# SA Water's Long Term Plan for Kangaroo Island

*(Including the Middle River and Penneshaw Water Supply Systems)*

*December 2009*

Government of South Australia

SA Water

WATER FOR GOOD

## Table of Contents

## Acronyms

| | |
|---|---|
| The Plan | SA Water's Long Term Plan for Kangaroo Island |
| WSS | Water Supply System |
| KINRMB | Kangaroo Island Natural Resources Management Board |
| ABS | Australian Bureau of Statistics |
| LGA | Local Government Areas |
| KIC | Kangaroo Island Council |
| PWCM | Permanent Water Conservation Measures |

## Executive Summary

### SA Water's long term planning

The South Australian Government is committed to sustainable water resources for the State's regions and undertakes long term planning to ensure water supplies can meet demand for the future.

SA Water's Long Term Plan for Kangaroo Island (the plan) considers the current and projected potable water demand and supply, the state of water resources from which the potable supply is drawn and options for the future to ensure demand can be met.

### Kangaroo Island regional snapshot

Agriculture and tourism are the most significant contributors to the Kangaroo Island economy. The Kangaroo Island Strategic Tourism Plan (Urban and Regional Planning Solutions, 2006) estimates that approximately 150 000 visitors travel to Kangaroo Island each year. The Tourism Plan has a goal of increasing visitor numbers by 1-2 % per annum.

Tourists visiting the island may stay in tourist accommodation or holiday homes that are connected to the water supply system or at settlements or resorts that rely on independent supplies such as rainwater tanks.

The land use within the Middle River catchment is mainly pasture 50% and native vegetation 38% with 12% forestry (pine and blue gums plantations). There has been an increase in forestry in recent years with further increases foreshadowed. Where forestry replaces pasture the runoff from the catchment is reduced.

There was a 1% pa increase in population in Kangaroo Island between 2001 and 2006 and a small increase in the Kingscote population. The total number of dwellings grew at 2% pa and occupied dwellings grew by 1.7% pa.

### History of water supply to Kangaroo Island

Historically, supplied water has been sourced from surface water catchments. Kingscote was supplied from 1938 by the Cygnet River scheme. Prior to 1938 residents had relied on rainwater tanks supplemented by a 200 kilolitre government tank fed from a small catchment. In 1968, the currently operated Middle River Reservoir was commissioned.

Prior to 1999, Penneshaw's Water Supply System (WSS) was sourced via water purchased from large privately owned farm dams. The supply became insufficient to meet the required water demand and was often of poor quality. More recently, Penneshaw's WSS has been sourced from a sea water desalination plant, which was commissioned in 1999.

### Current SA Water potable water supply systems

The two SA Water WSS providing potable water on Kangaroo Island are the Middle River and Penneshaw WSS. The two WSS are independent.

The Middle River WSS supplies the townships of Kingscote, Brownlow and Parndana and the surrounding rural areas.

Penneshaw WSS supplies the township of Penneshaw.

**Non-potable schemes**

In the context of the plan, non-potable schemes include:

- Rainwater tanks
- Stormwater harvesting
- Wastewater reuse

These schemes are generally not considered by Health SA to meet the Australian Drinking Water Guidelines for human consumption, but provide a useful resource for non-potable applications such as stock watering or irrigation of parks and gardens.

The regulation and funding for these schemes is not administered by SA Water, but SA Water recognises the importance of these schemes, both in terms of the reduced demand on its supplies and in heightening the awareness of the need for water conservation in the community.

These schemes are generally run by local government or the community.

**South Australia's water security planning**

In June 2009 the South Australian Government released *Water for Good*, the State's plan to secure water supplies for our future.

*Water for Good* details policies and actions to secure sustainable water supplies for South Australia to 2050, taking into consideration population growth and the impacts of climate variations. One of the key action outcomes of *Water for Good* is to 'ensure regional water demand and supply plans are in place for all regions throughout the State'.

These regional water demand and supply plans will be developed to secure adaptable, efficient and enduring water supply and management options to support economic prosperity, population growth and an enhanced quality of life for all South Australians.

The regional water demand and supply plans will build on other water planning processes and consider all water resources within a region. The Government's Office for Water Security will develop these plans with support from key organisations including:

- SA Water
- Department of Water, Land and Biodiversity Conservation
- Environment Protection Authority
- Natural Resources Management Boards
- Local Government

SA Water's long term plans will form a part of the overall water security planning process. The Office for Water Security aims to complement, build on and, in some cases, inform existing plans and, in the case of SA Water's long term plans, will do this by introducing new strategies to address those issues not within the scope of SA Water's infrastructure planning process.

Strategies to provide a secure water future may include the diversification of water supplies to include more non-potable water usage through the capture and use of stormwater and rainwater and recycling of wastewater.

*Water for Good* also includes various measures to improve the way our communities and businesses use water, building on current initiatives such as permanent water conservation measures, the Business Water Saver Program, building regulations and rebates for water efficient devices. Further information on *Water for Good* is available at: www.waterforgood.sa.gov.au.

**Long term planning scope**

SA Water's Long Term Plan for Kangaroo Island (the plan) considers the potable water supply within the area defined by SA Water's two water supply systems (WSS) namely Middle River and Penneshaw over a study period of 25 years (i.e. 2007/08 – 2032/33).

While the plan focuses on the potable WSS, an integrated water cycle planning approach is desirable. The plan therefore discusses non-potable schemes.

While the intent of the plan is not to extend the existing SA Water potable WSS to settlements / townships outside the current supply areas, the plan does consider potential future demands and possible future connection options.

It is noted that any augmentation to / extension of SA Water's existing potable WSS to accommodate future projected growth and development would be undertaken on a commercial basis taking into account any Community Service Obligations .

Embedded within the long term planning process is a regular review process which enables SA Water to ensure that assumptions made during the development of long term plans remain valid and applicable. It is the intention of SA Water to review major assumptions annually and to undertake a complete review of the plan every five years.

An outcome of the plan will be to guide the scheduling of capital works for the Kangaroo Island region.

**Stakeholder engagement**

In developing the plan several methods of stakeholder engagement were implemented:

- An internal SA Water Project Reference Group was established
- An extensive community engagement process

These methods of stakeholder engagement ensure coordination of technical expertise and inputs from other government agencies, local government and the community.

**Historical water demand**

Historical SA Water annual data for the period 2000/01 to 2007-08 indicates growth in the number of customer connections for each WSS. However, in spite of this growth in customer connections the data shows indications of a 'flat-lined' or downwards trend in township demand in recent years. This can likely be attributed to the South Australian water conservation measures and the community's responsible water practices.

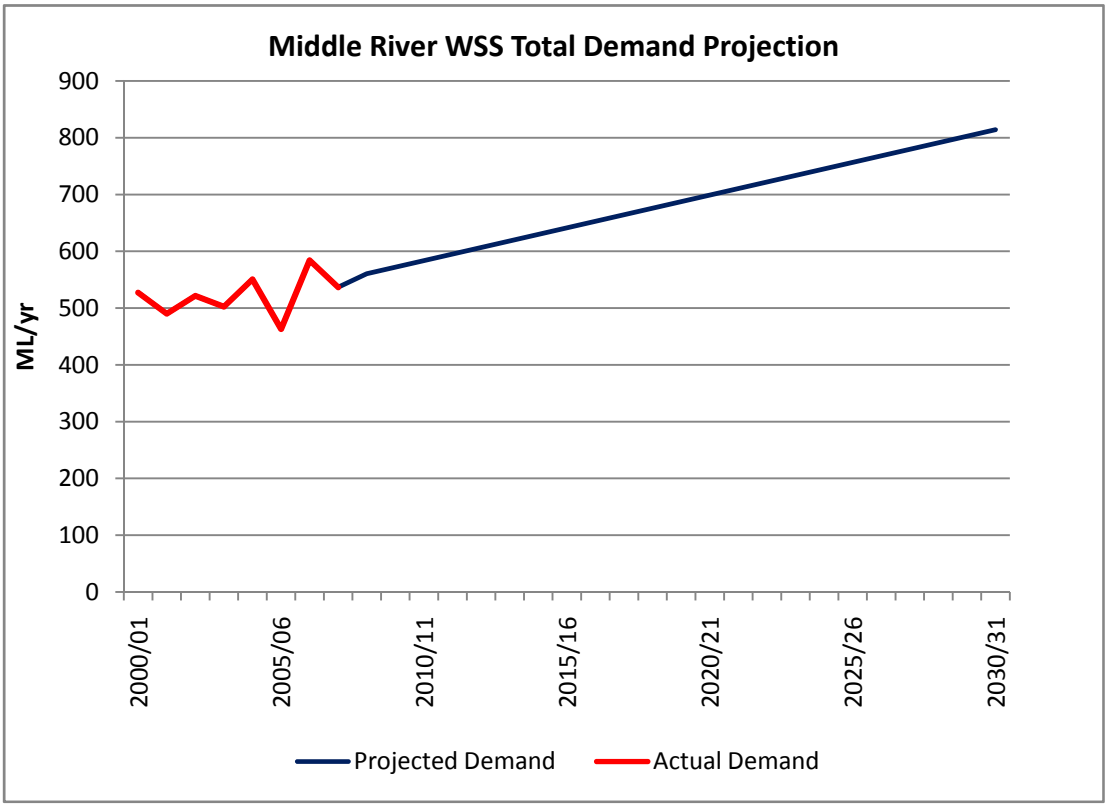
Demand from the Middle River country lands customers is more variable than the urban demand and can increase significantly in dry years. It shows a general increase in demand since 2000/01 resulting in an overall increasing demand for the Middle River WSS.

Historical data is used within the plan to calculate the demand per connection.

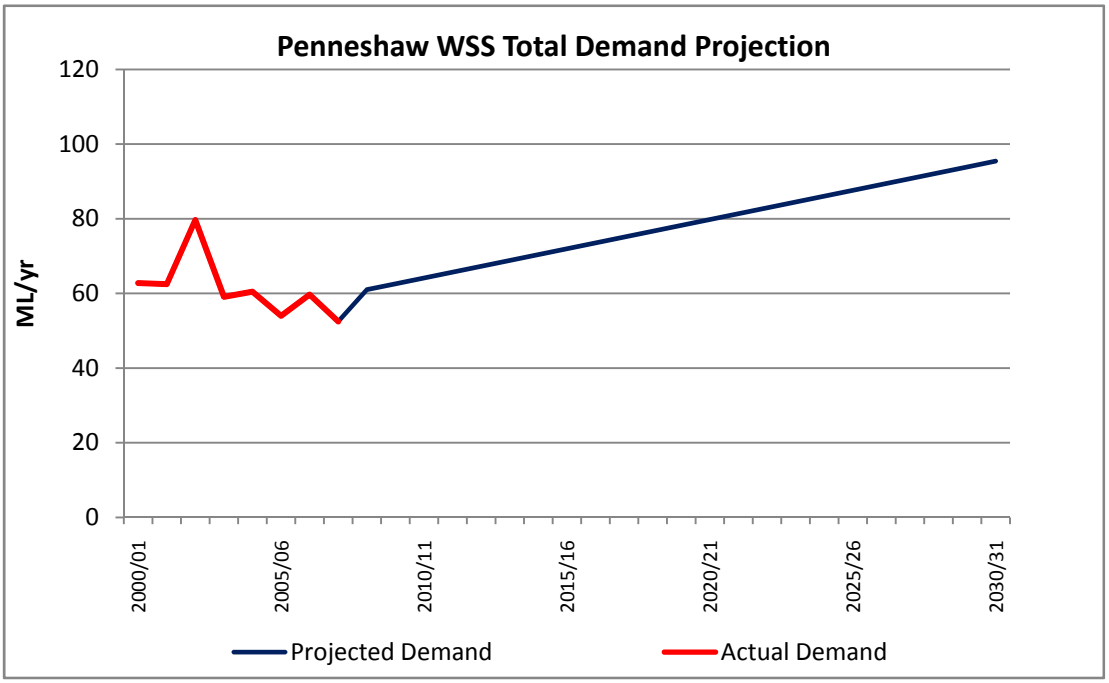
**Projected water demands**

The plan includes future demand projections for the study period of 25 years. In preparing these projections an analysis of the connections within each WSS was first undertaken. Future growth in connections has been projected by applying historical connections growth rates

The future connections projections have been converted into future demand projections using the calculated demand per connection.




**Summary Figure 1 Middle River WSS Total Demand Projection**




**Summary Figure 2 Penneshaw WSS Total Demand Projection**

**The effect of climate on water demand**

There is still some uncertainty about the extent of climate change expected in the future due to the uncertainty in future greenhouse gas emissions.

Investigations undertaken on other water supply systems around the state using the results from CSIRO climate change studies have indicated that climate change could potentially increase demand by up to 10% towards the end of the study period due to an decrease in annual rainfall and an increase in average temperature and evaporation.

The annual assumptions review embedded in the long term planning process will ensure that SA Water is able to monitor demand and adjust any project milestones as a consequence

**Existing water sources**

Reticulated Water supply on Kangaroo Island is sourced from two resources; the Middle River and seawater using desalination via the Penneshaw desalination plant.

*The Middle River*

The Middle River provides the water supply to the Middle River WSS. The Middle River Reservoir is located approximately 50 km west of Kingscote and has a design capacity of 470 ML and a catchment area of approximately 101 square kilometres.

The dam that forms the reservoir was constructed in 1968 and has spilled every year since it was completed. In June 2007 a 'fuse' was installed on the spillway to raise the level and increase the reservoir capacity by 15% to approximately 540 ML.

The drought in recent years has impacted on reservoir inflows both by:

- reducing the volume of spill, and
- reducing the period over which the reservoir spills.

Inflows into the reservoir are likely to decrease in the future due to the effects of climate change reducing rainfall in the catchment and from any increase in areas developed for forestry.

*Seawater*

The Penneshaw seawater desalination plant draws seawater from Backstairs Passage adjacent to Penneshaw. There is good movement of seawater in this area and the volume available is effectively unlimited.

*Non reticulated supplies*

Water from a number of other sources is used on Kangaroo Island. A large portion of the island is not connected to the SA Water supply system and water is usually obtained from rainwater tanks and farm dams storing local surface water.

As is the case in many country areas significant numbers of people with a reticulated supply also use rainwater for in-house uses.

**Existing source analysis**

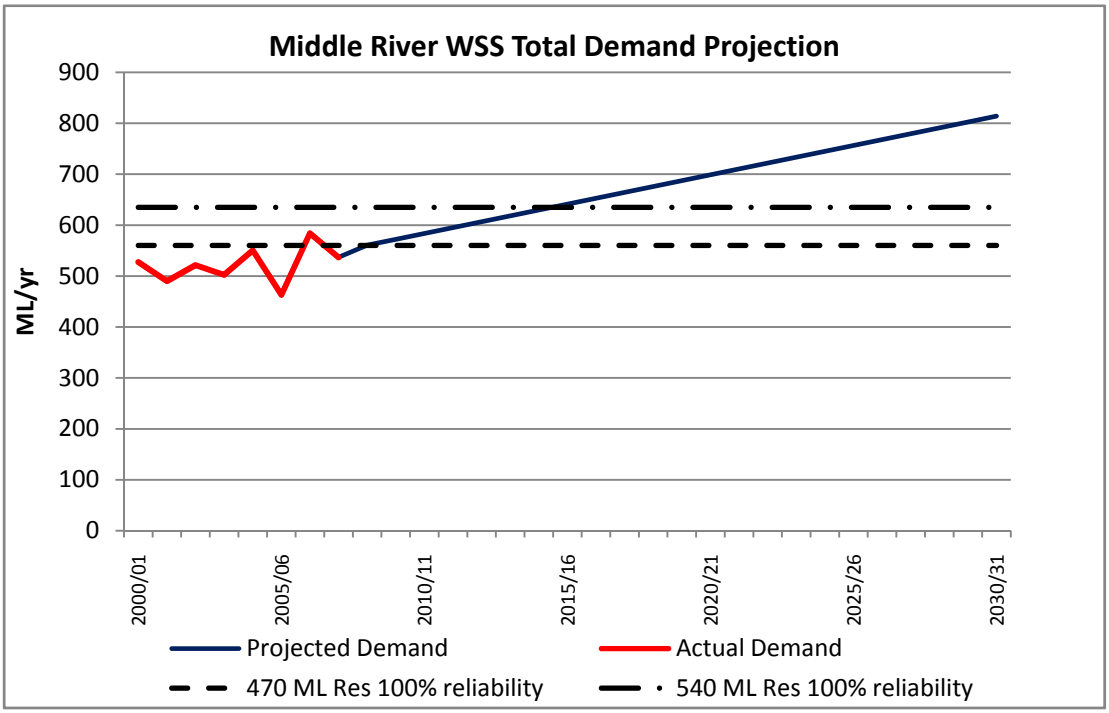
Middle River

The Middle River Reservoir fills and spills over winter and continues to spill while natural intakes continue during spring. In drought years eg 2006, the reservoir stops spilling in early spring. This restricts the volume available for supply to the stored volume plus any continuing natural inflows. To increase the volume available for supply requires an increase in storage capacity.

