next 50 years (i.e. dividing the predicted serviced population by 2.6). This is consistent with the existing situation. However, it is recognised that the number of residential tenements and overall residential tenement demands are likely to vary over time, in response to evolving demographic changes such as the size of family together with changes in the proportional mix of housing types. Such variations are unavoidable and difficult to predict accurately. A summary of projected Residential and Non-Residential ET from 2001 to 2051 is presented in Table 6.2 based on Councils' population projections. This issue will also be subject to ongoing review.

Table 6.2 Predicted Equivalent Tenements for the Central Coast from 2001 to 2051

Year	Equivalent Tenement Projections			
	Serviced Population	Residential ET	Non-Residential ET	Total ET
2001	285,200	109,695	27,424	137,118
2011	318,960	122,677	30,669	153,347
2021	355,120	136,585	34,146	170,731
2031	391,340	150,518	37,629	188,147
2041	427,570	164,447	41,112	205,559
2051	463,800	178,154	44,538	222,692

Predicted non-residential demands for government, commercial and industrial consumers, UAW, and the equivalent tenement demand estimates have been based on pro-rata increases with the overall serviced population. In practice, the ratios will vary over time, in response to changes to the regional economy and the levels of industrial water use. Such variations are unavoidable and difficult to predict accurately, but are likely to have limited impact on demand forecasts. This issue will also be subject to ongoing review.

6.4 Per Capita Demand

Water demands for water supply systems are commonly expressed in terms of "per capita" demand. The per capita demand is the total annual water consumed, including residential and non-residential uses as well as UAW, divided by the serviced population.

Historic and projected per capita demands for the Central Coast are shown in Table 6.3. The per capita water demands for the period 1985 to 2001 have been extended to the year 2051 based on the predicted water savings set out in Section 5. The projections have been based on the population and residential and non-residential ET forecasts (type and mix of development) in Sections 6.2 and 6.3 respectively.

Table 6.3 Per Capita Water Demands

Year	1985	2001	2011	2021	2031	2041	2051
Per Capita Water Use (Litres per person per day)	470	329	311	296	288	285	282
Demand reduction – historic		30%					
Demand reduction – projected (incremental over 10-year period)			5.5%	4.8%	2.7%	1.0%	1.0%

From 1985 to 2001, the per capita (unrestricted) demand has been reduced by 30% due primarily to the introduction of user-pays pricing and a number of the other water saving measures outlined in Section 5. This demonstrates the effectiveness of demand management measures to date.

However, it is recognised that further reductions in (unrestricted) demands are unlikely to continue at the rate achieved in the past, particularly on the Central Coast where per capita demands are already comparatively lower than in other major urban areas within Australia – refer Section 6.6 and Figure 6-3. Those demand reduction measures achieving significant savings at reasonable cost have already been introduced; additional reductions will be at a declining rate and will be achieved at higher unit cost.

The proposed reduction in per capita demand (15% demand reduction relative to the 2001 demand over the next 50-years), reflects the gradual penetration of new sustainable housing and water efficient appliances into the community and conservation strategies generally (refer to *Working Paper 6 – Development of Further Options for the Gosford Wyong Joint Water Supply Scheme, NSW Department of Commerce July 2003*[8]).

6.5 Future Annual Water Demands

Future water demands are a product of the serviced population and the per capita demand in Table 6.3. While the population is increasing over time, overall increase in demands is partially offset by a decline in per capita consumption.

The predicted unrestricted annual water demands for the Central Coast are presented for the period 2001 to 2051 in Table 6.4. Demands are shown with and without the water saving measures discussed in Section 5. i.e. excluding BASIX, the propagation of water efficient devices for residential consumers, and a corresponding 15% reduction in government, commercial and industrial demand (through the range of measures outlined in Table 5.1 Summary of Water Saving Measures), Other measures include the mid-range global warming forecasts (0.15 ^{0}C per decade) and a 10% allowance for UAW. Part of the long term reduction in government, commercial and industrial demand will be achieved by current and future recycling.

Table 6.4 Predicted Future Water Demands

Year	***Annual Water Demand Projections***		
	Upper Bound: Without saving measures (ML/a)	**Lower Bound: With 20% saving measures (ML/a)**	***Adopted with 15% (ML/a)***
2001	34,280	33.265	33.265
2011	38,340	35.69	36.15
2021	42,680	37.4	38.36
2031	47,040	39.6	41.08
2041	51,440	42.55	44.51
2051	55,220	*45.29*	47.63

Figure 6-2 provides a graphical representation of the predicted water demands for the projected population with estimated upper and lower bound demands. The upper bound is based on the pre-restriction, pre-BASIX demands applying to the future population.

The lower bound demand is based on the projected population with estimated savings associated with BASIX, propagation of water efficient devices, mid-range global warming effects and an additional 5% water savings. It is assumed that the government, commercial and industrial sectors will achieve the same proportional savings as the residential sector.

To allow for some safety margin in predictions, the adopted demand scenario is based on the achievement of water savings associated with BASIX and propagation of water efficient devices, and mid-range global warming effects. It is assumed that government, commercial and industrial sectors will achieve the same proportional savings as the residential sector.

Reuse projects, efficiency gains and alternative water sources established during the current drought are estimated to have achieved long term demand reductions in the government, commercial and industrial sectors of around 15 % relative to 2001 demands for the existing level of development.

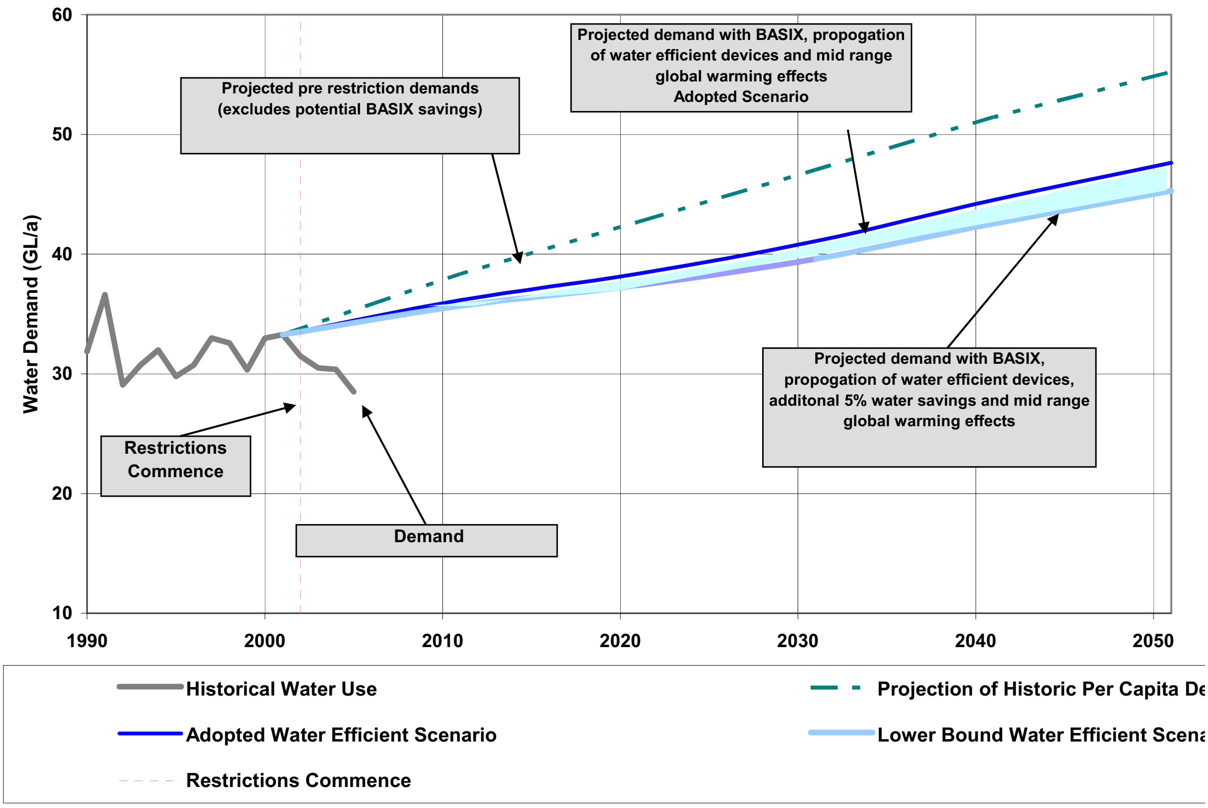

Figure 6-2 Predicted Future Annual Water Demands.

Further reductions in demand may be achieved through a combination of additional water saving measures and local recycled water schemes identified in the Gosford City and Wyong Shire IWCM strategies (Sub Plans).

In the event that the population does not grow as predicted or greater water savings are achieved, the annual water demand will be reduced, extending the life of any proposed augmentation. The converse will also apply if the water demand grows faster than predicted, bringing forward the need for the next augmentation.

The GWCWA will continue to monitor and analyse the Gosford and Wyong Councils' water consumption to refine any long-term trends in daily and annual water consumption and if necessary modify *WaterPlan 2050* to reflect the changed circumstances.

6.6 Benchmarking per Capita Demand

The demand in year 2001, the current demand with Level 4 restrictions and the predicted 2051 per capita demand for the Central Coast have been compared with the current per capita demand of a number of cities in Figure 6-3.

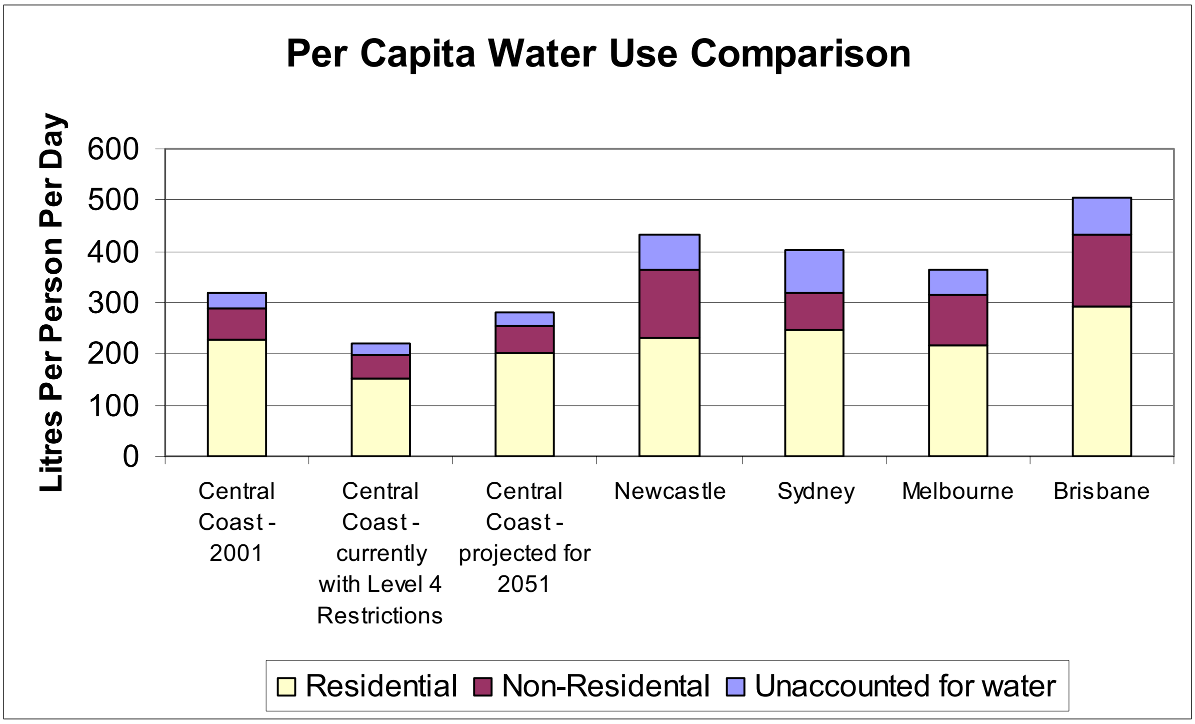

Figure 6-3 Comparison of Per Capita Water Demands

6.7 Future Peak Day Demand

The sizing of the major water supply headworks components such as storages and some raw water transfer mains are determined by the annual water demand. The distribution system including water treatment plants, pumping stations, distribution mains and reservoirs is designed to cater for peak day (summer) demands and the reticulation system for peak instantaneous demand.

With a climate adjusted model, a ratio of peak day demand to the average daily demand of 2.3 has been adopted.

The analysis did not however consider the changes in demand patterns that could arise with the adoption of the water saving measures in Section 5. These could further reduce this ratio over time e.g. by garden watering being reduced by permanent restrictions on watering times. This issue will also be subject to ongoing review.

Table 6.5 Predicted Peak Day Demands

Year	*Peak Day Water Demand Projections*	
	Without water saving measures (ML/d)	**Adopted demands with water saving measures (ML/d)**
2001	254	216
2011	284	228
2021	316	242
2031	348	259
2041	381	280
2051	409	300

The peak day demand with water saving measures for the year 2051 is equivalent to the existing 300 ML/d water treatment capacity on the Central Coast (i.e. 160 ML/d at Mardi WTP and 140 ML/d at Somersby WTP). Additional treatment capacity may not be required over the duration of *WaterPlan 2050,* if the proposed water-saving measures are implemented and effective.

There are, in addition to peak demand days, extreme events such as wild fires occurring in extremely hot and windy days in summer that can cause extremely high demands. The community expects that the water supply will be capable of maintaining supply during these critical periods, particularly for fire fighting.

As periods of such high demand are relatively limited, it is possible to supply peak demands in excess of the headworks capacity by using surplus reservoir storage in the distribution system, preferably close to the major centres of demand. This will be more cost effective than providing additional headworks capacity to meet these abnormal events.

6.8 Water Restrictions

Water restrictions are currently based on the status of water stored on the Central Coast. Table 6.6 provides background to trigger points to the introduction and lifting of water restrictions and the reduction in demand.

Water restrictions in the future will not achieve similar demand reductions once the water saving measures in Section 5 are implemented. This is partly because of the proposed permanent limitations on the hours of garden watering, restrictions on washing down of hard surfaces and the use of trigger hoses for car washing which has eliminated much of the waste that is normally targeted under Level 1 restrictions.

Future water restrictions are set out in the Department of Commerce's *System Analysis and Modelling Report*[9] including trigger points to initiate and lift restrictions and the target water reduction.

Table 6.6 Current Water Restriction Trigger Points

Level of Restriction	Initiate restrictions when total storage falls to	Remove restrictions when total storage rises to	Target Reduction in Demand
1	40%	47%	8%
2	30%	40%	16%
2a/2b	22%	30%	24%
3	18%	22%	30%
4	14%	18%	32%
5	12%	15%	38%

6.9 Risks in Predicting Future Water Demands

Future water demands are a function of population projections, development type and mix, climate change and the current assumptions on the effectiveness of demand management to reduce predicted per capita demand. In the event that the population growth is greater than expected or the demand management is less effective, it could be necessary to advance the next stage of the augmentation works.

Conversely, if the demand is less than predicted, the augmentation works can be deferred. The augmentation strategy will incorporate staging to enable incremental increases in scheme capacity and security, to match population growth and associated water demands.

Ongoing monitoring and review of water demands will be necessary if *WaterPlan 2050* is to remain relevant. This will include monitoring the outcomes of the IWCM strategy, effectiveness of BASIX to reduce demands in new homes and the number of existing homes installing water efficient devices (residential retrofit program), rainwater tank and 4 to 5 star rated washing machines.

7. Water for the Environment

Gosford and Wyong Councils are committed to protecting the environmental values of the rivers, coastal lakes and estuaries on the Central Coast and to developing and operating the water supply in a sustainable manner. Local fishing, agriculture and hospitality industries as well as the recreational amenity for the community rely on healthy rivers and waterways.

7.1 Healthy rivers

Environmental flows to improve river health are being progressively implemented in river systems across Australia (see also Section 3.1). In NSW, environmental flows are being provided that mimic as far as practical, the patterns of streamflows that would have occurred naturally in the rivers.

Environmental flows are provided by either deliberately releasing water from storages or by rules, which both limit the volume and timing of river extractions by water users. In both cases, the objective is streamflows that mimic the natural flows in those systems.

The policy document, *NSW Environmental objectives for water quality and river flow*[2,] identifies the water quality and river flow objectives for all NSW waters. Environmental objectives have been developed in conjunction with the community for Tuggerah Lakes (refer *Tuggerah Lakes Management Plan*[10]) which includes its tributaries - Wyong River and Ourimbah Creek and the Hawkesbury and Nepean Rivers (refer *Draft Hawkesbury and Nepean Catchment Action Plan and River Health Strategy*[11]) which incudes the tributaries - Mangrove Creek and Mooney Creek

Restoring elements of the natural streamflows can contribute in many ways to the health of the rivers. For instance, fish such as Australian Bass migrate downstream to spawn and the depth and speed of water over certain river features (such as waterfalls and shallow rocky patches and weirs) must be in the right range for the fish to be able to cross.

7.2 Impact of the Central Coast Water Supply on the Environment

The Central Coast water supply affects the river ecology in a number of ways. Water is extracted from Mangrove, Mooney and Ourimbah Creeks and Wyong River reducing the down stream flow into Hawkesbury River and Tuggerah Lakes. In particular, lower inflows into the estuarine sections upstream of Tuggerah Lakes could affect salinity gradients and water chemistry, possibly affecting some sections of the local aquatic ecology. This could be particularly important during periods of low flow and high temperatures.

The Councils have undertaken a program to construct fish passages (fish ways) around the weirs. Fish ways have been completed at lower Wyong River Weir and the lower weir on Ourimbah Creek (not part of the water supply system, refer Section 2.2) in 1990 and 2004 respectively. The fish way on Ourimbah Creek Weir (part of the water supply system), will be upgraded in the near future. The provision of a fish way on Mangrove Creek Weir will be considered in conjunction with the development of the Water Sharing Plan for the Central Coast. Prior to the fish passages, the weirs were a barrier to fish migration.

Mooney Dam and Mangrove Creek Dam, being storages on the upper reaches of their respective creeks, can affect the river ecology in the following ways:

a Releases from Mangrove Creek Dam for extraction downstream at Mangrove Creek Weir will not reflect the natural streamflows due to rainfall and can lead to changes to the river geomorphology including bank erosion;

b Releases from both storages are likely to be of colder water and could potentially introduce cold water pollution to Mooney Creek, Mangrove Creek and Wyong River (via releases through Boomerang Creek Tunnel);

c The dam walls are barriers for fish migration but being higher in the catchment are not as significant as Mangrove Creek, Wyong River and Ourimbah Creek Weirs.

The GWCWA will be undertaking environmental studies to assess the impact of environmental flows on the water quality and environmental health of the lower Wyong River and Tuggerah Lakes. The results of the research will be considered by the Department of Natural Resources in the development of environmental flow rules, the WSPs and access licence conditions for the sources supplying the Central Coast water supply.

7.3 Water Sharing Plans

The water licences currently issued under the *Water Administration Act 1912* provide current access rules to the rivers and creeks and do not make specific provision for environmental flows and health of the rivers. The *WM Act* introduced the concept of WSPs to allocate water to the environmental needs of rivers (refer 3.1).

The WSPs not only specify the environmental rules to protect river health but provide licence holders with greater certainty over their allocations of water and open up water trading opportunities. In preparation of the plans, the following environmental and social factors are assessed:

a Protection of low flow to:

- i achieve sustainable basic ecological processes
- ii share water with other users including stock and domestic users.

b Protection of in-stream flow variability to:

- i provide triggers for ecological events such as fish spawning
- ii flood wetlands and maintain river geomorphology.

c Sustainable allocation of water resources to:

- i manage the water use within sustainable limits
- ii develop a water trading system to reallocate water to high value uses.

The WSP breaks the catchments into sections that are assessed for environmental, social and economic values. The level of flow protection attempts to balance the environmental needs of the river against social and economic impacts. The WSP will specify the following access licence conditions for each of the surface water sources used by the Central Coast water supply:

a flow rules to cease pumping;

b flow rules to commence pumping;

c rules for protecting "flushes and freshes"; and

d rules for protection of natural pools.

The WSPs are designed to manage point extractions e.g. for irrigation. The WSPs will, however have to address a regional water supply with multiple sources on different creeks and rivers with highly variable flow (depending on the rainfall in the catchments). The multiple sources are typically operated to maximise the yield of the Central Coast water supply while taking advantage of the best available water quality at least cost.

The WSPs are generally based on a rolling three-year average extraction for local water utility access licences. Due to the flow variability of unregulated coastal rivers, Central Coast water supply may need to pump two to three times the average annual demand in wet years, for example to refill Mangrove Creek Dam after a drought (the current situation), and the three year rolling average will be inadequate.

The amount of water that can be diverted for town water supply also depends on the extraction capacity. On the Central Coast, a significant proportion of the streamflows occur as floods (high flow rates), which exceed the capacity of the extraction pumps and therefore cannot be harvested.

The operational flexibility required by the Central Coast water supply will need to be considered in development of the WSPs (by DNR) – negotiations are continuing between DNR and GWCWA to establish a suitable and appropriate access regime. The outcomes from Sydney Catchment Authority licensing arrangements currently being finalised should assist in this process.

7.4 Implications for Central Coast Water Supply

The introduction of environmental flow conditions will principally affect the extractions from Wyong River and Mangrove Creek, which are the major sources for the scheme. Extractions from Ourimbah Creek Weir are subject to the conditions set out in the Water Sharing Plan (WSP) for the Ourimbah Creek. This WSP includes a provision for review in conjunction with the Greater Metropolitan (now Central Coast) WSP.

The weirs on Wyong River and Mangrove Creek are close to the tidal limit and extractions will affect short sections of the river/creek downstream of the weir. Wyong River is a major tributary of Tuggerah Lakes and changes in flow may affect water quality in the lakes.

NSW Environmental o*bjectives for water quality and river flows*[2] seek to protect low flows in the river and limit the percentage of daily flow extracted. Central Coast water supply can provide low flow protection below the 85th percentile on the flow duration curve for the Wyong River without significantly affecting the secure yield (refer to Figure 7-1)

Figure 7-1 illustrates the potential impact of limited daily flow access (eg. limiting extraction to a maximum of 60% of daily flow) and the resulting need to obtain greater high flow access to compensate for loss of mid-flow access and meet future growth.

The GWCWA will undertake environmental studies to identify the sensitivity of the Wyong River below the weir and Tuggerah Lakes to changes in tributary inflow in the different flow ranges. Once these studies are finalised, it should provide the basis for introducing environmental flow requirements for the lower Wyong River Weir.

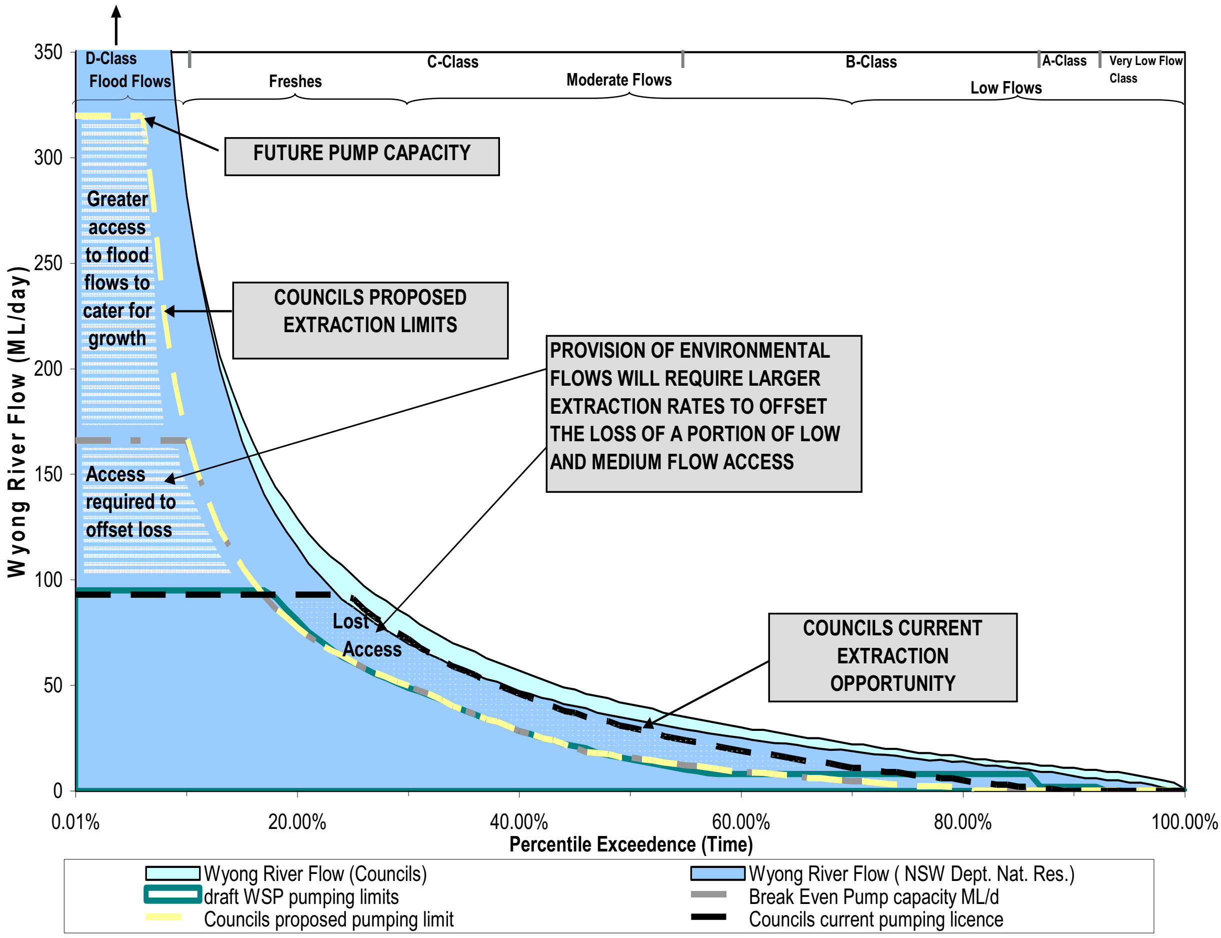

Figure 7-1 Wyong River Flow Duration Curve with Current and Potential Future Access to Water under WSPs.

7.5 Risks with Uncertainty of Access Licence Conditions

A major risk facing the long-term security of the Central Coast water supply is access licence conditions issued under the *WM Act* to extract water from the surface sources on the Central Coast.

The access conditions are established in WSPs prepared by the DNR (refer Section 3.1.1). The plans have a life of ten years at which time the plans are reviewed and amended as necessary to accommodate changed circumstances to achieve the long-term objective of sustainable river systems.

Changes to the access conditions in the water licence may affect the secure yield of the existing system (refer Section 8). The change from the current access rules to options proposed in the WSP has the potential to reduce significantly the secure yield of the Central Coast water supply unless alternative access conditions are provided in the high flow range. GWCWA has been and remains in consultation with DNR in the development of a suitable and appropriate access regime.

8. System Modelling and Analysis

The purpose of modelling a water supply (in this case the Central Coast water supply) is to assess the future performance of the water supply with a range of future augmentation options under different operating scenarios.

Some of the key attributes that the model can assess include:

a Calculation of the recovery time for the stored waters for:

   i *Base Case* (interim upgrade works and drought contingency measures);

   ii *Base Case* with various augmentation options.

b Assessment of the impact of future water licence and access conditions on the secure yield of the Central Coast water supply whilst satisfying environmental flow objectives;

c Determination of the long term system yield for:

   i *Base Case*;

   ii *Base Case* with various augmentation options.

d The best way to develop a staged augmentation program to ensure the supply exceeds demand over the duration of the *WaterPlan 2050.*

e evaluation of the potential impact of climate change on the system yield.

The Department of Commerce has prepared a *System Modelling and Analysis Report*[9] for the Central Coast Water Supply. The report evaluates the yield of the existing scheme and the interim upgrade works under the current access conditions and the proposed access conditions (refer Table 8.1) to protect environmental flows.

The modelling does not consider or account for the possible impact of major bushfires in water catchments. Investigations in the ACT after the 2003 major fires indicate short-term increase in streamflows due to vegetation loss (accompanied by deterioration in water quality); and longer-term reduced streamflows (more than 50 years; maximum 15% reduction after 17 years) due to increased evapo-transpiration because of rapid vegetation growth.

Whilst there is a risk of major bushfires in the Central Coast water catchments, the diverse water sources available and other drought contingency measures now available, are mitigating factors to overall water supply management on the Central Coast. Under any strategy, the next stage of augmentation can or may need to be advanced to deal with such risk.

8.1 Overview of models

8.1.1 Rising Demand Model (RDM)

The GWCWA in collaboration with Newcastle University has developed a hydrology model for the Central Coast water supply, which simulates the daily behaviour of the system using the WATHNET software package. The model incorporates daily variations in demand that is based on stimulated daily rainfall and temperature variations, known as the Rising Demand Model (RDM).

Historical rainfall records for the Central Coast were used to generate 1000 scenarios of daily rainfall data. Each rainfall scenario is 50 years in length. Historical rainfall records were also correlated against available streamflow records (which are generally of shorter duration and not necessarily at the points of extraction). The rainfall scenarios were then used to generate the corresponding 1000 sequences of daily streamflows for Mangrove, Mooney and Ourimbah Creeks and Wyong River.

Rising demand Model (RDM) the operating rules and procedures for the water supply infrastructure were incorporated into the model. These covered the following areas:

a environmental flow rules;

b extraction of water from Mangrove and Ourimbah Creeks and Wyong River;

c releases from Mangrove Creek Dam to Mangrove Creek and Wyong River;

d transfers from Mooney Dam to Somersby WTP;

e operation of drought contingency supplies (including the Hunter connection);

f transfers of water between Gosford and Wyong; and,

g water restrictions.

This model can also assess the probability of future storage levels and system yield for each option for the next 50 years with the water demands increasing with population growth. It has been used to determine the probability of Mangrove Creek Dam recovery to 42% storage capacity (the storage at which restrictions could be lifted) within a specified period (see Section 8.5).

8.1.2 Fixed Demand Model (FDM)

The Department of Commerce has also developed a model with monthly time steps and calibrated the model against daily flow records at Wyong River, Ourimbah and Mangrove Creek Weirs. This model is referred to as the Fixed Demand Model (FDM).

The FDM calculates a secure yield for the Central Coast water supply based on drought security criteria, which limits the frequency, duration and intensity of water restrictions.

The fixed demand model is able to determine the secure yield of the Central Coast water supply for a range of water-licence access conditions and augmentation options. It can plot the storage behaviour for a fixed demand based on a repeat of the extended historical streamflow records.

While there are drought contingency measures available to maintain supply (such as temporary Porters Creek weir and temporary desalination), these are not included in the yield calculations.

8.1.3 Combined Central Coast/Hunter Water Model

With the construction of the 35 ML/d Hunter connection, the operation of the FDM (Section 8.1.2) and the RDM (Section 8.1.1) have been broadened to simulate Hunter Water's headworks. The models are able to identify when supply from the Hunter is available or restricted, and can examine the effect of various transfer rules on the performance of both the Central Coast and Hunter Water supplies.

These models include the additional headwork elements of Chichester, Tomago and Balickera-Grahamstown sources and incorporate provision for future upgrading of Balickera pumping station and the proposed Tillegra Dam.

Water demands in the models are based on the climate-variable monthly demands simulation models used by Hunter Water with average year demands of 73.5 GL in 2006 and growing by 0.6 GL per annum. Allowances can also be included for water savings flowing from projected water efficiency improvements (as per Section 5). Initially, it has been assumed that percentage water savings for the Hunter will be approximately half the projected savings for the Central Coast. As in the Central Coast models, there is provision to model demand hardening and global warming impacts on demands.

8.2 Modelling of Environmental Flows

The GWCWA is currently undertaking an environmental study on lower Wyong River and Tuggerah Lakes to determine the potential impact of transfers from Wyong River to Mardi Dam. The results will be critical in determining future environmental flow rules, development of the WSP and determination of the access conditions for the water licence.

Based on preliminary negotiations with the Department of Natural Resources, the access conditions set out in Table 8.1 have been used in the modelling of the augmentation options pending the completion of the proposed environmental studies.

Table 8.1 Access Conditions for Surface Water Sources

Water Source	Modelling Access Conditions (Case WSP3)	
	Cease to Pump (CTP)*	**Allowable daily extraction ****
Lower Wyong River Weir	85th percentile	60% (above CTP)
Upper Wyong River near Bunning Creek	95th percentile	60% (above CTP)
Ourimbah Creek Weir	As per Ourimbah WSP	As per Ourimbah WSP
Mooney Dam	Inflows less than or equal to 0.6to be released from Dam	100% (above the CTP)
Mangrove Creek Dam	Releases from MCD shall be the lesser of: • inflow • 2.7 Ml/d during September to April inclusive • 2.0 ML/d during May to August inclusive •	100% (above the CTP)
Mangrove Creek Weir	95th percentile	100% (above the CTP)
Mangrove Creek Weir with transfers to Mangrove Creek Dam	95th percentile	60% (above CTP)
MacDonald River	95th percentile	60% (above CTP)
Hunter water sources	As per Hunter Water operating licences	As per Hunter Water operating licences

** Percentile flow based on natural end of system flows*
*** Percentage of flow relates to the daily natural flow at the end of the system*

An environmental flow regime cannot be introduced until the storage in Mangrove Creek Dam has sufficiently recovered and the Central Coast water supply augmented to increase system yield under the proposed access conditions. In the interim, current access conditions will apply for Wyong River, Mangrove Creek and Mooney Mooney Creek. The access conditions for Ourimbah Creek are detailed in the *Water Sharing Plan, for the Ourimbah Creek*[12]*.*

8.3 Definition of System Yield

System Yield is a measure used to quantify the available water resource (surface water, groundwater etc) based on long-term (historical) data e.g. streamflows, rainfall, water table.

The design system yield required for the Central Coast water supply has been defined in terms of the drought year demand (10% above average year demand) that meets the following conditions:

During the 122 years of extended historical flow records from 1885 to 2006:

a restrictions applied in less than 5% of months in the 122-year period;

b fewer than 12 restriction events in the 122-year period; and

c no event with Mangrove Creek Dam falling below Boomerang Creek Tunnel level (equivalent to 20% storage capacity) in the 122-year period.

For a repeat of all drought events starting with storages at 50% full (i.e. above the restriction level) and supply restrictions applied:

a no event with Mangrove Creek Dam falling below its minimum operating level; and

b not more than 5 events in 1000 years with Mangrove Creek Dam falling below Boomerang Creek Tunnel level.

8.4 Modelling of Climate Change

System modelling and analysis has been based on historical temperature rises of about 0.15^0 C per decade continuing over the life of *WaterPlan 2050*. However, CSIRO projections indicate that without greenhouse gas-reduction strategies, temperatures could in fact increase by up to 0.6^0 C per decade.

A sensitivity analysis has been undertaken to model the impact of these temperature changes. This analysis indicates that in the event of temperature increases of 0.6^0 C per decade instead of 0.15^0 C, it would bring forward the need to augment the scheme from the year 2050 to approximately 2035.

Global warming is likely to include increases in evaporation. Midrange estimates of evaporation increases are 4% per 1^0 C of global warming. Increased evaporation will increase outdoor water use in dry periods. It will also result in reduced runoff from the catchments and associated streamflows. For NSW coastal areas, CSIRO climate change predictions include a decline in winter and spring rainfall but probably an increase in coastal rainfalls in summer.

A rainfall-runoff model was used to estimate the month-by-month percentage changes in runoff and streamflows in the catchments on the Central Coast because of rainfall reductions and increased evaporation resulting from each 1^0 C of global warming. The estimated percentage changes have been incorporated into current system model. The system model also calculates variations in monthly demands based on rainfall and evaporation.

8.5 Modelling of Storage Recovery

The time to refill Mangrove Creek Dam has been calculated for the *Base Case* (refer Section 2.3.4) using the RDM (Section 8.1.1). The model calculates the recovery time associated with a range of probabilities i.e. 10%, 50%, 90%, 99%, 99.9% using the long-term historic flows (1885 to 2006) and a repeat of the 1993 to 2006 drought with the current stream access conditions. Results of the analysis are presented in Table 8.8.2 and Figure 8-1.

Table 8.8.2 Probability of Mangrove Creek Dam Refilling to 40% Capacity.

Probability of recovery	10%	50%	90%	99%
Years to recover to 40% storage capacity	Mid-2008	2011	2016	2021

The probability of storage recovery (Table 8.8.2) is calculated for the *Base Case* using current stream access conditions until the storage first achieves 50% capacity or 10 years (which ever occurs first). At that stage, the environmental flow rules in Table 8.1 would apply.

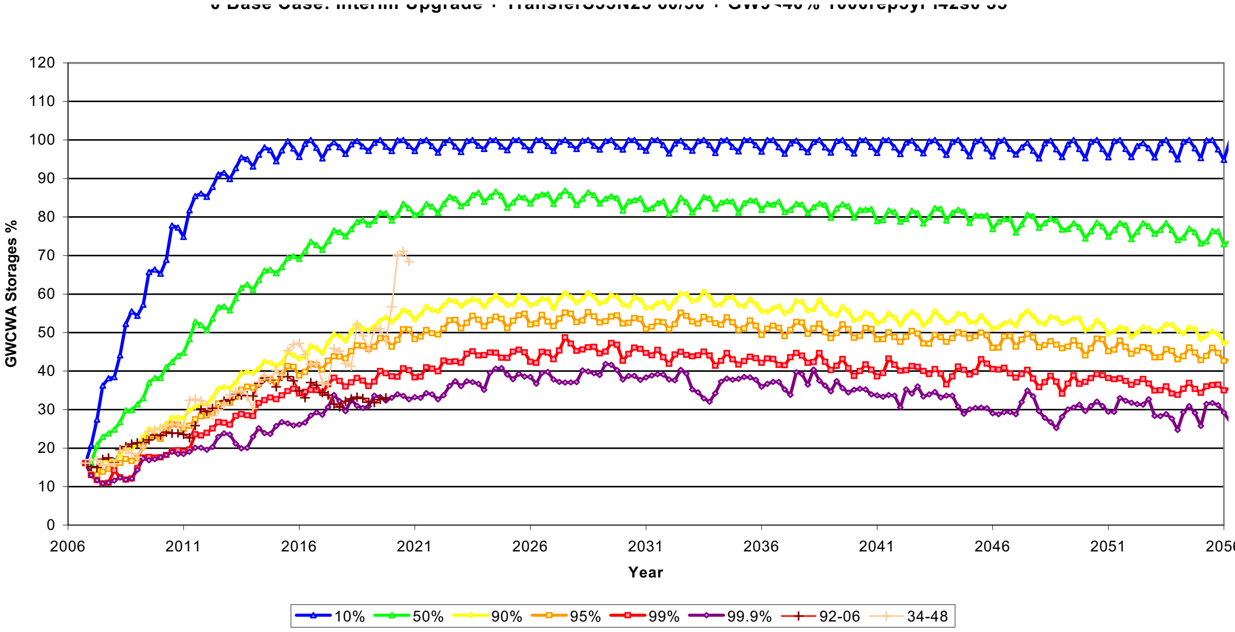

Figure 8-1 Probability of Central Coast Storage Recovery

8.6 Impact of Access Conditions on System Yield

Two system yields for the *Base Case* have been calculated - firstly using current access conditions and secondly using access conditions in Table 8.1. The system yield has been calculated on the basis that the net storage of the Central Coast has recovered to 85% capacity before the start of the next drought.

The impact of the more stringent access conditions reduces the secure yield as demonstrated in Table 8.3 from 43,900 ML/a for current access conditions to 40,000 ML/a for the probable access conditions in Table 8.1.

Table 8.3 Impact of Access Conditions on *Base Case* Yield

	Current access conditions	**Access conditions in Table 8.1**	**Access conditions in Table 8.1 but with Wyong River access reduced from 60% to 30% allowable daily extraction**
Base Case Yield	43,900 ML/a	40,000 ML/a	35,000 ML/a
Corresponds to annual water demand in year	2039	2027	2005

9. Future Water Sources

The Central Coast water supply has relied on the surface water sources of the Wyong River and Ourimbah, Mangrove and Mooney Creeks. The opportunities to develop new surface water sources on the Central Coast are limited by the absence of other significant rivers and creeks.

The drought contingency program implemented because of the current drought has resulted in the diversification of the above sources to include:

a groundwater drawn from aquifers in Gosford and Wyong LGA; and

b transfers from Hunter Water Corporation comprising surface water from the Williams River stored in Grahamstown reservoir and groundwater from the Tomago sand beds.

Pre-construction activities for a permanent 20 ML/d desalination plant located at Toukley have also been undertaken including applying for development consent from the Minister for Planning (currently pending). No decision has been made regarding the construction of the facility, which would form part of the future permanent water supply works for the Central Coast. This is an option considered in *WaterPlan 2050*.

In addition, the Councils are undertaking the necessary pre-construction activities for a number of temporary desalination plants. These plants will be installed if necessary to prevent the available storage on the Central Coast falling below 10% of capacity.

Existing surface water sources on the Central Coast will continue to supply the bulk of the existing demand on the Central Coast using the infrastructure already in place. Additional water required to meet the growth in demand and drought security, will be sourced from one or more of the following:

a surface water (Section 9.1);

b groundwater (Section 9.2);

c recycled water (Section 9.3);

d rainwater tanks (Section 9.4);

e stormwater harvesting (Section 9.5)

f sea water (Section 9.6); and

g purchasing upstream water entitlements (Section 9.7).

The 1985 Headworks strategy also considered linkage of the Central Coast water supply with Sydney Water. This strategy was rejected due to high cost and environmental concerns. Linkage with the Hunter Water was identified as the longer-term preferred strategy, which has been implemented. Linkage with the Sydney water system has not been considered as part of *WaterPlan 2050*.

Raising the height and capacity of the Mangrove Creek Dam (to 420,000 ML) was also considered in the 1985 Headworks strategy. While increasing the Dam height remains possible, it would not be necessary within the planning horizon of *WaterPlan 2050*.

The Central Coast water supply has adequate storage capacity available in Mangrove Creek Dam to meet 6 years of current demand or 4 years of predicted 2050 demands (i.e. without accounting for intervening rainfall). Mangrove Creek Dam is supplied from a catchment, which is of insufficient area to guarantee a rapid recovery of the storage from its current low level. The original design envisaged linking the Dam with Wyong River so that extractions from Wyong River during high flows could be transferred to Mangrove Creek Dam for storage.

A critical deficiency of the current scheme is the lack of infrastructure to refill Mangrove Creek Dam from Wyong River and to maintain the storage at a reasonable level in the face of increasing population and climate change.

9.1 Surface Water

The major surface water sources in Gosford and Wyong LGA are illustrated in **Figure 9-11**. Table 9.1 provides a summary of the catchment areas and annual average streamflows (historical record). These sources are already developed, to varying degrees, to meet the Central Coast town water needs.

The average annual streamflows in Wyong River, and to a lesser extent Mangrove Creek, are significantly greater than Ourimbah and Mooney Mooney Creeks.

The runoff from the catchment upstream of Mangrove Creek Dam is stored in the Dam and does not form part of the streamflow downstream at Mangrove Creek Weir, effectively reducing the average annual streamflow to 30,000 ML/a.

Table 9.1 Estimated Average Annual Streamflows

CATCHMENT	Catchment Area (km^2)	Extracted Historical 1885-2006 (ML/a)
Upper Wyong River at proposed weir site	175	40,900
Lower Wyong River Weir (includes upper Wyong River Weir)	355	84,500
Ourimbah Creek Weir	88	26,400
Mooney Dam	39	16,800
Mangrove Creek Dam	101	18,600
Mangrove Creek Weir (excluding Mangrove Creek Dam catchment)	241	30,000
TOTAL	**723**	**176,300**

It should be recognised that although the average annual inflow in Mangrove Creek Dam is 18,600 ML/a, the most significant feature contributing to this figure is a number of relatively infrequent high rainfall years offsetting more frequent lower rainfall years.

For example, while Mangrove Creek Dam almost filled in three very wet years after construction, the Dam storage has been steadily declining since 1993. Drought security on the Central Coast is extremely sensitive to the storage available in Mangrove Creek Dam at the start of a drought.

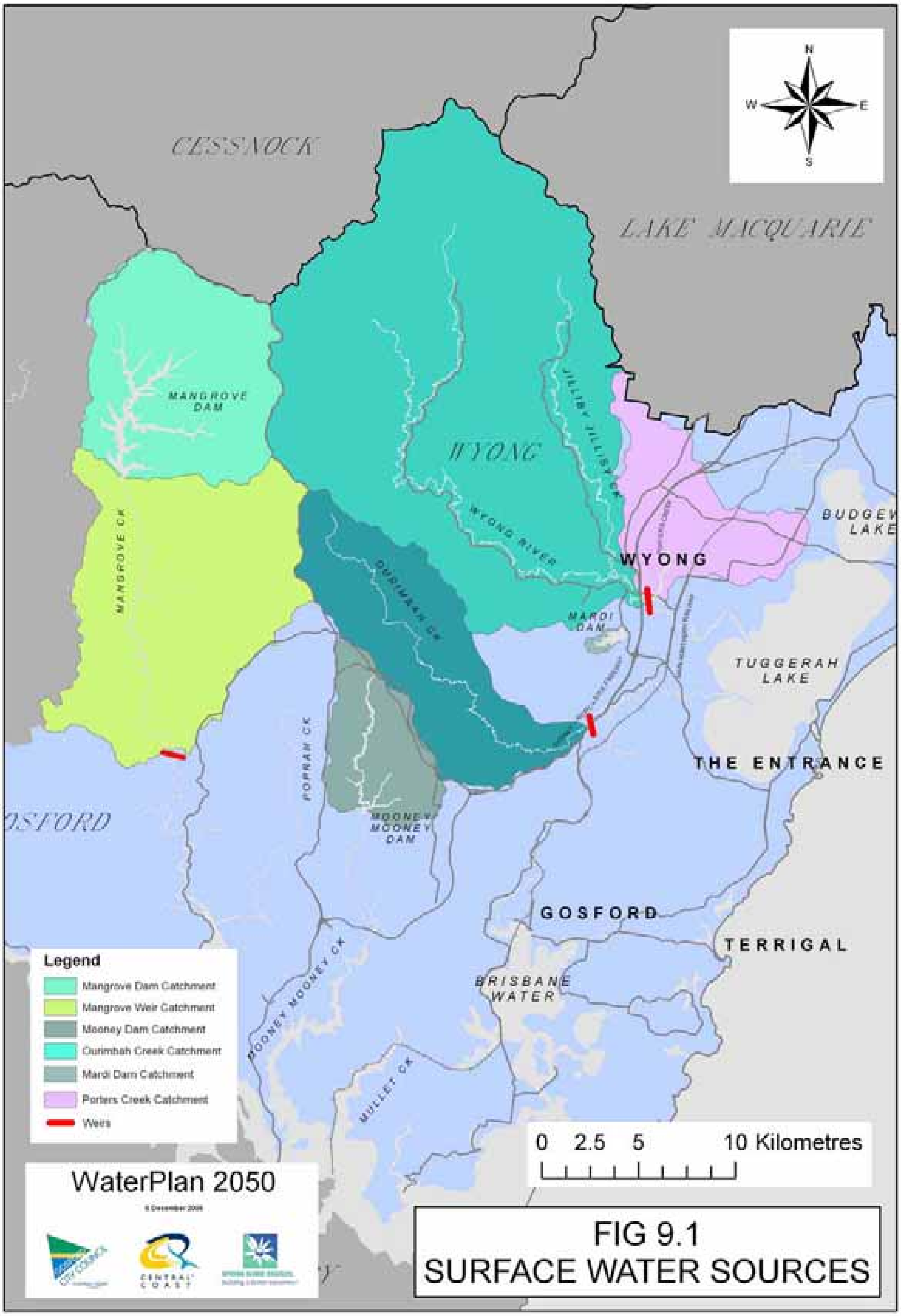

Figure 9-1 Surface Water Sources on the Central Coast.

There is potential to harvest further water, particularly from Wyong River as the current net extraction is a small percentage of the average annual flow. The 1985 Headworks Strategy proposed the construction of an upper Wyong River Weir and pumping station designed to capture and transfer flood events through Boomerang Creek Tunnel into Mangrove Creek Dam.

In light of the regulatory and policy changes since 1985 outlined in Section 4.2, the following options involving transfers from surface water sources have been re-evaluated:

a Lower Wyong River Weir to Mangrove Creek Dam transfer system;

b Upper Wyong River Weir to Mangrove Creek Dam transfer system;

c Mangrove Creek Weir to Mangrove Creek Dam transfer system; and

d MacDonald River to Mangrove Creek Dam transfer system.

Other source options considered in the 1985 Headworks Strategy, such as Wollombi Brook, Glennies Creek and Colo River have not been considered further as they offer no substantive advantages over the above sources.

The MacDonald River drains a large catchment (1680 km^2) located to the west of Mangrove Creek Dam and outside Gosford and Wyong LGA. The river flows into the Hawkesbury River upstream of Mangrove Creek. Despite the large catchment, the average flows are only marginally greater than the average flow at lower Wyong River.

In addition to the above source options and transfer systems, the 1985 Headworks Strategy included an option involving a second lower Wyong River off-river storage based on Toobys Creek (a tributary of Ourimbah Creek). A proposed Toobys Creek Dam can be linked to Mardi Dam by a tunnel enabling the transfer of water from the lower Wyong River and Ourimbah Creek. This storage would effectively duplicate storage already available in Mangrove Creek Dam, but defers the need for the transfer system with its associated costs.

In summary, unless there is a strong link from Wyong River, lower Mangrove Creek or MacDonald River effectively increasing inflow into Mangrove Creek Dam or an alternative source of supply such as desalination, the security of supply will remain highly dependent on the rainfall and runoff from the relatively small catchment of Mangrove Creek Dam.

The development of schemes based on surface water sources is set out in Section 10.

9.2 Groundwater

As part of the drought contingency measures, Gosford and Wyong Councils engaged a specialist hydro-geologist to review the previous report on groundwater potential on the Central Coast and to undertake a groundwater investigation to source potential irrigation and town water in Gosford and Wyong LGA. The investigation identified a number of potential groundwater sources and recommended an extensive test-drilling program prior to the development of production bores.

Following testing, production bores have been developed adjacent to existing water supply infrastructure at Ourimbah Creek Weir, Mardi Dam, Braithwaite Park, Mangrove Creek Weir and Somersby WTP. Groundwater sources at Woy Woy and Niagara Park are also being developed.

The groundwater source at Woy Woy is potentially the largest identified. The bores are within the urban area and may affect existing spear points developed for garden watering.

The DNR is currently reviewing options for managing existing domestic bores with the production bores for the Central Coast water supply. The Central Coast water supply is likely to gain priority of use of the groundwater sources in periods of water shortage under the Ministerial powers specified in the *WM Act.*

Environmental concerns have previously been raised regarding the possible affects that groundwater extraction may have and these include the following:

a draw down of the water table (adjacent to the bores) affecting native vegetation;

b salt water intrusion into the aquifer; and,

c possible contamination of groundwater from urban development.

These concerns have been addressed in the Environmental Impact Assessment and Development Application (DA) for Woy Woy groundwater. The DA has been approved and construction of the groundwater infrastructure is currently in progress, including a water treatment plant to remove high levels of iron in the groundwater.

The groundwater at lower Mangrove Creek contains high levels of boron and requires dilution with the surface water in Mangrove Creek to meet the *2004 Australian Drinking Water Guidelines*. Narara groundwater contains high levels of total dissolved salts (600-800 ppm range). It is proposed to pump the Narara groundwater to Somersby WTP with the inclusion of water from the Department of Agriculture dam at Narara to achieve suitable dilution.

Table 9.2 summarises the capacity and status of production bores developed from the comprehensive groundwater investigations. The location of groundwater resources on the Central Coast are shown in Figure 9-2.

Table 9.2 Estimated Sustainable Yields of Production Bores

BORE FIELD PRODUCTION	MEDIAN ESTIMATE		STATUS
	Annual ML/a	Day ML/d	
Somersby	50	0.14	Completed
Narara	445	1.22	Completed
Woy Woy	1 400	3.84	Completed
Mangrove Weir	462	1.27	Completed
Ourimbah (east-and west)	500	1.37	Completed
Braithwaite Park	50	0.14	Completed
Mardi	45	0.12	Completed
Various irrigation bores	80	0.22	Ongoing
Sub Total	3 030	**8.3**	
Addition of Department of Agriculture Dam (Narara)	310	0.85	Completed
Total	**3 340**	**9.15**	

The predicted daily yield is 9.15 ML/d (3,340 ML/a) when all the proposed bore fields are in full production. This includes local non-potable bores established in the urban areas to irrigate sporting facilities, parks and gardens in Gosford and Wyong LGAs. These non-potable bores will save approximately 80 ML of town water per year.

The water quality and environmental issues of the production bores limit the effective use of groundwater to drought contingency measures and it cannot be relied on to form the basis of a long-term augmentation strategy for the Central Coast water supply. The Groundwater Contingency Program is strictly a drought management measure to be kept in reserve for drought events.

Two additional groundwater sources identified in the initial investigation were considered to have long-term potential to augment the Central Coast water supply:

a Coastal sand dunes at Tuggerah and Budgewoi Beaches;

b Kulnura/Mangrove Mountain aquifer.

Further assessments of these sources identified significant constraints with the development of groundwater sources in the coastal dunes. The groundwater sites were adjacent to Wyrrabalong National Park and Munmorah State Conservation Area with high conservation value native vegetation and groundwater dependent ecosystems. The extraction of groundwater would draw down the water table adversely affecting the root zones of native vegetation and the groundwater dependent ecosystems.

The Kulnura/Mangrove Mountain groundwater source was shown to have strong links with the streamflows in the local streams including Ourimbah, Mooney Mooney and Mangrove Creeks and Wyong River. Further development of the groundwater sources would lead to a decline in the streamflows in the sources currently supplying the Central Coast (refer *Groundwater Simulation and Optimisation Modelling of the Kulnura – Mangrove Mountain Aquifer Systems*[17]*).*

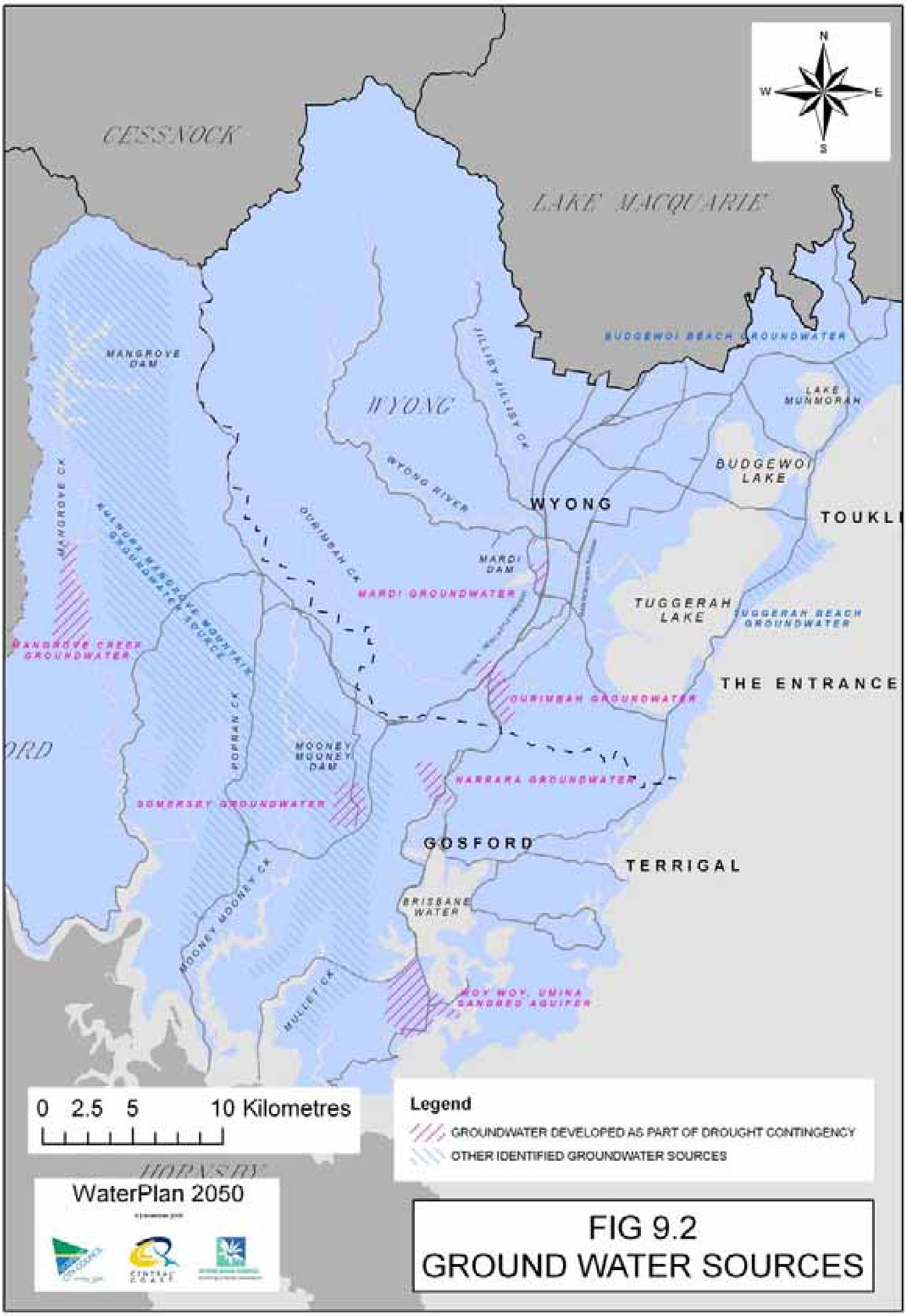

Figure 9-2 Central Coast Groundwater Resources

9.3 Recycled Water

The demand for town water for non-potable uses can be significantly reduced by replacing it, where appropriate, with recycled water.

Water is recycled when wastewater (stormwater, greywater or sewage) is treated and then supplied to farms, parks, golf courses, business and homes for non-potable uses. It can be used for a large number of purposes including farm and green space irrigation and, at a domestic level, for toilet flushing, garden watering and clothes washing. Recycled water, with higher levels of treatment, can be used for a wide range of industrial purposes. Additionally, it potentially could provide a supply source for town water supply schemes.

Recycled water can be extracted and reused onsite (greywater recycling) at a local level through sewer mining (for reuse on golf courses and sporting fields) and at a municipal level from wastewater treatment plants with adjacent reticulated recycled water schemes.

As well as reducing demand for high quality town water, recycling can reduce stress on the environment by capturing some of the water and nutrients that would otherwise be discharged to the environment. As a non-rainfall dependent supply option, increasing the share of recycled water can also reduce the impact of future droughts and potential impacts of climate change as it reduces demand on the town water supply.

The IWCM strategies currently being prepared by Gosford and Wyong Councils will identify the opportunities for recycling and evaluate the economic, social and environmental benefits of local recycling projects within the Councils' areas of operation.

Recycled water is an integral part of ensuring a sustainable supply for the Central Coast and plays an important role in a diversified portfolio of demand and supply options. Wyong Council has completed the following three major recycling projects (for non-potable uses) capable of reusing up to 2000 ML/a, of recycled water:

a Bateau Bay Reclaimed Water Scheme which supplies up to 500 ML/a of tertiary treated and disinfected reclaimed water from Bateau Bay WWTP to Tuggerah Lakes Golf Club, EDSACC (North and South), Bateau Bay Croquet Club, Toowoon Bay Caravan Park and Surf Club, Swadling Park, the Entrance High School, the Golden Hind Bowling Club, Golf Driving Range, Our Lady of Rosary School, Bateau Bay Bowling Club and Jubilee Oval.

b Toukley Reclaimed Water Scheme which supplies up to 1260 ML/a of tertiary treated and disinfected reclaimed water from Toukley WWTP to Magenta Shores development, Toukley Golf Club, Darren Kennedy and Harry Moore Ovals including the amenity blocks , Toukley and St Mary's Primary Schools, Norah Head Cemetery, and Toukley RSL Bowling Club.

c The use of up to 250 ML/a of reclaimed water for landscaping and construction through the installation of package tertiary treatment plants and tanker loading facilities at Mannering Park, Charmhaven, Wyong South and Gwandalan WWTPs.

Gosford City Council has completed on-site recycling of effluent at Kincumber and Woy Woy WWTPs, and is providing tanker facilities at both plants. The recycled water will be used for dust suppression, road works and watering of landscaped areas.

In addition, the Council has developed a water recycling strategy, which identifies potential water recycling projects in Gosford. The two major short-term projects identified in this strategy are as follows:

a Kincumber Water Recycling Scheme, which will supply up to 137 ML/a to open space irrigation, Kincumber Public School and industrial users such as concrete batching plants; and

b Gosford CBD Water Recycling Scheme, which will supply up to 300 ML/a, to commercial, industrial, residential development and open space irrigation in and around the Gosford CBD.

The Councils are pursuing recycling where it is feasible and practical. Many factors must be taken into account before undertaking a recycled water scheme. Features of a successful scheme include:

a close proximity of the users to the source of treated wastewater or stormwater to minimise transfer costs;

b long term customers that are located close to each other to maximise reuse opportunities;

c high quality recycled water to ensure protection of public health and the environment;

d the costs of recycled water schemes are competitive with the cost of alternate water supply options;

e a regulatory framework that supports the reuse application;

f appropriate pricing; and

g community acceptance of the recycled water scheme.

9.3.1 Recycled Water for Non-Potable Use

9.3.1.1 Recycling in Homes

Water use in the residential sector for toilet flushing, clothes washing, garden watering and car washing accounts for approximately 60% (about 135 KL/a per single house) of current total water in this sector. Substituting recycled water (greywater or treated wastewater) for such uses reduces the demand for town water. This could be a significant opportunity for recycled water, wherever costs and community acceptance make it practical and feasible.

As a broad rule of thumb, it is not practical to reticulate recycled water into existing suburbs, as the cost of the “third pipe” is prohibitive. In existing suburbs, rainwater tanks and greywater diversion systems are more cost effective options. Greywater diversion systems (direct use without treatment) can only be used for sub-surface garden irrigation.

In new “green field” developments, such as Warnervale, there is a wider range of cost effective options including rainwater tanks, reticulated recycled water and greywater diversion and treatment systems. There is potential to supply well in excess of the 40% reduction in water demand (a requirements of BASIX) if two or more sources are developed.

The legislative basis for BASIX is the *Environmental Planning and Assessment Regulation 2000* and Councils cannot specify a higher standard as a condition of development. However, there may be potential to provide lower developer contributions for developments incorporating greater levels of recycling and a number of developers are promoting sustainable new developments.

Recycled water from the wastewater treatment plants or rainwater tanks is used for similar applications under the current *NSW Code of Practice, Plumbing and Drainage*[13] and it is unlikely to be cost effective to supply both systems on new housing estates at this stage. However, if research on the public health risks of using rainwater to provide hot water in the home (hot water tanks significantly reduce pathogens) is successful, there may be further applications acceptable to the regulatory agencies.

9.3.1.2 Onsite Greywater and Recycled Water for Homes

Greywater is wastewater from a household's shower, basin, bath and washing machine. It can be directly diverted to a garden, using an authorised device and plumbing fittings that can easily be installed by a plumber. Many households are seeking to do this in the current drought to minimise the impact of water restrictions on garden watering.

Recent amendments to the *NSW Code of Practice, Plumbing and Drainage* permit the installation and maintenance of direct greywater diversion schemes for the sub-surface irrigation of gardens by licensed plumbers without Council approval.

Council approval is required for onsite greywater and sewage treatment and storage systems. Treated greywater and recycled water can be used for toilet flushing, clothes washing, garden watering and car washing. NSW Health accredits onsite greywater and sewage treatment systems. The cost of an onsite aerated greywater and sewage treatment and storage system is in the order of $10,000. Onsite systems require some expertise for successful operation and maintenance. They are generally impractical in urban areas with reticulated water and sewerage services.

9.3.1.3 Recycling in Multiple Occupancy Dwellings and Commercial Buildings

The reuse of greywater in multiple occupancy dwellings and commercial buildings (offices and shopping centres) is seen as a logical extension of BASIX to these types of developments. However, developers' concerns with the cost of complying, has led to the deferral of the mandatory 40% reduction in water use originally envisaged under BASIX.

The regulatory basis for onsite greywater treatment and reuse systems is included in the 2006 revision of the *NSW Code of Practice, Plumbing and Drainage.* The approved applications include toilet flushing, clothes washing, garden watering, car washing and cooling water for air conditioners.

In most instances, onsite greywater-treatment systems in multiple occupancy and commercial buildings will be a more expensive solution than a reticulated recycled water scheme if there is a reasonable concentration of buildings in proximity to a wastewater treatment plant or recycled water main.

Gosford Council requires a "third pipe" to be provided in new multi-unit developments in Gosford CBD to facilitate the future recycling of water within the CBD. Similar conditions could also be applied to the Entrance CBD where there is also high-density re-development of existing residential areas.

9.3.1.4 Recycled Water for Parks, Gardens and Sporting Facilities

Recycled water can successfully replace town water for the irrigation of parks, gardens, sporting facilities and nurseries. With recent developments in micro-filtration, it is possible to cost effectively provide high quality recycled water which can be applied at any time without access constraints and with very low public health risks. The demand will tend to be seasonal requiring larger transfer capacities and possible storage, resulting in higher costs.

Where parks, gardens, sporting facilities and nurseries are in reasonable proximity to a recycled water source or main, it would be practical to replace the town water source with recycled water.

Where parks, gardens, sporting facilities and nurseries are isolated from recycled water infrastructure, sewer mining may be viable. Sewer mining involves the extraction of raw sewage from the collection system, and treatment generally through a biological process followed by micro-filtration.

9.3.1.5 Recycling Water for Industry

Recycled water can replace town water in some industrial processes. For instance, industries that require boiler feed water, such as power stations and refineries, generally use reverse osmosis technology to remove dissolved salts that otherwise deposit in the boiler tubes. There are a number of examples where industries have opted to receive highly treated recycled water to reduce their operating costs. Examples include the BlueScope Project in Wollongong suppling recycled water to the steel works, Kurnell recycling project supplying the Caltex Refinery and Carbon Black, and Eraring Power Station, which uses recycled water from Dora Creek WWTP.

The existing industries that could substitute recycled water for town water on the Central Coast include Munmorah and Vales Point Power Stations, local coalmines and selected industries in Wyong employment zone and Somersby industrial area.

While it is possible to identify existing industries that could convert to recycle water, it is difficult to plan for future industries, as the water requirements are specific for each industry.

9.3.1.6 Recycled Water for Farms

As there are few farms supplied from the Central Coast water supply, the benefit of substituting recycled water for town water is small. However, there are a number of farms along the Wyong River and Ourimbah Creek that could replace surface raw water and groundwater extractions with recycled water if such a supply was available.

If the farmers transfer their water entitlements to the GWCWA in return for recycled water, the increased streamflow would improve the system yield of the Central Coast water supply. The main difficulty with farm recycling projects is the seasonal demand pattern. Unless there is a large recycled water storage, which is costly to construct and difficult to manage, only the reclaimed water produced in the summer months is used.

9.3.2 Recycled Water for Indirect Potable Reuse and Environmental Flow Substitution (EFS)

9.3.2.1 Technology Developments for Recycled Water

With recent developments in wastewater treatment and membrane technology, several new applications are now technically feasible subject to detailed review and evaluation.

Advances in membrane filtration technology have resulted in membranes that require a lower pressure differential to operate. Membrane filtration typically covers a range of technologies including micro-filtration, nanofiltration, ultrafiltration and reverse osmosis. Reverse osmosis is the technology used in many desalination plants to remove insoluble and soluble salts and bacteria and viruses.

Developments in micro-filtration have reduced the pressure differential required across the membrane to approximately 2 metres of head. such low-pressure differential reduces power demand at the pumps and associated production of greenhouse gases. Micro-filtration significantly reduces the number of pathogens and viruses in the recycled water.

Reverse osmosis technology also has an application in treating recycled water as it requires approximately 25 to 30% of the power required for desalination of seawater and provides very high quality water.

Although less energy is required by RO using treated effluent than seawater, it does not remove all contaminants (some dissolved solids remain in the product water) and is not foolproof (membranes foul and deteriorate over time). Whilst this is not a significant problem with desalination of seawater, it could be in relation to treated effluent with potential health risks. Hence, ADWG and water authorities generally adopt a "multiple-barrier" approach to water supplies generally and in particular to use of recycled effluent.

9.3.2.2 Environmental Flow Substitution (EFS)

Substitution of raw water by recycled water for environmental flows in local streams will potentially increase the availability of raw water for town water purposes.