While the Middle River is spilling during the winter months there is water available for capture and storage. Capture of additional water is subject to the approval from the Kangaroo Island Natural Resources Management Board.

The current reliability of the Middle River Reservoir has been assessed. Based on current catchment conditions and historic rainfall the safe yield for the Middle Reservoir at the design capacity of 470 ML was estimated to be 560 ML/a. The safe yield for the increased capacity of 540 ML is estimated to be 630 ML/a.

The Middle River WSS demand projection shown above is compared to these system capacities in summary figure 3.




**Summary Figure 3 Middle River WSS Total Demand Projection**

Summary Figure 3 shows the Middle River WSS total demand projection will exceed the reliable yield of the 540 ML storage capacity in approximately 2013/14. To maintain a reliable supply the water supply system will need to be augmented.

The predicted impacts of climate change on the Kangaroo Island environment have been set out by the KINRMB State of the Region 2009 Report. Hydrologic modelling has been undertaken using the predicted worst case SRES Scenario which predicts up to 11% rainfall reduction by 2030.

Output from the climate change scenario indicated a reduction in average annual runoff of approximately 31% in 2030.

The minimum annual climate change adjusted streamflow from the climate change scenario has been used in the development of the future options.

It is estimated that the potential use of water from the Middle River in 2032 would be up to approximately 1000 ML. This allows for meeting demand estimated to be 825 ML, potential losses in the treatment process 40-80 ML (dependent on process type) and reservoir evaporation loss 100-125 ML (dependent on storage volume). This is an increase of 300 ML/a above the current draw from the Middle River system of approximately 700 ML/a (offtake and evaporation).

The hydrologic modelling undertaken suggests that the reservoir will spill even in future drought years and indicates that there will be sufficient water available for the environment and to provide 1000 ML for public water supply provided sufficient storage capacity is constructed.

The current capacity of the Middle River WTP and the supply main from Middle River to Kingscote is 3ML/d. In 2032 with an annual demand of 825 ML/a the peak day demand from the system is projected to be 5.3 ML/d and will exceed the available capacity.

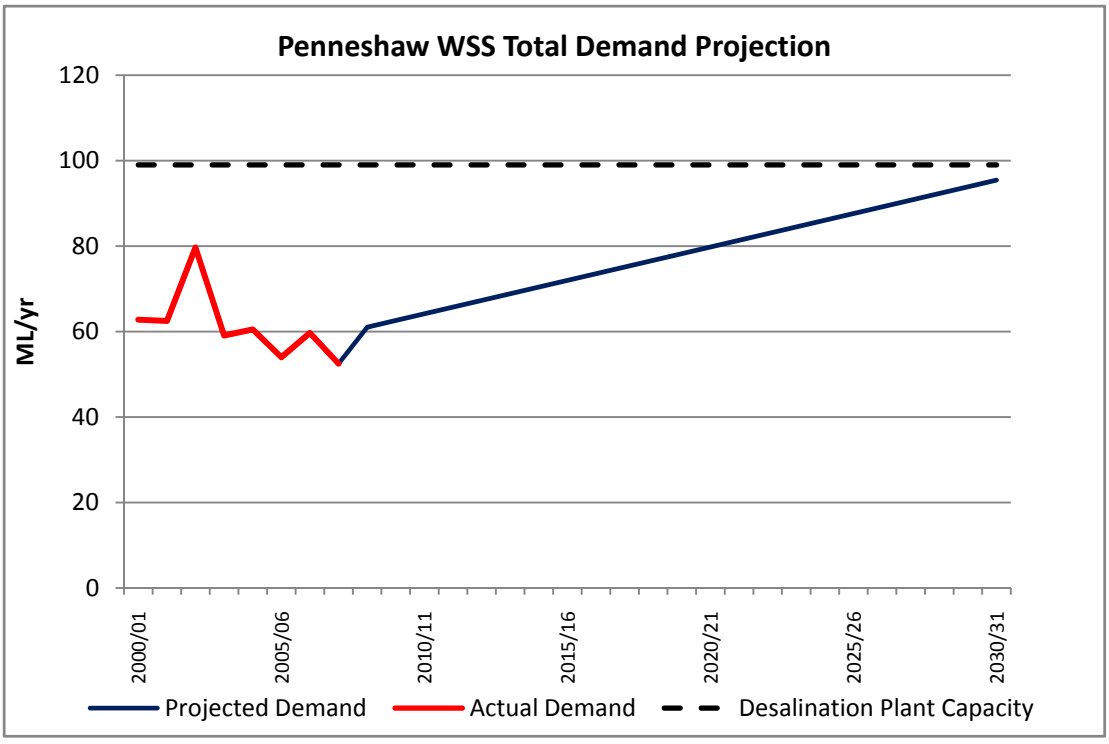
Future augmentation options for the Middle River WSS need to address both the available resource and the network capacity constraints.

As the resource managers, the KINRMB and DWLBC have the responsibility to ensure that the surface water resources are being managed sustainably. SA Water has discussed with these agencies the need to ensure that sufficient inflows to the Middle River Dam are secured for the purposes of the public water supply.

*Penneshaw*

Summary Figure 4 shows that at the end of the study period the average demand from the Penneshaw WSS is projected to be approximately 95 ML/a. The existing capacity of the Penneshaw desalination plant together with the balancing storage has sufficient capacity to meet the projected demand.

Climate change will have no impact on the supply from the Penneshaw desalination plant. Any increased in demand due to Climate Change will be addressed during the annual review process.




**Summary Figure 4 Penneshaw WSS Total Demand Projection**

**Augmentation options for the Middle River WSS**

In this report five options have been investigated for augmenting the Middle River WSS. These options are:

1. Construct a larger dam at Middle River

2. Construct a new 250ML raw water storage near Middle River reservoir
3. Construct a new 250 ML in-system storage near Kingscote.
4. Supplement supply by constructing a new 0.75ML/day seawater desalination plant near Emu Bay/North Cape.
5. Supply all Middle River WSS demand from a new seawater desalination plant with a capacity of 2.5ML/day located in the vicinity of Emu Bay/North Cape.

The five options were assessed based on a water balance and supplying the projected future annual demand of 825 ML.

**Options assessment for the Middle River WSS**

In order to provide a suitable method of assessing the options listed above, SA Water has adapted the Multi Criteria Analysis process used in other Long Term Plans specifically to suit the Kangaroo Island system.

A multi criteria analysis provides significant benefits, such as:

- Providing a framework for incorporating complex and large amounts of information
- Combining quantitative and qualitative aspects of decision making
- Is able to highlight the strengths and weaknesses of any particular option
- Provides an open and transparent methodology which can involve stakeholders
- Can incorporate a diverse range of opinions and expertise

While a multi criteria analysis is particularly helpful to prioritise options it should only be considered as a supporting tool as there may be other externalities which may influence certain decisions.

In general, multi criteria analysis processes use a triple-bottom line approach which considers environment, social and economic factors. As part of this analysis, SA Water has chosen to add a fourth category of Technology and Functionality to ensure that the most sustainable solution is also a practical solution.

The multi criteria analysis process used in this project therefore involved the use of four sustainability categories, namely:

- Environment
- Social
- Economic
- Technology/Functionality

The weightings given to the sustainability categories were determined by the SA Water project team and confirmed by a representative group of key stakeholders. These key stakeholders also determined the weightings given to the environmental and social subcriteria. This process enabled the planning team to identify those options that will deliver the most benefit for the security of the Middle River WSS.

Within the economic criteria, a broad cost analysis was undertaken on high level concepts for comparative purposes only. For the purposes of the analysis, notional sites were considered and will require further investigation during the next stage of the project development. Allowances were

made for provision of necessary power supplies and land acquisition but did not include the costs for making the option carbon neutral.

The results of the multi criteria analysis indicate:

- A raw water storage located near Middle River WTP is the more favourable option based on social and environmental criteria followed by the treated water storage and new dam.
- The treated water storage scheme ranks as most favourable on economic and technology/functionality criteria.
- On a technology/functionality level the raw water storage and the treated water storage schemes come out the best due to them being standard technology that SA Water has extensive experience in constructing and operating.
- Overall, the treated water storage scheme (i.e. Option 3) is shown to be the most favourable approach

**Other considerations**

The Penneshaw system does not show a shortfall in the timeframe for this plan, however it is likely that augmentation of the system will be required in 25 years time. At this time the desalination plant would be operating almost continuously and increasing the desalination plant capacity would be the most likely augmentation option.

SA Water has in the past received approaches from the communities at American River, Emu Bay and the Eastern Cove townships (eg Island Beach, American Beach) for the provision of a reticulated water supply. Schemes have been designed and costed to extend mains to these townships but due to the cost of the long lengths of mains required have not been considered economical.

In accordance with SA Water's Customer Services Division procedures and standardised approach, any proposal to provide potable water to an area would need to be operationally feasible and would need to meet the standard criteria for assessing mains extensions.

These towns have thus been broadly investigated in the long term plan to provide an indication of augmentation requirements to enable connection to the potable water supply system. Further work will be required to determine the specific needs of each of these communities.

Middle River treated water contains relatively high concentrations of dissolved organic carbon (DOC) that, when in contact with chlorine for an extended period can lead to increased concentrations of disinfection by-products (DBPs). SA Water has been managing this issue with an aeration process in the Kingscote Tank. Options for augmenting the Middle River WSS that involve storing large volumes of treated water for extended periods of time (i.e. Option 3) will require additional measures to ensure that the level of disinfection by-products is not increased.

Alternative treatment measures will continue to be explored during further development of the preferred option, however for the purposes of this report it has been assumed in the MCA that the existing Middle River WTP would be upgraded to ultrafiltration/nanofiltration membrane technology.

**Summary**

The following points summarise the investigation

- Demand from the Middle River WSS has been increasing for the past eight years.
- The community, local councils and other stakeholders anticipate that growth will continue occur on Kangaroo Island.
- The installation of the fuse on the Middle River Dam has increased the available resource for the Middle River WSS by 15%.
- As the resource managers, the KINRMB and DWLBC have the responsibility to ensure that the surface water resources are being managed sustainably. SA Water has discussed with these agencies the need to ensure that sufficient inflows to the Middle River Dam are secured for the purposes of the public water supply.
- Demand projections indicate that a new resource will be required in about five years for the Middle River WSS and after 2030 for the Penneshaw WSS.
- SA Water recognises the importance of community water schemes, such as stormwater harvesting, and water conservation, in terms of the reduced demand on SA Water supplies, and in heightening the awareness of the need for water conservation in the community.
- A sustainability analysis (using a multi criteria analysis technique) was undertaken which highlighted that the option of a treated water storage near Kingscote is most worthy of further investigation followed by a raw water storage near the Middle River WTP.
- A large storage near Kingscote is consistent with future options should either a seawater desalination plant or a larger Middle River Dam be constructed.
- Additional work would be required to determine the specifics of the option. This work could include:
    - Assessment of storage sites near Kingscote to determine the most suitable site
    - Baseline environmental investigations for the marine and terrestrial environment.
    - Assessment of the cultural heritage of the site (particularly with reference to Aboriginal and European Heritage).
    - Evaluation of the most effective arrangement of the storage in terms of water quality characteristics and staging.

**Ongoing review of Long Term Plan**

SA Water's procedures for developing and amending long term plans specify:

- Major assumptions contained in long term plans will be reviewed on an annual basis.
- A major departure from an assumption (i.e. significantly higher or lower population or demands than was originally predicted) can trigger a total review of the plan and the strategies it recommended.
- At a minimum Long Term Plans will be completely reviewed every five years.

The assumptions (departure from which can cause a major review of the Long Term Plan) can be known as trigger points or key parameters. The key parameters or trigger points in this plan are listed below:

- Population of Kingscote and Penneshaw
- Actual demand
- Available supply from the Middle River Reservoir
- Government policy with regards to carbon neutrality
- Impact of climate change on available resources and demand

These assumptions will be monitored and checked annually by the SA Water project team and the strategy presented in this document reviewed in light of these assumptions.

**Recommendations**

The long term planning recommendations can be summarised into the following:

- Annual review of the long term plan
- Water source augmentation

These recommendations will be used to guide the scheduling of capital works for Kangaroo Island. To accommodate any immediate supply or demand shortfall, SA Water may recommend to Government the implementation of further demand management initiatives.

An overview of the long term planning recommendations is given in summary table 1 below.

**Summary Table 1 Recommendation Overview**

| Recommendation | Deliverable | Timing |
|---|---|---|
| Annual review of long term plan | | |
| SA Water to review the following major assumptions annually:<br>• Historical SA Water water supply system connections and demand<br>• Projected connections<br>• Projected demand<br>• Impact of climate on demand<br>• Surface water allocation provision | Confirm existing trends and whether timing for implementation of recommendations proposed in the long term plan is appropriate or needs to be amended | Annually |
| Water supply system augmentation | | |
| Further investigations into the construction of a treated water storage at Kingscote including<br>• addressing water quality issues associated with storing treated water for extend periods of time<br>• arrangement of storage infrastructure and suitability for staging | Treated water storage constructed in stages | Investigations in 09/10, stage 1 storage built 10/11 – 11/12<br><br>Further storage stage(s) constructed as required from annual review process |
| Further investigations into using desalination to supplement demands in the 2030+ timeframe | Future augmentation options scoped. | As required by annual review process, by post 2030. |

# 1 Background

## 1.1 Long Term Plan Overview

SA Water's Long Term Plans provide a proactive approach to planning the strategic direction for augmenting SA Water's assets with particular reference to ensuring infrastructure and resources have capacity to meet customer requirements into the future.

SA Water's Long Term Plan for Kangaroo Island (The Plan) considers the area defined by the Middle River and Penneshaw water supply systems (WSS) over a study period of 25 years (i.e. 2007/08 – 2032/2033). Refer to Section 1.2 for more detail pertaining to these WSS.

The Plan incorporates:

- An analysis of existing water resources and infrastructure within the study area
- An analysis of historical SA Water WSS connections and demand
- An estimation of population growth and development on Kangaroo Island
- Projection of future water demands to the end of the study period
- An assessment of the impact of climate on demand
- An assessment of potential WSS augmentation options
- Suggested WSS augmentation options

An outcome of The Plan will be to guide the scheduling of SA Water's capital works for Kangaroo Island.

### 1.1.1 Water Security Plan

In March 2008, the South Australian Government established the Office for Water Security to provide a single point focus for water security planning across government. The Office for Water Security was tasked with the responsibility to develop a State Water Security Plan for South Australia.

On 29 June 2009 the South Australian Government released *Water for Good*, the State's plan to secure water supplies for our future.

*Water for Good* details policies and actions to secure sustainable water supplies for South Australia to 2050, taking into consideration population growth and the impacts of climate variations. One of the key action outcomes of *Water for Good* is to 'ensure regional water demand and supply plans are in place for all regions throughout the State' (page 130).

These regional water demand and supply plans will be developed to secure adaptable, efficient and enduring water supply and management options to support economic prosperity, population growth and an enhanced quality of life for all South Australians.

The regional water demand and supply plans will build on other water planning processes and consider all water resources within a region. The Government's Office for Water Security will develop these plans with support from key organisations including:

- SA Water
- Department of Water, Land and Biodiversity Conservation
- Environment Protection Authority

- Natural Resources Management Boards
- Local Government

SA Water's long term plans will form part of the overall water security planning process. The Office for Water Security aims to complement, build on and, in some cases, inform existing plans.

In the case of SA Water's long term plans, the Office for Water Security will do this by introducing new strategies to address those issues not within the scope of SA Water's infrastructure planning process. Strategies may include the diversification of water supplies through the capture and use of stormwater and rainwater, wastewater recycling and desalination, to provide a secure water supply.

*Water for Good* also includes various measures to improve the way our communities and businesses use water, building on current initiatives such as permanent water conservation measures, the Business Water Saver Program, building regulations and rebates for water efficient devices. Further information on *Water for Good* is available at: www.waterforgood.sa.gov.au

### 1.1.2 Project Reporting Structure

An ordered project reporting structure has been established to ensure:

- The Minister for Water Security remains well briefed regarding The Plan
- Coordination of inputs from other government agencies
- Opportunity is provided to local government and the community to provide input

To achieve these, three broad approaches have been adopted

- Internal Project Reference Group
- Stakeholder Consultation
- Community Engagement

The SA Water Internal Project Reference Group consists of representatives from the following teams

- Asset Management
- Environmental Management
- Engineering
- Operations
- Stakeholders Relations (Community Involvement Group)
- Systems Planning
- Water Treatment Design

Integral to the development of the Long Term Plan has been the involvement from the community in identifying key issues and reviewing water security options. Key stakeholder groups were given the opportunity to contribute to the community engagement process ensuring that all issues relevant to the scope of the Plan could be identified and addressed.

The engagement established effective structures that gave opportunities for stakeholders to review, follow up and comment on issues raised at the commencement of the project and provided an opportunity to deliver key messages and information to the community.

## 1.2 Existing Water Supply Systems

There are two SA Water WSS providing potable water to Kangaroo Island; Middle River and Penneshaw WSS.