High quality recycled water complying with the ANZECC guidelines can be used to substitute for environmental flows in the rivers and could be an intermediate step in the development of a planned indirect potable reuse scheme. The *2006 Metropolitan Water Plan* for Sydney proposes the replacement of environmental releases from Warragamba Dam with highly treated recycled water.

A State Government committee is currently developing a policy for EFS. The policy will include water quality requirements and release patterns to support environmental flow requirements. The outcomes are likely to be applied initially for environmental flows in the Hawkesbury/Nepean River system to offset extractions by the Sydney Catchment Authority. The work under this project could provide a basis for application on the Central Coast.

The most obvious opportunity for environmental flow replacement on the Central Coast would be the transfer of recycled water (treated to meet ANZECC Guidelines) from Wyong South and Charmhaven wastewater treatment plants to the Wyong River Weir to replace river water for environmental flows in the Wyong River below the weir.

In Gosford LGA, the environmental flow releases from Mooney Dam and Mangrove Creek Weir are not significant and do not warrant the development of a scheme.

Section 12 evaluates the costs and benefits of EFS at lower Wyong River Weir.

9.3.2.3 Potable Reuse

Technology developments discussed above have raised the potential for potable reuse of recycled water. Potable reuse is usually categorised as follows:

a **Direct** potable reuse occurs when the recycled water is transferred directly to a reservoir or reticulation within the water supply distribution system.

b **Indirect** Potable Reuse (IPR) where the recycled water is returned to a major raw water supply storage, aquifer or river source where it is diluted, stored and re-treated before distribution.

Direct Potable Reuse

There are the only two known examples worldwide where direct potable reuse is practiced - Singapore and Windhoek (Namibia).

In Singapore, approximately 1% of the water supply is supplemented by highly treated recycled water, known as NEWater. The NEWater is mostly directed to industrial reuse with the balance added to reservoirs connected to the urban water supply system. The treatment process includes tertiary treatment, reverse osmosis and disinfection. Water quality monitoring of the recycled water is extensive.

In Windhoek, in the period 1968 to 2002 a water reclamation plant operated on an intermittent basis during periods of drought to supplement the urban water supply. On average, recycled water formed about 10% of the urban water supply. During this period, the system went through a succession of modifications and improvements. Since 2002, the sequence of treatment has included ozonation, coagulation, floatation, dual media filtration, further ozonation, activated carbon filtration, ultrafiltration and chlorination. The outflow from the water treatment plant is connected directly to the urban water supply system. The potable reuse adds 24 ML to the total daily consumption of about 135 ML (18%).

Indirect Potable Reuse (IPR)

Unplanned IPR occurs on a large scale worldwide, typically, where a town extracts river water for its water supply needs downstream from where another town discharges its treated wastewater. Examples in Australia include towns along river systems such as the Murray River, and Sydney Water extractions from the Hawkesbury River at Richmond (effluent discharges occur as far upstream as Mt Victoria, Bowral, Mittagong and Goulburn). Typically, the effluent volume in the river/aquifer from which water is extracted is very low.

Worldwide practice is to place/maintain environmental barriers between the recycled water treatment and the end-user by discharge into waterways, large storages or to groundwater aquifers. This allows further natural processes to occur, reducing contaminants by dilution, dispersion, absorption in sediments or by suspended matter, biodegradation and biotransformation. These processes are not well understood but are probably collectively responsible for the reduction of residual contaminants in most treated sewage effluents.

Recycling directly into drinking water storages reduces such natural processes and barriers. Any planned IPR proposal to supplement drinking water supplies needs to take account of the increased health risks associated with reduced environmental buffers as well as the concentration and continuous recycling of effluent that may be subject to limited storage time and dilutions.

South East Queensland Water is currently in the process of augmenting its water supply sources through IPR using effluent transferred from Brisbane and Gold Coast wastewater treatment plants back to the major storages for reuse. This is understood to be the first planned application of IPR for town water supply purposes in Australia. ***Regulatory Framework***

Section 3 deals with the current regulatory basis for the use of recycled water. At this stage, there is no precedent for planned direct or indirect potable reuse on the Central Coast.

It is unlikely that direct potable reuse will be possible in the near future; given the multiple barrier approach to the management and protection of town water supplies as set out in the *2004 Australian Drinking Water Guidelines. ,*. However, as indicated, unplanned IPR is already occurring in a number of areas in Australia, and the challenge for health authorities will be the development of guidelines to formalise the current position. There is potential that planned IPR may be a feasible option in the future.

Central Coast Opportunities

The main opportunities for IPR on the Central Coast are the transfer of highly treated recycled water from Kincumber wastewater treatment plant to Mooney Dam in Gosford LGA and from Wyong South and Charmhaven wastewater treatment plants to Mardi Dam in Wyong Shire.

A disadvantage with IPR at Gosford is the distance (24km) and the high pumping head (over 300 metres) to transfer water from Kincumber wastewater treatment plant to Mooney Dam. At Wyong, the pumping head and distance to transfer water from Wyong South WWTP to Mardi Dam are approximately 20 metres and 5 km respectively.

9.3.2.4 Risks Associated with IPR

Return of treated (sewage) effluent into a drinking water reservoir can potentially pose a significant health risk if not managed appropriately. A comprehensive qualitative health risk assessment would need to be carried out to determine whether the scheme could be safely implemented.

Guidelines or Codes of Practice have been developed for most recycled (non-potable) water applications by State and Territory Governments to protect public health and the environment. These Guidelines and Codes of Practice are generally different in each jurisdiction with a resulting complexity that has delayed the effective implementation of recycled water projects across Australia.

As a result, the Federal Natural Resource Management Ministerial Council and the Environment Protection and Heritage Council have prepared *National Guidelines for Water Recycling, November 2006*[14] which are intended to apply nationally. These guidelines do not include IPR, however it is proposed that Phase two of the guidelines (programmed for completion at the end of 2007) will focus on reuse, managed aquifer recharge and recycled water for drinking.

The Guidelines are based on a Hazard Assessment and Critical Control Point (HACCP) approach. Subject to the guidelines being endorsed by the NSW Government, all recycled water proposals in NSW will in the future be subject to a HACCP study, which is rigorous and satisfies those Government agencies with statutory roles.

A HACCP study for IPR would need to approach the whole water cycle including the sewerage and water supply systems and still comply with the *2004 Australian Drinking Water Guidelines*. In addition, issues such as community acceptance and legal liability issues have also to be resolved.

The recent referendum on the introduction of indirect potable reuse in Toowoomba highlights the need to have broad and strong community support prior to committing to IPR opportunities.

The introduction of any IPR system will need to entail a significant trial and testing period prior to implementation. Such a trial is likely to take several years in order to develop the necessary expertise, suitable operating procedures, monitoring and testing regimes, and quality control processes. The operator of an IPR system will need to be well resourced, and have in place proven and robust governance and management systems. These will be essential to ensure that the necessary high levels of system performance are achieved, and that public health is maintained at all times.

The precautionary principle should be applied to the selection process for raw water sources as it is to environmental impact assessments i.e. where there is an effective choice of source waters available for town water use, then the water with the least contamination should be preferred.

9.3.3 Availability of Reclaimed Water

The locations of the existing wastewater treatment plants and effluent mains are shown in Figure 9-3. These plants will continue to expand to serve infill and new development areas on the Central Coast. There are no plans at this stage for the construction of additional wastewater treatment plants within the timeframe of *WaterPlan 2050.*

The estimated current and year 2050 average dry weather flows (ADWF) into the wastewater treatment plants are set out in Table 9.3. It is assumed that the average dry weather flow will approximate 200 L/EP/d with the installation of water efficient appliances and fittings into new homes and the other water saving measures proposed in Section 5. This estimate assumes there will be no large-scale residential reuse of greywater.

Table 9.3 Treated Effluent Produced at Wastewater Treatment Plants

Wastewater Treatment Plant	Year 2006 ADWF (ML/d)	Year 2050 ADWF (ML/d)
Charmhaven	8.0	24.0
Wyong South	7.0	14.4
Toukley	8.3	8.3
Bateau Bay	9.6	11.5
Mannering Park	1.6	2.4
Kincumber	23.4	24.0
Woy Woy	8.4	10.2
TOTAL	**66.3**	**94.8**

The wastewater treatment plants provide secondary treatment for effluent discharged to the ocean at Norah Head, Wonga Point and First Point (Winney Bay).

Recycled water distributed from Charmhaven, Wyong South, Toukley, Bateau Bay and Mannering Park wastewater treatment plants is filtered and disinfected after secondary treatment.

Recycled water can be sourced from the existing wastewater treatment plants and associated rising mains shown in Figure 9-3. For individual sites remote from these works, it may be feasible to sewer mine from adjacent sewer mains. Sewer mining involves the extraction of raw sewage, storage (in some instances), treatment and reuse.

While the volume of reclaimed water available after treatment is not affected by secondary treatment and filtration/micro-filtration processes, more advanced treatment processes producing higher quality water, such as reverse osmosis, can process up to approximately 70% of the volume of effluent with the remainder discharged as a waste stream. This level of treatment is required for most industrial reuse, EFS and IPR.

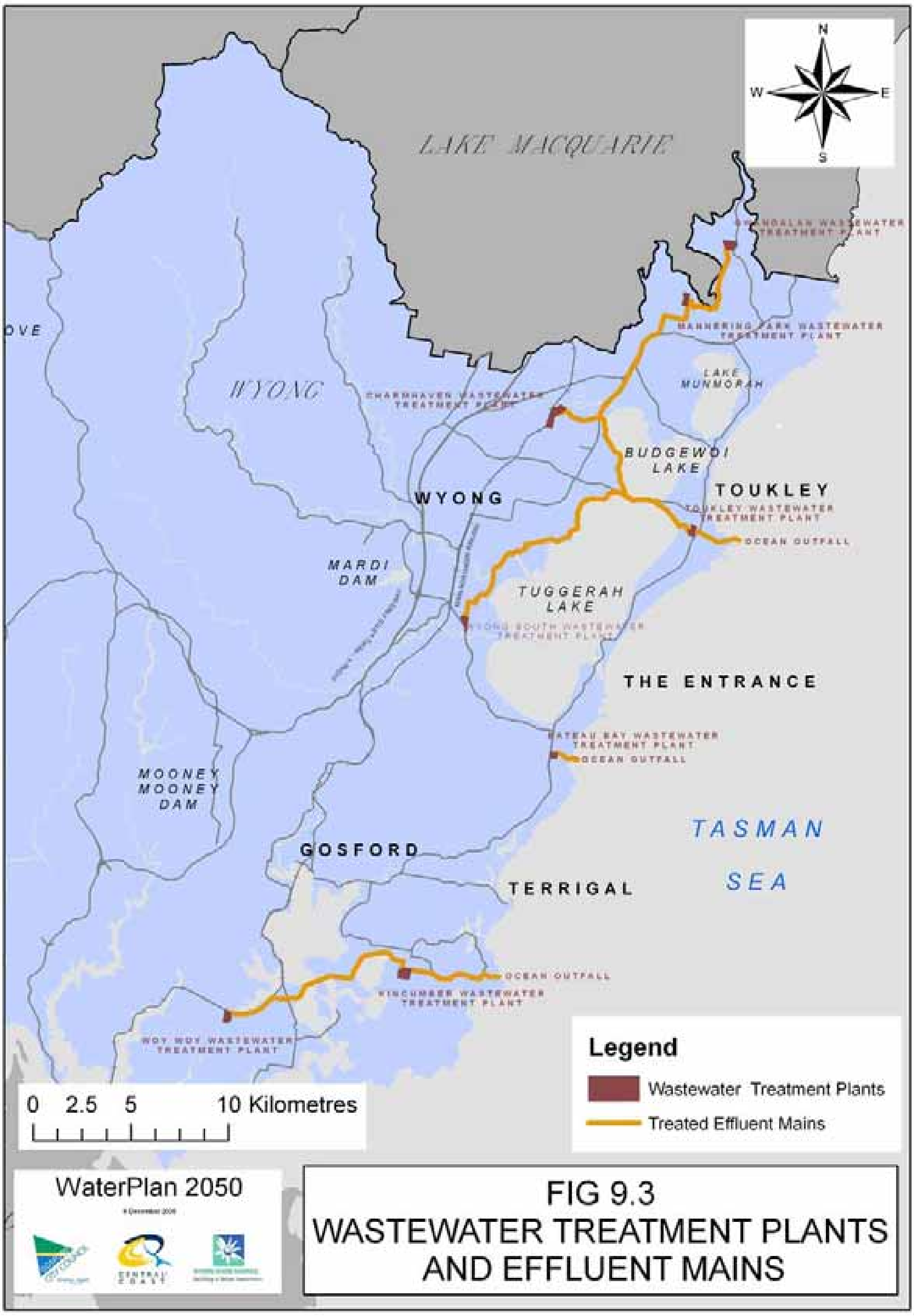

Figure 9-3 Location of wastewater treatment plants and treated effluent mains

9.3.4 Identification and Location of Potential Recycling Projects

The IWCM strategies for Gosford and Wyong will identify the potential for recycled water within the urban areas. The opportunities for EFS and indirect potable reuse are integrated with the water supply headworks, and evaluated with other headworks options in Section 12 of *WaterPlan 2050.*

9.4 Rainwater Tanks

From a water supply perspective, rainwater and stormwater are considered separately. Rainwater is water captured as runoff from roofs and stored in a rainwater tank. The rainwater tanks are normally privately owned, and maintained by the homeowner.

The *NSW Code of Practice, Plumbing and Drainage* sets out the appropriate plumbing requirements and permissible uses for rainwater and rainwater tanks. While there has been a recent relaxation in the permitted uses, NSW Health recommends that in urban areas, with a reticulated water supply, rainwater be used only for garden watering, vehicle washing and topping up pools and internally for toilet flushing and clothes washing.

While there is a growing trend for homeowners with gardens to install rainwater tanks for garden watering particularly during periods of restrictions, the potential savings are not large. Garden watering is seasonal and does not always coincide with periods of high rainfall required to refill the tank. With the trend to native gardens requiring significantly less water, the benefit of rainwater tanks used exclusively for garden watering could reduce further over time.

The ability of a rainwater tank to reduce demand on the town water supply significantly depends on a number of factors including the size of tank, the roof area draining to the tank, rainfall and the proposed uses and associated demand. For a rainwater tank to be most effective, it should be connected into the internal house plumbing to supply toilet flushing and clothes washing.

The yields of 2 KL and 5 KL rainwater tanks supplying garden watering, toilet flushing and clothes washing have been calculated using the DEW rainwater tank model for a home with a roof area of 150 m^2 draining to the rainwater tank.

The analysis evaluates the difference between dwellings with older single flush toilets and top loading washing machines and dwellings fitted with dual flush toilets and front loading washing machines. The analysis was based on rainfall and temperature at Mardi Dam weather station for the period 3/11/1995 – 3/11/2006.

The results summarised in Table 9.4 demonstrate:

a the benefit of installing a 5 KL tank connected into the internal house plumbing; and

b the yield of a rainwater tank connected to efficient devices is less than one connected to older style less efficient devices.

Table 9.4 Water Yield of Rainwater Tanks

Scenario	Yield / Water Saving (2,000 L tank)	Yield / Water Saving (5,000 L tank)
Average household (occupancy 2.6) with: a single flush toilet (143 L/d) b older style top loading washing machine (123 L/d) c outdoor demand average 150 L/d.	59 KL/a	82 KL/a
Average household (occupancy 2.6 with: a dual flush toilet (52 L/d) b water efficient washing machine (45 L/d) c outdoor demand average 150 L/d	49 KL/a	64 KL/a

Both Councils currently provide rebates to encourage the installation of rainwater tanks on existing houses connected to the Central Coast water supply. The rebate ranges from $150 for smaller tanks servicing outdoor use only, through to $1,000 for larger tanks connected externally and internally.

The IWCM Sub Plans indicate that rainwater tanks (in conjunction with water efficient appliances) achieve the water efficiencies required by BASIX in the most cost effective manner. In most instances, rainwater tanks will be more cost effective than recycled water unless the housing estate has reticulated recycled water.

9.5 Stormwater Water Harvesting

Stormwater is surface water that has run off from hard surfaces such as roads, footpaths and driveways and includes runoff from roofs that is not captured in rainwater tanks. The *NSW Code of Practice Plumbing and Drainage* sets out the permitted uses for stormwater, which are limited to garden watering and open space irrigation.

The quality of urban stormwater is dependent on the activities undertaken in the urban catchment. While the runoff from roofs is reasonably good, runoff from roads, parks and gardens can contain litter, oils, greases, fertilisers, pesticides and pathogens. In industrial areas, there can also be storage tanks with a broad range of chemicals and waste products that can be discharged accidentally or deliberately into the drainage system.

Large scale stormwater harvesting is generally only feasible in new developments where storage areas can be set aside as part of the open space provisions. While there are opportunities to provide stormwater detention basins in existing urban areas particularly in association with ovals and golf courses, they are generally limited in size by the lack of space and poor storage sites.

The Councils have identified the following stormwater harvesting sites in Gosford and Wyong LGAs:

a Erina Depot – nursery redevelopment;

b Duffys Reserve;

c Patrick Croak Oval/Brentwood Village;

d Mountain Road tanker filling station;

e Mingara Regional Athletic Track;

f Mingara Indoor Swimming Pool;

g Pat Morley Oval tanker filling station; and

h Sir Joseph Banks tanker filling station.

The Erina Depot – nursery redevelopment, Mountain Road tanker filling station and Mingara Regional Athletic Track schemes have been completed and work is progressing on the remaining sites.

In addition, the Councils are installing rainwater tanks on existing facilities at over 40 ovals and reserves for on site irrigation. The tanks will capture and store rainwater water backed up with recycled water brought in by road tanker.

A major stormwater recycling project is also planned for the proposed urban development at Warnervale. Runoff from the urban areas would normally drain to wetlands on the upper reaches of Porters Creek, a tributary of Wyong River. The environmental impact assessment identified that greater stormwater flows from the urban area will modify the natural wetting and drying cycle in the wetlands.

As a mitigating measure, it is proposed to develop a stormwater harvesting project transferring stormwater (temporarily stored in detention basins) by pipeline through to Wyong River Weir to supplement environmental flows. Once the planning for Warnervale urban area is advanced, this proposal will be developed.

The IWCM strategies will review all the opportunities for stormwater detention and harvesting in existing and proposed development areas and the opportunities for open space irrigation. This information will be progressively feed into *WaterPlan 2050* through the ongoing monitoring and review procedures incorporated in risk management.

9.6 Sea Water

Desalination is the process of producing drinking water by removing dissolved salts from a water source such as seawater, estuarine water, treated wastewater or brackish groundwater. Desalination produces high quality water independent of rainfall and thus is immune from drought and potential climate change.

Desalination is widely used throughout the world including throughout the Middle East, in the United States, Spain, Singapore, Japan, Trinidad and Tabago; and to supply drinking water on cruise ships. It is also used around Australia – in isolated communities (for example Kangaroo and Rottnest Islands), for industrial processes, and in mining and power generation (for example Bayswater Power Station in NSW). A desalination plant has been built to supply 125 ML/d of town water for Perth and a contract has recently be let for a 250 ML/d plant to augment Sydney's water supply.

The two most widely used and commercially proven technologies are Reverse Osmosis (RO), using membrane technology, and thermal distillation (evaporative method). In RO, saline water is pressurised to force water molecules through a fine pore membrane that blocks salt ions, viruses, micro-organisms and other impurities which a retained by the membrane in a concentrated solution for subsequent disposal. Around 40 - 45% of the intake water is converted to drinking water while the remainder is returned to the ocean as seawater concentrate (containing twice as much salt as normal seawater).

It should, however, be noted that the RO membranes are not 100% effective all the time. The membranes foul and deteriorate over time and are replaced, typically every 5 to 7 years for seawater desalination.

Since the 1980s, the cost of desalinated water using reverse osmosis has reduced by over half owing to advances in membrane technology (electricity usage has dropped by 40%), economies of scale using larger process trains and pumps and optimisation based on operational experience. With considerable ongoing research into membrane technology, further efficiency gains are possible in the future.

The GWCWA has prepared a concept design and an Environmental Impact Assessment for a 20 ML/d desalination plant on Wyong Council owned land adjacent to Toukley wastewater treatment plant as part of the contingency planning for the Central Coast water supply.

To achieve a 200 total dissolved solids (TDS) level of treatment to match the quality of the existing supply, a 2-stage membrane process has been proposed in the concept design i.e. part of the treated water is passed through a second series of membranes and blended with desalinated water from the first stage to achieve the desired water quality.

The principal disadvantage of desalination is the high pumping head required to force water through the membranes. The high-energy requirement (equivalent to some 800 m head of water for seawater desalination) has associated impacts on greenhouse gas generation if power is sourced from fossil fuel-based electricity generation.

Based on the studies undertaken for the permanent desalination plant at Toukley, the additional energy required to supply 230 kL of desalinated water to a household (i.e. 100% of average household unrestricted annual demand) is approximately 800 kW-hrs or 10% of typical household energy demand per year. For a water supply with seawater desalination contributing 25% of total demand, the additional energy use would be equal to 2.5% of household energy demand.

Future improvements in desalination technology are likely to both reduce costs and energy demand.

9.7 Purchasing Upstream Water Entitlements

On the Central Coast, the majority of water licences held by farmer and irrigators are on Wyong River, Jilliby Jilliby Creek, and Ourimbah Creek. A summary of the licensed annual entitlements held by the agricultural sector in these systems is presented in Table 9.5.

Table 9.5 Water Entitlements Held by the Agricultural Sector on the Central Coast

Surface Water Source	Annual entitlement (ML/a)	Major Uses
Wyong River	3,100 (estimated)	Turf farming and pasture irrigation
Ourimbah Creek	1,988	Horticulture and nurseries
Jilliby Jilliby Creek	994	Turf farming and pasture irrigation
Total annual entitlement	**6,100**	

The water licence held by the GWCWA for the lower Wyong River was issued under the *Water Administration Act 1912,* and limits the pumping capacity to 125 ML/d. The water licence for Ourimbah Creek Weir was issued under the *Water Management Act 2000* after completion of the *Water Sharing Plan for the Ourimbah Creek*. The licence provides a 5,000 ML/a entitlement and specified daily access conditions.

The average annual extraction by the GWCWA over the past 15 years was 10,925 ML/a, from Wyong River; and 3,558 ML/a, from Ourimbah Creek.

The unused agriculture entitlement forms part of the streamflow and is available for extraction by the GWCWA. Increased yields by the GWCWA through the purchase of existing water licences held by the agricultural sector will only occur if it results in reduced extraction by current active users. Existing users, which rely on the use of water as a key input into their business, are unlikely to sell water entitlements.

The purchase of unused (sleeper) agricultural water entitlements will not alter the streamflows in Wyong River and Ourimbah Creek or increase the yield of the Central Coast water supply. Purchase of unused entitlements would however prevent future increases in extraction upstream of the water supply intake and could provide a cost effective method of safeguarding future access to flows.

The pumping records held by the former NSW Department of Natural Resources for individual licensees are inadequate to assess historical usage. Anecdotal evidence indicates that considerably less than the full licensed entitlement is actually pumped from the streams.

In order to determine properly the feasibility for either purchasing or restricting the water licences held by the agricultural sector, better information is needed on the actual extractions being made by each licence holder. This would require direct communication with each of the licence holders or for the Department of Natural Resources to enforce metering of extractions.

10. Formulation of Augmentation Options

The augmentation options are designed to meet (in stages) the water demands for a growing population on the Central Coast. Future demands are premised on a commitment to an effective demand management strategy as set out in Sections 5 and 6. Failure to achieve the nominated water savings will lead to the earlier augmentation of the Central Coast water supply with the associated costs and impacts.

The IWCM strategies for Gosford and Wyong (refer Section 9.3) identify a number of local and municipal recycled water and stormwater reuse schemes within urban areas that reduce demand on the Central Coast water supply. The Councils will implement the more cost effective measures in a separate staged program of works.

While it is anticipated that the above local and municipal recycling measures will reduce demand by 5 to 10%, this benefit can be offset by changes to the environmental flow rules in the rivers and hence is regarded as a buffer against future uncertainties. Similarly, the use of groundwater is strictly a drought contingency measure (see Section 9.2).

The larger scale recycled water options are considered and evaluated in the context of *WaterPlan 2050*. These include the use of stormwater from new developments at Warnervale for EFS and recycled water from Kincumber, Wyong South and Charmhaven wastewater treatment plants for EFS and/or indirect potable reuse.

10.1 *Base Case*

10.1.1 Background to *Base Case*

The *Base Case* is the starting point for all future augmentations. It is common to all options and includes the existing works described in Section 2, the interim upgrade works approved by the GWCWA Board in November 2004 and the permanent drought contingency works, which improve the performance of the existing headworks (refer Figure 10-1). They include:

a a 33 ML/d transfer system between Morisset and Warnervale to enable the transfer of water between Hunter Water and GWCWA (scheduled completion by Dec 2006) ;

b connecting the rising main from Mangrove Creek Weir to Somersby WTP with Mooney Dam to enable the transfers of up to 70 ML/d to Mooney Dam (scheduled completion by March 2007);

c upgrading Mooney Dam pumping station to 60 ML/d (following drought recovery);

d upgrading the transfer capacity from the lower Wyong River pumping station to Mardi Dam from 72 ML/d to 125 ML/d by duplicating the suction main and rising main to Mardi Dam (scheduled completion by November 2007);

e upgrading the transfer capacity from Mardi Dam to Mardi water treatment plant from 100 to 160 ML/d and ultimately 240 ML/d (scheduled completion January 2009):

f a new 160 ML/d Mardi high lift pumping station that will enable water transfers from Tuggerah No. 2 reservoir to Gosford (scheduled completion by January 2009); and

g raising the capacity of Mardi Dam from 7,400 ML to 8,800 ML (scheduled completion by October 2008).

10.1.2 Hunter Water transfers

The Hunter connection was initially implemented as a drought contingency measure to enable the transfer of water from the Hunter through to the Central Coast. It was originally proposed to transfer 20 ML/d on average to the Central Coast subject to the availability of water in Grahamstown storage.

A key attribute of the Hunter connection is that it complements both the Hunter and Central Coast Systems and is compatible with many of the other long-term options.

In light of the deteriorating drought position on the Central Coast, Hunter Water agreed to increase the transfer rate to 25 ML/d subject to GWCWA providing financial assistance for pre-treatment at Balickera. This enables water to be treated prior to storing in Grahamstown Reservoir. This reduces the risk of diverting flood flows with high nutrient levels into the reservoir.

Subsequently, Hunter Water Corporation has advised that transfers up to 33 ML/d are feasible subject to joint funding of the augmentation works (refer Table 10.1) in Hunter Water's area of operation. The current estimate for these works is $17M with the GWCWA contribution being approximately $11.7M. Additionally, GWCWA will pay an agreed rate for water transferred.

Table 10.1 Jointly Funded Works in Hunter Water Area

Part	Description	Estimated Capital Cost	Completion
1	Construction of 2.0 km of 600 mm diameter pipeline between Rathmines and Wangi	$3.0M	Completed 2007
2	Construction of 5.0 km of 600 mm diameter pipeline between Fennell Bay pumping station and Toronto No. 3 reservoir	$6.0M	December 2007
3	Upgrading of the HWC Balickera Pumping Station to a capacity of 2,000 ML/d	$7.0M	March 2008
4	North Stockton and Tomago sand bed preliminary groundwater studies (payment only required if storage decreases to 75%)	$1.0M	Subject to Hunter storage level
	Total	**$17.0M**	

The 33 ML/d transfer rate in conjunction with the interim system upgrades and permanent drought contingency works will increase the system yield for the Central Coast water supply to 40,000 ML/a. The 33 ML/d average transfer rate is conditional on the storage in Hunter Water's system exceeding 70% capacity. The transfer rate reduces progressively as the level in Hunter Water's system falls.

The system yield for the *Base Case* is assessed on the basis that the transfers from Hunter to the Central Coast occur when the storage in Mangrove Creek Dam is less than 60% capacity (see Section 8.1.3).

While there is no direct connection between Hunter Water and Mangrove Creek Dam, the Hunter supply will reduce demand on the existing Central Coast surface water supply and the releases required from Mangrove Creek Dam to maintain supply.

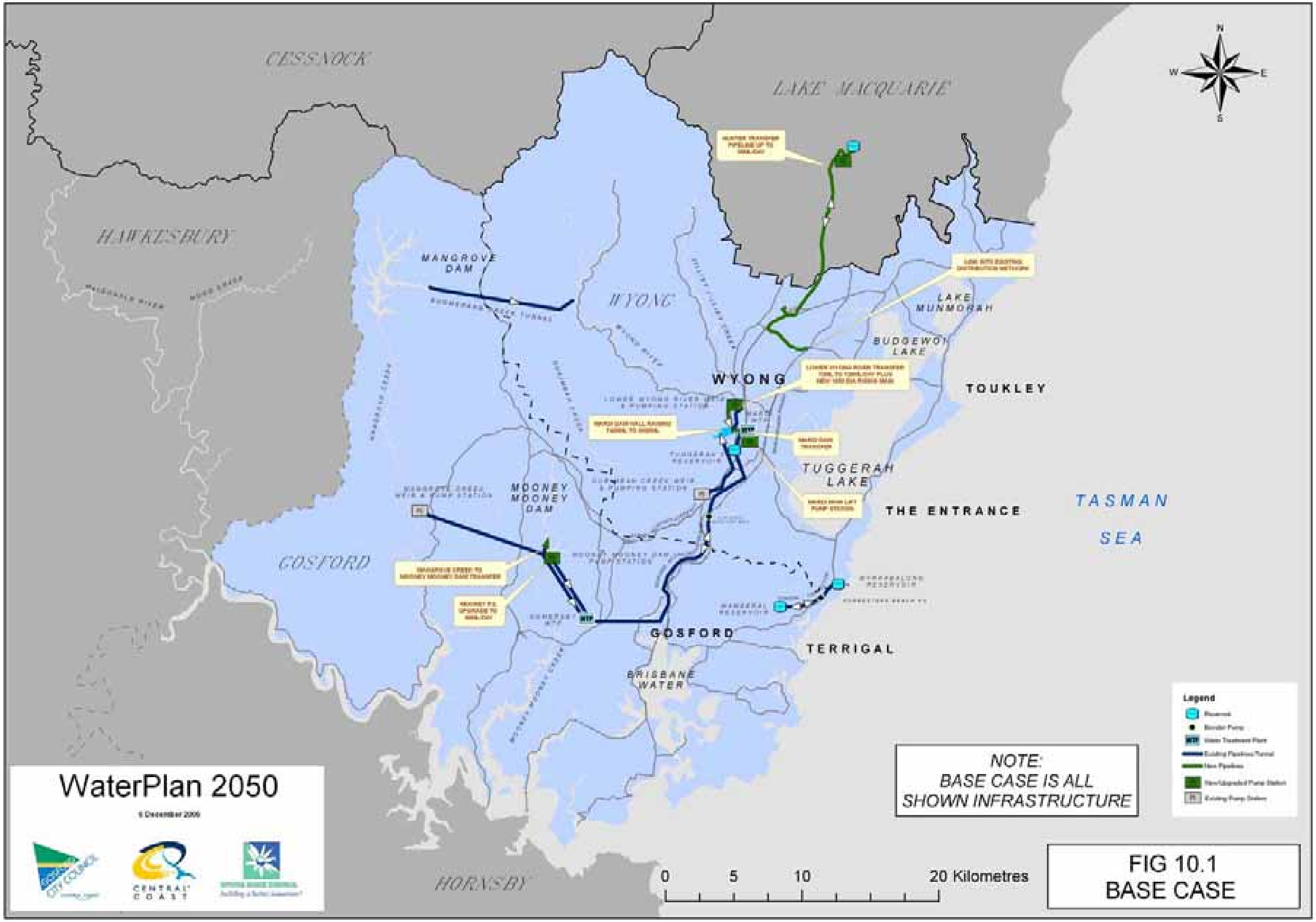

Figure 10-1 *Base Case*

10.1.3 Storage Recovery for the *Base Case*

With the *Base Case* works in place and operating, the Central Coast water supply will remain primarily dependent on surface water flows in Wyong River and Ourimbah, Mooney Mooney and Mangrove Creeks. Mangrove Creek Dam can provide drought security once the storage level recovers. This storage will supplement surface water sources in drought years to maintain supply.

The probability of recovery of Mangrove Creek Dam (from the current level) has been modelled for the *Base Case*. The results are summarised in Section 8.5.

With the completion of the *Base Case* works and system augmented to cater for 2050 demands, it is potentially possible to lift Level 1 restrictions once the total storage on the Central Coast recovers to 40% capacity. As a result, it is possible that the Central Coast will remain on restrictions for many years unless additional measures are introduced to facilitate recovery of Mangrove Creek Dam.

The system yield for the *Base Case* (once the dam has recovered to 85% capacity) with the proposed access conditions in Section 8.6 is 40,000 ML/a. This corresponds to the predicted annual water demand on the Central Coast in the year 2021. For demands in excess of this figure, additional augmentation works will be required.

In light of the recovery scenarios and probabilities outlined in Section 8.5 and Table 8.1, the long-term augmentation options identified in Section 9 could be advanced to improve the recovery of storage over and above the *Base Case.* These options are described in detail in Section 11.

System modelling has examined the effectiveness of each augmentation option in assisting in the recovery of the storage on the Central Coast as well as the long-term improvement in security of supply once environmental flows are introduced.

10.2 Formulation of Options

The objective of the *WaterPlan 2050* is to provide a safe, sustainable and secure water supply for the Central Coast to the year 2050. The strategy should incorporate diversity of sources, flexibility to adapt the plan to changing circumstances such as climate change and provide opportunities for future staging.

Ten options have been formulated to address the two major issues facing the Central Coast water supply namely:

a the recovery of Mangrove Creek Dam storage within a reasonable timeframe while maintaining supply; and

b the development of a long-term solution for the Central Coast, which will provide a secure supply for the growing population while maintaining the health of the rivers.

There are three broad types of solutions available involving:

a The transfer of additional surface water from adjacent rivers and streams to Mangrove Creek Dam to facilitate recovery of the storages and the long term security of supply;

b The development of alternative water sources that can reduce the demand on the existing Mangrove Creek Dam. The recovery of Mangrove Creek Dam will continue to rely on the runoff from its own relatively small catchment but releases from the dam will be reduced.

c Combination of the above.

10.3 Identified Water Source Options

The 1985 Headworks Strategy identified a broad range of additional surface water sources and transfer systems available to meet the long-term supply needs of the Central Coast. With the decision to proceed with Mangrove Creek Dam, a number of these combinations are no longer relevant.

A shortlist of the remaining potentially viable options together with other identified potential water source options is set out in Table 10.2.

Table 10.2 Identified Water Source Options

Option Number	Description
Base Case + 1	Regional Tillegra Dam
Base Case + 2	Upper Wyong River to Mangrove Creek Dam transfer system
Base Case + 3	Mangrove Creek Weir to Mangrove Creek Dam transfer system
Base Case + 4	Second lower Wyong Off-river Storage (Toobys Creek Dam)
Base Case + 5	MacDonald River to Mangrove Creek Dam transfer system
Base Case + 6	Lower Wyong River to Mangrove Creek Dam transfer system
Base Case + 7	20 ML/d permanent desalination plant at Toukley.
Base Case + 8	Large scale retrofit of rainwater tanks on existing houses
Base Case + 9a *Base Case* + 9b	Environmental flow substitution 10 ML/d at lower Wyong River Weir 20 ML/d at lower Wyong River Weir
Base Case + 10a *Base Case* + 10b *Base Case* + 10c	Indirect potable reuse 10 ML/d to Mardi Dam 20 ML/d to Mardi Dam 10 ML/d to Mooney Dam

Option 1 – Tillegra Dam on the Williams River was identified in the 1970s as the next major augmentation for Hunter Water. Tillegra Dam was selected because of its large catchment, good rainfall and regular flood events, which would allow the proposed 450,000 ML storage to fill in 6 to 10 years. The Dam will more than double the current storage in the Hunter and significantly improve the drought security of the Hunter Water system.

Tillegra Dam can act as a regional storage for both Hunter and the Central Coast. Under a draft proposal, the dam could supply 35 ML/d continuously (or 12,800 ML/a) to the Central Coast under all circumstances.

While the transfers would not directly lead to increased storage in Mangrove Creek Dam, it would reduce the need for releases from the dam when the flow in Wyong River and Ourimbah, Mooney Mooney and Mangrove Creek is inadequate to maintain supply.

Options 2, 3, 5 and 6 continue to utilise Mangrove Creek Dam as the key storage with the development of a new transfer system from Wyong River, Mangrove Creek or MacDonald River. With these options, Mangrove Creek Dam is not solely reliant on run-off from its catchment.

Option 4 involves the construction of a new storage on Toobys Creek, which has a small catchment immediately to the south of Mardi Dam. Both dams would be interconnected by a short tunnel through the southern ridge of Mardi Dam. Toobys Creek Dam (acting as an extension of Mardi Dam) would rely on water transferred from lower Wyong River and Ourimbah Creek to Mardi Dam. The new storage would partially replace storage already existing in Mangrove Creek Dam and defer the construction of the Wyong River to Mangrove Creek Dam transfer system (Options 2 and 6).

Option 7 involves a permanent 20 ML/d desalination plant located at Toukley, for which the GWCWA has completed pre-planning. A desalination plant would provide a reliable base load that is not dependent on rainfall. With desalination, water will be pumped directly into the distribution system.

The large-scale retrofit of rainwater tanks on existing houses (Option 8) accelerates the installation of tanks but does not greatly benefit the long-term security of supply. Under BASIX, most new homes in infill and green field development sites will incorporate a rainwater tank. In addition, any existing residential dwelling demolished and redeveloped or subject to major renovation will also be subject to BASIX. Over the next 50 years, a large percentage of the existing freestanding residential dwellings without tanks will be converted. The benefits of these rainwater tanks to the future water supply have been accounted for in (reduced) demand estimates.

Options 9 and 10 involve the staged transition from EFS, through to indirect potable reuse and are described in Section 9.3.

A detailed description and staging of each option and the associated capital, operating and maintenance costs and net present worth are set out in Sections 11 & 12.

11. Description of Options

11.1 Introduction

The future Central Coast water supply scheme will comprise the *Base Case* (refer Section 10.1) in combination with the augmentation options identified in Section 10.3. This section provides a detailed description of the 10 augmentation options available. Section 12 will evaluate each of the 10 options based on financial, environmental, social and operational considerations to determine the more promising options for the initial augmentation (Stage 1).

The yield of the Central Coast water supply has been assessed for the *Base Case* plus each augmentation option in Table 11.1. This has enabled a tentative staging of the works to meet in steps, the predicted annual water demands of a growing population over the next 50 years with the water saving measures. The proposed staging of the augmentation works is shown for each option.

Actual water demands will be monitored in the future by the GWCWA and the timing of staging reviewed periodically to ensure it is appropriate for the actual population growth and water demands.

All the options include the construction of a new intake and pump station on the lower Wyong River. The existing pumping station is reaching the end of its useful life, and should be replaced as soon possible.

The number of pumps, capacity and type will be determined by the access conditions in the new water licence. The access conditions are dependent on the results of the environmental studies for the Wyong River estuary and the Central Coast Macro WSP.

The pump station will be designed to transfer up to 160 ML/d from Wyong River to Mardi Dam, with provision to install additional pumps in future to increase the transfer capacity to 320 ML/d. The provision of this pump station is essential for the introduction of environmental flows for all options including those incorporating alternative sources.

The increased pumping capacity from lower Wyong River will enable the transfer of a greater proportion of high flow events in the Wyong River to Mardi Dam. This will reduce the current dependency on access during low flows in the Wyong River. The ability to access a greater proportion of high flow events will also trigger the implementation of environmental flow rules.

11.2 System yield

System yields have been calculated for the *Base Case* and the *Base Case* plus Options 1 to 10 respectively with the access conditions as specified in Table 8.1. The results are summarised in Table 11.1.

Table 11.1 System Yield of *Base Case* in conjunction with Options 1 to 10 respectively.

***Base Case* +** **Option No.**	**Description of Option**	**System yield ML/a**	**Maintains supply to the year***
Base Case	Interim upgrade works and permanent drought contingency measures	40,000	2027
Base Case + 1	Regional Tillegra Dam	47,800	2053
Base Case + 2	Upper Wyong River to Mangrove Creek Dam transfer system	45,600	2045
Base Case + 3	Mangrove Creek Weir to Mangrove Creek Dam transfer system	42,900	2035
Base Case + 4	Lower Wyong River off-stream storage (Toobys Creek Dam)	48,400	2055
Base Case + 5	MacDonald River to Mangrove Creek Dam transfer system	45,500	2045
Base Case + 6	Lower Wyong River to Mangrove Creek Dam transfer system with Gates on Mangrove Creek Dam	50,000	Beyond 2050
Base Case + 7	20 ML/d permanent desalination plant at Toukley wastewater treatment plant	46,600	2049
Base Case + 8	Large scale retrofit of rainwater tanks on existing houses (80,000 tanks)	43,700	2039
Base Case + 9	Environmental flow substitution at lower Wyong River Weir: (a) 10 ML/d (b) 20 Ml/d	43,800 44,700	2039 2042
Base Case + 10	Indirect potable reuse: (a) 10 ML/d into Mardi Dam (b) 20 ML/d into Mardi Dam (c) 10 ML/d into Mooney Dam	44,000 47,600 44,000	2040 2052 2040

11.3 Combination of sources

In most cases, the *Base Case* plus any one of the augmentation options is unable to alone meet the predicted 2050 water demands (47,630 ML/a). Augmentation of the Central Coast water supply will generally require at least two augmentations. In selecting the initial augmentation option, consideration has to be given to its compatibility with future augmentation options.

From an economic perspective, it is unlikely that an initial augmentation, based on a surface water source will be augmented at a later stage by another surface water source, due to the higher capital costs of the surface water sources (Options 1 to 6), when compared with alternative sources of supply (Options 7 to 10), particularly at a reduced scale to meet the 2050 demands. In Section 13, combinations of surface water sources and alternative water sources are developed into long-term strategies.

11.4 Staging of augmentation works

Water supply augmentations are primarily staged so that the system yield can satisfy a growing demand at all times. Additionally, the required large capital investments are staged to minimise long-term financial costs to the community.

The augmentation options should satisfy the predicted demand up to the date shown in Table 11.1. Ongoing population growth and increasing water demand makes it necessary to further augment the water supply system despite the water savings measures in place (eg water efficient devices, leakage reduction, WELS and water recycling).

There are potential benefits of advancing the staged augmentation program to assist in drought recovery, to provide greater flexibility in operation and diversity of sources particularly in the event that climatic conditions deteriorate faster than assumed. Adopting a "just in time" approach to the staging of water supply headworks introduces significant risks that necessary infrastructure will not be in place when required. Key risk areas include uncertainties associated with climate and climate change, regulatory change and difficulty obtaining the necessary approvals.

Most of the surface water sources will successfully combine with one or more of the alternative sources and vice versa. For example, in the case of desalination, it is possible to provide an additional 10 ML/d unit (i.e. total capacity 30 ML/d) to achieve the 2050 target demand without resorting to other options.

Additionally, there is an incremental option to raise the storage in Mangrove Creek Dam by installing gates across the spillway. The gates will increase the total storage to 230,000 ML. In conjunction with one of the options that transfer water into Mangrove Creek Dam from an external source, it has the potential (particularly in the event of water banking with Hunter Water Corporation) to increase the system yield by a further 3,000 ML/a at a small additional cost.

11.5 Option 1 – *Base Case* plus regional Tillegra Dam

Hunter Water has been investigating a dam on the Williams River at Tillegra to improve the drought security of its water supply system. The source of the Williams River is in the Barrington Tops with a large catchment in a high rainfall area with regular flood events.

The proposed dam would have a capacity of 450,000 ML and is expected to fill in six to ten years. The area of inundation is cleared grazing land with approximately 50% of the affected land purchased to date. The remaining land is held by 50 private owners.

Based on a commitment by the Premier, Hunter Water will “fast track” the environmental and engineering studies for the project and oversight the construction of the dam. The preliminary estimate for the dam as announced by the Premier is $300 M. Estimates that are more detailed will be prepared on completion of the studies.

The dam could be jointly funded by Hunter Water and the Central Coast. The financial arrangements have not been resolved but are anticipated to include a capital contribution towards the cost of the dam (based on proportional benefit) and a unit rate for water.

Under the current 20-year agreement with Hunter Water, the transfer rate reduces from 35 ML/d to 20 ML/d when the net storage in the Hunter falls below 70% capacity. The quantity transferred reduces further as the net storage declines with transfers ceasing at 30% storage capacity.

When the agreement expires, the ability of Hunter Water to continue the transfers will be limited unless it is able to improve the drought security of its infrastructure to meet the growth in Hunter demand.

The construction of Tillegra Dam will significantly increase the drought security for Hunter Water and ensure ongoing transfer of 35 ML/d to the Central Coast throughout the year, regardless of the level in Mangrove Creek Dam and Grahamstown reservoir. The transferred water will be treated and used to supply the northern areas of Wyong Shire.

While there is no direct connection between Hunter Water and Mangrove Creek Dam, the Hunter supply will reduce demand on the existing Central Coast surface water supply and the releases required from Mangrove Creek Dam to maintain supply (see Section 10.1.2).

Table 11.2 Augmentation Staging for Option 1

Year	Description of the Augmentation Option	GWCWA System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d	-
2013	Construction and commissioning of Tillegra Dam	47,800

Augmentation Option **1**

Description ***Base Case* + regional Tillegra Dam**

Basis of Option Harvests flood flows in the Williams River and provide significant on-stream storage for the joint benefit of Hunter and Central Coast.

Financial *Potential cost sharing not yet determined.*

Capital Cost
NPV (7% over 50 yrs)
$/KL Yield
Levelised Cost (gross)

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River. (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment)	2009 to 2014
• New 450,000 ML Tillegra Dam constructed on the upper Williams River.	2013

Key System Attributes

- Increased security for Hunter Region and increased reliability in water transferred to the Central Coast from Hunter Water.
- Poor drought recovery time due to the time taken for planning and construction of the Tillegra Dam.

Key Environmental Attributes

- The environmental impact of Tillegra Dam will occur in Hunter Water's area of operation. The environmental impact assessment will be undertaken by Hunter Water.
- Approximately 50 privately owned properties would need to be acquired by Hunter Water to enable the construction of Tillegra Dam.
- The Williams River downstream of the Dam may be affected by reduced streamflows.

Key Limitations

- The Central Coast could be on restrictions for an extended period awaiting completion of Tillegra Dam.

Key Risks

- The regulatory approvals for Tillegra Dam could delay or jeopardise the project leaving the Central Coast without a short-term solution if Tillegra Dam is not undertaken in conjunction with one of the other options.
- The cost sharing arrangements need to be analysed in detail for different combinations of capital cost and ongoing cost of water to ensure the project is viable and competitive with other options.

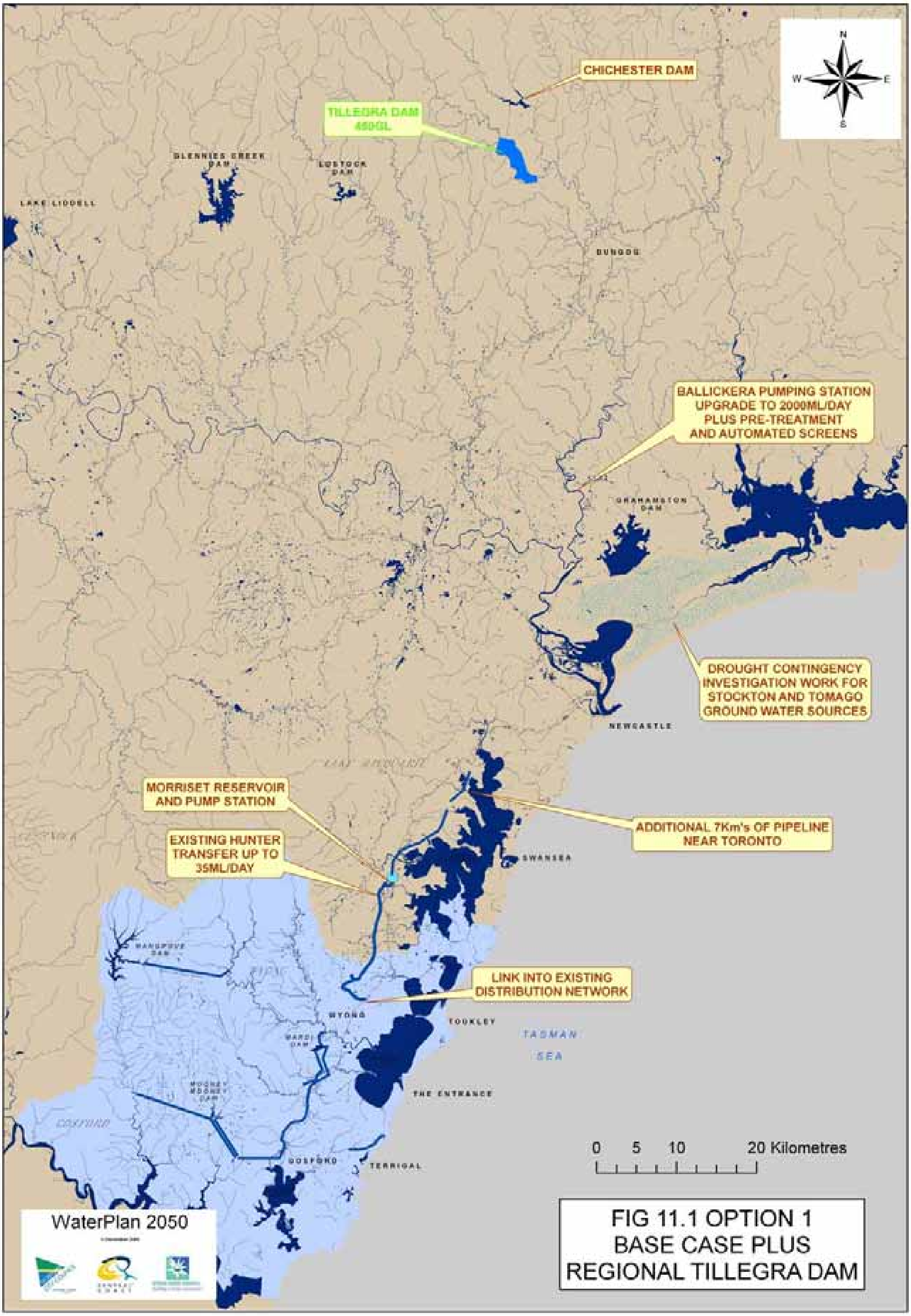

Figure 11-1 *Base Case* plus regional Tillegra Dam

11.6 Option 2 – *Base Case* plus upper Wyong River to Mangrove Creek Dam transfer system

The upper Wyong River to Mangrove Creek Dam transfer system is designed to transfer water from upper Wyong River to Mangrove Creek Dam to supplement runoff from the dam's relatively small catchment. The transfer system comprises a weir on the upper Wyong River, intake pumping station and pipeline to the portal of Boomerang Creek Tunnel (refer Figure 11-2).

This option is similar to the adopted scheme in the1985 Headworks Strategy, but reduced in scale to reflect lower water demands and likely water access conditions. In addition, Option 2 does not include the next stage in the 1985 Headworks Strategy, which proposed the construction of a transfer system from Boomerang Creek Tunnel to Mardi WTP (effectively duplicating Option 6).

The weir site was selected downstream of the confluence of Bunning Creek and Wyong River in order to include the catchment of Bunning Creek. The catchment area at the weir site is approximately 175 km2. The proposed weir is a concrete gravity structure incorporating a mechanical flap gate design to operate automatically to capture low recurrence interval floods. The storage behind the weir is approximately 160 ML.

With the predicted population and water demands, the upper Wyong pumping station capacity will be 160 ML/d for the proposed access conditions set out in Table 8.1. A 1350 mm diameter pipeline (500 metres in length) will be constructed from the weir along Bunning Creek to the portal of Boomerang Creek Tunnel.

Table 11.3 Augmentation staging for Option 2

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of weir and 160 ML/d pumping station on the upper Wyong River and transfer pipeline along Bunning Creek to the portal of Boomerang Creek Tunnel	45,600

Augmentation Option 2

Description ***Base Case*** **+ Upper Wyong River to Mangrove Creek Dam Transfer System**

Basis of Option Harvests a portion of infrequent flood flows from the upper reaches of Wyong River and transfers them to Mangrove Creek Dam for storage.

Financial

Capital Cost	$38 M
NPV (7% over 50 yrs)	$41 M
$/KL Yield	$0.62/kL
Levelised Cost (gross)	$1.38/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River. (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment)	2009 to 2014
• New Weir on Wyong River near Bunning Creek	2010
• 160 ML/d pump station adjacent to new weir	2010
• 500 m of 1350 mm diameter transfer main from pump station to tunnel portal	2010
• 20 KM of 33 KV Transmission line pump station	2010

Key System Attributes
- Delivers additional water for storage into Mangrove Creek Dam.
- Enables more effective use of Mangrove Creek Dam.
- Good drought recovery time even under dry climatic conditions.

Key Environmental Attributes
- Will increase extractions of water from the upper middle reaches of Wyong River potentially affecting long stretches of Wyong River.
- Requires a 200 m diversion of Wyong River.
- Proposed weir is collapsible and will not form a significant barrier during medium to low flows.
- Construction of a high voltage power line from Wyong to Bunning Creek will cause some loss of amenity.

Key Limitations
- Does not integrate well with other scheme elements and possible future elements such as Hunter transfer system and environmental flow substitution.
- Releases from Mangrove Creek Dam would continue to be discharged down the Wyong River.

Key Risks
- More susceptible to hydrological changes than a lower Wyong River transfer system.
- Likely to experience significant difficulty in obtaining environmental approvals and associated water licence due to potential impact on streamflows in the mid to upper section of Wyong River.
- High risk of project delays due to likely difficulties in obtaining the necessary approvals.

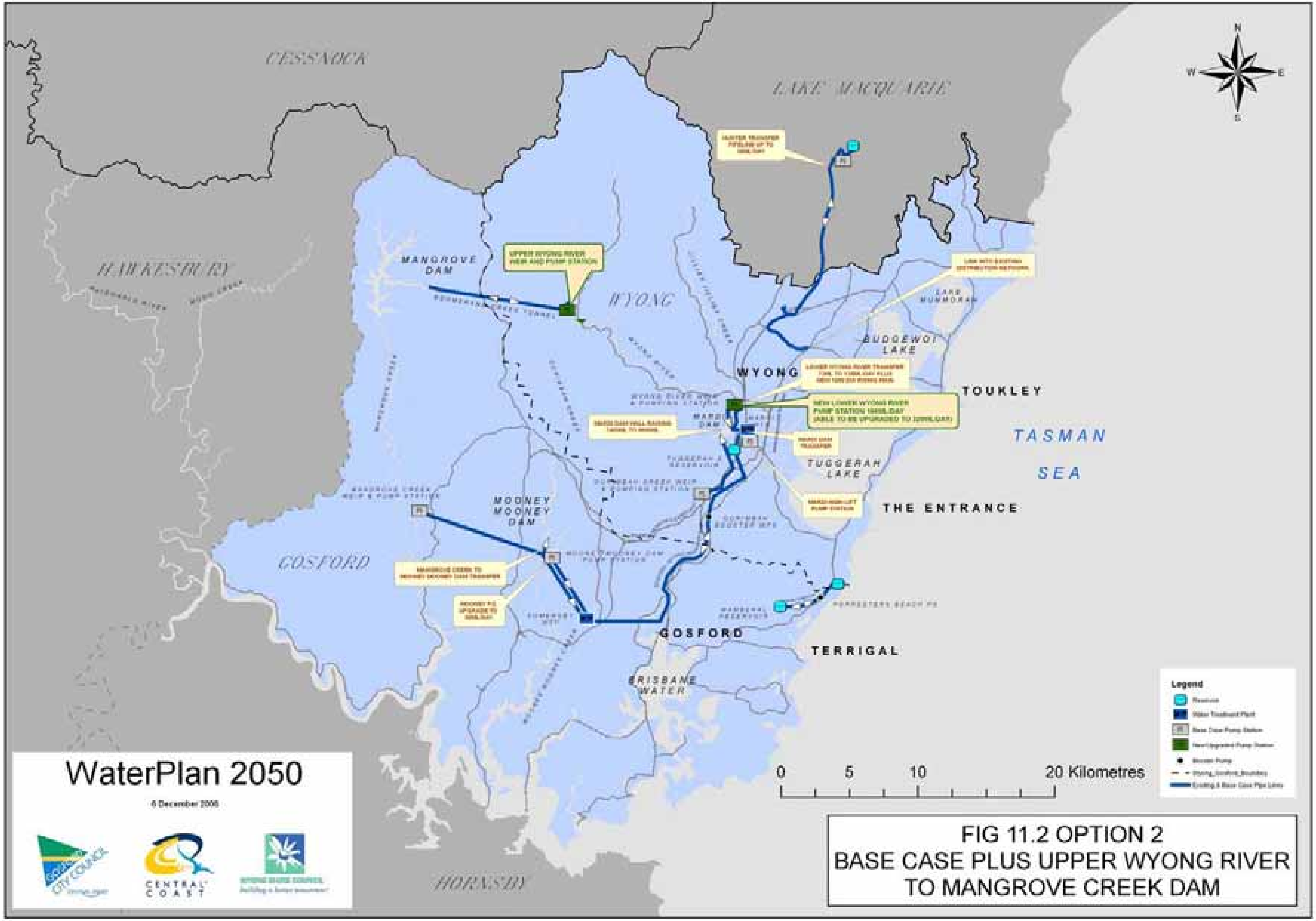

Figure 11-2 *Base case* plus upper Wyong River to Mangrove Creek Dam

11.7 Option 3 – *Base Case* plus Mangrove Creek Weir to Mangrove Creek Dam transfer system

The Mangrove Creek Weir to Mangrove Creek Dam transfer system is designed to transfer surplus flows at the Mangrove Creek Weir back to Mangrove Creek Dam to supplement run-off from the dam's relatively small catchment. The scheme comprises the installation of additional pumps in the existing lower Mangrove Creek pumping station and construction of a rising main and access road along Mangrove Creek to the dam (refer Figure 11-3).

This option is based on the catchment of Mangrove Creek Weir (approximately 140 km^2) and excludes the catchment of Mangrove Creek Dam. Mangrove Creek catchment is drier and considerably smaller than Wyong River catchment.

Under the current operating rules, flows of up to 140 ML/d in Mangrove Creek at the weir can be transferred directly to Somersby WTP. With the proposed connection between the rising main from Mangrove Creek Dam to Somersby WTP, with Mooney Dam, any transfers in excess of demand can be diverted and stored in Mooney Dam providing it is not full.

Option 3 will extend this concept by "banking excess" flows in Mangrove Creek Dam. DNR have indicated that additional extractions associated with a Mangrove Creek Weir to Mangrove Creek Dam transfer system will initiate daily flow access rules similar to those proposed for Wyong River. 95^{th}/60% access rules have been assumed in the analysis of this option.

Option 3 comprises modification to the existing pumping station adjacent to the Mangrove Creek Weir with the installation of additional pumps and the construction of a 750 mm diameter pipeline (17.5 km in length) and access road along Mangrove Creek to Mangrove Creek Dam.

The additional water that can be harvested by the proposed transfer system is effectively offset by reduced access during low and medium flows once the environmental flow rules are introduced.

Table 11.4 Augmentation staging for Option 3

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of an access road and transfer pipeline between Mangrove Creek Weir and Mangrove Creek Dam and modifications to the Mangrove Creek pumping station	42,900

Augmentation Option **3**

Description ***Base Case*** **+ Mangrove Creek Weir to Mangrove Creek Dam Transfer System**

Basis of Option Harvests a portion of high flows at Mangrove Creek Weir and transfers them to Mangrove Creek Dam for later use.

Financial

Capital Cost	$60 M
NPV (7% over 50 yrs)	$59 M
$/KL Yield	$1.74/kL
Levelised Cost (gross)	$1.62/kL

Main Elements	Completion Date
• Construction of a new 160 ML/d pumping station on the lower Wyong River. (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment)	2009 to 2014
• Modifications to the Mangrove Creek pumping station.	2010
• Construction of 1050 mm diameter pipeline and access road (17.5 km in length) along Mangrove Creek to the dam.	2010

Key System Attributes

- Significant reliance on the Mangrove Creek as the major source of supply.
- Enables more effective use of Mangrove Creek Dam.
- Poor drought recovery time under dry climatic conditions.

Key Environmental Attributes

- Construction of a pipeline and access track along Mangrove Creek to Mangrove Creek Dam would cause some environmental impacts, particularly during construction.
- Will enable increase extractions of water from the middle to upper flow ranges and reduced low flow extractions.
- Worst performing surface water solution from a greenhouse gas perspective.

Key Limitations

- Does not integrate well with other scheme elements and possible future elements such as Hunter transfer system and EFS.
- The likely access rules for extraction of water from Mangrove Creek Weir would include a proportion limit on daily access. This would effectively off set the increased extractions during high flow events.
- Increases the system yield to only 42.9 ML/a, and is not as cost effect as some other surface water source options.

Key Risks

- More susceptible to hydrological changes than some of the other surface water sources.
- Lack of construction access and difficult construction conditions increase the risk of increased construction costs.

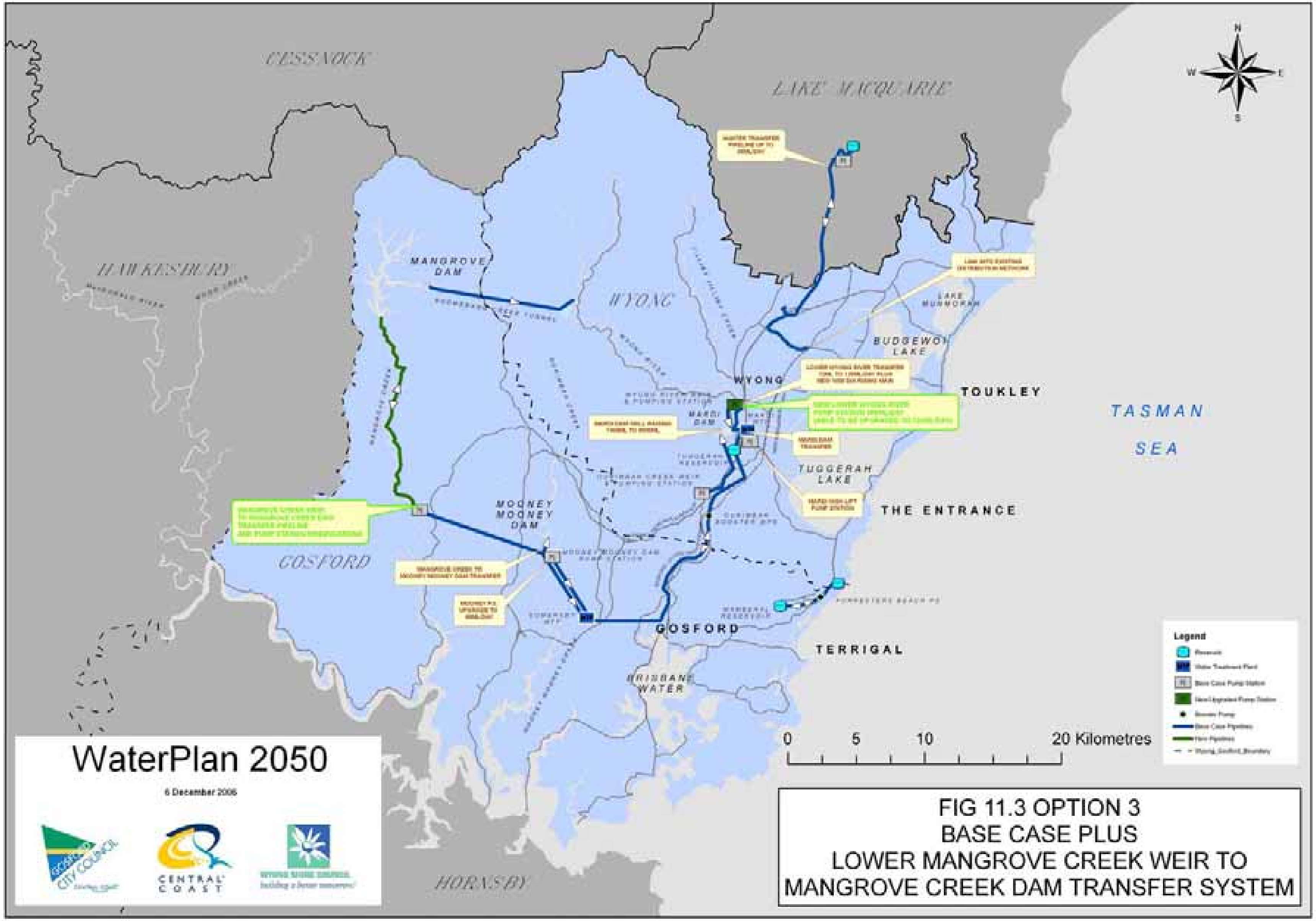

Figure 11-3 *Base Case* plus Mangrove Creek Weir to Mangrove Creek Dam transfer system

11.8 Option 4 – Base Case plus second lower Wyong off-creek storage

The second off-creek storage (near Mardi Dam) is designed to harvest water from lower Wyong River and Ourimbah Creek during high flows to be stored for later use. This second storage would be located at Toobys Creek.

Option 4 (refer Figure 11-4) includes the construction of an off-river storage on Toobys Creek and a connecting tunnel to Mardi Dam. Toobys Creek is a tributary of Ourimbah Creek, with a catchment of approximately 7 km^2 in Ourimbah State Forest. The dam site lies approximately 2 kilometres to the southeast of Mardi Dam.

Previous studies have identified a dam site on Toobys Creek with potential to store up to 50,000 ML. The 20,000 ML storage would be impounded by a concrete faced rock fill embankment. A 2100 mm diameter tunnel between Mardi Dam and Toobys Creek Dam will enable the transfer of water between storages.

This option also includes the installation of additional pumps in the lower Wyong River pumping station and duplication of the rising main by the year 2040 to increase the transfer capacity to Mardi Dam to 320 ML/d.

Toobys Creek Dam (20,000 ML capacity) acts as an alternative storage to Mangrove Creek Dam and will defer the need for a supplementary source until the year 2040.

Table 11.5 Augmentation staging for Option 4

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of Toobys Creek Dam and tunnel through to Mardi Dam.	-
2041	Installation of additional pumping capacity in lower Wyong River pumping station to 320 ML/d	48,400

Augmentation Option 4

Description ***Base Case*** **+ second lower Wyong Off-Creek Storage**

Basis of Option Harvests high flows in the lower Wyong River with additional storage adjacent to Mardi Dam.

Financial

Capital Cost	$89 M
NPV (7% over 50 yrs)	$73 M
$/KL Yield	$0.75/kL
Levelised Cost (gross)	$1.70/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment).	2009 to 2014
• New 20,000 ML dam on Toobys Creek.	2010
• Tunnel and pump transfer system between Mardi Dam and Toobys Creek Dam.	2010
▪ Installation of additional pumps on lower Wyong River Pump Station to increase capacity to 320 ML/d.	2041

Key System Attributes

- The storage in Toobys Creek Dam duplicates the existing storage in Mangrove Creek Dam but defers the need for a transfer system to Mangrove Creek Dam.
- Integrates reasonably well with other scheme elements and possible future elements such as Hunter transfer system and EFS.
- Good drought recovery time even under dry climatic conditions.

Key Environmental Attributes

- Extractions from the lower Wyong River Weir will be in accordance with the flow access conditions incorporated in the Water Sharing Plan.
- The environmental impact of Toobys Creek Dam is high, with the loss of over 100 ha of forest and significant changes to streamflow, fish passage and bed movement in Toobys Creek downstream of the dam wall.
- It is also considered that there would be quite high environmental impacts during the construction of the new Dam.

Key Limitations

- Minimal.

Key Risks

- Likely to experience significant difficulty in obtaining environmental approval and a water licence/works approval for the dam.
- The regulatory approvals for Toobys Creek Dam could delay or jeopardise the project and leaving the Central Coast without a short-term alternative.