The Middle River WSS supplies the townships as listed below and the surrounding rural areas.

- Kingscote
- Brownlow
- Parndana

Penneshaw WSS supplies the township of Penneshaw.

Refer to Figures 1 and 2 for a plan illustrating the broad WSS areas.

The water supply to the Middle River WSS is sourced from the Middle River Reservoir and the water supply to the Penneshaw WSS is sourced from the Penneshaw seawater desalination plant. The two WSS are independent.

### 1.2.1 Middle River

Runoff from the Middle River catchment is captured in the Middle River Reservoir. The reservoir has a design capacity of 470 ML and has overflowed every year since the dam was constructed in 1968 however in recent drought years the volume spilled has considerably reduced.

Water is pumped from the reservoir to the Middle River Water Filtration Plant (WFP) and filtered water is stored in the 4.5 ML Middle River EL 208 Tank. This water then flows by gravity approximately 50 kilometres through a pipeline to the 4.5 ML Kingscote EL 65 Tank supplying Parndana, Brownlow and country lands customers along the pipeline route. A break pressure tank is located on Kohinoor Hill to reduce pressures in the section of main between Kohinoor and Kingscote. Kingscote is supplied from the Kingscote Tank.

The Middle River supply has always been reliable however in the drought of 2006/07 a combination of increased demand and low inflows resulted in the supply being supplemented with water from another source. Subsequently temporary works have been completed to raise the level of the existing Middle River dam spillway to increase the reservoir capacity by 70 ML (15%) to a total of 540 ML.

At peak times during the system is nearing capacity.

### 1.2.2 Penneshaw WSS

Penneshaw is supplied by a seawater desalination plant with a capacity of 300 kL/d. Prior to its completion in 2003 the supply was sourced from two privately owned farm dams.

The desalination plant supplies water to the reticulation system and a 32 ML treated water storage.

### 1.2.3 Areas Not Currently Supplied by SA Water

There are areas of Kangaroo Island that are not currently connected to SA Water's supply systems. These include townships such as American River and Emu Bay and rural areas. The recent drought conditions have highlighted these areas, as their traditional resources that rely on rainfall become scarcer.

Demands from standpipes used to supply water carted to these areas have been accounted for in the Country Lands demand projections. This report does not investigate options for other small townships or broad acre farming areas. These areas will be addressed via a separate process between these communities or their representative groups (eg the Kangaroo Island Council) and SA Water.

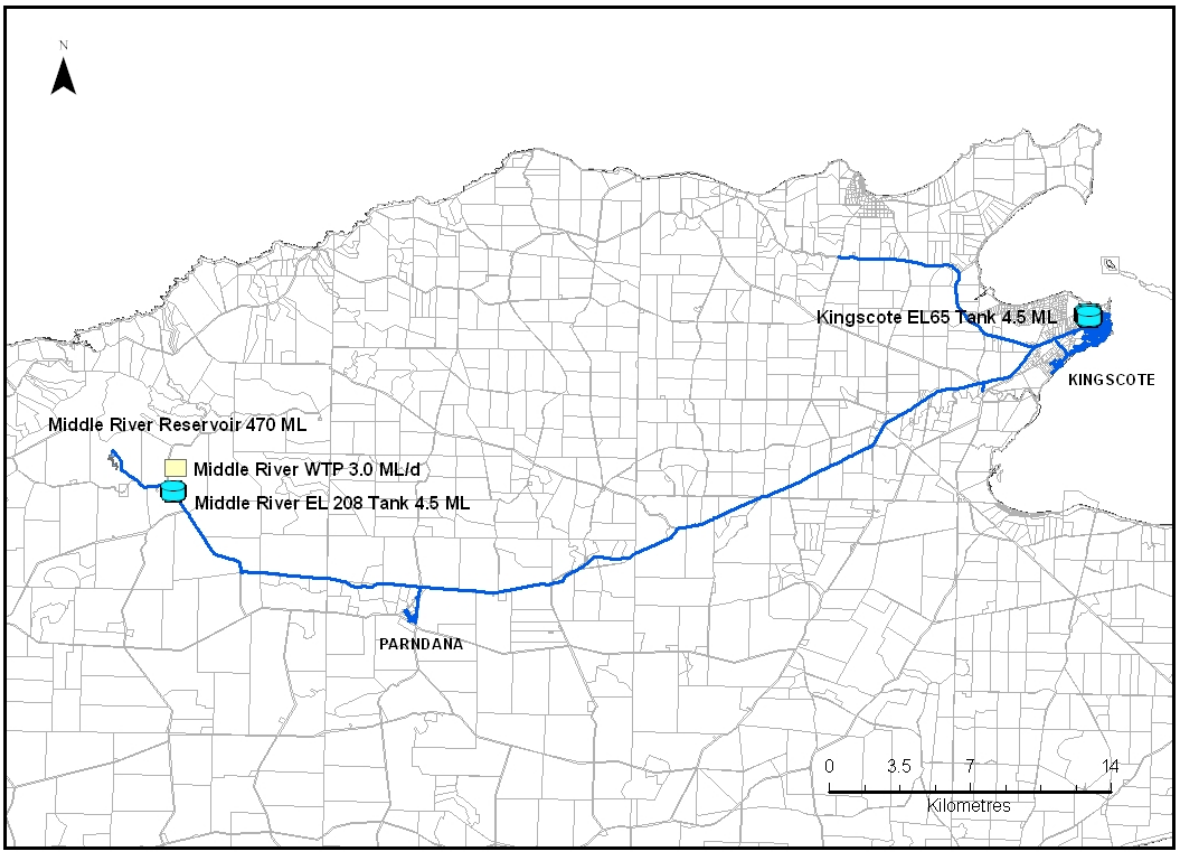



**Figure 1 Middle River WSS**

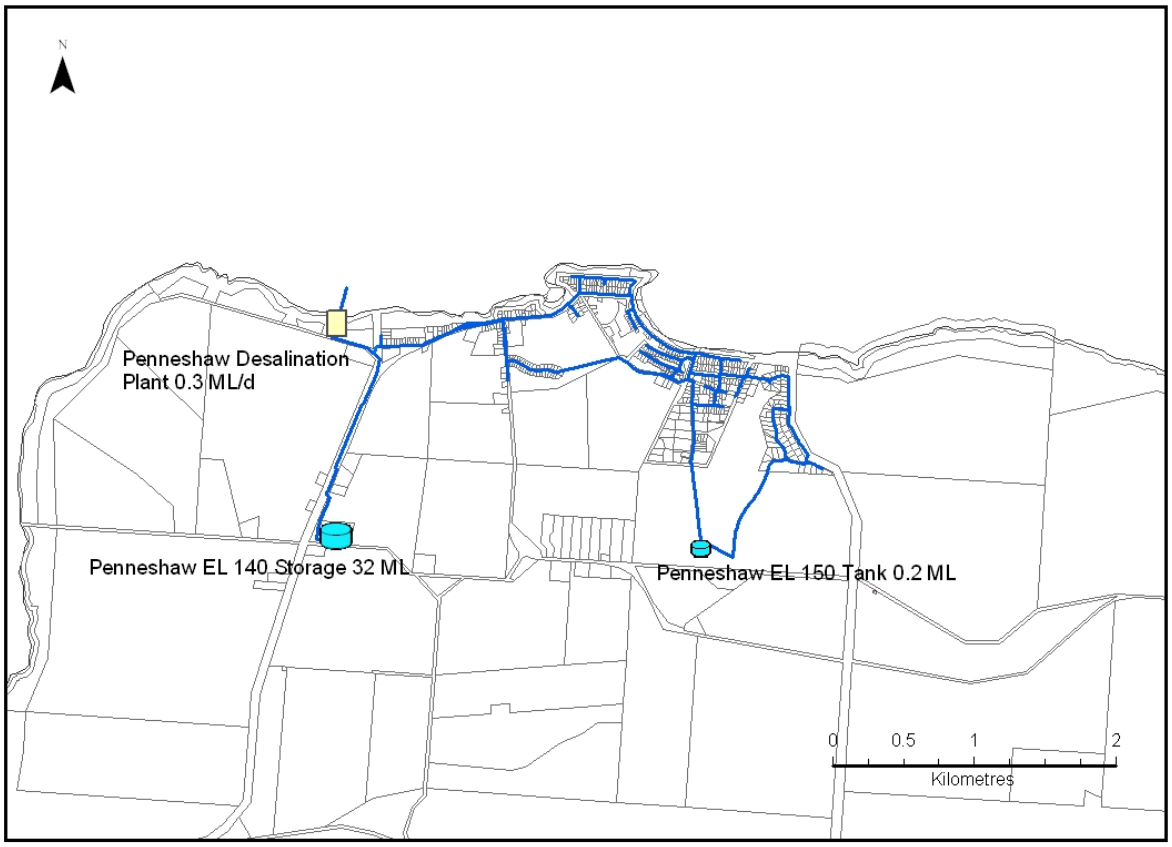



**Figure 2 Penneshaw WSS**

# 2 Community Consultation

## 2.1 Community Engagement and Communication

Integral to the development of the Long Term Plan has been the involvement from the community in identifying key issues and reviewing water security options. Key stakeholder groups were given the opportunity to contribute to the community engagement process ensuring that all issues relevant to the scope of the Plan could be identified and addressed.

The engagement process was designed to target specific stakeholder needs and interests and to provide the broader community with an opportunity to have input to SA Water's Long Term Plan.

The engagement process therefore established effective structures that gave opportunities for stakeholders to review, follow up and comment on issues raised at the commencement of the project and provided an opportunity to deliver key information to the community.

In particular, SA Water prepared a communication and community engagement plan to deliver on the following specific objectives:

- To engage Kangaroo Island community through key stakeholders and community interest groups in the development and review of SA Water's Long Term Plan for Kangaroo Island
- To provide a means whereby the community is able to inform SA Water of its projected growth and development over the next 25 years and the impact that this will have on projected demand for water
- Facilitate a process for the Kangaroo Island Council to have structured input to the development of the Long Term Plan
- To obtain community support for the Long Term Plan
- To ensure the communication needs of the communities on Kangaroo Island are met through the delivery and distribution of information that is easy to read and understand
- To enable SA Water and key stakeholder groups to communicate key messages about their roles and activities in managing and securing water resources and supply for Kangaroo Island

Key stakeholder groups were invited to participate in the community engagement process. The process included:

- Communication about the management of the region's water resources and SA Water's infrastructure planning and projects for Kangaroo Island
- Issues identification
- Long Term Plan scope and structure
- Technical options to be considered
- Multi Criteria analysis including input to the ranking of social and environmental criteria by key stakeholders
- Presentation of the preferred augmentation option and community response

Participants were invited to highlight issues relating to Kangaroo Island water and water security. The issues raised were not limited to SA Water's area of responsibility but involved broad government policies and other agency policies and projects.

Stakeholder information sessions at key stages of the process were held with each group at various locations across Kangaroo Island. Stakeholder groups participating in the workshops included:

- Kangaroo Island Council
- Advance Kingscote
- Parndana Progress Association
- Penneshaw Progress Association
- Kangaroo Island Development Board Inc.
- Kangaroo Island Natural Resources Management Board (KINRMB)
- Tourism Kangaroo Island
- Department for Water Land and Biodiversity Conservation (DWLBC)
- Department of Environment and Heritage (DEH)
- Primary Industries and Resources SA (PIRSA)
- Agriculture KI (AgKI)
- Eco-Action KI
- KI Grape Growers Association

A fundamental principle applied to the engagement process involved the establishment of a feedback loop through meeting minutes and factsheets. The Issues Table in Appendix A provides a mechanism for all contributions to be acknowledged and documented and forwarded to relevant areas of Government for further consideration if required.

## 2.2 Strategy Implementation and Outcomes

At the first series of meetings, held between December 2008 and February 2009, the focus was on the objective of the Long Term Plan, community engagement and communication processes and the Long Term Plan process timeframes. The first meetings also focussed on the five augmentation options being considered which are discussed further in Section 5.0.

Stakeholders were encouraged to be involved in these meetings and provide comments on the Long Term Plan process and augmentation options being considered. The input strongly contributed to the development of SA Water's Long Term Plan by representing community issues and suggesting possible strategies for water security to sustain the economic growth of the region.

SA Water attended the KI Field Day in February 2009 to provide the broader Kangaroo Island community with an opportunity to comment on the options.

During the community engagement process a number of issues were raised with respect to water management and planning. The need to account for increases in demand by planning effectively for changes in population, industry growth and agriculture was expressed. Other topics raised included the future of the Middle River Reservoir, climate change and the need to consider alternative options to secure water supply. There was a common view that any additional water required to meet future demand should be sourced from Kangaroo Island's existing resources such as Middle River rather than introducing a new resource.

The Issues Table in Appendix A provides a comprehensive list however the key issues raised at the first series of meetings include:

- a general view that the annual projected growth of approximately 2% per annum was accurate (this is discussed further in Section 3.0)
- doubts that the power cable from the mainland has sufficient capacity to cope with additional load
- a preference for green energy in line with the green credentials of Kangaroo Island
- interest in whether other sources could be investigated such as Magill's/James Wandell's Dams/Cygnet River
- interest in the impact forestry has on catchments and a view that the forestry industry needs to be accountable for the potential impact on catchment areas
- an understanding that in an average year approximately 12 000ML per annum will spill at Middle River although the volume is significantly less in dry years.
- interest in why American River/Emu Bay/Island Beach were not being considered in Long Term Plan
- a common view that the flow rate from standpipes is too slow and takes carters and farmers too long to fill water tanks
- a view that grape growing is not a growth industry
- a strong view that the option selected must have minimal impact on the existing environment/biodiversity eg marine/glossy black cockatoos/marine parks
- how the plan will address the 25% rule (NRM Plan)
- the community should be wiser about a sustainable water service rather than SA Water sourcing additional water to meet demand. For example, it was questioned whether supplying water for irrigation purposes (grapes/potatoes/orchards) is sustainable. Rather than source additional water to meet demand over next 25 years, there was a view that the Kangaroo Island community should look at the way it uses water and make some hard decisions about who should be able to use water
- there could be a benefit to the primary producers located adjacent the reservoir if they were able to secure the water allocation from the Middle River Catchment should Middle River Reservoir be relinquished (and a desalination plant be constructed)
- in some regions of SA there is a shift in land management practices eg from cropping systems to livestock or to less till. This could have an impact on catchments
- currently, Kangaroo Island is experiencing annual growth in tourism (short stay) of about 15%
- while some country land users may use potable water for domestic purposes, a large majority use the water for stock or horticultural purposes only, not for drinking

At the second meeting in March 2009, key stakeholders were provided with an overview and opportunity to discuss or confirm issues raised at stakeholder meetings. Stakeholders were also provided with an overview of the Multi Criteria Analysis (MCA) to be used to identify a preferred option(s) to meet future projected demand.

Stakeholders undertook an exercise to provide SA Water with an understanding of the level of importance the community places on specific environmental and social criteria.

The results of the workshop are contained in Appendix B. They indicate that the community considers the augmentation option should have regard for the potential impact on the terrestrial and aquatic ecosystems. It also highlighted that community acceptability of the preferred option is important, indicating the community values its involvement in the Long Term Plan process.

The project team then allocated weightings to each criterion. The outcomes of this process are contained in Section 7.

At the third information session in August 2009, stakeholders were provided with details of the preferred option following the formal assessment of the augmentation options. Stakeholders were also provided with an overview of the next steps and timeframes.

# 3 Demand

## 3.1 Historical SA Water Demand Information

Historical SA Water annual data was collected for the period 2000-01 to 2007-08 and has been interrogated for trends in customer connections and total demand.

The following figures summarise the customer connections and total demand data for each WSS. For the Middle River WSS the data has been separated into residential, non residential (urban) and country lands (rural) components. Penneshaw data has been separated into residential and non residential (urban) components.

Figure 3 and Figure 4 indicate the growth in the number of customer connections over this 8 year period.

In spite of this growth in customer connections Figure 6 and Figure 6 show indications of a downwards trend in total urban demand in recent years. This can likely be attributed to the raised awareness of the need to conserve water and the impact of water restrictions.

Demand from the Country Lands customers is more variable than the urban demand. It varies from 40% of the total in dry years (2006/07) and to 27% of the total in wet years (2004/05). Average over the last 5 years is 35% of the total demand. (Consumption from standpipes is included in the country lands demand).

Kangaroo Island customers are currently on Permanent Water Conservation Measures.

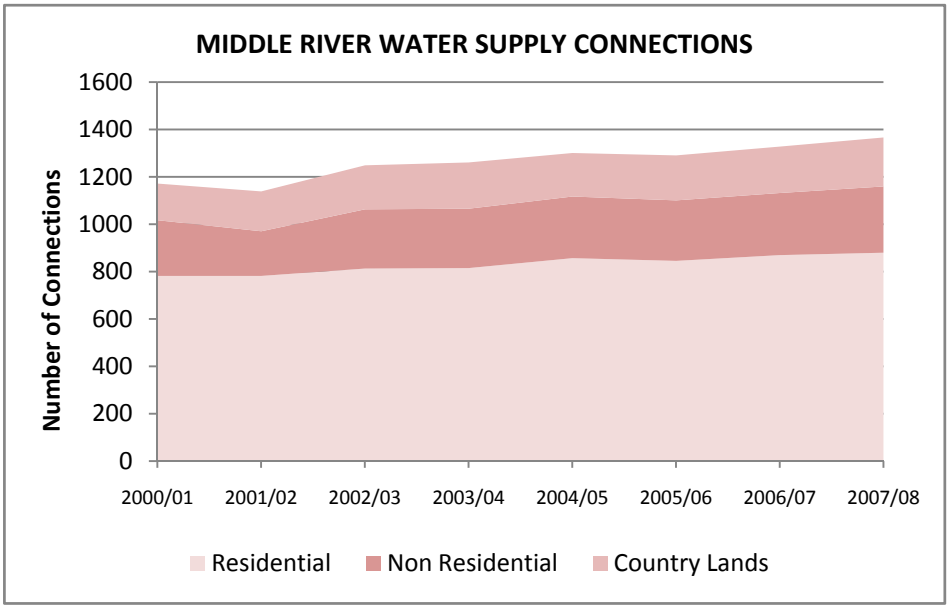



**Figure 3 Middle River WSS Historical Customer Connections**

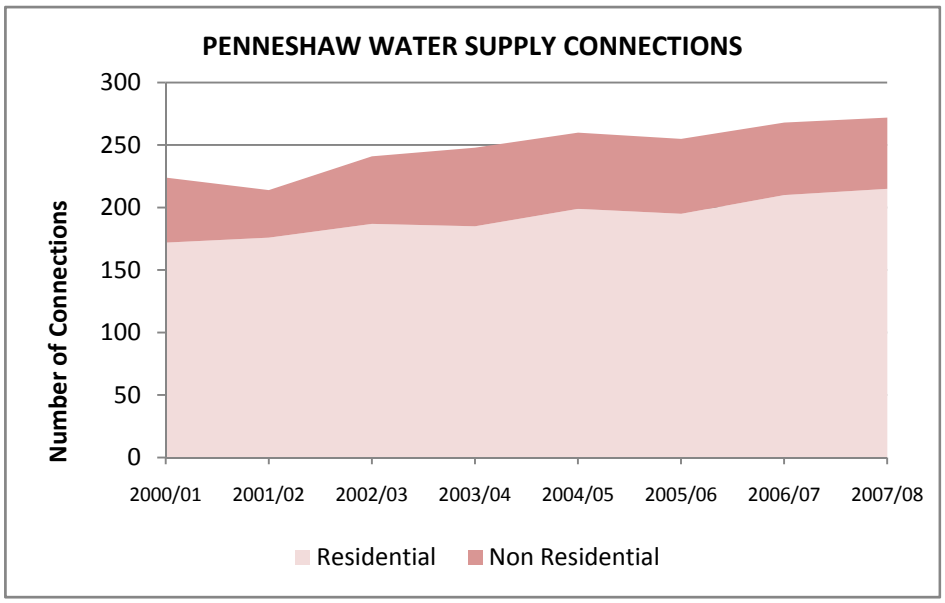



**Figure 4 Penneshaw WSS Historical Customer Connections**

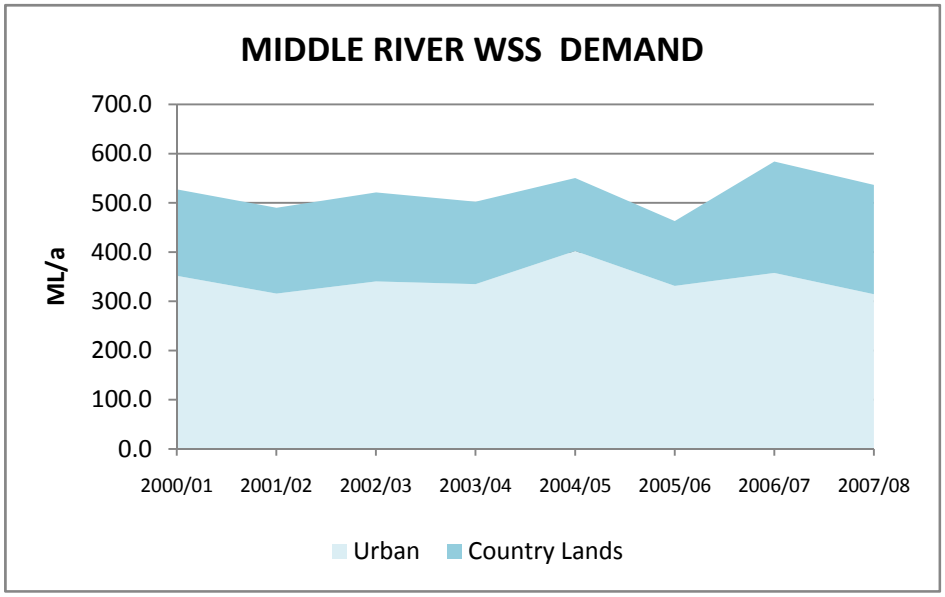



**Figure 5 Middle River WSS Historical Total Demand**

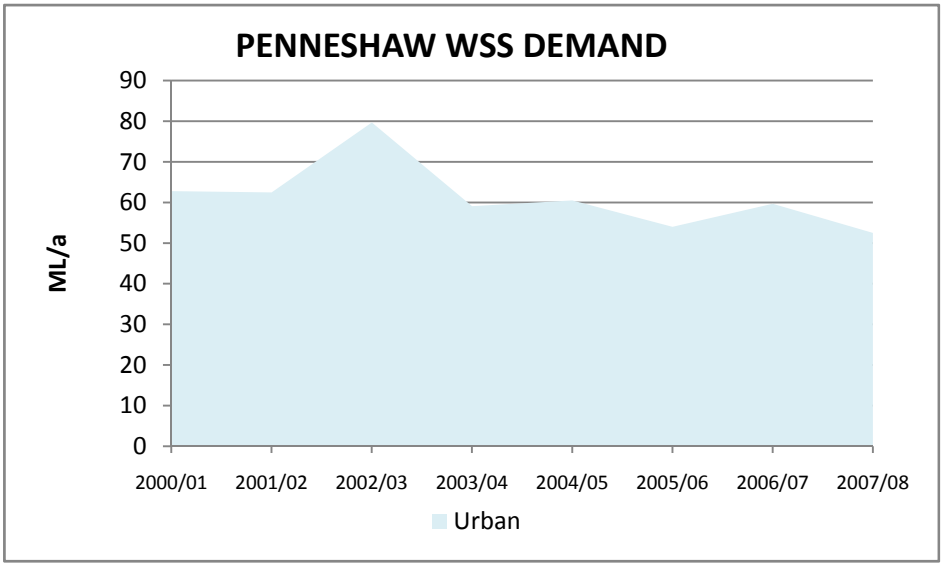



**Figure 6 Penneshaw WSS Historical Total Demand**

Using this data the historical total demand per connection has been calculated.

For the purpose of this investigation the data for the last 5 years has been used for calculating the total demand per connection for the Middle River WSS and the Penneshaw WSS. Table 1 and Table 2 summarise the average total demand per connection for townships and rural demand for each WSS.

The high demand in Penneshaw in 2002/03, a dry year, was prior to Permanent Water Conservation Measures and is not considered representative of current demands.

**Table 1 Middle River WSS Total Demand / Connection (kL/year)**

| Township | Residential | Non-Residential |
|---|---|---|
| Urban | 280 | 430 |
| Rural | n/a | 880 |

**Table 2 Penneshaw WSS Total Demand / Connection (kL/year)**

| Township | Residential | Non-Residential |
|---|---|---|
| Urban | 205 | 270 |

Historical SA Water instantaneous flowmeter data was analysed for the years 2004-05 and 2005-06 prior to the introduction of water restrictions, to establish peaking factors for the Middle River WSS.

Peaking factors help to assess the magnitude of daily, weekly and seasonal variations in water usage.

The following table summarises the average peak day, peak week and peak month factors for the Middle River WSS. (Note: flowmeter data was not available for individual townships.)

**Table 3 Middle River WSS Peaking Factors**

| WSS | Peak Day | Peak Week | Peak Month |
|---|---|---|---|
| Middle River | 2.36 | 2.19 | 1.84 |

The Penneshaw WSS incorporates a large balancing storage to allow the desalination plant to operate at its optimum capacity and to allow periodic maintenance shutdowns. As there is in excess of 6 months storage available the peaking of flows is not an issue for the Penneshaw supply.

## 3.2 Census Information

Australian Bureau of Statistics (ABS) Census of Population and Housing data from 1996, 2001 and 2006 was collated for Kingscote (Urban Centre) and total Kangaroo Island.

The total number of persons and occupied / unoccupied dwellings for Kingscote township and the total for Kangaroo Island is displayed in Table .

**Table 4 Census Data for Kingscote and all Kangaroo Island (ABS 1,2,3)**

| Town | 1996 | | | 2001 | | | 2006 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total persons | Occupied Dwellings | Unoccupied Dwellings | Total persons | Occupied Dwellings | Unoccupied Dwellings | Total persons | Occupied Dwellings | Unoccupied Dwellings |
| Kingscote | 1529 | 626 | 108 | 1671 | 686 | 124 | 1692 | 745 | 147 |
| Kangaroo Island Total | 4118 | 1532 | 623 | 4238 | 1693 | 762 | 4456 | 1814 | 854 |

There was a 1% pa increase in population in Kangaroo Island between 2001 and 2006 and a small increase in the Kingscote population. The total number of dwellings grew at 2% pa and occupied dwellings grew by 1.7% pa.

Planning SA population projections indicate a population of 5300 in 2016 and 5400 in 2021.

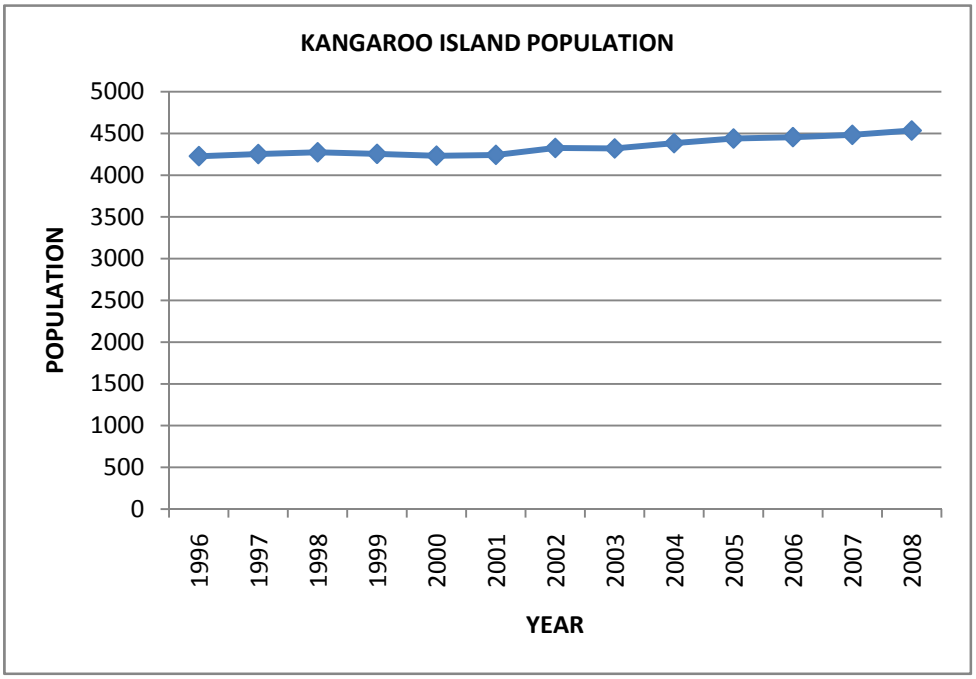



**Figure 7 Total Population for Kangaroo Island (DC) (ABS.4)**

### 3.2.1 Tourism Demand

Tourism makes a significant contribution to the Kangaroo Island economy. The Kangaroo Island Strategic Tourism Plan (Urban and Regional Planning Solutions, 2006) estimates that approximately 150 000 visitors travel to Kangaroo Island each year. The Tourism Plan has a goal of increasing visitor numbers by 1-2 % per annum.

Tourists visiting the island may stay in tourist accommodation or holiday homes that are connected to the reticulated water supply or at settlements or resorts that rely on independent supplies such as rainwater tanks.

### 3.2.2 Rural Demand

Rural demand is climate dependent. In recent drought years rural demand has been approximately 40% of total demand from the Middle River WSS. This is above the average of the last 8 years. With lower rainfall and less natural runoff into farm dams farmers have had to place greater reliance on the reticulated supply. Water carting for stock and to augment rainwater tank supplies has also increased.

The effect of reduced rainfall and more dry years in the future as a result of climate change will maintain the high demand from rural customers.

## 3.3 Regional Land Use Framework

In March 2009, Planning SA released a draft document titled "Kangaroo Island Regional Land Use Framework" (The Framework).

The Framework is a volume of the Planning Strategy for South Australia which sits 'beneath' South Australia's Strategic Plan (SASP) and "provides a 'bridge' between broad state-wide planning and local council land use planning." More specifically it should provide guidance to councils when reviewing their development plans.

The Framework lists as a challenge the need to increase the capacity of water infrastructure to support population and tourist growth and industry expansion.

The availability of water supplies on Kangaroo Island is raised as an issue in The Framework. The document states that despite the use of rainwater tanks, shortages still occur during peak visitor periods over the summer months.

The Framework also outlines the additional pressure being placed on the region's water supplies as a result of growing industrial, residential and tourism development. Managing the demand for water use by raising awareness among residents and holiday makers is seen as essential to achieving South Australia's sustainable water efficiency target.

The objectives outlined in The Framework, which are the overarching goals to be achieved through land use and development, are considered to be incorporated in this investigation's future demand projection based on information received during initial stakeholder consultation

## 3.4 Future Demand

As part of this investigation a future demand projection scenario has been prepared for each WSS with regard to the study period of 25 years. In preparing these projections an analysis of the urban and rural demand for each WSS was undertaken.

The projections have been prepared based on historical trends in the SA Water customer connections and demand data (refer Section 3.1).

The connections projection was calculated by extrapolating growth of existing connections using residential growth and non-residential growth for each WSS. These growth rates are outlined in Table 5 and Table 6. This provided a higher growth rate than that based on developer projections derived from previous stakeholder consultation (KBR 2007).

**Table 5 Middle River WSS Projected Connections Growth Rates**

| Township / Country Lands | Residential Growth Rate Connections/Year (%) | Non-Residential Growth Rate Connections/Year (%) |
|---|---|---|
| Urban | 13 (1.5) | 4 (1.4) |
| Rural | n/a | 7 (3.4) |

**Table 6 Penneshaw WSS Projected Connections Growth Rates**

| Township | Residential Growth Rate Connections/Year (%) | Non-Residential Growth Rate Connections/Year (%) |
|---|---|---|
| Penneshaw | 5 (3.2) | 2 (3.5) |

The connections projection was converted to a total demand projection for each WSS by using the total demand per connection as displayed in Table 1**Error! Reference source not found.** and Table 2**Error! Reference source not found.**. The overall increase in demand equates to a 2.0% pa increase in demand in the Middle River WSS and a 2.6% pa increase in demand from the Penneshaw WSS. These increases are similar to the current growth rate of dwellings on Kangaroo Island.

Peak demands were then estimated for the Middle River WSS by applying the estimated average peaking factors as detailed in Table 3.