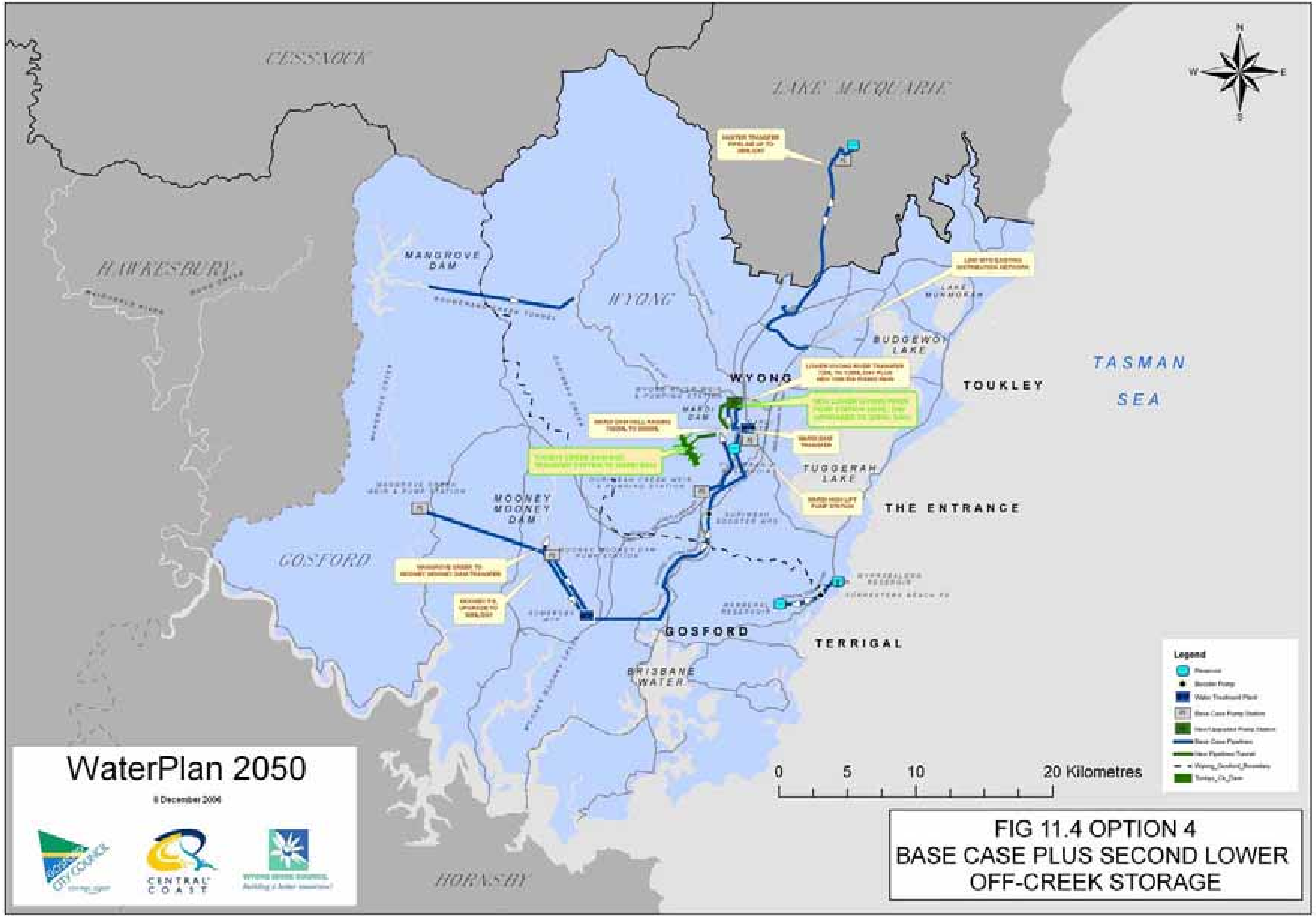

Figure 11-4 *Base Case* plus second lower Wyong off-creek storage

11.9 Option 5 – *Base Case* plus MacDonald River to Mangrove Creek Dam transfer system

The 1985 Headworks Strategy included options to transfer water from the MacDonald River to Mangrove Creek Dam. The originally estimated mean annual flow in the MacDonald River based on synthetic streamflow data (developed at the time through the correlation of rainfall records with limited streamflow data) was 185,000 ML/a.

Sydney Catchment Authority (SCA) established a gauging station at St Albans in 1990. A recent review of SCA streamflow data obtained from the gauging station resulted in a significant downgrading of the mean annual streamflow. Since the gauging station was established the average annual steam flow at the St Albans gauge has been approximately 50,000 ML/a.

While the MacDonald River catchment at St Albans is 1,680 km^2, the annual flow is only marginally greater than the annual flow at the lower Wyong River Weir (catchment 355 km^2). The mean annual discharge of the MacDonald River is “skewed” by the occasional flood event. This catchment is significantly drier than the catchment of Wyong River.

The revised hydrology casts doubt on the viability of the option originally presented in the 1985 Headworks Strategy. A revised MacDonald River scheme (refer Figure 11-5) was developed using the SCA streamflow data. It involves the construction of a weir on the MacDonald River downstream of the junction with Mogo Creek, a 40 ML/d pumping station, a 750 mm diameter rising main (18 km in length) and access road along Mogo Creek and Little Mogo Creek to a 2.8 kilometre tunnel under the Judge Dowling Range to Mangrove Creek Dam.

The pipeline route along MacDonald River and Mogo Creek is located mainly in farming land and the access road along Mogo Creek will require some upgrading. A new road will be constructed through undisturbed native vegetation along Little Mogo Creek, which is located in Yengo National Park. The area is recognised as having aboriginal heritage sites of cultural significance and forms part of the major communication route “Boree” between the Hawkesbury and Hunter Valleys.

Table 11.6 Augmentation staging for Option 5

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of a weir and pumping station on MacDonald River and transfer pipeline/tunnel between MacDonald River and Mangrove Creek Dam	45,500

Augmentation Option **5**

Description ***Base Case* + MacDonald River to Mangrove Creek Dam Transfer System**

Basis of Option Harvests flows in the MacDonald River and transfers them to Mangrove Creek Dam for later use.

Financial

Capital Cost	$108 M
NPV (7% over 50 yrs)	$101 M
$/KL Yield	$1.57/kL
Levelised Cost (gross)	$2.01/kL

Main Elements	Completion Date
• Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment).	2009 to 2014
• New weir on MacDonald River downstream of the junction with Mogo Creek near St Albans.	2010
• 40 ML/d pumping station adjacent new weir.	2010
• 18 km of 750 mm diameter transfer main from pump station to tunnel portal.	2010
• 2.8 km tunnel to Mangrove Creek Dam.	2010

Key System Attributes

- Provides water from another catchment.
- Water harvested from MacDonald River during high flow events transferred to Mangrove Creek Dam for storage and use during dry climatic periods.
- Provides a reasonable drought recovery time under dry climatic conditions.
- Enables more effective use of Mangrove Creek Dam.

Key Environmental Attributes

- Will increase extractions of water from MacDonald River potentially affecting long stretches of the river and other water users.
- Involves the construction of a new weir on the MacDonald River.
- Involves construction within the Yengo National Park and extensive destruction of native vegetation along Little Mogo Creek for the construction of the transfer pipeline and tunnel to Mangrove Creek Dam.

Key Limitations

- Does not integrate well with other scheme elements and possible future elements such as water banking with the Hunter or EFS.

Key Risks

- Considered more susceptible to hydrological changes than some of the other surface water sources.
- Unlikely to obtain environmental approvals.
- High risk of significant community opposition to construction within a national park.

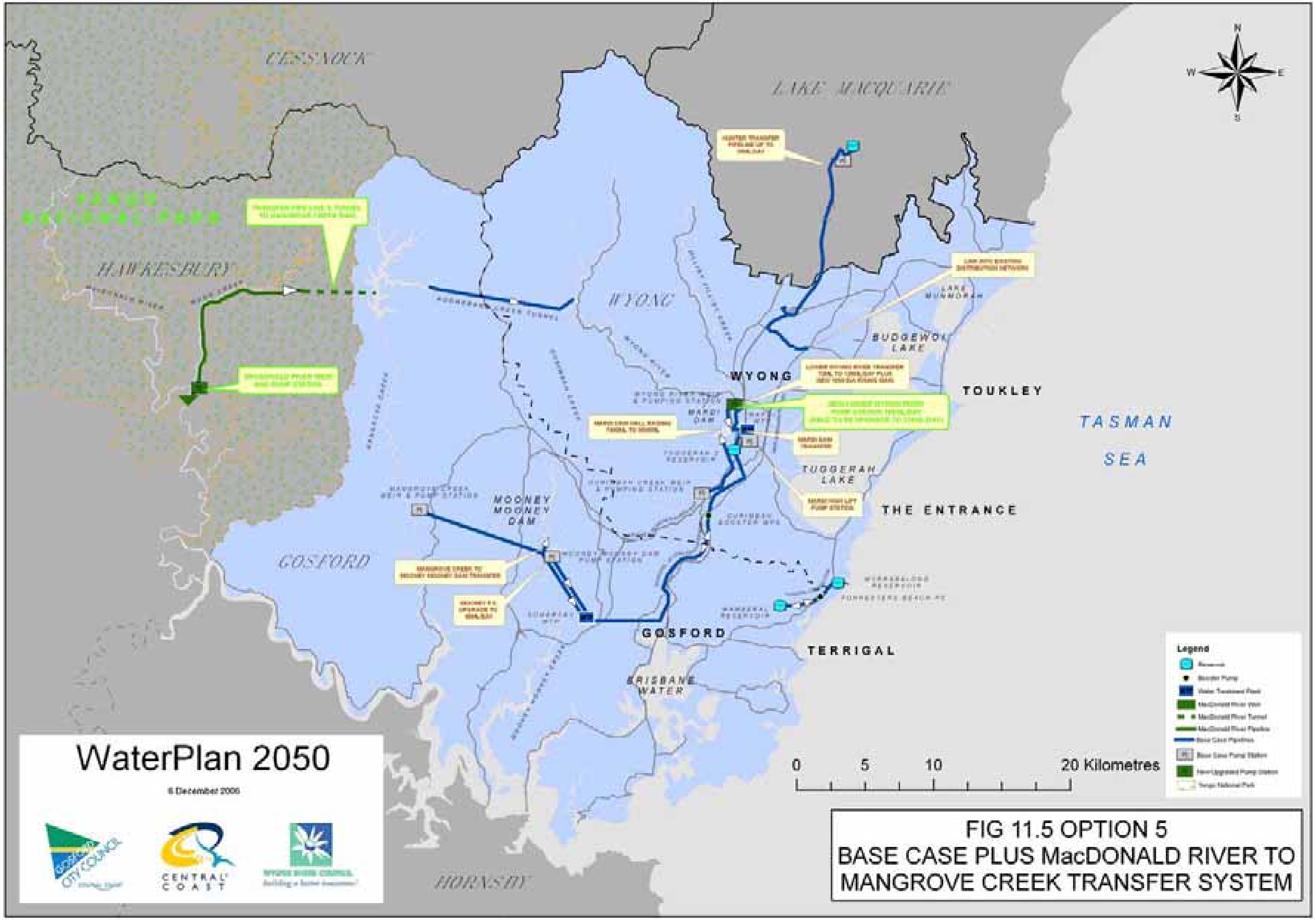

Figure 11-5 *Base Case* plus MacDonald River to Mangrove Creek Dam transfer system

11.10 Option 6 – *Base Case* plus lower Wyong River to Mangrove Creek Dam (MCD) transfer system and Gates on MCD

The lower Wyong River to Mangrove Creek Dam transfer system is designed to transfer water from Mardi Dam to Mangrove Creek Dam to supplement run off from the dam's relatively small catchment. The transfer system comprises a pipeline from Mardi Dam along the Wyong River and Bunning Creek to Boomerang Creek Tunnel. It enables water harvested from Ourimbah Creek and Wyong River during high flows to be temporarily stored in Mardi Dam before transfer through to Mangrove Creek Dam (refer Figure 11-6).

Mardi Dam will buffer the high transfer rates from Wyong River and Ourimbah Creek with a lower transfer rate from Mardi Dam to Mangrove Creek Dam. It is proposed that the general operating range for Mardi Dam will be between 50% and 100% of capacity. The remaining 50% capacity will be retained for emergency supplies.

The proposed Mardi Dam pumping station will house pumps to supply both Mardi WTP and the transfer system to Mangrove Creek Dam. The maximum transfer rate from Mardi Dam to Mangrove Creek Dam will be 160 ML/d with all pumps operating.

An analysis has been undertaken to optimise the transfer system to Mangrove Creek Dam. Several options were evaluated including different diameter tunnels and pipelines. The lowest cost solution on a net present worth basis is the construction of a 1050 mm diameter buried pipeline (21 km in length) to the outlet of Boomerang Creek Tunnel at Bunning Creek.

The pipeline can also be used to transfer water from Mangrove Creek Dam to Mardi WTP under gravity. With this option, the current practice of releasing water from Mangrove Creek Dam to Wyong River for extraction at lower Wyong River pumping station will cease. This will provide a net environmental benefit to Wyong River by returning the flow regime to a more natural state.

Additionally, there is energy and associated green house gas benefits, since water harvested from Mangrove Creek Dam catchment will generally gravitate directly from Mangrove Creek Dam to Mardi water treatment plant. Currently, this water is released into either Mangrove Creek or Wyong River requiring pumping from the weir to the water treatment plants.

Once the transfer system is commissioned, there is potential to introduce water banking between Hunter Water and GWCWA benefiting both authorities and changing the relationship for GWCWA from bulk water customer to partner. This could lead to a reduction in the cost of water purchased from Hunter Water as the bulk water rate is over twice the actual operating and maintenance costs associated with the water transfers.

Water banking will involve supplying the Central Coast's northern area from the Hunter when there is suitable flow in the Williams River. This will reduce demand on the Central Coast water supply enabling greater diversions of water to Mangrove Creek Dam. The increased storage in Mangrove Creek Dam would enable the Central Coast to supply the southern areas of the Hunter in drought events. Further benefit can be gained by installing gates on Mangrove Creek Dam spillway increasing the net storage from 190,000 to 230,000 ML.

Water banking will benefit both parties. Hunter Water will benefit from low cost additional storage that will improve its drought security pending the construction of Tillegra Dam. The Central Coast water supply will benefit by having access to the major river sources in the Hunter at a reduced cost.

The option includes the installation of additional pumps in the lower Wyong River pumping station and duplication of the rising main to increase the transfer capacity to Mardi Dam to 320 ML/d. It also includes installation of gates on Mangrove Creek Dam spillway increasing the net storage from 190,000 to 230,000 ML

Table 11.7 Augmentation staging for Option 6

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2010	Construction of a transfer pipeline between Mardi Dam and Mangrove Creek Dam Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d	46,600
Yet to be determined	Installation of Gates on MCD increasing storage capacity from 190 GL to 230 GL.	50,000

Augmentation Option	**6**
Description	***Base Case* + Lower Wyong River to Mangrove Creek Dam Transfer System**
Basis of Option	Transfers excess water from Mardi Dam to Mangrove Creek Dam for storage.

Financial

Capital Cost	$80.3 M
NPV (7% over 50 yrs)	$77 M
$/KL Yield	$0.33/kL
Levelised Cost (gross)	$1.73/kL

Main Elements	**Completion Date**
• Construction of a new 320 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps	2009 to 2014
• 2.2 Km of 1050 mm pipeline from lower Wyong River pump station to Mardi Dam.	2009 to 2014
• 21 km of 1050 mm diameter pipeline from Mardi Dam to Bunning Creek tunnel.	2008 to 2009
• 160 ML/d pump station, co located with the new Mardi Dam to Mardi water treatment plant transfer system.	2008 to 2009
• Install gates on Mangrove Creek Dam to increase storage capacity from 190,000 ML to 230,000 ML.	When storage rises to 70 %

Key System Attributes

- Water harvested from Wyong River and Ourimbah Creek during high flow events transferred to Mangrove Creek Dam for storage and use during dry climatic periods.
- Enables water captured by Mangrove Creek Dam to gravitate directly into Mardi Water treatment plant under most circumstances.
- Secures releases from Mangrove Creek Dam from extraction by other users and stream losses.
- Enables more effective use of Mangrove Creek Dam.
- Integrates well with other scheme elements and possible future elements such as Hunter transfer system and EFS.
- Provides the fastest drought recovery times of all the options.

Key Environmental Attributes

- Eliminates current practice of transferring water from Mangrove Creek Dam to the lower Wyong River Weir. This eliminates current environmental impacts associated with cold-water pollution, artificial pulsing of flows and geomorphic impacts.
- Best performing of all the surface water options in relation to energy consumption and greenhouse gasses.

Key Limitations

- Once constructed there is limited scope to increasing the transfer rate from Mardi Dam to Bunning Creek tunnel without incurring major additional costs.

Key Risks

- Longer-term yield benefits could be reduced if Water Sharing Plan limits access to high flows or water accounting mechanisms artificially limit access during wet years.

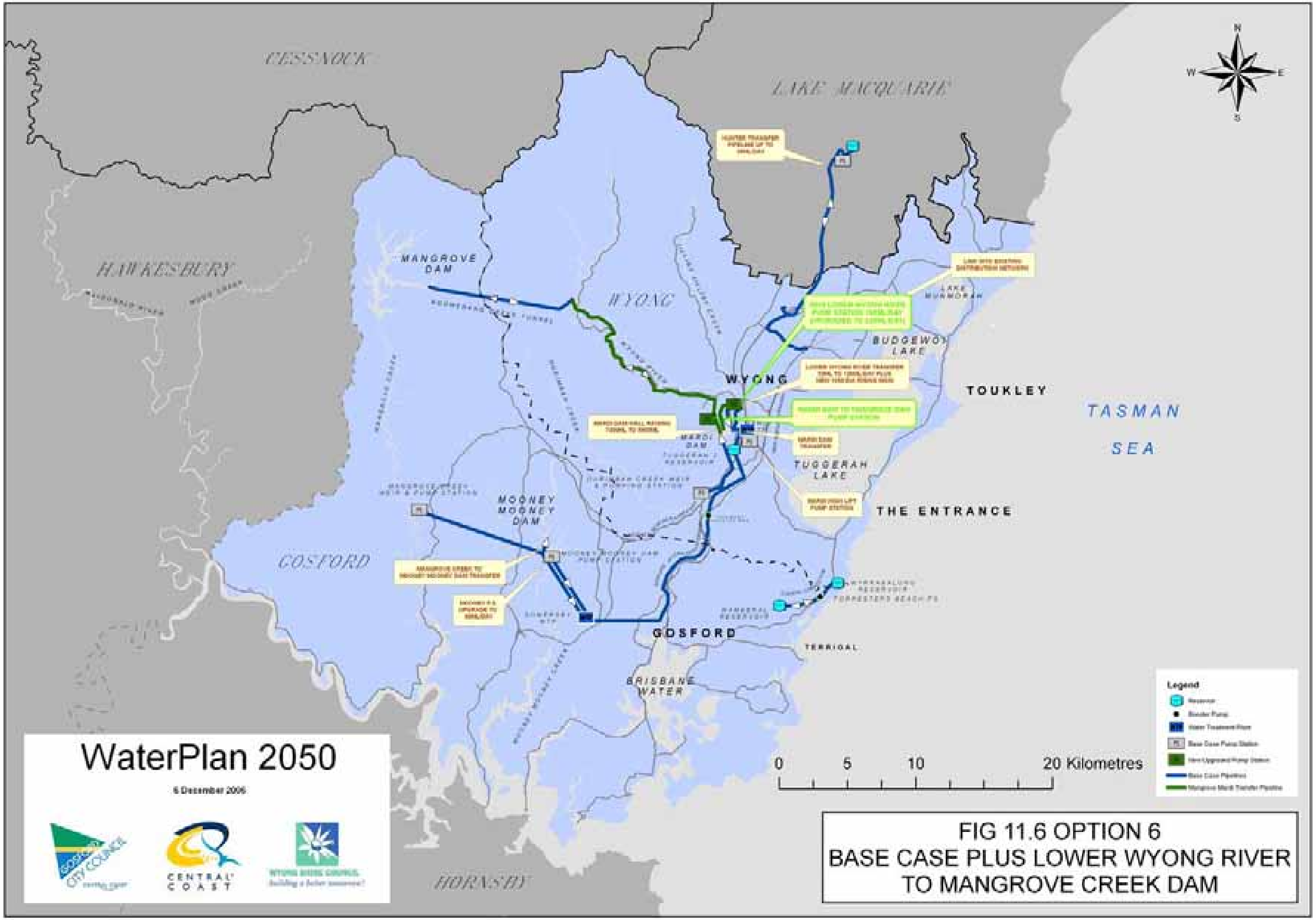

Figure 11-6 *Base Case* plus lower Wyong River to Mangrove Creek Dam transfer system

11.11 Option 7 – *Base Case* plus 20 ML/d permanent desalination plant

The GWCWA has prepared a concept design and an Environmental Impact Assessment for a 20 ML/d desalination plant on Wyong Council owned land adjacent to Toukley wastewater treatment plant as part of the drought contingency planning for the Central Coast water supply.

The intake for the plant will consist of a series of buried radial collector wells drawing seawater from underneath the ocean at Lakes Beach (refer Figure 11-7).

The disposal of the reject saline water (up to 30 ML/d) from the reverse osmosis (RO) process will be transferred to the existing Norah Head effluent ocean-outfall tunnel. This arrangement will have the added benefit of improving the performance of the outfall as the combined effluent and brine streams will approach ocean salinity levels for much of the time.

The treated water quality specification for the desalination plant will comply with the current *2004 Australian Drinking Water Guidelines* and match the existing town water quality as closely as possible. This will allow water to be pumped directly into the supply with no discernable taste impacts.

The consequence of the adopted treated water quality specification is that a two-stage RO system will be required. That is, the treated water from the first stage RO will need to pass through a second set of RO membranes.

The treated water from the desalination plant will be pumped to Toukley, where a connection to the existing water distribution system will be made. This will allow water to be fed into the Toukley, Budgewoi and the Entrance systems.

The 20 ML/d desalination plant will be incorporated initially into the Central Coast water supply as a base load supply (acting in a similar way to Option 1 – Tillegra Dam) substituting for surface water supplies. This will reduce the need for releases from Mangrove Creek Dam when the available flow in Wyong River, Ourimbah, Mooney and Mangrove Creeks is inadequate to maintain supply and the levels in Mardi and Mooney Dams are low.

In principle, the desalination plant will operate at 50% capacity once Mangrove Creek Dam recovers to 60% storage in order to reduce energy consumption and operational costs. This is the minimum operating capacity achievable without affecting the life of the RO membranes.

A 20 ML/d desalination plant in conjunction with the *Base Case* will be sufficient to satisfy the 2049 annual water demand. The *Base Case* plus 30 ML/d of desalination supply will satisfy the predicted annual water demand beyond the year 2050.

The principle disadvantage of desalination is the high-energy costs and associated green house gas production. The costs of operating the desalination plant has been calculated with power purchased from the State Grid (Option 7a) and with green power (Option 7b).

Table 11.8 Augmentation staging for Option 7

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of a 20 ML/d permanent desalination plant adjacent to Toukley WWTP	46,600

Augmentation Option	**7a / 7b**
Description	***Base Case* + 20 ML/d SWRO Desalination at Toukley (7a: Standard Power or 7b: Green Power)**
Basis of Option	Provides 20 ML/d of desalinated water from seawater for delivering into the town water supply system.

Financial	**7a (Standard Grid Power)**	**7b (Green Grid Power)**
Capital Cost	$85 M	$85 M
NPV (7% over 50 yrs)	$125 M	$135 M
$/KL Yield	$1.62/kL	$1.75/kL
Levelised Cost (gross)	$2.23/kL	$2.33/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment).	2009 to 2014
• Construction of 20 ML/d reverse osmosis desalination plant adjacent Toukley wastewater treatment plant.	2010
• Construction of intake wells at Lakes Beach.	
• Provide protective coating to the Norah Head outfall tunnel.	

Key System Attributes
- Does not rely on rainfall/streamflow for the supply of water.
- Provides a consistent supply of water.

Key Environmental Attributes
- Relatively high-energy use during operation compared to other options. For Option 7a, this will result in additional green house gas emissions.
- Construction of the desalination plant adjacent to the Toukley sewage treatment plant and the use of buried intake works will result in negligible visual impacts.
- Potential impacts to the aquatic environment from the discharge of the reject brine water from the desalination process will be minimised by discharging with effluent from the wastewater treatment plants.

Key Limitations
- Relatively high operating cost.
- Does not integrate well with other scheme elements and possible future elements such as Hunter Transfer systems and EFS in order to make better use of less expensive surface water supplies.
- Provides poor drought recovery time under dry climatic conditions.

Key Risks
- Operating cost is very susceptible to increases in the cost of electricity.

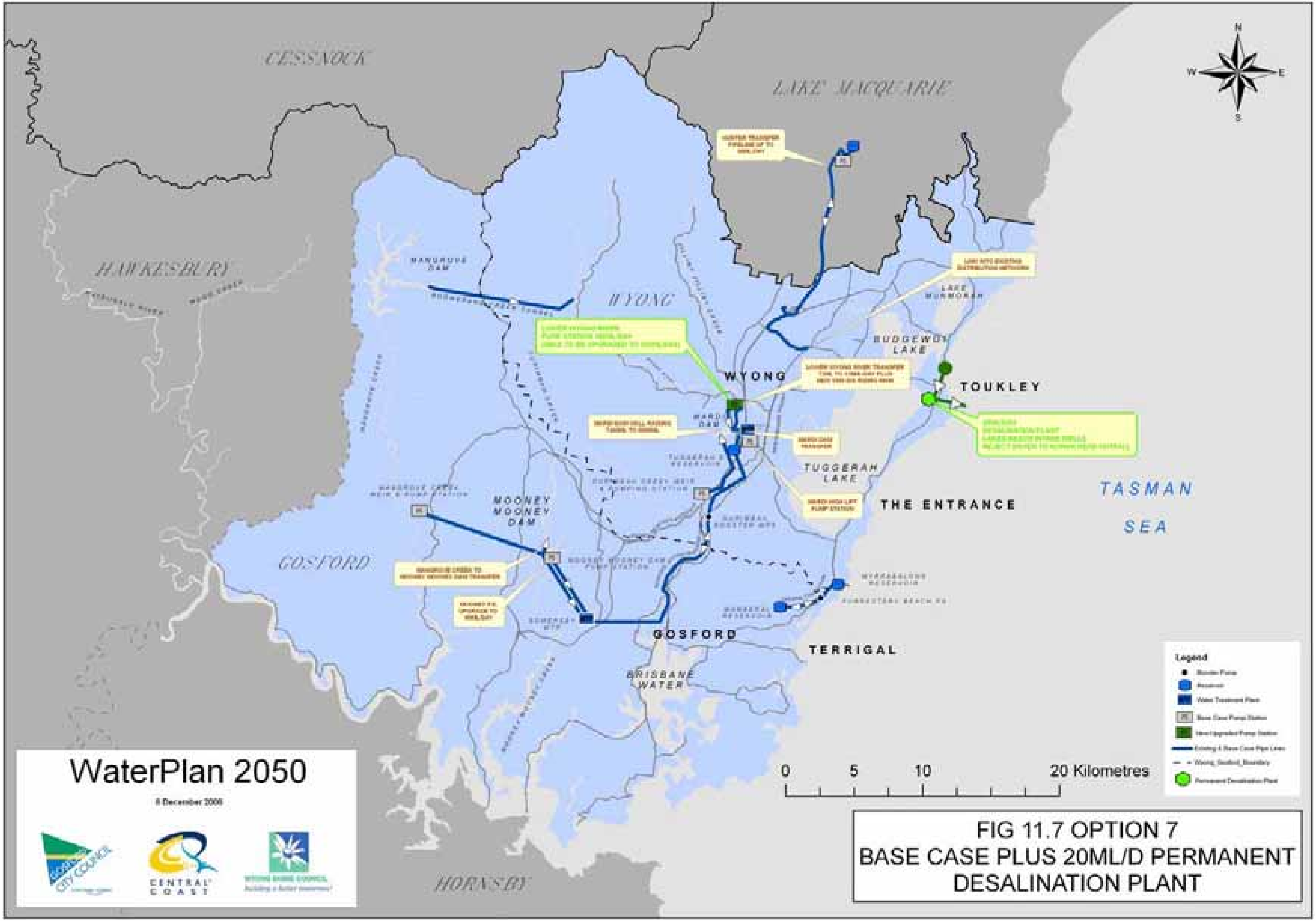

Figure 11-7 *Base Case* plus 20 ML/d permanent desalination plant

11.12 Option 8 – *Base Case* plus installation of rainwater tanks on existing houses

This option will involve the installation of 5 KL rainwater tanks on 80,000 existing residential dwellings. The option is based on the tanks will be supplying external garden watering and will be interconnected with the internal plumbing to provide water for toilet flushing and clothes washing.

The rainwater tanks will reduce town water demand and subsequently the need for releases from Mangrove Creek Dam to maintain supply. The filling of Mangrove Creek Dam will remain dependent on run off from the dam's relatively small catchment. The rainwater tanks will defer the need for an augmentation of the Central Coast water supply.

It is proposed that rainwater tanks be introduced progressively over the next 5 to 10 years through an expansion of the existing rainwater tank rebate-program with the full cost of the rainwater tank including installation met by Council.

In an average year, each rainwater tank could supply up to 82 KL of water. With the penetration of water saving devices such as dual flush toilets and front loading washing machines, it is estimated that the yield from the rainwater tanks will decline in conjunction with the and reduced demand to 64 KL/a per dwelling. **Note**: The adopted yield to system demand curve to 2050 incorporates progressive installation of water efficient appliances over time.

The installation of approximately 80,000 rainwater tanks on the Central Coast will increase the system yield from 40,000 ML/a to approximately 43,700 ML/a which is adequate to meet year 2038 annual water demands.

The financial assessment of this option is based on an assumed cost of $3,000 to retrofit a 5 KL tank on an existing home to supply external garden watering and internally for toilet flushing and clothes washing. The cost to install a rainwater tank and the plumbing alterations to the roof guttering and connections internally will vary significantly between individual homes. In many instances, the cost is likely to be significantly higher than the assumed $3,000 per house used in the financial analysis for this option. The maintenance costs are based on an average pressure pump-life of 10 years and not replacing the rainwater tanks during the 50-year life of *WaterPlan* 2050. The cost of pump replacement is factored into the financial analysis.

Table 11.9 Augmentation staging for Option 8

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d	-
2008-2017	Progressive installation of 80,000 5 KL rainwater tanks on existing dwellings	43,700

Augmentation Option **8a / 8b**

Description ***Base Case* + Rainwater Tanks at 80,000 Existing Dwellings (Option 8a by 2012 or Option 8b by 2017)**

Basis of Option Involves the installation of rainwater tanks onto existing homes as a method of offsetting demand from the water supply system.

Financial	**8a (80,000 tanks by 2012)**	**8b (80,000 tanks by 2017)**
Capital Cost	$250 M	$250 M
NPV (7% over 50 yrs)	$220 M	$189 M
$/KL Yield	$5.08/kL	$4.37/kL
Levelised Cost (gross)	$3.18/kL	$2.87/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment).	2009 to 2014
• Installation of 80,000 rainwater tanks on existing homes across the Central Coast.	2008-2012 (Option 8a) 2008-2017 (Option 8b)

Key System Attributes

- Requires minimal additional centralised infrastructure.
- Requires individual homeowners to install rainwater tanks on their homes.

Key Environmental Attributes

- Reduces the amount of water extracted from streams.
- The embodied greenhouse gas emissions are high compared to most other options.
- Reduces stormwater discharges from the residential areas and befits stormwater management.
- Provides the resident with a greater appreciation of household water use and water efficiency.

Key Limitations

- The Councils would have limited control on rate or number of tank installations.
- Provides poor drought recovery time under dry climatic conditions.

Key Risks

- Relies on individual residents to maintain tanks correctly over the long term. Potential for poorly maintained systems to increase demand on the town water supply.
- Several key parameters used in the estimation of the yield of a rainwater tank, such as roof area, tank size and internal connections are unlikely to be universally achievable for existing homes. Consequently, the achievable aggregate yield may be lower in practice than estimated.
- There is a high risk that 80,000 rainwater tanks will not be installed by 2012 or even 2017.
- The cost for many existing homes could be significantly higher than the $3,000 for internally connected tanks assumed in the financial analysis of these options.

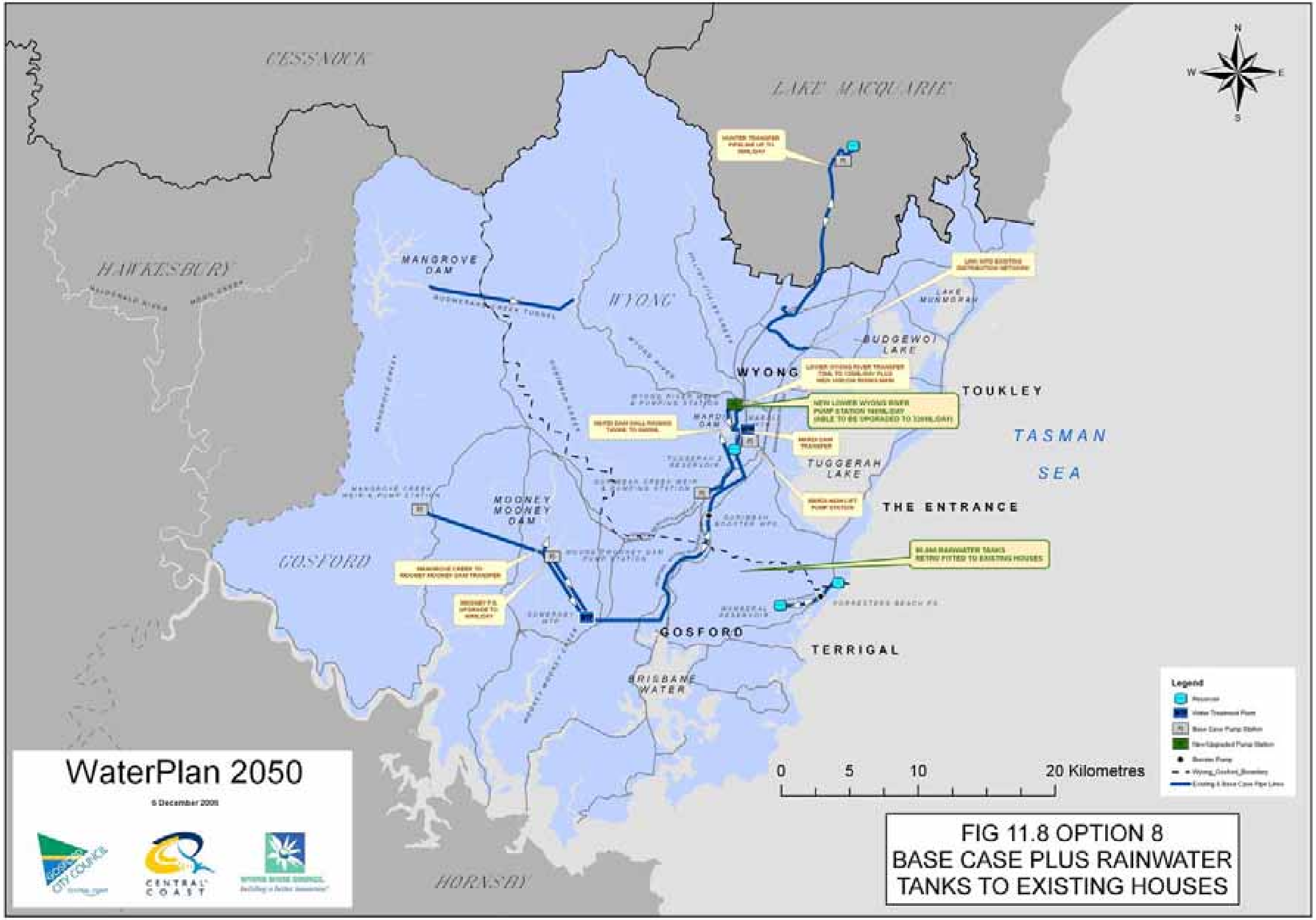

Figure 11-8 *Base Case* plus installation of rainwater tanks on existing houses

11.13 Option 9 – *Base Case* plus environmental flow substitution

Environmental Flow Substitution (EFS) seeks to free up natural stream-flows for extraction and use in the town water system. On the Central Coast, the Wyong River and Ourimbah Creek have the most stringent access conditions and hence provide the greatest opportunity for EFS. Conversely, Mooney Dam will not significantly benefit from an EFS scheme for the reasons outlined above.