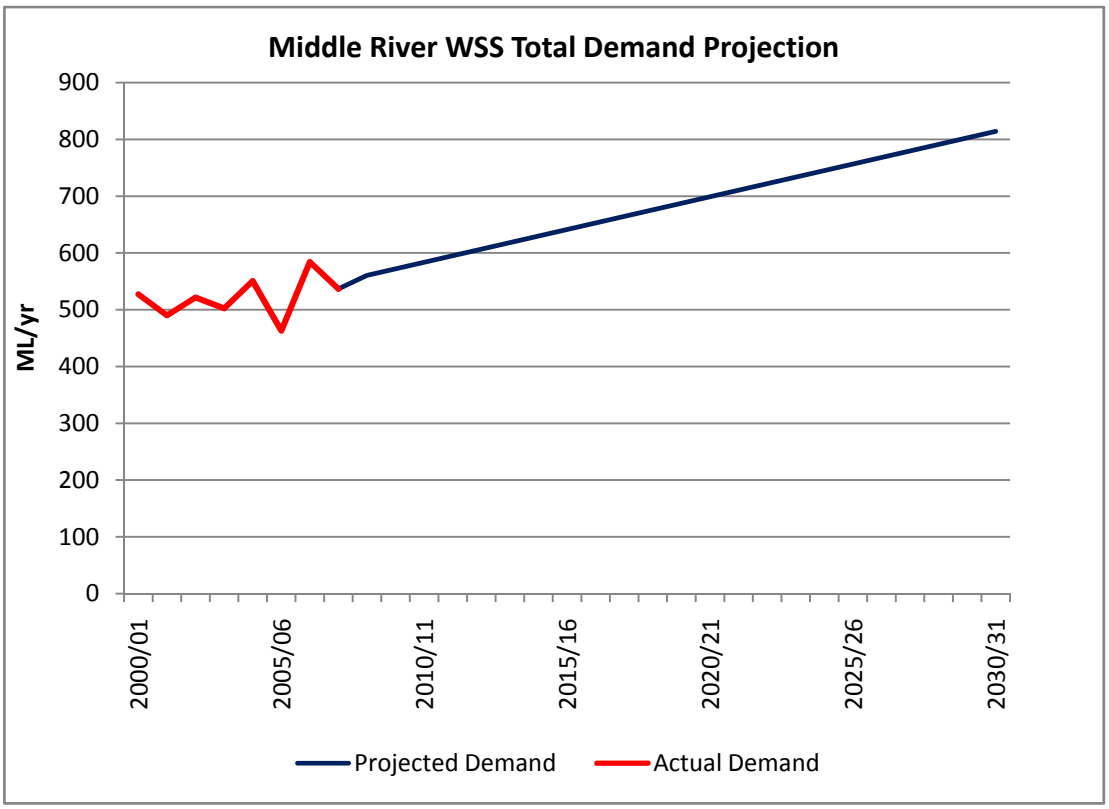



**Figure 8 Middle River WSS Total Demand Projection**

Consultants KBR (2007) carried out a survey of the Kangaroo Island Council and other stakeholders in 2006 to identify potential future development likely to affect water demand. Based on the feedback from this group of regulatory authorities, and business development organisations/industry stakeholders the future growth in demand was estimated to be approximately 2% per annum. This is generally in line with current growth projections used by the Kangaroo Island Council and was considered satisfactory by other stakeholders during the briefing sessions.

The graph shows that at the end of the study period the average demand from the Middle River WSS is projected to be approximately 825 ML/a.

The peak day flow is estimated to increase from approximately 3 ML/d to 5.3 ML/d.

The future demand projection for Penneshaw is shown in Figure 9.

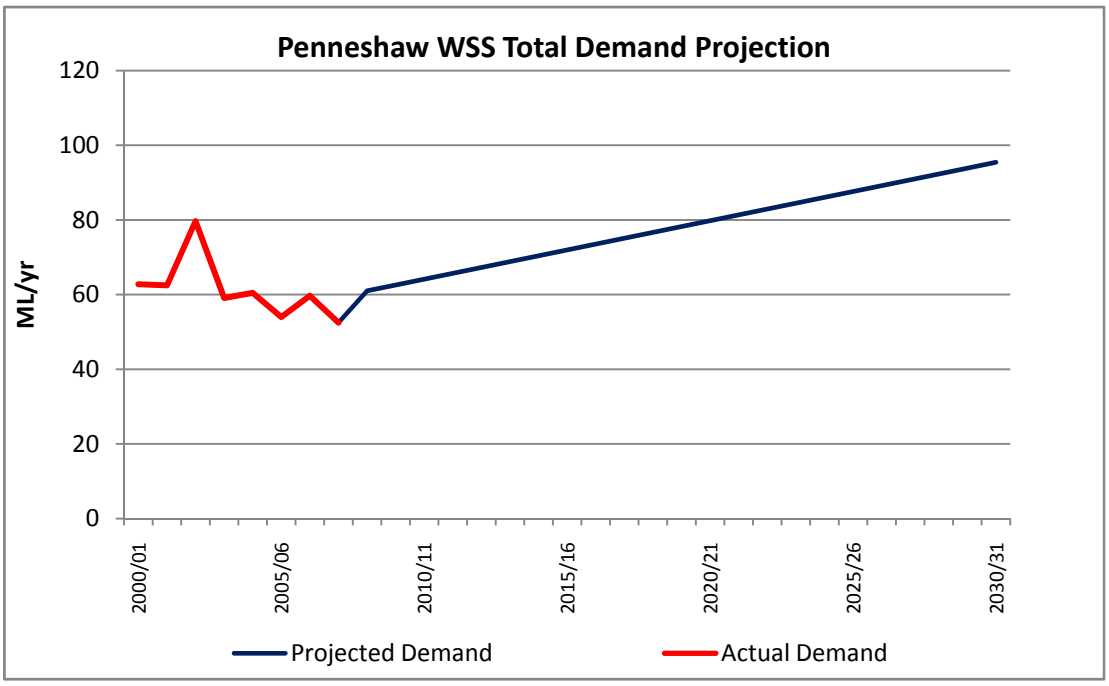



**Figure 9 Penneshaw WSS Total Demand Projection**

The figure shows that at the end of the study period the average demand from the Penneshaw WSS is projected to be approximately 95 ML/a.

### 3.4.1 Climate change

There is still some uncertainty about the extent of climate change expected in the future due to the uncertainty in future greenhouse gas emissions

Investigations undertaken on other water supply systems around the state using the results from CSIRO climate change studies has indicated that climate change could potentially increase demand by up to 10% towards the end of the study period due to a decrease in annual rainfall and an increase in average temperature and evaporation.

The annual assumptions review embedded in the long term planning process will ensure that SA Water are able to monitor demand and adjust any project milestones as a consequence.

# 4 Existing Sources

Sections of the following chapter have been reproduced with permission from the following sources: KBR 2007. Investigation into future reticulated water demands in Kangaroo Island.

SA Water's supply on Kangaroo Island comes from two sources, namely:

- Middle River water supplied from the Middle River Reservoir
- Seawater desalination

## 4.1 Middle River

The Middle River provides the water supply to the Middle River WSS. The Middle River Reservoir is located approximately 50 km west of Kingscote and has a design capacity of 470 ML and a catchment area of approximately 101 square kilometres.

The dam that forms the reservoir was constructed in 1968 and has spilled every year since it was completed. In June 2007 a 'fuse' was installed on the spillway to raise the level and increase the reservoir capacity to approximately 540 ML.

The land use within the Middle River catchment is mainly pasture 50% and native vegetation 38% with 12% forestry (pine and blue gums plantations). There has been an increase in forestry in recent years with further increases foreshadowed. Where forestry replaces pasture the runoff from the catchment is reduced.

The drought in recent years has impacted on reservoir inflows both by:

- reducing the volume of spill, and
- reducing the period over which the reservoir is spills.

Inflows into the reservoir are likely to decrease in the future due to the effects of climate change reducing rainfall in the catchment and from any increase in areas developed for forestry.

SA Water has discussed with the KINRMB and DWLBC the need to ensure that sufficient inflows to the Middle River Dam are secured for the purposes of the public water supply.

The Middle River WTP uses the conventional treatment processes of flocculation, sedimentation, filtration and chlorine disinfection. In 2007 the WTP was upgraded to include the MIEX process, an additional pretreatment stage, to help enhance the water treatment process.

### 4.1.1 Middle River Dam

The Middle River dam is a thin walled, prestressed concrete structure which was constructed in 1968. It is prestressed to the foundation with tensioned cables grouted into foundation rock and the dam body.

Due to the presence of alkali-aggregate reaction (AAR) in the concrete Middle River's Dam structure is gradually deteriorating, potentially compromising the long term structural integrity of the wall.

Investigations are currently being undertaken to reassess the structural integrity of the dam to determine when upgrading or replacement will be required.

The results of these investigations will determine:

- whether the existing dam wall can be reinforced (buttressed) or whether it will need to be replaced by constructing a new dam wall
- when this work should be undertaken.

A new dam located 50 m downstream of the existing dam and constructed to the existing dam design full supply level would have a volume of 520 ML. If the new dam were constructed to the current raised spillway level the storage volume would increase to approximately 600 ML.

Funds for upgrading the dam wall have been allocated on SA Water's capital works plan commencing in 2019/20. The timing of this work and the nature of the work to be undertaken will be dependent on the outcome of the current dam investigations.

Should the results of the dam investigations indicate work to upgrade the dam is required before 2019 the funding and work will be brought forward.

Augmentation of the Middle River WSS will be required before a decision will be made on dam upgrading and future augmentation options have been assessed assuming the Middle River dam will be replaced in 2019.

## 4.2 Seawater

The Penneshaw seawater desalination plant draws seawater from Backstairs Passage adjacent to Penneshaw. There is good movement of seawater in this area and the volume available is effectively unlimited.

Kangaroo Island is surrounded by the sea and much of the coastline has access to the areas with good tidal movement and currents. Such locations are suitable for extraction of seawater for desalination and provide for environmentally acceptable disposal of the concentrate stream.

## 4.3 Non Reticulated Supplies

Water from a number of other sources is used on Kangaroo Island. A large portion of the island is not connected to the SA Water supply system and water is usually obtained from local surface water – farm dams and rainwater tanks.

### 4.3.1 Wastewater Reuse

SA Water does not own or operate any sewerage systems on Kangaroo Island. The Kangaroo Island Council (KIC 2009) operates Community Wastewater Management Schemes (CWMS) for Kingscote, Parndana and Parndana East. A scheme is under construction in American River, and a scheme is under consideration for Penneshaw.

Treated effluent from the Kingscote CWMS is used for irrigation at the golf course, race course and for private irrigation. The schemes for American River and Penneshaw will also incorporate reuse of effluent. Council is also investigating possible reuse at Parndana.

### 4.3.2 Groundwater

KRB (2007) reviewed the available information on groundwater on Kangaroo Island and concluded that potable groundwater is in short supply on Kangaroo Island with the majority of bores providing saline water (>2000 mg/L) and low yields (<1 L/s)(Barnett and Dodds, 2000). Borehole data from 700 bores on

Kangaroo Island suggests that fresh water occurs as limited and localised supplies sitting atop saline aquifers (Appendix E Mooney and Grinter 2000 cited in KINRMB 2003 P27).

#### 4.3.3 Rainwater Tanks

Rainwater tanks are extensively used in Kangaroo Island in areas without a reticulated water supply. As is the case in many country areas significant numbers of people with a reticulated supply also use rainwater for in-house uses.

Reliability of a scheme needs to be considered, especially those dependent on the rainfall, as climate variability and long term climate change can potentially provide inadequate supply in periods of drought. During the recent drought many users of schemes such as rainwater tanks have had to seek a backup source until the rainwater tanks were replenished.

During droughts it is common for rainwater tank supplies to be augmented with water carted from standpipes fed from the reticulated systems. During the drought in 2006 approximately 40 ML of water was carted from standpipes, (7% of the Middle River system demand) .

As most houses already have a rainwater tank installed it is difficult to estimate the amount of water that could be harvested from additional uptake of domestic rainwater tanks across the project area. This will depend upon the mixture of incentives to encourage uptake and education and public awareness.

#### 4.3.4 Stormwater

The Kangaroo Island Council is currently investigating possible stormwater reuse at Kingscote, Parndana and Penneshaw.

Currently up to 13 ML of mains water in Kingscote, 1 ML in Parndana and 1.4 ML in Penneshaw is used by recreational facilities, mainly for watering ovals and parks. Harvested stormwater could potentially be used to replace this mains water.

### 4.4 Overview of Supply Situation

#### 4.4.1 Middle River

The Middle River Reservoir fills and spills over winter and continues to spill while natural intakes continue during spring. In drought years eg 2006, the reservoir stops spilling in early spring. This restricts the volume available for supply to the stored volume plus any continuing natural inflows. To increase the volume available for supply requires an increase in storage capacity.

While the Middle River is spilling during the winter months there is water available for capture and storage. Capture of additional water is subject to the approval from the KINRMB.

Consultants AWE (Australian Water Environments) have undertaken an hydrological study of the Middle River catchment using historical rainfall records. (AWE 2008)

A range of scenarios were investigated including current catchment conditions, increased forestry, and reduced rainfall due to climate change.

The reliability of the Middle River Reservoir has been assessed using the streamflow output from this study. With current catchment conditions and historic rainfall the safe yield for the Middle Reservoir at

the design capacity of 470 ML was estimated to be 560 ML/a. The safe yield for the increased capacity of 540 ML is estimated to be 630 ML/a.

The Middle River WSS demand projection shown above in Section 3.4 is compared to these system capacities in figure 10.

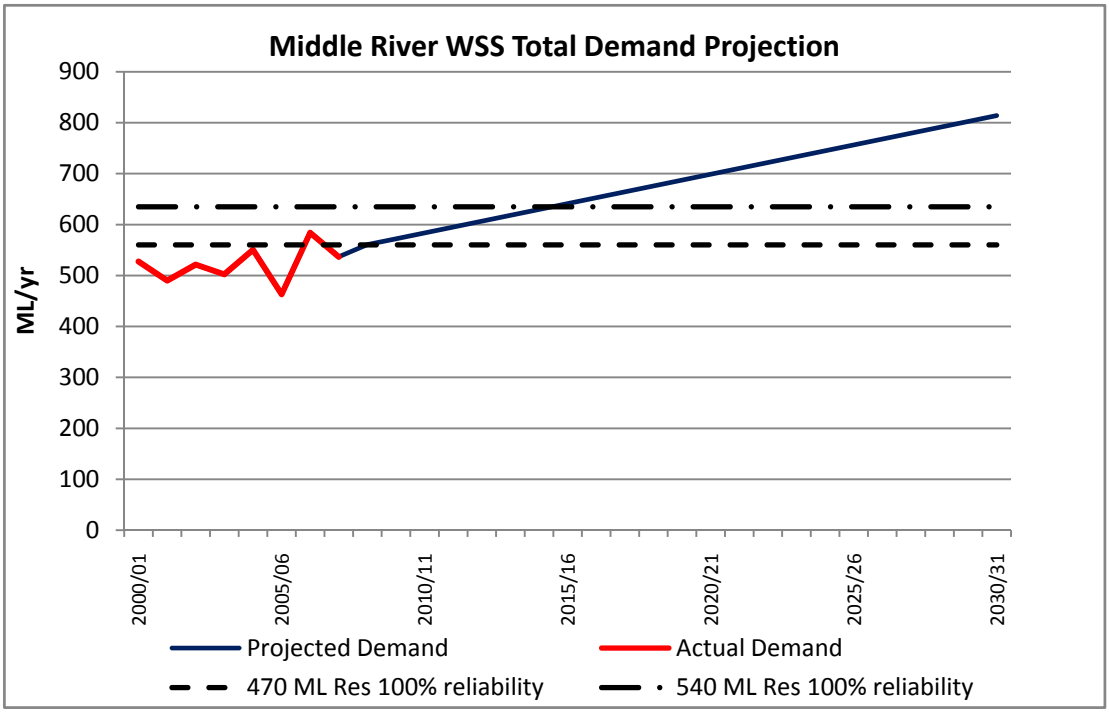



**Figure 10 Middle River WSS Total Demand Projection**

Figure 10 shows the Middle River WSS total demand projection will exceed the reliable yield of the 540 ML storage capacity in approximately 2013/14. To maintain a reliable supply the water supply system will need to be augmented.

The predicted impacts of climate change on the Kangaroo Island environment have been set out by the KINRMB State of the Region 2009 Report. AWE ran the hydrologic model using the predicted worst case SRES Scenario which predicts up to 11% rainfall reduction by 2030.

Output from the climate change scenario indicated a reduction in average annual runoff of approximately 31% in 2030. The largest reductions in reservoir inflows occur during the spring months although large reductions in runoff occur in all months,

The minimum annual climate change adjusted streamflow of 2305 ML output from the climate change scenario has been used in the development of the future options. The monthly distribution of flow was determined using the individual monthly climate adjusted 90% exceedence values

It is estimated that the potential use of water from the Middle River in 2032 would be up to approximately 1000 ML. This allows for meeting demand estimated to be 825 ML, potential losses in the treatment process 40-80 ML (dependent on process type) and reservoir evaporation loss 100-125 ML (dependent on storage volume). This is an increase of 300 ML/a above the current draw from the Middle River system of approximately 700 ML/a (offtake and evaporation).

The hydrologic modelling undertaken suggests that the reservoir will spill even in future severe drought years and there should be sufficient water available for the environment and to provide 1000 ML for public water supply provided sufficient storage capacity is constructed.

The current capacity of the Middle River WTP and the supply main from Middle River to Kingscote is 3ML/d. In 2032 with an annual demand of 825 ML/a the peak day demand from the system based on the peaking factors shown in Table 3 is projected to be 5.3 ML/d and will exceed the available capacity.

Future augmentation options for the Middle River WSS need to address both the available resource and the network capacity constraints.

As the resource managers, the KINRMB and DWLBC have the responsibility to ensure that the surface water resources are being managed sustainably. SA Water has discussed with these agencies the need to ensure that sufficient inflows to the Middle River Dam are secured for the purposes of the public water supply.

### 4.4.2 Penneshaw

Figure 11 shows that at the end of the study period the average demand from the Penneshaw WSS is projected to be approximately 95 ML/a. The existing capacity of the Penneshaw desalination plant together with the balancing storage has sufficient capacity to meet the projected demand.

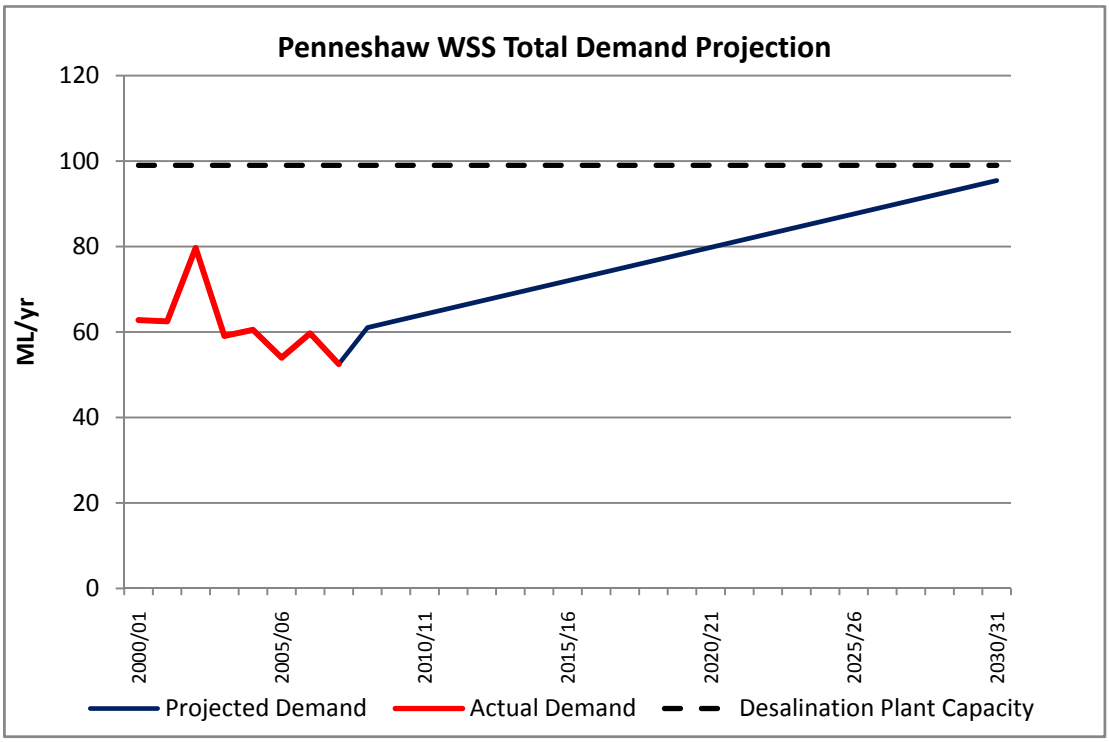



**Figure 11 Penneshaw WSS Total Demand Projection**

Due to the large balancing storage available the peaking of flows is not an issue for the Penneshaw supply.

Climate change will have no impact on the supply from the Penneshaw desalination plant.

# 5 Augmentation Options for the Middle River WSS

Sections of the following chapter have been reproduced with permission from the following source: PB 2008. Long Term Plan for Kangaroo Island Water Supply Option Investigations and Comparisons

In this report five options have been investigated for augmenting the Middle River WSS. These options are:

1. Construct a larger dam at Middle River
2. Construct a new 250ML raw water storage near Middle River reservoir
3. Construct a new 250 ML in-system storage near Kingscote.
4. Supplement supply by constructing a new 0.75ML/day seawater desalination plant near Emu Bay/North Cape.
5. Supply all Middle River WSS demand from a new seawater desalination plant with a capacity of 2.5ML/day located in the vicinity of Emu Bay/North Cape.

The five options were assessed based on a water balance and supplying the projected future annual demand of 825 ML as determined in section 3.4.

## 5.1 Assumptions

The following assumptions have been made in the preparation of these options.

- The minimum annual inflow to the Middle River Reservoir was based on the minimum annual inflow of 2305 ML output from the Middle River hydrologic model using existing catchment land use and the historic rainfall record adjusted for future climate change. The monthly distribution of this inflow was determined from the monthly distribution of the individual monthly 90% exceedence values.
- To allow for operation constraints the water balance analysis required a minimum of 4 weeks supply in storage for options 1 to 4 and 2 weeks storage in summer and 6 weeks storage in winter for option 5
- Where membrane treatment of the Middle River water was assumed an allowance of 6% losses was allowed for.
- The capacity of the existing WTP and transfer system was assumed to be 3 ML/d.
- Except for option 1 any future replacement Middle River dam would be constructed downstream of the existing dam but built to the same FSL with a capacity of 520 ML.
- If the option requires capture of additional water from the Middle River then the appropriate approvals can be obtained from the resource managers (i.e. the KINRMB and DWLBC)

The five options in this section have been investigated using a desktop analysis only. The sites selected for storages, pipe routes and treatment plants should be considered notional and there will be alternative sites which can be explored once it is decided to pursue an option. Options 2 to 5 discussed in this section have the potential to be staged based on actual demands. There is limited opportunity to stage the works associated with Option 1.

In Section 7 options are assessed using a multi criteria analysis (MCA). As part of this assessment, options have been assessed against criteria under four categories, namely

- Social/community
    - Amenity value of infrastructure (e.g. impact on landscape)
    - Community acceptability of option

- Heritage impact

- Environment:
  - Estimate of greenhouse gas emissions over 25 years
  - Impact on aquatic ecosystems (e.g. waste disposal)
  - Impact on terrestrial ecosystems
- Economic/commercial
  - Total cost to customer/utility/government
  - Total cost per ML
- Technology/functionality
  - System complexity
  - Operability

## 5.2 Construct a Larger Dam at Middle River

### 5.2.1 Option Overview

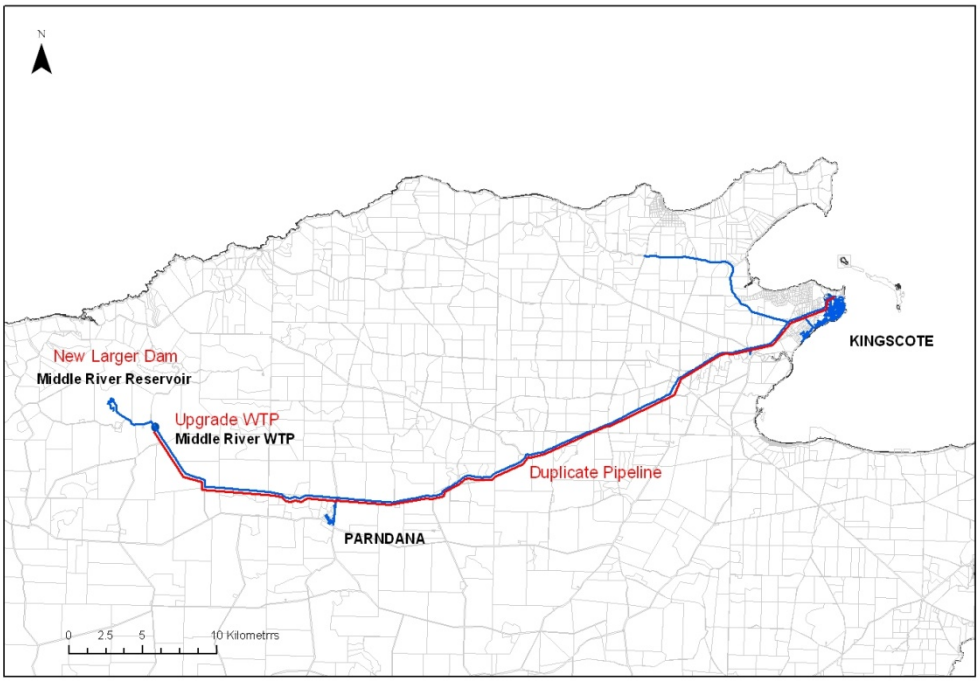



**Figure 12 : Location Map : Large Dam at Middle River**

The existing Middle River Dam has spilled every year since it was constructed. A new higher dam constructed immediately downstream of the existing dam could provide additional water. A dam wall constructed from roller compacted concrete has been assumed to create a storage with a capacity of 1000 ML. The dam would have a full supply level approximately 3.4 metres above the design full supply level of the existing dam and would inundate approximately 8 Ha around the edge of the existing reservoir.

The raw water pumping station located at the base of the existing dam would be relocated downstream of the new dam.

As the existing Middle River WTP and main supplying Kingscote operates at capacity during summer, to supply the future increased peak day demand the WTP capacity would be upgraded from 3 ML/d to 5 ML/d and 50 km of pipeline from Middle River Tank to Kingscote would be duplicated.

An additional 4 ML Tank would be constructed adjacent to the existing Middle River Tank.

### 5.2.2 Benefits and Risks

The benefits and risks for the option of construction a larger dam terms of the multi criteria analysis (MCA) (discussed in Section 7) are discussed below.

- Larger reservoir will inundate native vegetation. Pipeline installation will impact on roadside vegetation *(Multi Criteria Analysis criterion: Impact on terrestrial ecosystems).*
- New larger reservoir will reduce flow downstream *(Multi Criteria Analysis criterion: impact on aquatic/marine environment).*
- New larger reservoir would be more intrusive in reservoir reserve area. *(Multi Criteria Analysis criterion: Perceived amenity impact).*
- Makes use of existing water resource rather than new resource*. (Multi Criteria Analysis criterion: Community acceptability of option).*

## 5.3 Construct a Raw Water Storage near Middle River Reservoir

### 5.3.1 Option Overview

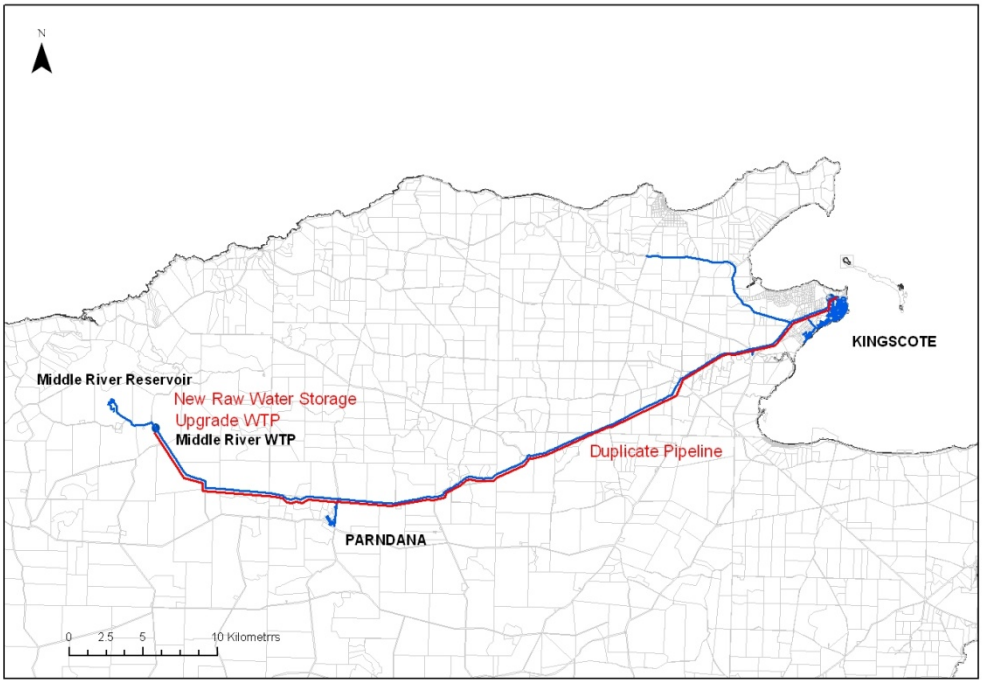



**Figure 13 : Location Map : Raw Water Storage at Middle River**

Instead of constructing a larger dam to store additional water a new 250 ML raw water storage would be constructed adjacent to the Middle River WTP. Raw water would be pumped into the storage during winter and spring while the reservoir is spilling. At the end of spring both the reservoir and the raw water storage would be full and available for use until the following winter.

As the existing Middle River WTP and main supplying Kingscote operates at capacity during summer, to supply the future increased peak day demand the WTP capacity would be upgraded from 3 ML/d to 5 ML/d and 50 km of pipeline from Middle River tank to Kingscote would be duplicated.

An additional 4 ML Tank would be constructed adjacent to the existing Middle River Tank.

In about 10-12 years the existing Middle River Dam will reach the end of its economic life and would need to be replaced at its existing full supply level.

### 5.3.2 Benefits and Risks

The benefits and risks for the option of construction a raw water storage in terms of the multi criteria analysis (MCA) (discussed in Section 7) are discussed below.

- Pipeline installation will impact on roadside vegetation *(Multi Criteria Analysis criterion: Impact on terrestrial ecosystems).*
- Using an additional raw water storage will reduce flow downstream *(Multi Criteria Analysis criterion: impact on aquatic/marine environment).*
- Makes use of existing water resource rather than new resource*. (Multi Criteria Analysis criterion: Community acceptability of option).*

## 5.4 Construct an In-system Treated Water Storage

### 5.4.1 Option Overview

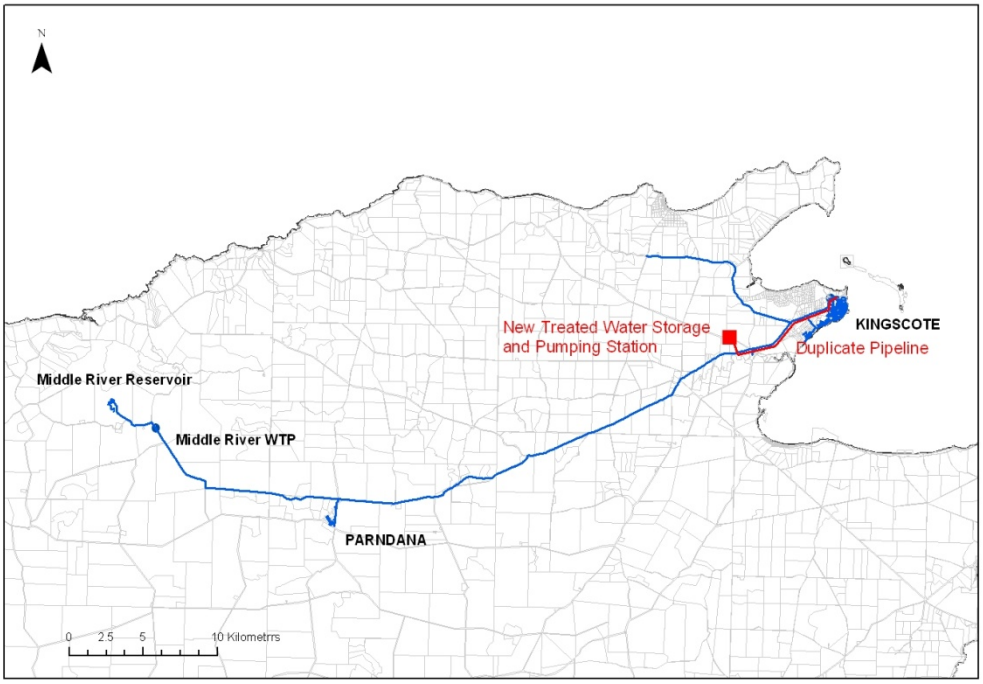



**Figure 14 : Location Map : In-system Storage near Kingscote**

A new 250 ML treated water storage would be constructed near Kingscote. Treated water would be pumped into the storage during winter and spring while the reservoir is spilling. At the end of spring both the reservoir and the treated water storage would be full and available for use until the following winter.

A pumping station would pump from the storage to supply demand. In about 10-12 years the existing Middle River Dam will reach the end of its economic life and would need to be replaced at its existing full supply level.

The storage could be constructed in stages as required to match growth in demand and could be located to facilitate integration with a possible seawater desalination plant post 2030.

### 5.4.2 Benefits and Risks

The benefits and risks for the option of construction of a treated water storage in terms of the multi criteria analysis (MCA) (discussed in Section 7) are discussed below.