WP2050 has identified several EFS proposals, and these are detailed below.

11.13.1 Warnervale stormwater

A stormwater harvesting project based on the collection, storage and transfer of excess runoff from future urban development in Warnervale will be used to provide environmental flows at lower Wyong River Weir.

A significant portion of the new development areas in the northern areas of Wyong Shire is upstream of Porters Creek Wetland. This wetland is the largest freshwater wetland on the Central Coast and has significant ecological value. To protect the naturally occurring wetting and drying cycles of the wetland, it is proposed that the new development includes water sensitive urban design principles. These aim to minimise the impact of increased and more rapid runoff from hard surfaces such as roads and roofs.

Hydrological assessment estimate that even with local water sensitive urban design measures in place that there will still be more water entering the wetland than under natural conditions, particularly during low and moderate rainfall events. The stormwater harvesting project will capture this water in local collection wetlands, transfer to a storage facility at the old brick pit, pipe it around Porters Creek wetland, treat in an artificial wetland and release it into the fish way on the lower Wyong River Weir (refer Figure 11-9). This water can be used to substitute for environmental flows.

This will enable additional water to be harvested from the lower Wyong River Weir than would otherwise have been possible when environmental flows are introduced.

In the longer term subject to a possible upgrading of the water treatment process, stringent risk management and monitoring measures being undertaken, there may be potential to release the collected runoff into the weir pool. This would provide some additional water during low flow periods when the natural flow in Wyong River is less than the available run-off.

The improvements in yield from this project are dependent on the rate of development and the resulting volume of stormwater produced from urban runoff.

11.13.2 Recycled water from Wyong South WWTP

Recycled water treated to meet ANZECC Guidelines for freshwater ecology can be used for EFS. An advanced water reclamation plant will be built adjacent to Wyong South wastewater treatment plant to provide further treatment to achieve the required water quality, including the removal of persistent pharmaceuticals.

The advanced water reclamation plant will include nutrient removal, micro-filtration, reverse osmosis, UV disinfection and infiltration through an artificial wetland (to remove residual nitrates). The treated water quality will comply with ANZECC requirements and will be suitable for EFS.

The average daily flow of recycled water from Wyong South WWTP is 7 ML/d increasing with predicted population growth to 14.4 ML/d by the year 2050. The recycled water produced from the reverse osmosis plant is approximately 70% of the average daily flow or 5 ML/d rising to 10 ML/d in 2050.

An EFS scheme based solely on recycled water from Wyong South WWTP would include a 10 ML/d advanced reclamation plant constructed in two stages of 5 ML/d each, a transfer pumping station and a 375 mm diameter pipeline (5 km in length) from Wyong South advanced water reclamation plant to lower Wyong River Weir (refer Figure 11.9).

11.13.3 Recycled water from Wyong South and Charmhaven WWTPs

Recycled water from Charmhaven WWTP can be transferred to Wyong South advanced water reclamation plant through the existing effluent main for treatment and transferred to lower Wyong River Weir for EFS (refer Figure 11-9).

The estimated daily volume of recycled water available from Charmhaven WWTP is 8 ML/d increasing to 24 ML/d in 2050 with predicted population growth in the Warnervale area. This corresponds to an output capacity from the advanced reclamation plant using flow from both Wyong South and Charmhaven WWTP of approximately 10 ML/d by the year 2014 rising to 20 ML/d by the year 2040 (allowing for some local recycling schemes in the new urban areas in Warnervale).

The infrastructure would be constructed in two stages with the initial stage involving a 10 ML/d advanced water reclamation plant, pumping station and a 375 mm diameter rising main to lower Wyong River Weir.

11.13.4 Recycled water from Kincumber WWTP

In Gosford City, environmental flow releases required from Mooney Dam are too small to warrant the major expenditure required for an EFS scheme using an advanced water reclamation plant at Kincumber WWTP.

Table 11.10 Augmentation staging for Option 9

Year	Description of the augmentation option	System Yield (ML/a)
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of a 10 ML/d advanced water reclamation plant at Wyong South WWTP and pipeline to lower Wyong River Weir.	43,800

Augmentation Option **9a / 9b**

Description ***Base Case* + Environmental flow Substitution 10 ML/d (Option 9a) or 20 ML/d (Option 9b) recycled water at Lower Wyong Weir**

Basis of Option Highly treated recycled effluent is discharged below lower Wyong Weir to offset increases in pumping from the Wyong River into Mardi Dam.

Financial	**9a**	**9b**
Capital Cost	$30 M	$52 M
NPV (7% over 50 yrs)	$37 M	$44 M
$/KL Yield	$0.78/kL	$0.75/kL
Levelised Cost (gross)	$1.37/kL	$1.41/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River. (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment)	2009 to 2014
• Construction of a 10 ML/d (Option 9a) or 20 ML/d (Option 9b) advanced water reclamation plant at Wyong South Wastewater Treatment Plant and transfer pipeline to the lower Wyong River Weir.	2010

Key System Attributes

- Allows greater extractions from Wyong River following the introduction of environmental flow rules.
- Could be easily modified to facilitate indirect potable reuse, date, if acceptable to the community.
- Could be extended to Ourimbah Creek Weir to support additional extractions.
- Provides poor drought recovery time under dry climatic conditions.
- Combines well with Option 6, enabling additional transfers to Mangrove Creek Dam.

Key Environmental Attributes

- Reduces the discharge of secondary treated effluent at the Norah Head ocean outfall.

Key Limitations

- EFS to lower Wyong River would partially compete with EFS from the Warnervale stormwater harvesting project. These could be off set by some EFS to Ourimbah Creek.

Key Risks

- The community could perceive the project as having a negative impact on Tuggerah Lakes.
- Government policy is currently being developed for EFS. There is currently uncertainty as to how the policy will affect this option.
- Contamination of biota with endocrine disrupting chemicals (EDC) and other persistent pharmaceuticals that might affect consumers of fish and shellfish from this environment due to lack of removal capacity of treatment systems.
- Thorough and continuing health and environmental impact risk analysis is required over the life of this operation.

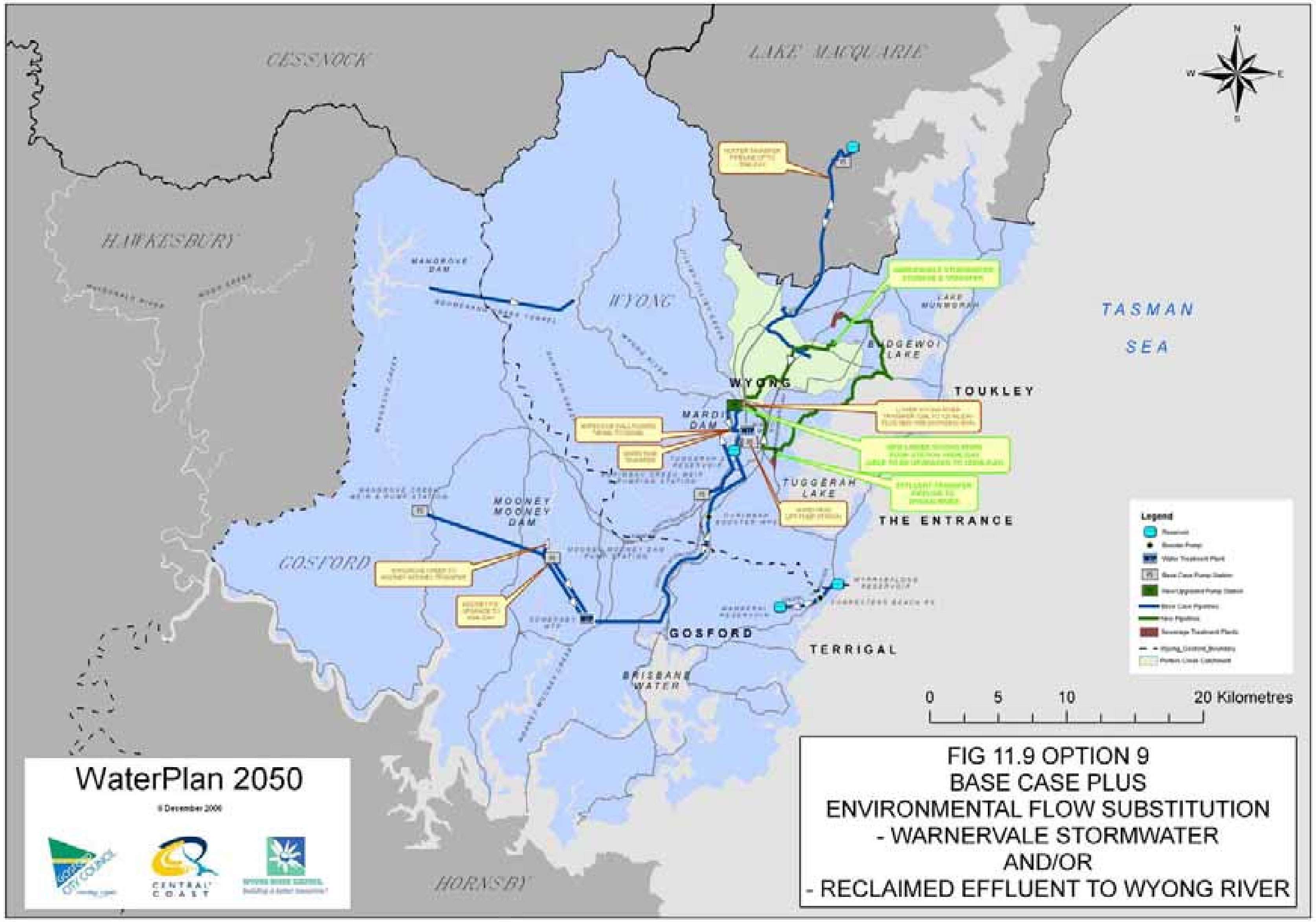

Figure 11-9 *Base Case* plus environmental flow substitution

11.14 *Option* 10 – *Base Case* plus indirect potable reuse

EFS can free up the natural streamflows in the river for extractions by the water supply. In low flow periods however, the recycled water volume can exceed the environmental flow requirement and the excess does not benefit the system yield.

Indirect potable reuse will provide a greater benefit for security of supply as the full volume is available for reuse. There are three potential opportunities for indirect potable reuse namely:

a transfers from Wyong South advanced water reclamation plant to lower Wyong River Weir and ultimately Mardi Dam;

b transfers from Charmhaven WWTP to Wyong South advanced water reclamation plant for further treatment before transfer to lower Wyong River Weir and ultimately Mardi Dam;

c transfers from Kincumber advanced water reclamation plant to Mooney Dam.

The infrastructure required is similar to that required for EFS except for higher treatment standards at the advanced water reclamation plant.

Indirect potable reuse particularly in Wyong Shire could be introduced with an initial stage involving EFS from Wyong South WWTP, with an option to follow later (subject to the establishment of a regulatory framework and community acceptance) by indirect potable reuse.

A flexible management approach could be developed for the lower Wyong River Weir to maximise the benefit of recycled water by changing the mode of operation from EFS in average/wet years to partial indirect potable reuse in drought years.

In Gosford Shire, an indirect potable reuse based on Kincumber wastewater treatment plant is part of a multi purpose scheme (developed in Gosford's IWCM) which includes supplying recycled water for parks and garden watering and new multi unit developments surrounding Gosford CBD, Somersby industrial estate with the remainder discharged to Mooney Dam for indirect potable reuse (refer Figure 11-10). Due to concerns about dilution in Mooney Dam, a maximum of 10 ML/d will be transferred from Kincumber advanced water reclamation plant to Mooney Dam.

Table 11.11 Augmentation staging for Option 10

Year	**Description of the augmentation option**	**System Yield (ML/a)**
2009	Completion of interim upgrade works and drought contingency works	40,000
2009 - 2014	Construction of lower Wyong River pumping station with ultimate capacity of 320 ML/d and install pumping capacity of 160 ML/d.	-
2010	Construction of a 10 ML/d advanced water reclamation system: • Wyong South WWTP to lower Wyong River: or • Kincumber WWTP and pipeline to Mooney Dam	44,000

Augmentation Option	**10a / 10b**
Description	***Base Case* + Indirect Potable Reuse 10 ML/d (Option 10a) 20 ML/d (Option 10b) highly treated recycled water into Mardi Dam**
Basis of Option	Recycled wastewater is highly treated and pumped to Mardi Dam for storage and use in the town water supply system.

Financial	**10a**	**10b**
Capital Cost	$34 M	$59 M
NPV (7% over 50 yrs)	$45 M	$50 M
$/KL Yield	$0.90/kL	$0.53/kL
Levelised Cost (gross)	$1.44/kL	$1.47/kL

Main Elements	**Completion Date**
• Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment)	2008 to 2009
• Construction of a 10 ML/d (Option 10a) or 20 ML/d (Option 10b) advanced water reclamation plant at Wyong South Wastewater Treatment Plant and transfer pipeline to the lower Wyong River Weir.	2010

Key System Attributes

- Provides a consistent supply of water unaffected by climatic conditions.
- Could be implemented in a staged approach by converting Options 9a &9b (EFS) following a rigorous trial period and acceptance by the community.
- Provides poor drought recovery time under dry climatic conditions

Key Environmental Attributes

- Reduces extractions from the creeks and rivers compared to the surface water options.
- Reduced discharge of effluent from the Norah Head Ocean Outfall.

Key Limitations

- Requires very high levels of system performance so that public health is maintained at all times.
- National guidelines covering indirect potable reuse are not in place yet. (proposed end 2007)

Key Risks

- There is a high risk that the community will not support the use of recycled wastewater in the town water supply system.
- There is a high risk that the necessary approvals would not be achievable in the near future.
- A breakdown of the; treatment process, management systems or monitoring systems would present a significantly higher risk to public health than other water sources.

Augmentation Option **10c**

Description ***Base Case*** **+ Indirect Potable Reuse 10 ML/d highly treated recycled water into Mooney Dam**

Basis of Option Recycled wastewater is highly treated and pumped to Mooney Dam for storage and use in the town water supply system.

Financial

Capital Cost	$54 M
NPV (7% over 50 yrs)	$65 M
$/KL Yield	$1.30/kL
Levelised Cost (gross)	$1.65/kL

Main Elements	**Completion Date**
▪ Construction of a new 160 ML/d pumping station on the lower Wyong River (civil works to cater 320 ML/d pumps, initial installation of 160 ML/d mech/elec equipment).	2008 to 2009
▪ Construction of a 10 ML/d reclaimed effluent treatment plant at Kincumber Wastewater Treatment Plant.	2010
▪ Construction of a 23.5 km long, 450 mm diameter pipeline to Mooney Dam.	2010

Key System Attributes

- Provides a consistent supply of water unaffected by climatic conditions.
- Does not offer the potential to be staged with initial implementation with EFS as a Mardi based system does.
- With the exception of desalination is the highest energy consuming and greenhouse gas emitting of option.
- Provides poor drought recovery time under dry climatic conditions.

Key Environmental Attributes

- Reduces extractions from the creeks and rivers compared to the surface water options.
- Reduced discharge of effluent from the Winnie Bay Ocean Outfall.

Key Limitations

- Limited potential to increase recycling volume due to the limited storage volume of Mooney Dam.
- Requires very high levels of system management, monitoring and performance so that public health is maintained at all times.
- National guidelines covering indirect potable reuse are not in place yet (proposed end 2007).

Key Risks

- There is a high risk that the community will not support the use of recycled wastewater in the town water supply system at this stage.
- There is a high risk that the necessary approvals would not be achievable in the near future.
- A breakdown of the; treatment process, management systems or monitoring systems would present a significantly higher risk to public health than other water sources.

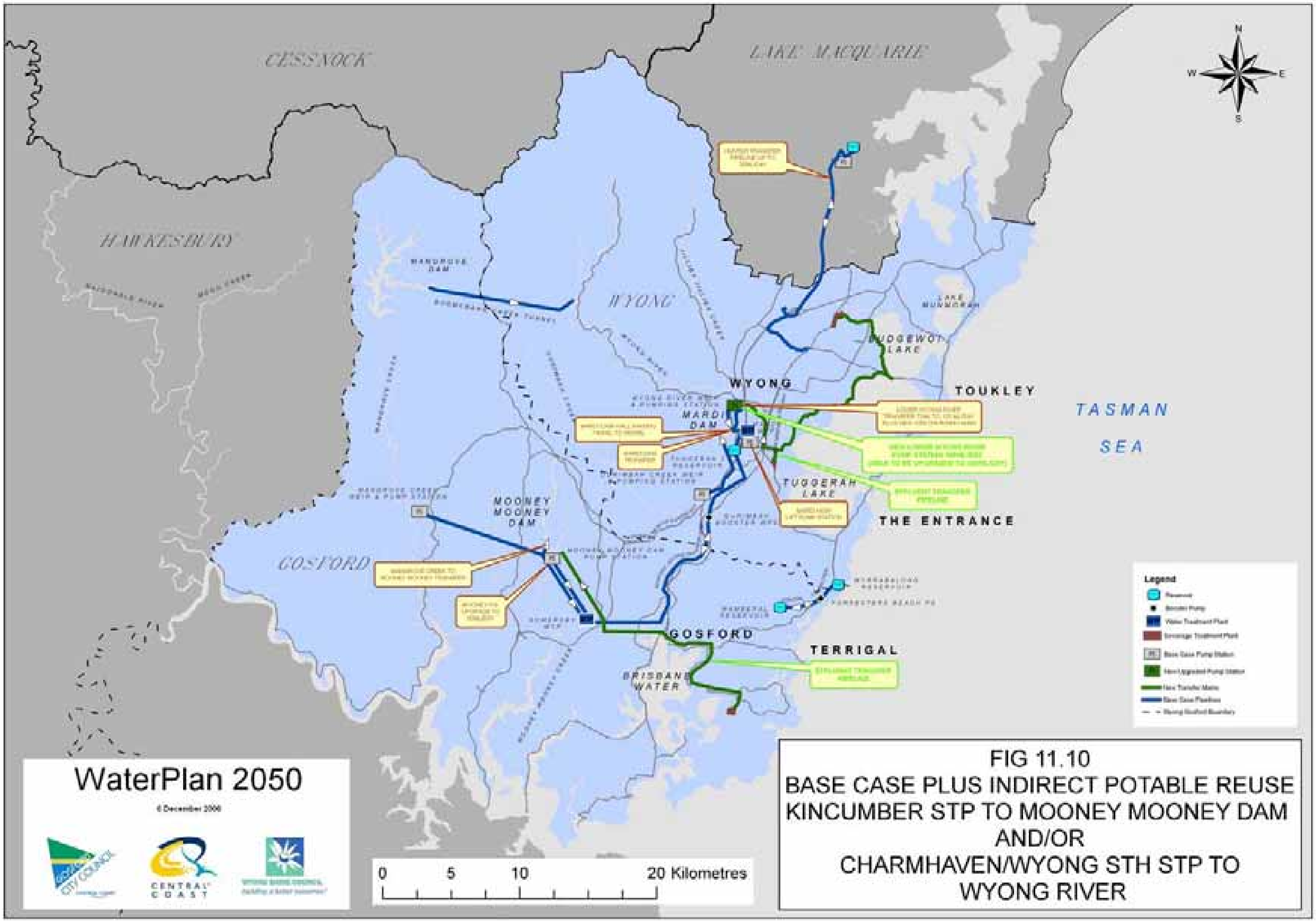

Figure 11-10 *Base Case* plus indirect potable reuse

11.15 Supplementary measures

The supplementary measures are designed to provide a small increment in yield to enable the water supply system (in combination with the *Base Case* and the initial augmentation option) to meet the 2050 demands. Four potential supplementary measures (apart from rainwater tanks) which will increase the system yield by 3,000 to 4,000 ML/a, these are:

a gates on Mangrove Creek Dam;

b 10 ML/d desalination plant;

c 10 ML/d of EFS at lower Wyong River Weir using recycled water;

d 10 ML/d of indirect potable reuse; and

e Stormwater harvesting – Warnervale.

The commissioning of the supplementary measures will depend on the initial augmentation option selected. Though no decision needs to be made now on selecting future supplementary measures, various combinations of the initial augmentation options and supplementary measures complement each other offering synergies while, other combinations offer much reduced benefits. The future supplementary measures therefore should be considered in the selection of the initial augmentation option.

Rainwater tanks will be progressively incorporated into the water supply system, as the old housing stock is either upgraded or demolished and rebuilt. Rainwater tanks will be incorporated progressively into a significant proportion of the housing stock by the year 2050.

11.15.1 Gates on Mangrove Creek Dam

Mangrove Creek Dam has been designed with provision to install 5 m high movable gates across the spillway channel. The gates will lift the top water level in the dam from RL 187.5 to 192.5 and increase the storage from 190,000 ML to 230,000 ML. The estimated cost to supply and install the gates is $5.6M.

The installation of gates is only justified if there is a transfer system from either Wyong River or MacDonald River (Options 2, 5 and 6) which maintains higher storage levels in Mangrove Creek Dam.

In the event that Hunter Water and GWCWA adopt *water banking*, the additional storage will improve the combined system yield and could potentially enable the deferment of the proposed Tillegra Dam in Hunter Water's area of operation.

The installation of gates on Mangrove Creek Dam increase the system security for the base case by about 3,000 ML/a and is extremely cost effective (refer Table 15.1). The provision of gates will raise the top water level and inundate an additional strip of vegetation around the perimeter of the storage.

Table 11.12 Relationship between system yield and storage in Mangrove Creek Dam

OPTION NO.	DESCRIPTION	GATED	SYSTEM YIELD (ML/a)
1	Lower Wyong River Weir to Mangrove Creek Dam transfer system.	No	46,000
1G	Lower Wyong River Weir to Mangrove Creek Dam transfer system.	Yes	50,000

11.15.2 10 ML/d desalination plant

This is similar to the proposal to construct a 20 ML/d desalination plant adjacent to Toukley WWTP. The smaller plant would not be required until approximately 2040, by which time the technology is likely to have improved significantly requiring considerably less energy to pass through the reverse osmosis plant.

11.15.3 Effluent flow substitution

This supplementary measure is based on the construction of a 10 ML/d advanced water reclamation plant at Wyong South WWTP and a pumping station and pipeline to lower Wyong River Weir to transfer highly treated reclaimed water to the downstream side of the weir.

11.15.4 Indirect potable reuse

This is similar to the EFS measure but with the discharge point upstream rather than downstream of the weir. The yield benefit of 10 ML/d of indirect potable reuse at lower Wyong River Weir is similar to 10 ML/d of EFS, though it is more compatible with Warnervale stormwater harvesting used as EFS.

12. Assessment of Augmentation Options

The Base *Case,* plus each of the ten augmentation options in Section 11, has different outcomes and system yields. Each augmentation is required prior to demand exceeding the system yield.

Successive augmentations will be generally based on adding one of the other remaining options to form a 50-year strategy. The compatibility of the options varies with some complementing each other and others being incompatible.

This section deals with the selection of the initial augmentation options, which will then be developed into strategies to meet the 50-year design horizon in *WaterPlan 2050*. The selection is based on the following primary criteria:

a financial assessment (Section 12.1);

b environment impact (Section 12.2);

c social impact (Section 12.3);

d system operation (Section 12.4); and

e ability to implement the option (Section 12.5).

For each of these primary criteria, there are several secondary criteria addressing issues that are more specific. The assessments in this Section provide the basis for identifying the best initial augmentation options.

12.1 Financial assessment

There are a number of financial indicators to be considered in making a capital investment on the Central Coast water supply. These include:

a capital cost;

b operating and maintenance costs;

c net present value (NPV) of the capital, operating and maintenance costs;

d impact on the customer through water charges (extra annual charge);

e the internal rate of return (IRR) for funds invested in the water supply;

f NPV per ML/a of system yield; and

g levelised costs.

The capital works program for a major infrastructure project such as the Central Coast water supply will be staged and spread over a number of years. <u>Net present value</u> is a standard method for financial evaluation of long-term projects and capital budgeting. Essentially, it assesses the present value in "today's dollars" of future cash flows of capital expenditure and ongoing operation and maintenance costs.

The <u>discount rate</u> used in the calculation of the net present values is a key input. The NSW Treasury has issued guidelines recommending sensitivity testing with 4, 7 and 10% discount factors with 7% discount factor being most commonly used for water infrastructure projects.

From the customer's perspective, the <u>extra annual charge</u> for residential customers will determine the affordability of implementing a particular course of action. The rating impact can be calculated in a number of ways and is affected by the specific financing arrangements of the investments. For the purposes of this analysis, the extra annual charge is the annual charge required to pay for the NPV capital (Capex) and operation and maintenance (Opex) costs of the option after developer contributions have been deducted.

The internal rate of return (IRR) on investment takes account of the cash flow of outlays on Capex and Opex and the environmental and social costs/benefits of each option including the value of new water supplied to consumers.

The unit cost/kL of system yield for each option is calculated by converting the NPV of each option (Capex & Opex) to an annual cost and dividing by the increase in annual yield for the option. This provides a measure of the cost effectiveness of an option to improve the yield of the scheme.

Levelised cost is frequently used to compare options and is a useful tool in ranking the cost effectiveness of options. The levelised cost is the cost in $/KL that would need to be charged on all new water supplied in excess of the current demand (2006 unrestricted average annual use) to fund the capital and operating costs of each option. The gross levelised cost considers the capital (Capex) and operation and maintenance (Opex) costs of the option. The net levelised cost includes the capital (Capex) and operation and maintenance (Opex) costs of the option together with the environmental and social costs/benefits (excluding the value of the water supplied).

In the case of the augmentation options in Section 11, the augmentations are designed to optimise the yield of the system and not a specific demand.

12.1.1 Financial Considerations and Results

The financial analysis of the options provides an assessment of the costs and benefits of the options relative to the *Base Case*. The analysis has been undertaken over a 50-year period with annual demands and associated operational costs increasing with predicted demand increases detailed in Section 6.

The Department of Commerce has estimated the likely capital, operating and maintenance costs for the staged program of works for the *Base Case* and each of the ten augmentation options. The capital costs were estimated using the *NSW Reference Rates*[15] published by the DEW and indexed to the year 2006.

The operating costs are based on the following assumptions:

a $80 / MW h for standard grid bulk power charges.

b $135/MW h for green-grid bulk power charges.

c Fixed annual operation and maintenance cost of 0.5% of capital costs for civil works and 4% for pumping stations, water reclamation plants and desalination plants.

d Special additional operating costs associated with membrane replacements are included for desalination plants and water reclamation plants.

e Water treatment costs have been assessed at a marginal operating cost of $50/ML of plant throughput. Plant throughput has been based on the average annual consumption reduced by amount of water from other sources including rainwater tanks, desalination and purchases from the Hunter.

Environmental and Social Benefits/Costs

The economic value of the environmental and social benefits/ costs has been based on the following Environmental Flow Benefits:

a Water supplied to satisfy environmental flows in low flow periods in the Wyong River is assumed to produce an environmental and social benefit of $200/ML.

b Options which speed storage recovery and allow earlier introduction of water sharing plan environmental flows, provide a greater benefit than the *Base Case*.

c An environmental benefit of \$20/ML is placed on high flows in the Wyong River. Schemes, which pump more water from high flows in the Wyong River, show a dis-benefit relative to the *Base Case,* and relative to alternate sources such as rainwater tanks, recycled water and desalination.

Greenhouse Gas Emissions and Carbon Tax (Greenhouse Gas Abatement Costs):

a Embodied energy estimates have been derived from assessments of embodied energy and $C0_2$ emissions for materials and equipment, provided by the Royal Melbourne Institute of Technology. The footprint estimates are based on the area of forest required to sequester the total CO_2 emissions assuming a photosynthetic rate of 30 tonnes CO_2 /Ha/year. Further discussion is in section 12.2.3.

b A carbon tax, of \$40/ tonne(Aus \$), of CO_2 emissions has been applied based on the recent UK Stern Report assessment of a mid-range value of US \$30/tonne.

Value of Water Supplied:

a Water supplied to consumers is valued at \$1.30/kL.

Value of Water in Storage:

a Water held in storage at MCD to supply water in future droughts is treated as an asset with a value of \$0.50/kL. The simulation analysis calculates the net present value of the annual increments in stored water value over the 50-year analysis period.

b Options, which achieve faster recovery than the *Base Case,* show an increase in the net present value of the stored water.

c This factor also identifies extra value in schemes, which are more robust in the long-term.

The staging of the works is based on system modelling to ensure the yield of the system always exceeds the projected annual demands.

A detailed summary of all financial indicators is provided in Table 15.1 .

12.2 Environmental Impact Assessment

Local water sources will continue to be the major source of supply for the Central Coast. The preliminary environmental assessment undertaken in this Section does not revisit the impact of the existing system, the interim upgrade works and drought contingency measures. These have been addressed separately in successive environmental assessments.

The environmental impact of extractions from surface water sources on the Central Coast will be addressed in the Central Coast Water Sharing Plan (refer Section 7). Protection for surface water sources will be achieved by the introduction of access conditions in water licences held by all entitlement holders.

This preliminary environmental assessment is principally concerned with the incremental impact of the augmentation options and is designed to assist in the selection of the proposed augmentation option. The environmental impact is considered under the following criteria:

a aquatic ecology;

b terrestrial ecology; and

c air pollution - green house gas production.

In many instances, it is possible to develop measures to reduce or eliminate the environmental impact. Where feasible, mitigations measures have been included together with estimated costs.

12.2.1 Aquatic Ecology

The impact of the initial augmentation options on the aquatic ecology can be considered under the following categories:

a impact of extracting water from surface water sources;

b construction of in stream structures;

c inter valley transfers of water affecting the biological communities within the acceptor basin:

  i impacts from physical characteristics of the transferred water (e.g. temperature, turbidity, conductivity);

  ii impacts from chemical constituents within the water (e.g. nutrients);

  iii biological impacts from the transfer of water (e.g. pathogens, weeds and pest species of fauna);

d impact of releases from Mangrove Creek Dam:

  i natural streamflows;

  ii cold water pollution; and

  iii river geomorphology.

12.2.1.1 Impact of Extractions

The Central Coast water supply relies on two separate coastal catchments for the capture of water for water supply purposes. Wyong River and Ourimbah Creek are tributaries of Tuggerah Lakes and Mangrove Creek and Mooney Mooney Creek are tributaries of the Hawkesbury River.

With the current system configuration, water from Wyong River and Ourimbah Creek is transferred to Mardi Dam before treatment and distribution to the customers. Mangrove Creek Dam currently stores water from its catchment and discharges it to the upper Wyong River and Mangrove Creek. Water from Mangrove Creek Weir and Mooney Dam is currently piped directly to Somersby WTP.

Under the drought contingency measures, the rising main from Mangrove Creek Weir to Somersby WTP will be connected to Mooney Dam to enable the transfer and storage of some high flows.

Water from Mangrove Creek Dam can be released to the upper Wyong River through the Boomerang Creek Tunnel and to Mangrove Creek through the variable level outlet tower.

Releases from Mangrove Creek Dam have occurred over most years since its construction.

The protected nature of the catchment and storage minimises the potential for inter-basin transfers of exotic aquatic flora and fauna from Mangrove Creek Dam to the lower reaches of Mangrove Creek and Wyong River. An aquatic survey undertaken on Mangrove Creek Dam indicated that no exotic fish species are currently present in the storage.

The DNR is preparing the Central Coast Water Sharing Plan. The plan is designed to improve the river health of the Central Coast rivers and share water between the environment and consumptive users.

The *Water Sharing Plan for the Ourimbah Creek* was completed in 2003. It is envisaged that this plan will be amended in conjunction with the preparation of the Central Coast Water Sharing Plan to achieve an integrated approach to the management of the four streams, which supply the Central Coast. The *Water Sharing Plan for the Ourimbah Creek* provides low flow protection and limits extraction through out the flow range for all users in the valley. Access conditions in the water licences issued for Ourimbah Creek currently reflect this WSP, which was developed without consideration of Wyong River, Mooney Mooney and Mangrove Creeks.

The impact of the Central Coast water supply extractions from lower Wyong River is limited to the tidal river downstream of the weir and the impacts of changed streamflows on water quality and aquatic flora and fauna in Tuggerah Lakes. Water releases, from Mangrove Creek Dam into the Wyong River, at Bunning Creek, affect a substantial length of Wyong River.

The application of the WSP approach to Wyong River will change the low flow extraction which forms the bulk of the current transfers to Mardi Dam and require greater extractions at higher flows to compensate. GWCWA and DNR have agreed to undertake a detailed aquatic study of the lower reach of Wyong River below the existing weir and Tuggerah Lakes to assess the environmental impact of the current and possible future extractions.

While the *Base Case* and the ten augmentation options listed below have been assessed using the access flow conditions specified in Table 8.1, the aquatic impact of the options will vary due to differences in the sources of supply, location of pumping stations and the rates of extraction. In Options 2 to 6, water is transferred between valleys affecting the natural streamflows.

An environmental flow regime cannot be introduced until the storage in Mangrove Creek Dam has recovered and the Central Coast water supply augmented to increase system yield under the changed access conditions. In the interim, current access is limited by conditions that apply for Wyong River, Mangrove Creek and Mooney Mooney Creek. The access conditions for Ourimbah Creek are detailed in the Ourimbah Creek WSP.