- Using a additional treated water storage will reduce flow downstream *(Multi Criteria Analysis criterion: impact on aquatic/marine environment).*
- Makes use of existing water resource rather than new resource*. (Multi Criteria Analysis criterion: Community acceptability of option).*
- Option allows flexibility in staging and integration with possible future seawater desalination plant *(Multi Criteria Analysis criterion: System operability).*

## 5.5 Construct a Small Seawater Desalination Plant

### 5.5.1 Option Overview

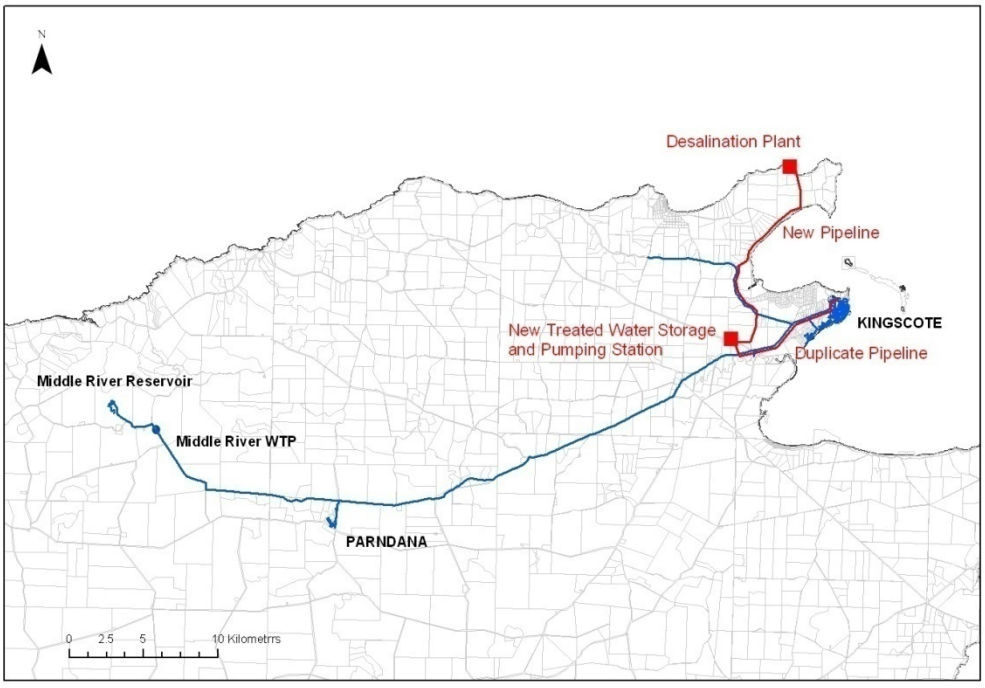



**Figure 15 : Location Map : Small Seawater Desalination Plant**

A new 0.75 ML/d seawater desalination plant would be constructed and desalinated water used to supplement the supply from the Middle River Reservoir. Desalinated water would be pumped into a new 110 ML storage located near Kingscote and mixed with treated water from the Middle River WTP.

A pumping station would pump from the storage to supply demand.

Upgrading of the Middle River WTP would be required to ensure that the output water quality was suitable to achieve a uniform water quality following mixing with desalinated water. It has been assumed that membrane filtration will be required to achieve this outcome.

In about 10-12 years the existing Middle River Dam will reach the end of its economic life and would need to be replaced at its existing full supply level. A locality in the Emu Bay/North Cape area was investigated for seawater desalination. This locality should be regarded as notional and more detailed investigations into its suitability would be part of a future stage of option development.

Location of a desalination plant in the Emu Bay/North Cape area may provide an opportunity to connect additional customers to the new supply main with consequent social and economic benefits. A plant in the North Cape area would benefit only a limited number of properties.

In order to develop this option to a suitable level for comparison against other options the following assumptions and limitations have been made in this report:

Assumptions:

- Reverse Osmosis technology has been assumed for each desalination plant option, as this is a proven technology, is widely used in seawater desalination plants worldwide (and is used at Penneshaw) and is the most efficient method of desalination (Desalination Working Group, 2007).
- The brine stream is disposed to the ocean
- Key components of a desalination plant are:
    - Pre treatment
    - Post treatment
    - Reverse Osmosis plant
    - Seawater inlet pipe (including offshore structures)
    - Brine outlet pipe (including offshore structures)
    - Connection from desalination plant to existing system
    - Pump Stations
        - Inlet Seawater (with screening)
        - Treated Water
        - Brine Discharge (if required)

Limitations:

- Pre and post treatment has been allowed in this analysis. However, the exact nature of these processes requires appropriate investigation during further development of these options. The type and extent of pre-treatment required will depend on seawater quality. This can vary widely depending on location.
- Additional work will be required to determine the availability, practicality, type and cost of providing power supply to the possible sites as well as transfer pump stations. Relevant authorities will need to be consulted to determine power supply capacity and network transmission capacity and the cost of any upgrades required.
- A more rigorous analysis of water depths, seasonal seawater quality, oceanographic conditions including tides, currents and mixing conditions and the marine ecosystems is required to allow assessment of potential environmental impacts of intake and outfall structures and discharge.

This analysis will include a more comprehensive investigation into the exact location of intake and outfall locations (including for the effect of desalination plant discharges) to optimise cost and minimise environmental impacts and the suitability of surrounding coastline for brine discharge (including depth, circulation and mixing, proximity to aquatic ecosystems, and important fisheries or aquaculture areas).

- More rigorous analysis of the impact on system water quality is required, particularly where blending between desalinated water and the existing Middle River supply is necessary.
- Geotechnical analysis of the pipe route, storage and treatment plant sites. Specifically with regard to the volume of rock likely to be encountered during excavation and the presence of ground water in storage excavations.
- Investigations of terrestrial site conditions (plant and pipeline locations) including flora, fauna and cultural heritage (Aboriginal and European) assessment.
- Investigations into the potential for Native Title claims, including over the seabed.

The primary environmental issues associated with seawater desalination are generally considered to be the management of the plant discharges (brine stream) produced as a by-product of the desalination process and energy usage associated with plant operation. Strategies for managing the brine stream fall within two broad headings: land based disposal (e.g. evaporation basins, deep-well injection) or marine based disposal (e.g. a marine outfall). Both options involve different environmental risk mitigation strategies that would need to be carefully addressed in the design of the plant. Marine based disposal has been assumed for the purposes of this report.

### 5.5.2 Benefits and Risks

The benefits and risks for the option of construction a small seawater desalination plant in terms of the multi criteria analysis (MCA) (discussed in Section 7) are discussed below.

- The construction of an intake and outfall structure for ocean disposal of the waste concentrate is typically achieved by trenching of the seabed, or drilling to install the outfall pipeline below the seabed. Construction may impact directly upon the marine environment, in particular existing benthic communities such as seagrass beds (*Multi Criteria Analysis criterion: Impact on aquatic ecosystems*).
- The construction of the desalination plant adjacent to the coast may be intrusive (*Multi Criteria Analysis criterion: Perceived amenity impact).*
- High energy consumption from operation (*Multi Criteria Analysis criterion: total Greenhouse gas emissions over 25 years*).
- Option has multiple sites for new infrastructure (*Multi Criteria Analysis criterion: Impact on heritage sites, Impact on terrestrial ecosystems*).
- Option provides two sources of water (*Multi Criteria Analysis criterion: System operability).*

## 5.6 Construct a Large Seawater Desalination Plant

### 5.6.1 Option Overview

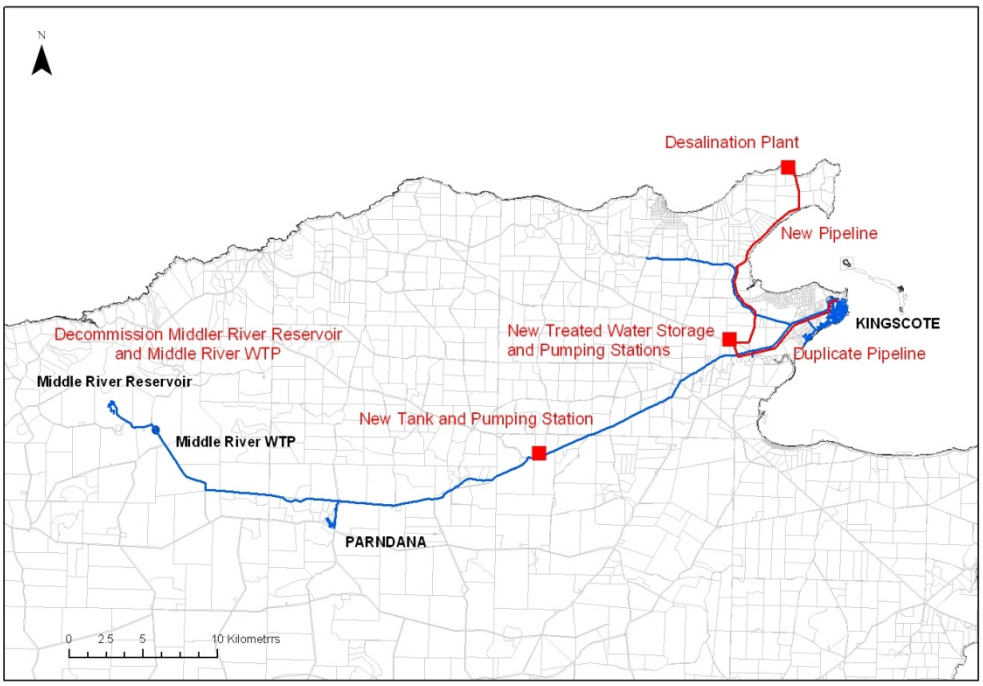



**Figure 16 : Location Map : Large Seawater Desalination Plant**

This option has the same assumptions and limitations relating to seawater desalination outlined in option 4 above.

A new 2.5 ML/d seawater desalination plant would be constructed in the vicinity of North Cape and Emu Bay. Desalinated water would be pumped into a new storage located near Kingscote. Pumping stations would pump from the storage to supply demand at Kingscote and on the main between the storage and a new storage tank located at Kohinoor Hill. A new pumping station would pump from this tank to Middle River Tank.

Middle River Reservoir would be decommissioned as a water supply. The dam could either be partially demolished and a smaller storage retained for emergency supply or the dam could be removed and the reservoir site rehabilitated and revegetated. The cost of partial dam removal and rehabilitation and revegetation have been included in this option.

Location of a desalination plant in the Emu Bay/North Cape area may provide an opportunity to connect additional customers to the new supply main with consequent social and economic benefits. A plant in the North Cape area would benefit only a limited number of properties.

### 5.6.2 Benefits and Risks

The benefits and risks for the option of construction a larger desalination plant in terms of the multi criteria analysis (MCA) (discussed in Section 7) are discussed below.

- The construction of an intake and outfall structure for ocean disposal of the waste concentrate is typically achieved by trenching of the seabed, or drilling to install the outfall pipeline below the seabed. Construction may impact directly upon the marine environment, in particular existing

benthic communities such as seagrass beds (*Multi Criteria Analysis criterion: Impact on aquatic ecosystems*).

- The construction of the desalination plant adjacent to the coast may be intrusive (*Multi Criteria Analysis criterion: Perceived amenity impact).*
- Option requires flow between Kingscote and Middle River Tank in opposite direction to design (*Multi Criteria Analysis criterion: Systems complexity*).
- Option has multiple sites for new infrastructure (*Multi Criteria Analysis criterion: Impact on heritage sites, Impact on terrestrial ecosystems*).
- High energy consumption from operation (*Multi Criteria Analysis criterion: total Greenhouse gas emissions over 25 years*).

## 5.7 Estimate cost range of options

The relative Capital Cost of the options presented above are shown below.

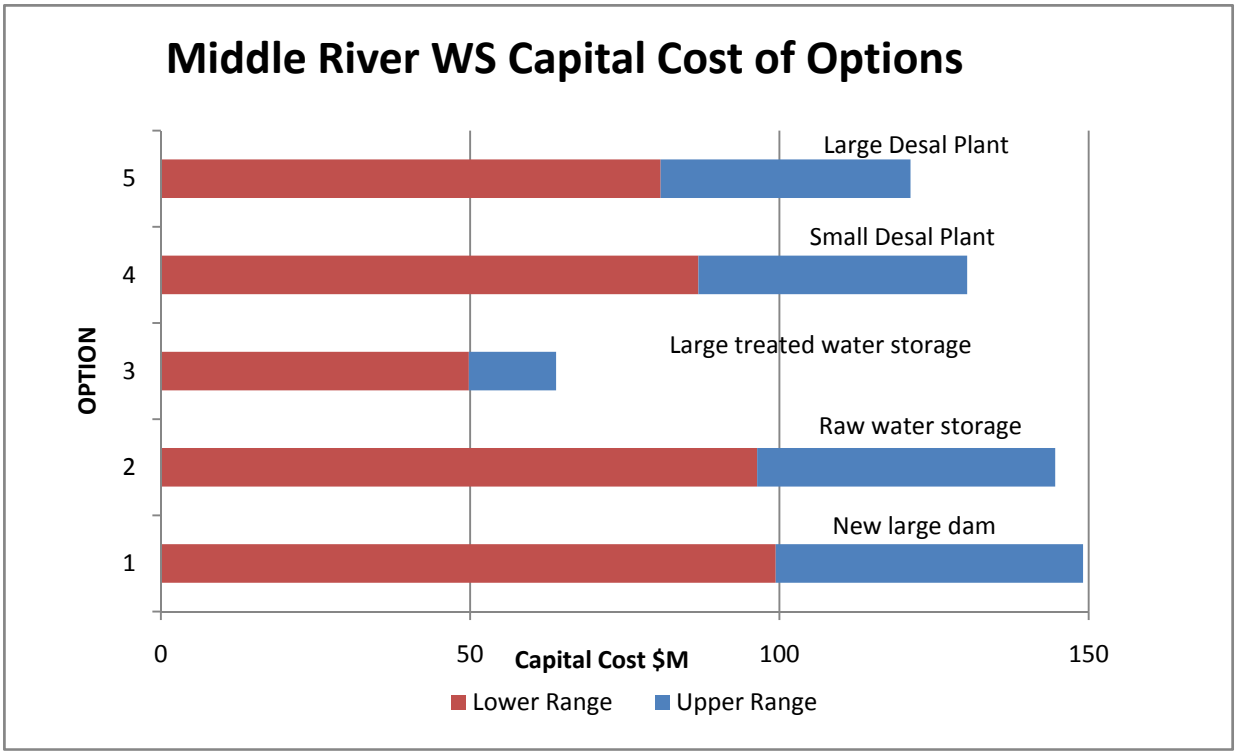



**Figure 17 : Capital Cost of Options**

Capital Works included in the options are summarised in Table 7.

**Table 7 Summary of major works included in the capital cost estimate**

| Capital Works \ Option | Large Dam | Raw water storage | Treated water storage | Small desal | Large desal |
|---|---|---|---|---|---|
| New 1000 ML dam and raw water PS | ✓ | | | | |
| Raw water storage (250 ML) and PS | | ✓ | | | |
| Treated water storage (ML) | 4 | 4 | 250 | 110 | 200 |
| Augmentation of Middle River WTP to 5 ML/d | ✓ | ✓ | | | |
| Treated water PS | | | ✓ | ✓ | ✓ |
| Upgrade Middle River WTP process | | | ✓ | ✓ | |
| Pipeline (km) | 50 | 50 | 6 | 21 | 21 |
| Seawater Desalination Plant (ML/d) | | | | 0.75 | 2.48 |
| Augmentation of electricity supply | | | | ✓ | ✓ |
| Revegetation offset | ✓ | | | | |
| Replace Middle River Dam in future and relocate raw water PS | | ✓ | ✓ | ✓ | |
| Decommission Middle River Dam and WFP | | | | | ✓ |
| Works to transfer water from Kingscote to Middle River | | | | | ✓ |

**Limitation on cost estimates**

The costs presented have been prepared on a similar basis for all options for the purpose of comparison, and should be considered as indicative only. Actual costs can only be determined on the basis of competitive tender.

For the purposes of this report, notional sites for treatment facilities and pipeline routes have been selected. These will be further investigated for the preferred option during the next stage of project development. Costs do not include the costs associated with making the options carbon neutral.

Further investigations will be required to determine if additional costs, over and above the allowance made, are required to reduce the environmental impact of brine discharge or seawater intakes for the desalination options (eg longer outfall pipeline).

# 6 Other Considerations

## 6.1 Penneshaw WSS

The Penneshaw system does not show a shortfall in the timeframe for this plan, however it is likely that augmentation of the system will be required in 25 years time. At this time the desalination plant would be operating almost continuously and increasing the desalination plant capacity would be the most likely augmentation option. When the plant was constructed allowance was made for a future doubling in capacity of the plant and balancing storage.

## 6.2 Supply to townships not currently supplied by SA Water

SA Water has in the past received approaches from the communities at American River, Emu Bay and the Eastern Cove townships (eg Island Beach, American Beach) for the provision of a reticulated water supply. Schemes have been designed and costed to extend mains to these townships but due to the cost of the long lengths of mains required have not been considered economical.

In accordance with SA Water's Customer Services Division procedures and standardised approach, any proposal to provide potable water to an area would need to be operationally feasible and would be subject to the following conditions:

- At least one third of land holdings to be served are developed
- More than two thirds of property owners who can be served are in favour of the proposal
- The cost of the scheme can be justified
- All property owners to be served will be required to pay a capital contribution as determined by SA Water
- SA Water has funds available to construct the work

These towns have thus been broadly investigated in the long term plan to provide an indication of augmentation requirements to enable connection to the potable water supply system. Further work will be required to determine the specific needs of each of these communities.

An extension of main from the Middle River WSS would be the preferred option to provide a reticulated water supply to Emu Bay and it is estimated that the additional demand from Emu Bay would be approximately 27 ML/a. This extra demand would increase the projected Middle River WSS demand by approximately 5% and would serve to bring forward any augmentation works by approximately 2-3 years.

A previous study has shown that the preferred option for supplying American River and the Eastern Cove townships would be to extend mains from the existing Penneshaw WSS. The additional demand is estimated to be 110 ML/a. With this increase in demand the total demand from the Penneshaw desalination plant would exceed the existing capacity of 99ML/a and a doubling of both the plant and the storage capacity would be required.