For all the options, environmental flows cannot be introduced until the system storage has recovered and the supply augmented to enable the proposed access conditions to be introduced. In the interim, the current access conditions will apply for Wyong River, Mangrove Creek and Mooney Mooney Creek.

a Option 1 (Tillegra Dam) involves the transfers of up to 35 ML/d of water from the Hunter. The water provided from Hunter Water will be part of Hunter Water's entitlement and be subject to the access conditions set out in its water licences. The Hunter connection will not affect the operation of the Central Coast water supply apart from enabling the introduction of environmental flows.

b Option 2 – the upper Wyong River to Mangrove Creek Dam transfer system is based on the extraction of water from high flows in the upper Wyong River. The water will be pumped through to Mangrove Creek Dam for storage. Water released from Mangrove Creek Dam to Bunning Creek will flow down the Wyong River for extraction at lower Wyong River Weir.

  Extractions from upper Wyong River Weir will reduce high flows and the releases from Mangrove Creek Dam will increase low flows for the length of river from the upper to lower Wyong River Weirs. In all other respects, the system will be similar to the *Base Case*.

This option also includes the installation of a collapsible weir to minimise the impact in-streamflows, fish migration and river geomorphology.

c Option 3 – Mangrove Creek Weir to Mangrove Creek Dam transfer system is based on extracting from high flows in lower Mangrove Creek at the weir.

DNR has advised that it will introduce access conditions on extractions from Mangrove Creek Weir similar to those proposed for Wyong River if this option proceeds. With the introduction of access conditions to limit the proportion of daily flows that can be extracted, this option is unlikely to affect the aquatic ecology or water quality in the Hawkesbury River.

d Options 4 – second lower Wyong off-creek storage (Toobys Creek Dam) is based on extracting from the medium to high flows in the lower Wyong River and Ourimbah Creek. The weir on the lower Wyong River is at the tidal limit.

Wyong River is the largest surface water on the Central Coast and the potential impact will be assessed in the proposed environmental studies.

e Option 5 involves extracting water from MacDonald River upstream of St Albans for transfer through to Mangrove Creek Dam. The impact of this extraction may affect the aquatic ecology of the MacDonald River and will compete with existing water uses between St Albans and the Hawkesbury River.

f Option 6 – the lower Wyong River to Mangrove Creek Dam transfer system is based on extracting a proportion of the medium to high flows from lower Wyong River and Ourimbah Creek. The water is stored in Mardi Dam before transfer by pipeline through Mangrove Creek Dam.

While the potential to transfer pest species from Mardi Dam to Mangrove Creek Dam has been assessed as low, it is proposed to install fine mesh “Johnson screens” in Mardi Dam outlet tower to exclude fish, fish eggs and weed species.

Releases from Mangrove Creek Dam (which currently are discharged into Bunning Creek - a tributary of Wyong River), will be transferred by pipeline from Boomerang Creek Tunnel to the Mardi WTP. This would result in Wyong River below Bunning Creek returning to a natural flow regime.

g Options 7, 8, 9 and 10 interact with the Central Coast streams in a similar manner to the *Base Case*. The additional water requirements over and above the *Base Case* are provided by alternative sources. In the case of Option 9 (EFS), the substituted flows will be treated to the necessary water quality to ensure ecological protection.

12.2.1.2 Construction of New In-stream Structures

Option 2 involves the construction of a weir and pumping station on the Wyong River downstream of the junction with Bunning Creek. The construction of the weir and diversion of the river will affect the local habitat and the weir has the potential to affect the migration of fish and the river geomorphology over the long term. This option includes the installation of a collapsible weir to minimise impacts during low to medium flows when extractions from this location are not occurring.

Option 5 involves the construction of a weir and pumping station on the MacDonald River. The MacDonald River at the weir site has a far larger catchment than a weir on upper Wyong River with very significant flood flows with high bed movement. A weir will need to be a significant structure to withstand the major flood events. The construction of the weir and pumping pool will affect local habitat and the weir has the potential to affect the migration of fish and the river geomorphology over the long term.

The construction of Toobys Creek Dam (Option 4) will effectively isolate Toobys Creek from Ourimbah Creek limiting the movement of biota. The length of creek between the dam and Ourimbah Creek will be deprived of flow adversely affecting the creek ecology. The dam will also prevent the movement of bed material downstream potentially affect the downstream creek geomorphology.

12.2.1.3 Impact of Inter-Valley Transfers

The surface water options involving inter valley transfers of water are:

a proposed transfer system from upper Wyong River to Mangrove Creek Dam (Option 2) will transfer water from upper Wyong River Weir direct to Mangrove Creek Dam;

b proposed transfer system from MacDonald River to Mangrove Creek Dam (Option 5) will transfer water from the MacDonald River weir direct to Mangrove Creek Dam; and

c proposed transfer system from lower Wyong River to Mangrove Creek Dam (Option 6) will supply water sourced from the Wyong River and Ourimbah Creek and temporarily stored in Mardi Dam to Mangrove Creek Dam.

Wyong and MacDonald River catchments and Ourimbah, Mangrove and Mooney Mooney Creek catchments have been partially cleared and developed. Exotic aquatic and terrestrial flora and fauna have been introduced and there is the potential to contaminate Mangrove Creek Dam and the upper reaches of Mangrove Creek.

Field assessments of Mardi Dam and Mangrove Creek Dam have been undertaken. The habitats of both storages are in good condition with no exotic species detected.

Mardi Dam will act as a barrier for transfers from lower Wyong River to Mangrove Creek Dam and provides opportunities for monitoring and surveillance. The installation of micro screens on the Mardi Dam outlet tower and ongoing monitoring and pest control in Mardi Dam will further reduce the likelihood of the transfer of exotic aquatic flora and fauna to Mangrove Creek Dam.

With Option 2, the transfers of high flows from upper Wyong River to Mangrove Creek Dam could lead to the introduction of exotic flora and fauna into the dam. While it is feasible to install a micro screens on the inlet to the pumps, the performance of such screens in flood events with high turbidity and flotsam is questionable. Similar arguments also apply to MacDonald River transfers.

Similarly, it is possible to transfer algae from one catchment to another. The transfer of blue green algae from Wyong River, Mardi Dam and MacDonald River to Mangrove Creek Dam could lead to a serious contamination of the storage if the nutrient levels and temperatures in the stored water are favourable for an algal bloom.

The spread of exotic aquatic flora and fauna and the transfer of algae and pathogens can be contained by a multiple barrier approach. The multiple barriers can be a combination of physical barriers such as screens/filters, storage detention and by ensuring the water supply system does not provide a suitable habitat for growth. For instance, algal blooms can be prevented by maintaining low nutrient levels in the stored waters.

The proposed multi barrier approach for Option 6 with extractions from Wyong River and Ourimbah Creek and transfer to Mardi Dam includes:

a regularly monitor the nutrient levels in Wyong River, Mardi and Mangrove Creek Dams and take preventative action if necessary;

b undertake regular aquatic surveys of Mardi Dam and Mangrove Creek Dam for early detection of exotic aquatic flora and fauna;

c provide separation of intake and outlet works in Mardi Dam to ensure a minimum 30 days detention in the storage to allow settlement of particulate matter;

d continue aeration of Mardi Dam to prevent stratification and subsequent short circuiting in the storage;

e provide 500 micron screens on the intake to the high lift pumping station at Mardi Dam (for transfers to Mangrove Creek Dam) to preclude the entry of fish, fish eggs and aquatic weeds; and

f install an aeration system in Boomerang Creek to prevent stratification near the inlet to Boomerang Creek Tunnel.

12.2.1.4 Impact of Releases from Mangrove Creek Dam

GWCWA commissioned Sinclair Knight Merz Consultants to undertake a risk assessment of the potential thermal impacts arising from the operation of Mangrove Creek Dam. The assessment was based on the discharge of Mangrove Creek Dam water to upper Wyong River through Boomerang Creek Tunnel and Mangrove Creek through the variable level outlet tower in the dam.

The report's conclusions regarding discharges to Mangrove Creek are still relevant and are as follows:

a The degree and extent of thermal impact from discharge from Mangrove Creek Dam to Mangrove Creek is likely to be minimal as a consequence of the ability to manipulate the source of transferred water through the existing multilevel off take, the present management objective of preventing thermal stratification (through artificial destratification of the stored waters) and substantial tributary inflows downstream of the dam.

b Because of the thermal stability of water stored within large dams, the daily range of natural stream temperatures within Mangrove Creek will become less extreme during transfers from Mangrove Creek Dam.

c In all scenarios, the extent and magnitude of impact cannot be evaluated given available data. Extent and magnitude will be a function of the temperature differential and volume of discharges and flows in receiving waters, ambient air temperature, inflows from tributaries and/or groundwater and other factors.

The releases to Mangrove Creek will continue to occur to supplement natural flow from the dam to Mangrove Creek Weir for all options except Option 3.

For all options except Option 6, Mangrove Creek Dam will continue releases to Wyong River for extraction downstream at the lower Wyong River Weir. These releases alter the natural streamflow, lead to increased bank erosion and potentially introduce cold-water pollution.

Cold-water pollution can be mitigated by installing an aerator close to the tunnel inlet to destratify the water in the Boomerang Creek arm of Mangrove Creek Dam. The outlet tower has provision for selective draw-off.

For Option 6, the transfer system will supply water from Mangrove Creek Dam back to Mardi WTP eliminating the need for releases from Mangrove Creek Dam to upper Wyong River. This will benefit the upper Wyong River ecology by protecting the natural streamflows and river geomorphology, eliminating cold-water pollution.

12.2.1.5 Aquatic Impact of Tillegra Dam

Tillegra Dam will act as an on-stream storage. The water licence for the Dam will specify the minimum flow that must pass through the Dam and the percentage of higher flows that can be retained in the storage for the benefit of Hunter Water and the Central Coast. This is often referred to as transparency and translucency.

The Dam will reduce the natural streamflows downstream, attenuate flood events and act as a barrier to fish migration. The releases of inflows into the dam can affect the downstream water quality and temperature. While the water quality will generally improve in the storage, it may affect the food sources for the aquatic flora and fauna. Releases from the Dam can lead to cold-water pollution, which can be attenuated by variable level outlet towers.

In addition, any bed material transported by the river will settle out in the storage. The water released from the Dam can cause erosion and bank instability downstream of the Dam and changes to the natural riverbed.

The construction of the Dam has also the potential to result in erosion at the borrow pits, quarries, access roads and Dam site and sedimentation in the river covering the natural riverbed.

The environmental impact of the proposed Tillegra Dam will be addressed in detailed aquatic studies associated with the environmental assessment of the proposal.

12.2.1.6 Aquatic impact of desalination plant

The impact on the aquatic ecology of a desalination plant adjacent the Toukley STP has been assessed separately in a Statement of Environmental Effects accompanying a development application lodged with the Department of Planning. While there is potential for a short term impact associated with the construction of the buried radial collector wells drawing sea water from underneath the surf zone at Lakes Beach, the long term issue of seawater concentrate (double salinity water) disposal has been resolved by discharging through the existing ocean outfall at Norah Head. The concentrate will blend with treated effluent and the “shandy” will approach the salinity levels in the sea.

12.2.2 Terrestrial Impacts

The replacement of the existing lower Wyong River pumping station and the construction of a new Mardi Dam outlet pumping station are common to all options. These works are subject to environmental assessment as part of the interim upgrade works.

Option 1 involves the construction of Tillegra Dam on the Williams River at Tillegra. The land is substantially cleared farmland. The dam is not expected to inundate areas of high conservation value. The option includes the re-afforestation of 2000 hectares around

Tillegra Dam to provide a water quality buffer and a carbon sink for greenhouse gas offsets.

Option 2 involves the construction of a weir and pumping station on the upper Wyong River and a 500 m pipeline predominately through cleared rural land adjacent to Bunning Creek to the portal of Boomerang Creek Tunnel. The weir requires a 200m diversion of Wyong River. The environmental impact will be the loss of approximately 500 m of riparian vegetation along the river for the diversion works and weir pool.

Option 3 involves the construction of an access road and pipeline from Mangrove Creek Weir to Mangrove Creek Dam. The route runs through a mixture of private farming land and bushland adjacent to Mangrove Creek.

Option 4 involves the construction of Toobys Creek Dam and a tunnel through to Mardi Dam. Toobys Creek Dam will involve substantial clearing of the dam site, quarry and storage area and the permanent loss of valuable habitat. The environmental impact of the construction of this dam is considered high.

Option 5 involves the construction of a weir and pumping station on MacDonald River, construction of an 18 km access road and pipeline along Mogo and Little Mogo Creek and a

2.8 km tunnel under the Judge Dowling Range to Mangrove Creek Dam. A significant length of the access road and pipeline and the tunnel are located in Yengo National Park.

A 10m wide strip along the pipeline route would be cleared to provide access and lay pipe along Little Mogo Creek. The section within the National Park would have a significant impact due to the clearing of native vegetation, the probable introduction of exotic weeds in the disturbed soil and the potential for soil erosion.

Option 6 involves the construction of a pipeline from Mardi Dam to Boomerang Creek Tunnel predominately through cleared rural lands. The pipeline route will be selected to avoid areas of high conservation value and where feasible run adjacent to the road either in the road easement or in private property adjacent to the boundary fence. The environmental impact of the pipeline is principally short-term construction impacts.

Option 7 involves the construction of a desalination plant adjacent to Toukley wastewater treatment plant. A detailed environmental assessment has been prepared separately and the impact on the land, which is cleared of native vegetation, is not significant but there is a short-term impact associated with the construction of the buried radial collector wells at Lakes Beach.

Option 8 involving the installation of 80,000 rainwater tanks in private property will have a very limited impact on terrestrial flora and fauna in the cleared area immediately adjacent to the tank.

Option 9 involves the construction of a water reclamation plant adjacent the existing Wyong South wastewater treatment plant and a 5 km pipeline from the water reclamation plant to the existing lower Wyong River Weir. The pipeline route will be selected to avoid areas of high conservation value and where feasible run adjacent to the road either in the road easement or in private property adjacent to the boundary fence.

Options 10a and 10b involve the construction of an advanced water reclamation plant adjacent the existing Wyong South wastewater treatment plant and a 5 km pipeline from the water reclamation plant to the existing lower Wyong River Weir.

Option 10c involves the construction of a water reclamation plant at Kincumber wastewater treatment plant and a pipeline from Kincumber to Mooney Dam. The pipeline will run where possible in the road reserves in the urban and industrial areas. A pipeline easement may be required once the route is finalised through private property on Somersby plateau.

12.2.3 Air Quality (or Energy Efficiency & Greenhouse Emissions)

The major impact of the Options on air quality is related to greenhouse gas emissions – both embodied and operational. Local air quality impacts resulting from construction and operation of all options are considered similar and can be managed using current best practices.

Carbon dioxide (the primary green house gas, $C0_2$) emissions (in terms of CO_2 equivalent, representing all greenhouse gases) have been estimated to construct and operate the *Base Case* and for each augmentation option over the 50 year design period.

The “embodied” carbon dioxide to construct each option is based on the emissions of carbon dioxide to manufacture the construction materials and equipment (i.e. plastic, steel concrete and mechanical equipment, refer Section 12.1.1) and does not include the transport of manufactured articles to site or onsite construction emissions. These are considered to be similar for all options.

The carbon dioxide emissions associated with the operation of the augmentation options are based on the green house gas emissions from coal fired power stations, which supply electrical energy to the Central Coast. Electrical energy is required to operate the pumps, water treatment plants, water reclamation and desalination plants. Estimates in Table 15.1 are the additional carbon dioxide emissions to operate each option for the 50-year design period over and above the *Base Case*. Estimates for the area of forest to offset the greenhouse gas emissions are also presented on Table 15.1

For the financial analysis in Sections 12 and 13, the cost of carbon dioxide emissions is priced at $40/tonne (based on the recommendations of the Stern report to the British Government). If the cost of carbon dioxide emissions is added to the standard grid power charge of $80/MW h assumed in this report, the total is approximately 15% less than the green grid energy charge of $135/MW h for bulk consumers.

Apart from the desalination option using the standard grid power, the additional greenhouse gas emissions associated with the construction and operation of all options can be offset if approximately 10% to 20 % of the total power purchased for the operation of the Central Coast water supply system is from green grid power.

12.3 Social Impact

12.3.1 Land Matters

a Option 1 – Regional Tillegra Dam is on the Williams River in Hunter Water's area of operation. The Dam and stored waters will necessitate the resumption of approximately 150 parcels of land owned by 50 landowners.

b Option 2 will require the acquisition of the riparian zone up and downstream of the proposed weir and pumping station on the upper Wyong River. This will enable the construction of the river diversion works, weir (and weir pool), and bridge. The Council currently own the land for the proposed access road and pipeline from the weir to the downstream portal of Boomerang Creek Tunnel.

c Option 3 involves the construction of a 17.5 km of 750 mm pipeline and access road from Mangrove Creek Weir to Mangrove Creek Dam. This route runs up the valley and will involve an easement through predominately privately owned lands.

d Option 4 involves the construction of Toobys Creek Dam. It will require the acquisition of the dam site, the land inundated by the stored waters, access roads, quarries, and associated infrastructure (about 100 Ha in total). This land is currently owned by NSW State Forests.

e Option 5 would require the acquisition of riparian land on MacDonald River for the construction of the weir, pumping station and weir pool. It would also require an easement for the pipeline through private land adjacent to Mogo Creek and an easement for the access road and pipeline adjacent to Little Mogo Creek in the Yengo National Park. An easement would also be required for the tunnel constructed through the Judge Dowling Range to Mangrove Creek Dam.

f Option 6 would involve the construction of a pipeline (22 km) and a booster pumping station. An easement for the pipeline will be required where it passes through private rural land. The acquisition of a small parcel of private land may be required for the booster pumping station.

g Option 7 involves the construction of a desalination plant including the seawater intake. The plant will be located adjacent to Toukley STP on council owned property. The buried radial collector wells at Lakes Beach and raw water pumping station will involve the alienation of a small area of public land.

h Options 9 and 10 involve the construction of an advanced water recycling plant at Wyong South and Kincumber within the existing wastewater treatment-plant sites.

The pipeline routes would follow, where possible, transmission line easements and road reserves.

12.3.2 Construction Impacts

The short-term impact of constructing pipelines is generally minor and limited in time. The pipeline routes are selected where feasible to avoid areas of high conservation value and generally are located along road verges or just inside the boundary fences in private property. While there is short-term construction noise, additional traffic and traffic management issues, the duration at any one location is generally less than 2 weeks.

The construction of weirs (such as the upper Wyong River Weir and MacDonald River weir) and pumping stations can take up to 18 months and involves considerable disruption to local landholders with construction noise and traffic. The short-term works will include site clearing, earthworks, pile driving, concrete works and mechanical and electrical installation. In the case of the upper Wyong River Weir, it will also include the construction of high voltage power lines up the valley.

The construction of Toobys Creek Dam will have a significant short-term impact with site clearing, development of quarries and major earthworks. The construction period would be 24 to 36 months and involve considerable noise and construction traffic bringing materials to site.

The construction of Tillegra Dam in Hunter Water's area of operation is a significant undertaking involving extensive pre-construction and construction activities. The construction period would be approximately five years and involve the development of borrow areas and quarries, the construction of the dam embankment and spillway and associated dam facilities and access roads.

12.3.3 Loss of Amenity

Loss of amenity through development can occur because of degrading the natural environment (terrestrial and aquatic), alienation of lands and recreational opportunities and the visual impact of the infrastructure. The following is a summary of the affects for each option:

a Option 1 – involves the construction of Tillegra Dam on the Williams River. The dam will function as a regional storage serving the Hunter and Central Coast. It will result in the resumption of private land for the stored waters. The Williams River downstream of the dam may be affected by modified streamflows, flooding and changes to the river geomorphology. This could affect the recreational values of the river and the access conditions for other licensed water users.

b Option 2 involves the construction of a weir and pumping on the upper Wyong River and a short pipeline to Boomerang Creek Tunnel. The extraction of water from the upper Wyong River will alter the natural streamflows and may affect the downstream water users (i.e. irrigation of turf farms). In addition, the construction of a high voltage power line from Wyong to the pumping station will affect the visual amenity of the valley and result in the alienation of some private land.

c Option 3 – Mangrove Creek Weir to Mangrove Creek Dam transfer system will result in the alienation of private land and clearing of some natural vegetation for the access road and pipeline.

d Option 4 – lower Wyong off-stream storage involves the construction of Toobys Creek Dam, which will alienate approximately 100 ha of high conservation value forest. The dam wall and associated roadwork will affect the visual amenity of the area. Toobys

Creek from the dam to the junction with Ourimbah Creek will be severely affected by short-term construction activities and in the long-term changes in streamflows.

e Option 5 – MacDonald River to Mangrove Creek Dam transfer system will reduce streamflows in the MacDonald River potentially affecting downstream water users and the recreational value of the river.

f Option 6 - lower Wyong River to Mangrove Creek Dam transfer system will result in the alienation of some private land (generally adjacent to boundary fences) for the pipeline. As the area is generally cleared and reasonable level, the construction of access roads will be minimal.

g Option 7 – permanent desalination plant adjacent to Toukley WWTP will result in the permanent alienation of a small area near an existing car park behind Lakes Beach for the intake well and access road. The desalination plant will be located on land owned by Council with minimal potential for visual impact or adversely affecting recreational activities.

h Option 8 – the installation of rainwater tanks in private properties can reduce the open space provisions particularly for small properties. The visual impact of rainwater tanks and the ongoing maintenance requirements may lead to a loss of amenity for some members of the community.

i Options 9 and 10 – effluent flow substitution and indirect potable reuse have similar infrastructure. The main impact will be the alienation of private land for the pipeline from Wyong South WWTP to lower Wyong River. This pipeline route will follow where possible power transmission lines and roads.

12.4 Operation of the Water Supply System

Several significant strategic operational issues should be considered when selecting a preferred option. These include:

a storage recovery time;

b reliability;

c flexibility and compatibility with future options; and

d ability to implement.

The cost of operation and maintenance has been included in the financial assessment in Section 12.1. All the options are required to comply with the appropriate guidelines and codes of practice for water quality. Providing the augmentations are staged to ensure the secure yield always exceed the annual water demands, the daily and annual demands can be met through the proposed headworks.

12.4.1 Storage Recovery

A critical factor for the Central Coast is the predicted time for recovery of the stored waters in Mangrove Creek Dam. Under average conditions, the storage refills (to 42% capacity) in less than 4 years principally as a result of runoff from the catchment of Mangrove Creek Dam.

For a repeat of the 1993 to 2006 rainfall (i.e. less than the long-term average), the run-off from the catchment of Mangrove Creek Dam is insufficient and must be supplemented by either transfers from an adjoining catchment or reduced dam releases due to supply from an alternative source.

For the options involving a transfer system from an adjoining catchment, the recovery time is dependent on the streamflows in Mangrove Creek Dam catchment, releases from the dam and transfers from the adjoining catchment once the transfer system is operational.

For the options involving the development of an alternative source of supply, recovery will be dependent on natural streamflows in Mangrove Creek Dam catchment combined with reduced releases from the dam once the alternative source is operational and supplying part of the demand.

The recovery is defined as the dam storage at which restrictions can potentially be lifted while meeting the drought security criteria in Section 8.3. In the case of the transfer systems, this has been calculated at 40% capacity. In the case of alternative sources of supply (e.g. desalination), the storage capacity can be reduced to 32% as the recovery is not as dependent of natural streamflows, particularly during drought events.

Table 12.1 provides the estimated time for the storage to recover under historical average conditions and for the repeat of the 1993 to 2006 drought for each of the ten options. For comparison, the recovery times are based on the assumption that all options can be constructed and commissioned within 3 years. In reality, the implementation time for options 1, 2, 4, 5 and 10 is considerably longer:

a Options 1 and 4 involve the construction of a major on-stream storage (Tillegra Dam and Toobys Creek Dam) which could take up to 10 years to commission due to the complex nature of the projects and the likely difficulties in implementation (refer Section 12.4.4).

b Options 2 and 5 involve the construction of a weir on either the upper Wyong River or MacDonald River and could take 5 years to implement.

c Option 10 involves the staged transition from EFS to indirect potable reuse. Indirect potable reuse cannot proceed until national guidelines and regulatory framework are in place.

Table 12.1 Time for Storage Recovery

Option	Description	Months for Storage Recovery	
		Historic average conditions	Repeat of 1993 – 2006 stream-flows
	Base Case	47	More than 156
1	*Base Case* + Regional Tillegra Dam	46	More than 156
2	*Base Case* + Upper Wyong River – Mangrove Creek Dam transfer system	41	73
3	*Base Case* + Mangrove Creek Weir – Mangrove Creek Dam transfer system	44	More than 156
4	*Base Case* + Lower Wyong River off-stream storage (Toobys Dam)	42	71
5	*Base Case* + MacDonald River – Mangrove Creek Dam transfer system	44	79
6	*Base Case* + Lower Wyong River – Mangrove Creek Dam transfer system	37	65
7	*Base Case* + 20 ML/d desalination plant at Toukley	36	79
8	*Base Case* + Install rainwater tanks on 80,000 dwellings	46	More than 156
9	*Base Case* + Environmental flow substitution (EFS)	45	More than 156
10	*Base Case* + EFS/indirect potable reuse	44	More than 156

12.4.2 Reliability

A reliable water supply scheme for the Central Coast will incorporate the following features:

a diversity in the sources of supply;

b optimisation of the existing infrastructure (for the capture and storage of water);

c redundancy in the headworks and distribution system; and

d contingency planning.

12.4.2.1 Diversity in the sources of supply

The surface water sources for the Central Coast water supply are concentrated in the western areas of Gosford and Wyong LGAs that experience lower rainfall than the coast. The catchments are limited in area (refer Table 9.1) and located adjacent to one another (refer Figure 9-1). The streamflows within each catchment can be affected by similar climatic conditions.

The reliability of the water supply can be improved by diversifying geographically the sources of supply (e.g. Option 1) and by developing alternative sources that are not dependent on rainfall over the water supply catchments (i.e. Options 1, 7 to 10).

Hunter Water, which draws its supplies from the Williams River and Tomago sand beds, will diversify the sources of supply to a new catchment in a high rainfall area and a groundwater system. The Hunter transfer system will be able to supply up approximately 25% of the current Central Coast demand once it is completed and operational.

The linking of the Hunter and Central Coast water supply schemes (commonly referred to as a water grid approach) improves security of both schemes through the diversity of sources and interconnection of the water supply infrastructure.

Desalination, EFS and indirect potable reuse are not dependent on rainfall or run off and provide a secure alternative to the surface water sources.

Rainwater tanks, particularly those installed on dwellings close to the coast, can benefit from coastal showers that do not reach the water supply catchments and can supplement supply even in low rainfall periods.

12.4.2.2 Optimisation of the existing water supply infrastructure

The *Base Case* or starting point for the augmentation is the existing water supply scheme with the interim upgrade works and the permanent drought contingency measures.

These works have strengthened the existing Central Coast water supply by improving the operation of the existing surface water system, and developing new sources i.e. groundwater and Hunter Water transfers.

Surface water sources will however continue to provide the bulk of the future water supply and the drought security will continue to be largely dependent on the volume of water stored at the start of the next drought.

The major under utilised asset on the Central Coast is Mangrove Creek Dam, which provides the critical water storage to maintain supply during droughts but is limited by the runoff from its relatively small catchment.

The Dam can be better utilised by constructing a transfer system from an adjoining surface water source i.e. Wyong River or MacDonald River, as per the original strategy.

Alternatively, but less effectively, Mangrove Creek Dam can be refilled by reducing the need for releases from the Dam in drought periods by providing an alternative source of supply i.e. desalination, rainwater tanks or Hunter Water transfers.

The effectiveness of the transfer system once constructed is dependent on the streamflows at the point of extraction, the extraction rules (set in the WSP) and the capacity of the transfer system. A transfer scheme based on the Wyong River, particularly from the lower Wyong River Weir, is likely to provide greater certainty due to higher streamflows in Wyong River, Councils existing water licence, entitlement and the relative simplicity in constructing a transfer system. The water entitlements for a number of adjoining rivers, including MacDonald River and Wollombi Brook are allocated to existing water users.

12.4.2.3 Redundancy

The existing Central Coast water supply has separate headworks centred on Mardi and Somersby water treatment plants with inter-connections through the coastal and Tuggerah distribution systems. This enables either system to supply the entire Central Coast in the event of infrastructure failures such as pumping station malfunctions or pipeline failures.

This has been further enhanced by the completion of the Hunter link providing a further independent source of supply. In a similar way, the development of alternative sources would continue to provide further redundancy in the Central Coast water supply scheme.

The lower Wyong River – Mangrove Creek Dam transfer system can provide additional benefits by linking Mangrove Creek Dam directly with Mardi WTP, thereby avoiding releases to the river and its impacts on the river, associated losses and pumping from the river.

12.4.2.4 Contingency planning

With the impacts of climate change still not clearly understood, it is desirable to have at least undertaken the planning required to fast track options that are not reliant on rainfall and runoff or are based on a climatically different catchment. This approach was adopted with the drought contingency planning for temporary desalination plants.

The planning can include investigation, concept design, detailed design and documentation, environmental studies, planning approvals, negotiating water licences and works approvals. This reduces the lead-time and uncertainty in implementing an option.

Contingency plans have also been developed for permanent desalination (Option 7). Such planning could also be undertaken for Options involving EFS, indirect potable reuse and Tillegra Dam.

Hunter Water requires additional storage in the medium-term to improve the drought security of its supply, and is planning to construct Tillegra Dam (a large storage on the Williams River) (Option 1). GWCWA could participate with Hunter Water in the environmental and engineering studies currently being undertaken for Tillegra Dam.

The increased yield from Tillegra Dam will enable Hunter Water to maintain transfers to the Central Coast when the current agreement expires in 20 years time. In addition, the dam could be operated conjunctively with Mangrove Creek Dam (providing the lower Wyong River-Mangrove Creek Dam transfer system is constructed). This would facilitate a water banking arrangement between the two authorities, which would further increase the systems yields of both schemes, and result in higher levels of environmental protection for all surface water sources.

12.4.3 Flexibility and Compatibility

Flexibility is the ability to adapt to changed circumstances and to incorporate different sources of supply and new technologies in the future. The option chosen initially to augment the existing Central Coast water supply should be compatible with all the potential future augmentation options.

A preliminary assessment of the compatibility of the augmentation options is set out in Table 12.2 in colour code. Green indicates that the augmentation options are compatible, yellow indicates potential compatibility possibly at a reduced scale and red indicates that they are either incompatible or unlikely to be cost effective.

Table 12.2 Compatibility between Augmentation Options

Option	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1 Regional Tillegra Dam										
2 Upper Wyong River – Mangrove Creek Dam transfer system										
3 Mangrove Creek Weir – Mangrove Creek Dam transfer system										
4 Lower Wyong River off-stream storage (Toobys Creek Dam)										
5 MacDonald River – Mangrove Creek Dam transfer system										
6 Lower Wyong River – Mangrove Creek Dam transfer system										
7 20 ML/d desalination plant at Toukley										
8 Install rainwater tanks on 80,000 dwellings										
9 Environmental flow substitution (EFS)										
10 EFS/indirect potable reuse										

12.4.4 Ability to Implement the Option

The ability to implement an option is dependent on a number of factors including:

a the community acceptance of the particular option;

b compliance with NSW Government policies; and

c regulatory approvals required.

Most community campaigns against a specific project are initiated by a small core group who are:

a affected directly by the proposal (i.e. land acquisition, loss of water rights or some other amenity);

b opposed to a particular solution or technology (i.e. weirs, dams and desalination plants); and/or

c concerned with the impact on the environment e.g. endangered flora and fauna.

The major regulatory hurdles for water supply infrastructure are the granting of a water licence, and works approval and planning approval for the project. The development of a new surface water source will require a water licence with access conditions and a works approval for the in-stream structures. The regulatory process and time frame to acquire a water licence and works approval can be lengthy and there is no certainty of a successful outcome.

As part of the planning approval process, an EIS must be prepared for projects with a significant environmental or community impact, or are specified as 'designated developments' under the *EP&A Act 1979*. Weirs, dams, water reclamation plants and recycled water projects are 'designated developments'. Where an EIS is not required, projects are still required to undertake an environmental impact assessment under the *EP&A Act 1979.*

The preparation and determination of an EIS requires detailed engineering and environmental studies that can significantly delay a project. The *EP&A Act* also has provision for third party procedural appeals to the Land and Environment Court for water supply facilities under Part 5 of the *Act.*

For projects involving the acquisition of private land, public utilities are required to comply with the *Acquisition (Just Terms Compensation) Act 1991.* The *Act* defines provides guidelines for compensation which are based on valuations by the Valuer General. Public utilities are required to negotiate with the landowners, with compulsory acquisition being used as the last resort.

Table 12.3 Regulatory Approvals Required for Augmentation Options

Option	EIS Required	Water Licence & Planning approval required
1 *Base Case* + Regional Tillegra Dam	Yes for dam	Yes for dam and extractions
2 *Base Case* + Upper Wyong River – Mangrove Creek Dam transfer system.	Likely for weir and power lines	Yes for weir, pumping station and extractions
3 *Base Case* + Mangrove Creek Weir – Mangrove Creek Dam transfer system	Possible for pipeline up Mangrove Creek	Trade off part of low and medium flow access for high flow access
4 *Base Case* + Lower Wyong River off-stream storage	Yes for dam	Yes for dam
5 *Base Case* + MacDonald River – Mangrove Creek Dam transfer system.	Yes for new weir and construction through Yengo National Park	Yes for weir, pump station and extractions
6 *Base Case* + Lower Wyong River - Mangrove Creek Dam transfer system	Unlikely for pipeline up Wyong valley	Yes to upgrade pumping capacity of lower Wyong PS capacity from 160 to 320 ML/d
7 *Base Case* + 20 ML/d desalination plant at Toukley	Deferred Development approval achieved for desalination unit	Yes for beach well intakes
8 *Base Case* + Install rainwater tanks on 80,000 dwellings	No for rainwater tanks	No
9 *Base Case* + Environmental flow substitution (EFS)	Yes for reclamation plant and return flows	Likely for return flows
10 *Base Case* + EFS/indirect potable reuse	Yes for reclamation plant and return flows	Likely for return flows
Note All options include a new pump station on the lower Wyong River to replace the existing pump station. The civil works will be sized to accommodate 320 ML/d pumping capacity - initially 160 ML/d pumping capacity will be installed.	Unlikely for new pumping station on lower Wyong River	Yes for new pumping station on lower Wyong River New extraction licence required which will include trade off part of low and medium flow access for high flow access

12.4.5 Operational Assessment Summary

An assessment based on the operational criteria in Section 12.4 was completed for the ten augmentation options. The assessment compares the performance of the individual option in conjunction with the existing Central Coast water supply (not in isolation). The results set out in Table 12.4 are colour coded with green indicating good performance, yellow is mediocre and orange poor.

Table 12.4 Operational Assessment of Options

Option		Storage Recovery	Reliability	Flexibility	Ability to Implement
1	Regional Tillegra Dam				
2	Upper Wyong River – Mangrove Creek Dam transfer system				
3	Mangrove Creek Weir – Mangrove Creek Dam transfer system				
4	Lower Wyong River off-stream storage (Toobys Creek Dam)				
5	MacDonald River – Mangrove Creek Dam transfer system				
6	Lower Wyong River – Mangrove Creek Dam transfer system				
7	20 ML/d desalination plant at Toukley				
8	Install rainwater tanks on 80,000 dwellings				
9	Environmental flow substitution (EFS)				
10	EFS/indirect potable reuse				

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13. Development of Strategies

13.1 Adaptive Management

The augmentation of the Central Coast water supply involves significant challenges in a region of high growth rates, limited water resources and with a water supply system affected by long-term drought from which it may take many years to recover. Compounding these challenges are the uncertainties related to consumer water-use behaviour in the future, community acceptance, regulatory requirements, policy changes, climate change, technological innovation and future energy costs.

The strategies in *WaterPlan 2050* seek to provide a sustainable and affordable water supply able to meet the predicted 2050 water demands on the Central Coast. They will generally involve the staged development of one or more of the options listed in Chapter 11.

The preferred strategy is likely to change in the future as new initiatives are developed. For instance, the recent announcement by the NSW State Government to provide financial assistance of up to $1500 to homeowners intending to install rainwater tanks (connected to the internal house plumbing) will lead over time to a reduction in demand deferring the need for subsequent augmentations. Similarly, the development of guidelines and a regulatory framework for indirect potable reuse would enable implementation of this option.

A key objective of *WaterPlan 2050* is to provide a sound basis for selecting the initial augmentation option, which will form the basis for future augmentations. Under the adaptive management plan proposed by GWCWA, the strategy will be updated every 5 years based on the results of detailed monitoring and developments in regulation, policy and technology. The monitoring will allow evaluation of the success of the IWCM strategies in reducing demand through the water saving initiatives and recycling projects, the effect of climate change on the security of supply, identify new developments and assess the impacts.

13.2 Augmentation Strategies

The augmentation strategies have been selected as a representative sample capable of supplying the predicted 2050 water demands for the Central Coast. The main function in developing strategies is to ensure that the initial augmentation option is compatible with all the likely future augmentations.

In When developing strategies, it has been assumed that water saving measures identified in the IWCM strategies (Sub Plans) prepared by both Gosford and Wyong Councils will be implemented. These measures are common to all options, and are predicted to achieve a 15% reduction in future water demands (over pre-drought demand).

The water savings will be achieved across all user groups (residential, government, commercial and industrial consumers). Failure to achieve this reduction will advance the next augmentation with associated cost and environmental impacts.

The IWCM strategies also identify a number of recycling projects (stormwater and reclaimed water) within the urban areas that will reduce demand by a further 5%. These include recycling water to Munmorah and Vales Point power stations and the new urban development at Warnervale. Both Councils are committed to recycling and, will continue to implement practical and feasible recycling projects. The larger regional recycling schemes involving indirect potable reuse and EFS are options developed in *WaterPlan 2050*.

These measures by themselves are not sufficient to provide a long-term sustainable water supply for the predicted population of 2050. Therefore, water efficiency and reuse must be combined with one or more of the augmentation options listed in Chapter 11.

A number of the surface water options were eliminated from further consideration as they did not provide any significant benefit in cost, system yield, environment protection or system operation. These are:

a Option 3 - Mangrove Creek Weir to Mangrove Creek Dam transfer system does not result in a significant increase in yield and will place further reliance on a relevantly small catchment that is more likely to be affected by climate change;

b Option 4 – Toobys Creek Dam is a high-risk option with a low probability of obtaining the necessary environmental approvals and a water licence within a reasonable period. It provides no net advantage over the upper and lower Wyong River to Mangrove Creek Dam transfer systems but significantly increases the environmental impact;

c Option 5 – MacDonald River to Mangrove Creek Dam transfer system is another high-risk option with a low probability of obtaining the necessary environmental approvals, water licence and approval for construction of the pipeline and tunnel in the National Parks. In addition, the landowners and water users in the MacDonald River valley are located in Hawkesbury Council LGA and are unlikely to support the proposal.

The flexibility and compatibility of options set out in Section 12.4 provides the basis for selecting the options to form strategies. The strategies have also been selected to include all the practical options raised by councillors, the community, the media, and more recently, by the NSW Government. The significant constraints are as follows:

a there is no benefit in constructing more than one Central Coast transfer system (Options 2 to 6) due to the high capital cost and concentration of water sources within a limited area;

b EFS or indirect potable reuse are most effective in combination with a lower Wyong River – Mangrove Creek Dam transfer system;

c Tillegra Dam is most effective in combination with a lower Wyong River to Mangrove Creek Dam transfer system; and

d indirect potable reuse is an alternative to EFS not an additional option.

Strategies A, B and C are all based initially on a transfer system from either the upper or the lower Wyong River to Mangrove Creek Dam. These transfer systems will take water from Wyong River in higher rainfall years for storage in Mangrove Creek Dam. The additional yield from the transfer systems is not sufficient to maintain supply to 2050, and must be supplemented by another option in future. In nearly all instances, it is cheaper to use an alternative source to supplement supply rather than developing a further high-cost surface water option.

Strategy D adopts desalination (option 7) with financial assessment based on green energy sourced from the grid. The 20 ML/d desalination plant would need to be augmented in the year 2040 to 30 ML/d. The existing site adjacent to Toukley WWTP will house the expanded plant, and the intake will be designed to incorporate additional radial collector wells in the future.

Strategy E is based on the installation of rainwater tanks on all existing freestanding dwellings on the Central Coast (Option 8a). The rainwater tanks are not sufficient to meet 2050 demands and are combined with either EFS at lower Wyong River (Option 9) or desalination powered with green power (Option 7b).

Strategy F is essentially EFS (Option 9); with the regular addition of 2000 rainwater tanks per annum to maintain supply (Option 8b). It is effectively the reverse order of Strategy E, with a slower uptake of rainwater tanks.

Strategy G involves the transitional from EFS to indirect potable reuse of reclaimed water and ultimately involves reclaimed water from Wyong South, Charmhaven and Kincumber water reclamation plants.

Strategy H involves the construction of a regional dam at Tillegra to serve both the Hunter and Central Coast. There is a risk that the construction of Tillegra Dam could be delayed pending the granting of planning approvals, a water licence with access conditions and works approval. In the interim, the Central Coast would be vulnerable to drought unless there is good rainfall in the Mangrove Creek Dam catchment or an interim measure is introduced.

Strategy H1 is based on the commissioning of Tillegra Dam in 2013. Tillegra Dam will be adequate to maintain supply with a 35 ML/d transfer system to 2040. At that stage, it will be necessary to either upgrade the transfer system or develop an alternative source of supply.

Strategy H2 reduces the risk with implementation of Tillegra Dam by initially constructing an upper Wyong River to Mangrove Creek Dam transfer system followed by Tillegra Dam.

Strategy H3 is based on the construction of the lower Wyong River to Mangrove Creek Dam transfer system to address the Central Coast's short-term needs followed by the staged construction of Tillegra Dam with stage 1 completed by 2013.

13.3 Comparison of Strategies

The strategies are compared in Table 15.2and address the following criteria:

a the yield of each strategy;

b the estimated time for the recovery of Mangrove Creek Dam under a range of climatic conditions;

c a detailed financial analysis of each strategy; and

d green house gas production over the 50-year life of the strategy.

The results indicate that there are a number of viable strategies based on an initial augmentation involving either an upper and lower Wyong River - Mangrove Creek Dam transfer system. The costs associated with the lower Wyong River – Mangrove Creek Dam are marginally higher; but are offset by environmental and operational advantages, including the ease of implementation and the greater certainty of storage recovery.

EFS appears to be a cost effective strategy on its own and in combination with the Wyong River transfer systems. However, it does little to improve the storage recovery in the short term. It is potentially a sustainable and cost effective second stage augmentation option providing there is regulatory approval for this approach.

Desalination using green power is not as cost effective as the alternative strategies but performs well in all other categories. Desalination based on power from the state grid is more cost effective but incurs substantial green house gas impacts.

14. Community Consultation

14.1 Background

GWCWA and the Councils have undertaken an extensive community consultation program to inform, consult and involve the community in a number of critical issues involving the Central Coast water supply scheme. These issues included water conservation measures, drought contingency planning and the development of *WaterPlan 2050*.

The community consultation program occurred in a number of forums including:

a Community Liaison Group;

b IWCM Project Reference Group;

c Focus Groups;

d formal consultation;

e surveys; and

f presentations and discussions with community groups.

The community's perspective on the critical issues facing the Central Coast water supply has provided an essential input into the development of *WaterPlan 2050*. On completion of the *Preliminary Working Draft WaterPlan 2050* (December 2006), Gosford and Wyong Councils resolved to place the Plan on public exhibition for further community comment.

14.2 Results of Community Consultations – Preliminary Working Draft WaterPlan 2050 – Dec 2006

Fifty-seven submissions were received and analysed. Individuals lodged approximately 70% of the submissions; and the remaining 30% came from community and environmental groups, government agencies, political parties, commercial interests and educational facilities.

The responses generally addressed only the specific issues of concern to the individuals or community groups. The submissions were analysed and the results are summarised in Table 14.1 to Table 14.3.

While ten respondents expressed concern at the time taken to implement a permanent solution to the Central Coast water supply, the twelve most commented upon issues in the submissions are noted in Table 14.1 below, with the number of submissions specifically expressing support (including conditional support) or opposition noted.

Non-potable reuse for watering of ovals, parks and gardens, industrial and similar uses was widely supported. Many respondents also supported further demand management measures such as mandating water efficient appliances, banning all external water use, increasing incentives and subsidies. Stormwater harvesting and recycling received some support.

Potable reuse, in principle, also received support from many respondents; however, opposition to such practice was also relatively high. Reasons for support in many cases were based on the belief that it could be implemented. Many of the submissions did not appreciate the following points:

a There are currently no state or national guidelines for potable reuse; national guidelines are under development for ***indirect*** potable reuse.

b ***Direct*** potable reuse (i.e. where recycled water is introduced directly into the potable supply) is not practiced in Australia, and worldwide practice is very limited (Windhoek, Namibia). It poses increased risk to public health, as there are no barriers between treatment processes and drinking.

c Planned ***indirect*** potable reuse offers the greatest potential with multiple barriers between the treatment process and drinking (i.e. dilution, in stream water-quality improvements, detention time, water treatment and disinfection).

Table 14.1 Key Issues

ISSUE	No. of Submissions	
	Supported	Not Supported
Non-Potable reuse	20	0
Demand reduction	18	0
Potable reuse	18	5
Temporary desalination plants	13	7
Rainwater tanks encouraged as a supplement	12	0
Increased rebates for rainwater tank installation	12	1
Stormwater recycling / harvesting	9	0
Groundwater extractions	1	8
Stepped water pricing or other pricing reforms	8	0
Banning of longwall coal extraction in water supply catchments	7	0
Greywater reuse	6	2
Planning and development controls to limit development / population growth until water supply security is restored	4	1

Several respondents identified a need for further and continuing community education regarding water conservation and potable reuse.

Temporary desalination plants, as drought contingency measure received overall support, but primarily as a last resort option during the current drought. There was little support for a permanent desalination plant.

With regard to rainwater tanks, a few respondents supported the following:

a mandatory installations on existing premises including connection to the internal plumbing; and

b targeting of non-residential premises for tank installations.

Comments were also made on improving procedures for obtaining subsidy and Council approvals. The cost and effectiveness of rainwater tanks was also questioned.

Table 14.2 presents the number and proportions of respondents specifically expressing support for each of the options. Note that some respondents support more than one option.

Table 14.2 Support for Options (in order of Option support: most to least)

OPTION		SUPPORT					
No.	Description	Individuals		Organisations		Total	
		No.	%	No.	%	No.	%
6	Lower Wyong River to Mangrove Creek Dam transfer	15	41%	5	29%	20 (4)*	37%
8	Large scale retrofit of rainwater tanks	10	27%	3	18%	13 (3)*	24%
9	Environmental flow substitution at Wyong Weir	10	27%	2	12%	12 (2)*	22%
10	Indirect potable reuse	10	27%	2	12%	12 (1)*	22%
2	Upper Wyong River to Mangrove Creek Dam transfer	7	19%	3	18%	10 (2)*	19%
3	Lower Mangrove Creek to Mangrove Creek Dam transfer	3	8%	0	0	3 (2)*	6%
4	Lower Wyong River off Creek Storage	3	8%	0	0	3 (1)*	6%
5	MacDonald River to Mangrove Creek Transfer	3	8%	0	0	3 (1)*	6%
1	Tillegra Dam	2	5%	0	0	2 (5)*	4%
7	20 ML/day permanent desalination plant	2	5%	0	0	2 (7)*	4%

** Other respondents who expressed conditional support not included in "support" figures.*

In addition, the following suggestions were made:

a Install a tidal barrier (earth weir) across Fagans Bay/Narara Creek at Gosford railway bridge and convert to freshwater storage.

b Construct shallow earth weirs along rivers and creeks, creating many pools and storing water along the full length of the river/creek.

c Collect and store water by constructing small dams in various locations especially in higher rainfall coastal areas, including National Parks.

d Possible Wollombi Brook contributing to Mangrove Creek Dam storage (option in 1985 headworks review but not mentioned in WaterPlan 2050).

e Increase storage capacity in Mooney Mooney creek catchment, it being the water supply catchment with the highest rainfall.

The first three suggestions would increase the yield of the scheme but result in significant environmental degradation. It is highly unlikely the planning approval or water licences would be granted to any of these options.

Wollombi Brook is already over allocated to the existing users in the valley and has proved to be an unreliable source during the drought.

The storage in Mooney Dam is adequate for the run off from its catchment. The transfer system arrangement from Mangrove Creek Weir to Somersby WTP is being modified to enable transfers to be diverted into the Dam during high flows in Mangrove Creek.

Table 14.3 presents the number and proportion of respondents specifically expressing no support for each of the options. Note that some respondents are opposed to more than one option.

Table 14.3 Options Not Supported

OPTION		NOT IN SUPPORT					
Option No.	Description	Individuals		Organisations		Total	
		No.	%	No.	%	No.	%
7	20 ML/day permanent desalination plant	9	24%	5	29%	14	26%
1	Tillegra Dam	6	19%	7	35%	13	24%
5	MacDonald River to Mangrove Creek Transfer	5	14%	3	18%	8	15%
3	Lower Mangrove Creek to Mangrove Creek Dam transfer	2	5%	2	12%	4	7%
4	Lower Wyong River off-creek storage	2	5%	2	12%	4	7%
2	Upper Wyong River to Mangrove Creek Dam transfer	1	3%	2	12%	3	6%
9	Environmental flow substitution at Wyong Weir	1	3%	2	12%	3	6%
6	Lower Wyong River to Mangrove Creek Dam transfer	1	3%	1	6%	2	4%
10	Indirect potable reuse	1	3%	1	6%	2	4%
8	Large scale retrofit of rainwater tanks	1	3%	0	0	1	2%

15. Recommended Strategy

15.1 Background

The WaterPlan seeks to identify medium and long-term changes and improvements to the Central Coast water supply that can be introduced to progressively:

a achieve a safe, reliable and secure water supply that meets community needs;

b ensure the supply and use of water is efficient and affordable; and

c protect the health of our rivers and creeks as well as the general environment.

In developing the WaterPlan, GWCWA and the Councils have considered:

a the existing water supply system;

b demand for and use of town water;

c water conservation and people's changing attitudes to water;

d need to provide water for the environment;

e local hydrology and the impact of climate change;

f current available sources of water;

g development and evaluation of strategies designed to achieve the defined outcomes; and

h community response to the Preliminary Working Draft of WaterPlan 2050.

In selecting a preferred strategy, GWCWA and the Councils have adopted an adaptive management approach to manage the uncertainties and risks related to consumer water-use behaviour in the future, community acceptance, regulatory requirements, policy changes, climate change, technological innovation and future energy costs.

The initial augmentation option in a staged strategy can set the direction for the future. In order to maximise future flexibility to adapt to changing circumstances, the initial augmentation option should be compatible with a range of potential future augmentation options.

15.2 The Recommended Strategy

15.2.1 Using water efficiently

All strategies in *WaterPlan 2050* are based on water conservation and supply substitution with recycle water and stormwater. The details of the water conservation and local reuse initiatives are outlined in the IWCM strategies prepared by Gosford and Wyong Councils.

The draft IWCM strategies include five scenarios. Scenario 1 broadly corresponds to the measures outlined in *WaterPlan 2050*. Scenario 5 achieves the greatest water savings and recycling but comes with increasing cost. Once the IWCM strategies are completed, each Council will select a scenario, which balances the benefits with capital investment.

There is potential to achieve better outcomes through targeting of existing homeowners with high levels of water consumption through a suite of measures designed to provide greater financial incentive to install water efficient devices and rainwater tanks. These include stepped pricing, review of the co-contribution for the residential retrofits with water efficient devices and combining Council and the proposed State Government rebates for rainwater tanks.

Water conservation and local reuse initiatives are not sufficient to provide a secure supply for the Central Coast necessitating an augmentation of the headworks.

15.2.2 Enhancing the existing water supply system

Ten augmentation options were developed in Chapter 11 using a range of water sources. While some options are able to meet the 2050 water demands for the Central Coast, many will require the staging of two or more options. The options are evaluated against financial, environmental and operational factors in Chapter 12. Strategies were developed in Chapter 13, using one or more of these options to meet the year 2050 water demands for the Central Coast.

The public exhibition of the *Preliminary Working Draft of WaterPlan 2050* and the feedback from the public submissions identifies many of the social issues associated with each option and strategy.

The key factors for comparing the ten options are summarised in Table 15.1and include:

a the yield of the Central Coast water supply for each option in combination with the *Base Case;*

b the estimated time for Mangrove Creek Dam storage to recover;

c financial indicators such as the capital cost of each option, the net present worth, levelised cost and the likely rating impact of each options;

d a preliminary environmental assessment including greenhouse gas emissions and aquatic and terrestrial impacts;

GWCWA and the Councils resolved to proceed with Option 6 (Wyong River – Mangrove Creek transfer system with the future installation of gates on Mangrove Creek Dam). This involves the construction of the following:

a a new pumping station on lower Wyong River Weir and duplication of the pipeline to Mardi Dam; and

b a new pumping station at Mardi Dam and pipeline from Mardi to Mangrove Creek Dam.

c installation of gates on Mangrove Creek Dam

The new pumping station on Wyong River will increase water harvesting from Wyong River during medium to high flows for temporary storage in Mardi Dam before being pumped through to Mangrove Creek Dam. The new transfer system will also lead to the quickest recovery of the dam storage.

The key benefits of the transfer system include:

a ability to harvest more water from the Wyong River and Ourimbah Creek during medium to high flows;

b ability to increase storage levels of Mangrove Creek Dam using excess water from Wyong River and Ourimbah Creek;

c enhanced environmental flows in the Wyong River during low flows;

d improved aquatic ecology in Wyong River with the end of water releases from Boomerang Creek Tunnel to the upper Wyong River, i.e. return to natural flow regime to Wyong River downstream; and

e good integration with current and future elements of the Central Coast water supply scheme and Hunter Water.

The proposed pipelines and pump stations could be completed by the end of 2010. This allows sufficient time for the planning, design, environmental assessment, regulatory approvals and construction; the project is estimated to cost $80M.

The design of Mangrove Creek Dam included provision for the future installation of spillway gates, which would increase the dam storage from 190,000 ML to 230,000 ML. The raising of Mangrove Creek Dam is cost effective, and will be triggered by the recovery of the storage to 70% capacity.

The major risk with the lower Wyong River – Mangrove Creek Dam transfer system is obtaining an appropriate access licence to extract water from Wyong River. Access licences are issued by the Department of Natural Resources once the Water Sharing Plan for the Central Coast has been finalised.

GWCWA is undertaking an environmental flow study on the impacts of proposed water extractions on the long-term health of the lower Wyong River and Tuggerah Lakes. The results of this study will be considered in the development of the Water Sharing Plans.

15.2.3 Future Augmentations

Any strategy that extends to the year 2050 must be both flexible and adaptable. *WaterPlan 2050* is based on a staged approach to increase the overall water resources, and to ensure that supply always exceeds demand.

Under the adaptive management approach, future augmentations will be based on the results of the proposed monitoring program and other changes as they occur over time. The monitoring program will evaluate the success of the IWCM strategies in reducing per capita water demands, review population growth and associated water demands and evaluate the impact of climate change on security of supply. The outcomes of the monitoring program and the five yearly reviews of WaterPlan 2050 will determine the need, selection and staging of future augmentation options.

Currently, there are essentially four potential second stage augmentation options that would compliment the proposed lower Wyong River – Mangrove Creek Dam transfer system; these are:

a Tillegra Dam (Option 1);

b permanent desalination (Option 7);

c environmental flow substitution (Option 9);

d indirect potable reuse (Option 10).

While *WaterPlan 2050* has broadly scoped these options, there is an ongoing need to continue to update these options to adapt to changing circumstances and technology improvements, which may on occasion require further investigation.

15.2.4 Implementation

The proposed augmentation works will be staged to ensure that supply exceeds demand for the period 2007 to 2050. The red line in Figure 15-1 indicates the increase in yield with each augmentation. The timing of the augmentation can be read of the horizontal axis.

The estimated annual demand is represented by a blue band. The band represents the possible range in demands between wet and dry years. From the year 2011 onwards, the safe yield of the augmented water supply system supply exceeds demand.

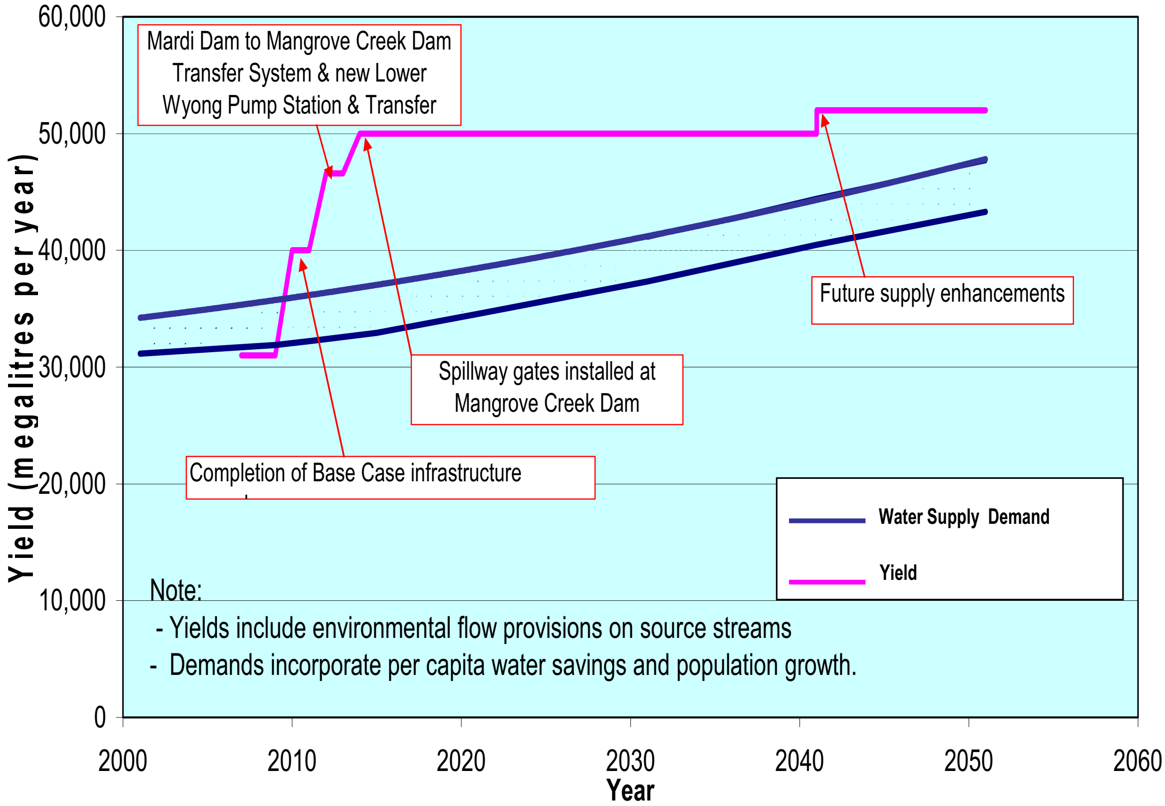

Figure 15-1 Staged Water Supply Increases

Table 15.1 Options summary analysis

WATER PLAN 2050 AUGMENTATION OPTIONS		Time to Lift Restrictions from Jan 2007			Capex 2006-2050	NPV at 7%									Levelised Cost		CO2/50yr			
Scenario	Yield GL/a	Average months	10.93-9.06 months	1 in 100yrs months	Total $M	Capex $M	Opex $M	Total $M	Benefits $M	$/yr/house Average	$/yr/house Peak	IRR	Yield GL/a	NPV/GL/a $/kL yield	Gross $/kL	Net $/kL	Embodied X 1000 T	Operating X 1000 T	Total X 1000 T	Footprint ha
No Upgrade	31.7	53	>156	211													0	720	720	480
Base Case																				
Interim Upgrade + Hunter Connection 35 ML/d	40.0	47	>156	129	76	70	25	94	148			11.7%	8.4	0.97	1.08	0.70	19	11	30	20
***Base Case* + River Water Sources**																				
1. Tillegra Dam 450 GL 2013	47.8	46	>156	118	Negotiations with Hunter Water Corporation are currently in progress regarding a potential financial contribution by the Central Coast to the proposed Tillegra Dam. Financial / affordability figures are dependent on the outcome of the negotiations.												Incremental values to cater for CC to be determined based on any additional activities over and above proposed for the Hunter's requirement			
2. Upper Wyong River - Mangrove Creek Dam Transfer	45.6	41	73	95	38	29	12	41	11	19	36	2.8%	5.6	0.62	1.38	1.06	13	87	100	67
3. Lower Mangrove Creek - Mangrove Creek Dam Transfer	42.9	44	>156	124	60	47	12	59	2	27	55	0.2%	2.9	1.74	1.62	1.34	21	147	168	112
4. Lower Wyong Second Off-Stream Storage	48.4	42	71	105	89	67	7	73	4	32	72	1.8%	8.4	0.75	1.70	1.47	31	59	90	160
5. Macdonald River - Mangrove Creek Dam Transfer	45.5	44	79	107	108	86	15	101	4	44	96	0.6%	5.5	1.57	2.01	1.75	38	112	149	100
6. Lower Wyong - Mangrove Creek Dam Transfer with gates on MCD	50.0	37	65	75	80	65	12	77	18	34	74	2.2%	10.0	0.66	1.73	1.37	28	37	65	48
***Base Case* + Long Term Desalination**																				
7a. 20 ML/d SWRO Desalination at Toukley (Std Power)	46.6	36	79	91	85	69	56	125	10	60	103	-3.6%	6.6	1.62	2.23	1.93	30	574	604	403
7b. 20 ML/d SWRO Desalination at Toukley (Green Power)	46.6	36	79	91	85	69	66	135	16	65	108	-4.1%	6.6	1.75	2.33	1.97	30	-59	-29	-19
***Base Case* + Refit Rainwater Tanks into Existing Houses**																				
8a. Rainwater Tanks at 80000 Existing Dwellings by 2012	43.7	46	>156	134	250	190	30	220	13	104	209	-2.4%	3.7	5.08	3.18	2.86	88	-76	11	8
8b. Rainwater Tanks at 80000 Existing Dwellings by 2017	43.7	45	>156	131	250	163	26	189	13	103	189	-2.4%	3.7	4.37	2.87	2.55	88	-75	13	9
***Base Case* + Environmental Flow Substitution**																				
9a. 10 ML/d recycled water at Lower Wyong Weir	43.8	46	>156	139	30	22	15	37	9	19	33	1.3%	3.8	0.78	1.37	1.04	10	102	113	75
9b. 20 ML/d recycled water at Lower Wyong Weir	44.7	44	>156	140	52	25	19	44	11	20	33	1.3%	4.7	0.75	1.41	1.10	18	175	193	129
***Base Case* + Indirect Potable Reuse**																				
10a. 10 ML/d highly treated recycled water into Mardi Dam	44.0	45	>156	136	34	25	19	45	11	23	39	0.9%	4.0	0.90	1.44	1.10	12	103	115	77
10b. 20 ML/d highly treated recycled water into Mardi Dam	47.6	44	>156	140	59	28	22	50	11	25	38	0.7%	7.6	0.53	1.47	1.16	21	177	197	132
10c. 10 ML/d highly treated recycled water into Mooney Dam	44.0	44	>156	140	54	43	22	65	7	30	56	-0.4%	4.0	1.30	1.65	1.35	19	226	246	164
***Base Case* + Incremental Supplies**																				
11a. +Mangrove Creek Dam Gates	43.0				6	5	4	9	10	3	6	7.3%	3.0	0.26	1.09	0.74	2	54	56	37
11b. +10 ML/d Permanent Desalination	43.1				44	37	42	79	16	36	57	-0.2%	3.1	2.18	1.76	1.40	15	3	18	12
11c. +10 ML/d recycled water at Lower Wyong Weir	43.4				20	16	15	31	8	14	24	2.1%	3.4	0.79	1.32	1.00	7	136	143	95
11d. +10 ML/d highly treated recycled water into Mardi Dam	43.6				23	20	18	37	9	17	29	1.7%	3.6	0.88	1.37	1.05	8	138	146	97
11e. Stormwater Harvesting at Porters Creek	42.0				22	19	5	24	5	9	20	2.9%	2.0	1.02	1.27	0.93	8	41	49	33

Table 15.2 Scheme summary analysis

GOSFORD-WYONG WaterPlan 2050 Scheme Options		Recovery Time to 42%			Capex 2006-2050	NPV at 7%								Levelised Cost			CO_2/50yr		
Scenario	**Yield**	**Average**	**10.93-9.06**	**1 in 100yrs**	**Total**	**Capex**	**Opex**	**Total**	**Benefits**	**IRR**	**Yield**	**NPV/GL/a**	**Gross**	**Net**	**CO_2/50yr**	**CO_2/50yr**	**CO_2/50yr**	**Footprint**
	GL/a	**months**	**months**	**months**	**$M**	**$M**	**$M**	**$M**	**$M**	**%**	**GL/a**	**$/kL yield**	**$/kL**	**$/kL**	**X 1000 T**	**X 1000 T**	**X 1000 T**	**ha**
No Upgrade	31.7	53	>156	211											0	720	720	480
***Base Case* + Surface Water Sources**																		
0. Interim Upgrade + Hunter Connection 35 ML/d	40.0	47	>156	134	76	70	32	102	151	10.9%	8.4	1.05	1.15	0.76	19	40	21	14
***Base Case* + River Water Sources**																		
A1. Hunter 35 ML/d + Upper Wyong-MCD + MCD Gates(2044)	48.6	41	73	95	44	29	8	37	13	3.2%	8.6	0.37	1.41	1.07	15	90	105	70
A2. Hunter 35 ML/d + Upper Wyong-MCD + 10 ML/d Desalination (2044)	48.7	41	73	95	82	33	10	42	13	1.3%	8.7	0.41	1.46	1.12	29	90	118	79
A3. Hunter 35 ML/d + Upper Wyong-MCD + 10 ML/d EFS (2044)	48.6	41	73	95	58	30	9	39	13	2.8%	8.6	0.39	1.42	1.08	20	113	133	89
A4. Hunter 35 ML/d + Upper Wyong-MCD + 10 ML/d IPR (2044)	49.2	41	73	95	61	0	9	39	12	2.7%	9.2	0.36	1.43	1.09	21	125	146	98
B1. Hunter 35 ML/d + Lower Wyong - MCD + MCD Gates	50.0	37	65	75	80	65	12	77	18	2.2%	10.0	0.66	1.73	1.37	28	37	65	48
B2. Hunter 35 ML/d + Lower Wyong - MCD + 10 ML/d Desalination (2045)	49.1	37	65	75	118	65	7	72	25	1.4%	9.1	0.68	1.76	1.29	47	47	85	57
B3. Hunter 35 ML/d + Lower Wyong-MCD + 10 ML/d EFS (2045)	49.0	37	65	75	94	62	6	68	25	2.5%	9.0	0.65	1.72	1.25	39	69	98	65
B4. Hunter 35 ML/d + Lower Wyong-MCD + 10 ML/d IPR (2045)	49.6	37	65	75	98	63	6	69	25	2.3%	9.6	0.62	1.73	1.26	30	80	110	73
C. Hunter 35 ML/d + Lower Wyong - MCD + MCD Gates with water banking financial arrangements and transfers whenever MCD<80%	51.6	37	65	75	80	66	13	79	34	2.6%	11.6	0.58	1.83	1.27	24	20	44	30
D. Hunter 35 ML/d + Green Energy Desalination 20 ML/d/30 ML/d (2047)	49.6	36	79	91	114	71	68	139	17	-7.9%	9.6	1.24	2.44	2.05	40	-39	1	1
E1. Hunter 35 ML/d + 80000 RWT by 2017 + 10 ML/d EFS (2039)	47.1	45	>156	131	307	195	30	225	11	-3.7%	7.1	2.71	3.31	2.98	79	4	75	50
F1. Hunter 35 ML/d + 10 ML/d EFS + 80000 RWT by 2047	46.9	45	>156	139	337	152	33	185	12	-4.8%	6.9	2.30	2.90	2.57	87	74	161	108
G1. Hunter 35 ML/d + 10 ML/d EFS (2010) + 20 ML/d EFS (2040)	47.4	45	>156	139	49	24	18	42	9	0.7%	7.4	0.48	1.46	1.14	17	183	200	133
H1. Hunter 35 ML/d + Tillegra 450 GL	47.8	47	>156	138	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA
H2. Hunter 35 ML/d + Upper Wyong-MCD + Tillegra 450 GL	47.8	41	73	95	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA
H3. Hunter 35 ML/d + Lower Wyong-MCD + Tillegra 100 GL	47.8	37	65	75	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA	TBA

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