## 6.3 Water Quality in the Middle River WSS

Middle River treated water contains relatively high concentrations of dissolved organic carbon (DOC) that, when in contact with chlorine for an extended period can lead to increased concentrations of disinfection by-products (DBPs). SA Water has been managing this issue with an aeration process in the

Kingscote Tank. Options for augmenting the Middle River WSS that involve storing large volumes of treated water for extended periods of time (i.e. Option 3) will require additional measures to ensure that the level of disinfection by-products is not increased. These measures include

- Additional aeration at the proposed storage
- Separate inlet and outlet pipe at the storage
- Reviewing the current disinfection regime to determine if suitable alternatives exist (e.g. Chloramination)
- Upgrade the existing Middle River WTP to ultrafiltration/nanofiltration membrane technology

These alternatives will continue to be explored during further development of the preferred option, however for the purposes of this report it has been assumed in the MCA that the existing Middle River WTP would be upgraded to ultrafiltration/nanofiltration membrane technology.

# 7 Options Assessment – Middle River WSS

In order to provide a suitable method of assessing the options discussed in Section 5, SA Water has adapted the Multi Criteria Analysis process used in other Long Term Plans specifically to suit the Kangaroo Island system.

A multi criteria analysis provides significant benefits, such as:

- Providing a framework for incorporating complex and large amounts of information
- Combining quantitative and qualitative aspects of decision making
- Is able to highlight the strengths and weaknesses of any particular option
- Provides an open and transparent methodology which can involve stakeholders
- Can incorporate a diverse range of opinions and expertise

While a multi criteria analysis is particularly helpful to prioritise options it should only be considered as a supporting tool as there may be other externalities which may influence certain decisions.

In general, multi criteria analysis processes use a triple-bottom line approach which considers environment, social and economic factors. As part of this analysis, SA Water has chosen to add a fourth category of Technology and Functionality to ensure that the most sustainable solution is also a practical solution.

The multi criteria analysis process used in this project therefore involved the use of four sustainability categories, namely:

- Environment
- Social
- Economic
- Technology/Functionality

Under each of these categories, criteria were developed which have been used to assess each option.

The four categories and each criterion in the categories were assigned weightings that have been used to calculate the sustainability score for each option. This is often referred to a two tiered weighting system and reduces the impact of one category having more criteria than another.

The general steps of the multi criteria analysis process used in this project were:

- Determine initial criteria (SA Water project team)
- Determine weightings of sustainability categories (SA Water project team)
- Rank criteria in order of importance (social and environmental categories) undertaken by a group of key external stakeholders
- Assign weightings (using ranking from reference group for social and environmental categories (SA Water project team)
- Assess options against criteria and calculate score using weightings.

## 7.1 Criteria

The sustainability criteria developed for this project are shown below:

| Criteria | Definition |
|---|---|
| **Social** | |
| Amenity value of infrastructure | Implementation of the options could mean a change to the aesthetic value of the landscape, either through infrastructure that may be visually obtrusive, less appealing or create an offensive odour or noise. A perceived reduction in the amenity value of the landscape reduces the social value in the community. |
| Community acceptability of option | Factors which could affect the community acceptability of an option include the original source of the water, the perceived reliability of the supply and the impact on the cultural and natural heritage of the community. The impact on cultural and natural heritage could include heritage or cultural value of a site for a new storage or site for a treatment plant. |
| Heritage impacts | Some options may impact on national, state, local or aboriginal natural or cultural heritage . |
| **Environment** | |
| Total Greenhouse gas emissions over 25 years | Some options may require more energy than others to construct and operate. This impact of construction emissions diminishes the longer the lifespan of the infrastructure. |
| Impact on aquatic ecosystem | Some options involve waste disposal (e.g. brine) that can have an impact on aquatic ecosystems. Alternatively, an option may cause an improvement to the water quality in a catchment that will have a positive impact on the aquatic ecosystems in the area. |
| Impact on terrestrial ecosystem | Some options will impact on the terrestrial ecosystem either during construction and/or during operation. This could include the clearance of native vegetation for pipelines, treatment plant sites or storages. The level impact can vary between options based on size, location and the quality of the vegetation affected. |
| **Economic/Financial** | |
| Total cost to consumer/utility/government | Present Value Cost |
| Total cost per ML | Present Value $/ML |
| **Technology/Functionality** | |
| System complexity | Considers the base infrastructure complexity. Particularly keeping in mind if an option complements existing infrastructure and types of infrastructure where it could be managed with the human resources (i.e. right number of staff and right skills) already available in the region. |
| Operability | Reflective of the system complexity however may consider how easy the system is to operate. In particular, if the option enhances the flexibility of the system by providing backup sources through additional sources of water or allows a degree of automation, etc. |

## 7.2 Weightings

The weightings for the sustainability categories were determined by the SA Water project team and confirmed by a representative group of key stakeholders. It was decided that all categories should receive the same weighting, as shown below in Table 8.

**Table 8: Sustainability category weighting**

| Sustainability Category | Weighting |
|---|---|
| Environment | 25% |
| Social | 25% |
| Economic | 25% |
| Technology | 25% |
| Total | 100% |

The rankings and weightings for the criteria under each category are shown below in Table 9. A representative group of key stakeholders were asked to establish the importance of the sub criteria for social and environmental using a scale of one to five (5 = most important, 1 = least important). The ranking was then established based on this assessment. Ranking for Technology/Functionality and Economic was undertaken by the SA Water project team.

**Table 9: Weightings and rankings for multi criteria analysis criteria**

| Criteria | Rank | Weight |
|---|---|---|
| **Social** | | |
| Amenity value of infrastructure | 2 | 28% |
| Community acceptability of option | 1 | 45% |
| Heritage impacts | 3 | 27% |
| **Environment** | | |
| Total greenhouse gas emissions over 25 years | 1 | 36% |
| Impact on aquatic ecosystem | 1 | 36% |
| Impact on terrestrial ecosystem | 3 | 28% |
| **Economic/Financial** | | |
| Total cost to consumer/utility/government | 1 | 50% |
| Total cost per ML | 1 | 50% |
| **Technology/Functionality** | | |
| System complexity | 1 | 50% |
| Operability | 1 | 50% |

## 7.3 Assessment of Options

Using the categories, criteria and weightings discussed above, the five options presented in Section 4 were assessed by the SA Water Project team.

The following outlines the major assumptions made in the assessment process:

- Each option was given a score out of five for each criteria. Scores are relative to the other options. However, the lower the score the more sustainable the option is considered.
- Amenity value of infrastructure was a qualitative assessment by the project team. Below ground pipelines were scored as likely to have a lower impact than desalination plants located on the coast.
- The community acceptability of each option was assessed considering views that were documented during the community engagement process.
- Greenhouse gas emissions from construction and operation were a quantifiable assessment based on industry standard calculations. Options were then ranked and scored.

- Impacts to aquatic and terrestrial ecosystems were based on available information and project team past experience.
    - The large dam was scored as likely to have a similar impact on terrestrial ecosystems as the desalination plant options due to the flooding of native vegetation by the dam and the potential impact on threatened species by the multiple construction sites required by the desalination plants.
    - The desalination plant options were scored as likely to have the greatest impact on marine ecosystems due to the possible issues of the saline flow return to the sea. Options that slightly reduced spill from Middle River Reservoir were scored as likely to have the lower impact on the marine environment.
- The scores presented below are based on cost estimates prepared by SA Water.
- Feasibility and technical scores were evaluated by the project team using SA Water's past experience.

**Table 10: RAW MCA scores for Middle River Options**

| Criteria | Weight | Large dam | Raw water storage | Treated water storage | Small desal | Large desal |
|---|---|---|---|---|---|---|
| | | | | | | |
| Amenity value of infrastructure | 28% | 3 | 1 | 1 | 5 | 5 |
| Community acceptability of option | 45% | 1 | 1 | 1 | 1.8 | 5 |
| Heritage impacts | 27% | 1 | 1 | 3 | 5 | 5 |
| | | | | | | |
| Greenhouse gas emissions over 25 years | 36% | 1.8 | 1.8 | 1.4 | 2.4 | 5 |
| Impact on aquatic ecosystem | 36% | 1.8 | 1 | 1 | 1.2 | 5 |
| Impact on terrestrial ecosystem | 28% | 5 | 1 | 2.3 | 5 | 5 |
| | | | | | | |
| Total cost ($) | 50% | 5 | 4.5 | 2.1 | 3.9 | 4.6 |
| Total cost per ML | 50% | 4.4 | 5 | 2.3 | 4 | 4.7 |
| | | | | | | |
| System complexity | 50% | 2.3 | 2.3 | 3.7 | 5 | 5 |
| Operability | 50% | 5 | 3.2 | 1.6 | 1.4 | 2.8 |

*NB A lower score represents an option expected to have a lower impact*
*Scores reflect relative assessment between options, not necessarily severity of impact*

The multi criteria analysis scores indicate:

- A raw water storage located near Middle River WTP is the more favourable option based on social and environmental criteria followed by the treated water storage and new dam.

- The treated water storage scheme ranks as most favourable on economic and technology/functionality criteria.
- On a technology/functionality level the raw water storage and the treated water storage schemes come out the best due to them being standard technology that SA Water has extensive experience in constructing and operating.
- Overall, the treated water storage scheme (i.e. Option 3) is shown to be the most favourable approach

**Table 11: Final MCA score of options**

| Criteria | Large dam | Raw water storage | Treated water storage | Small desal | Large desal |
|---|---|---|---|---|---|
| Social | 1.6 | 1.0 | 1.5 | 3.6 | 5.0 |
| Environment | 2.7 | 1.3 | 1.5 | 2.7 | 5.0 |
| Economic/Financial | 4.7 | 4.8 | 2.2 | 4.0 | 4.7 |
| Technology/Functionality | 3.7 | 2.8 | 2.7 | 3.2 | 3.9 |
| Total Score | 12.6 | 9.8 | 7.9 | 13.4 | 18.6 |

*NB The scores have evenly been factored up to assist with ease of comparison.*
*A lower score represents an option expected to have a lower impact*
*Scores reflect relative assessment between options, not necessarily severity of impact*

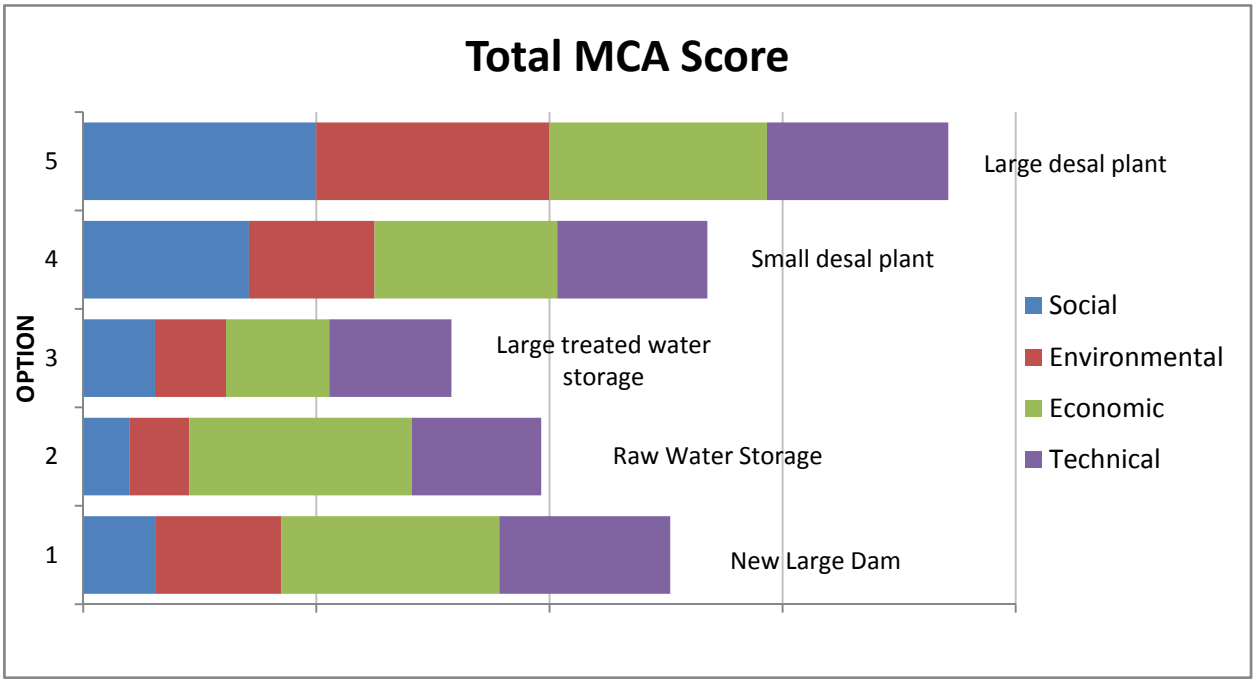



**Figure 18 : Total MCA Score**

# 8 Summary and Recommendations

The following points summarise the investigation detailed above

- Demand from the Middle River WSS has been increasing for the past eight years.
- The community, local councils and other stakeholders anticipate that growth will continue occur on Kangaroo Island.
- The installation of the fuse on the Middle River Dam has increased the available resource for the Middle River WSS by 15%.
- As the resource managers, the KINRMB and DWLBC have the responsibility to ensure that the surface water resources are being managed sustainably. SA Water has discussed with these agencies the need to ensure that sufficient inflows to the Middle River Dam are secured for the purposes of the public water supply.
- Demand projections indicate that a new resource will be required in about five years for the Middle River WSS and after 2030 for the Penneshaw WSS.
- SA Water recognises the importance of community water schemes, such as stormwater harvesting, and water conservation, in terms of the reduced demand on SA Water supplies, and in heightening the awareness of the need for water conservation in the community.
- A sustainability analysis (using a multi criteria analysis technique) was undertaken which highlighted that the option of a treated water storage near Kingscote is most worthy of further investigation followed by a raw water storage near the Middle River WTP.
- A large storage near Kingscote is consistent with future options should either a seawater desalination plant or a larger Middle River Dam be constructed.
- Additional work would be required to determine the specifics of the option. This work could include:
    - Assessment of storage sites near Kingscote to determine the most suitable site
    - Baseline environmental investigations for the marine and terrestrial environment.
    - Assessment of the cultural heritage of the site (particularly with reference to Aboriginal and European Heritage).
    - Evaluation of the most effective arrangement of the storage in terms of water quality characteristics and staging.

## 8.1 Ongoing Review of the Long Term Plan

SA Water's procedures for developing and amending long term plans specify:

- Major assumptions contained in long term plans will be reviewed on an annual basis.
- A major departure from an assumption (i.e. significantly higher or lower population or demands than was originally predicted) can trigger a total review of the plan and the strategies it recommended.
- At a minimum Long Term Plans will be completely reviewed every five years.

The assumptions (departure from which can cause a major review of the Long Term Plan) can be known as trigger points or key parameters. The key parameters or trigger points in this plan are listed below:

- Population of Kingscote and Penneshaw

- Actual demand
- Available supply from the Middle River Reservoir
- Government policy with regards to carbon neutrality
- Impact of climate change on available resources and demand

These assumptions will be monitored and checked annually by the SA Water project team and the strategy presented in this document reviewed in light of these assumptions.

## 8.2 Recommendations

The long term planning recommendations can be summarised into the following:

- Annual review of the long term plan
- Water source augmentation

These recommendations will be used to guide the scheduling of capital works for Kangaroo Island. To accommodate any immediate supply or demand shortfall, SA Water may recommend to Government the implementation of further demand management initiatives.

An overview of the long term planning recommendations is given in table 11 below.

**Table 12 Recommendation Overview**

| Recommendation | Deliverable | Timing |
|---|---|---|
| Annual review of long term plan | | |
| SA Water to review the following major assumptions annually:<br>• Historical SA Water water supply system connections and demand<br>• Projected connections<br>• Projected demand<br>• Impact of climate on demand<br>• Surface water allocation provision | Confirm existing trends and whether timing for implementation of recommendations proposed in the long term plan is appropriate or needs to be amended | Annually |
| Water supply system augmentation | | |
| Further investigations into the construction of a treated water storage at Kingscote including<br>• addressing water quality issues associated with storing treated water for extend periods of time<br>• arrangement of storage infrastructure and suitability for staging | Treated water storage constructed in stages | Investigations in 09/10, stage 1 storage built 10/11 – 11/12<br><br>Further storage stage(s) constructed as required from annual review process |
| Further investigations into using desalination to supplement demands in the 2030+ timeframe | Future augmentation options scoped. | As required by annual review process, by post 2030. |

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# Appendix A

Summary of Topics Raised at Information Sessions

***SUMMARY OF TOPICS RAISED AT INFORMATION SESSIONS***

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Demand** | | | | | | | | | | | | | | | |
| Demand projection | The projected annual growth of 2% is accurate | • | • | • | • | • | • | • | | • | | • | • | | Noted. Generally in line with growth projections |
| | The preferred option must benefit KI's water supply needs | | | • | | | | | | | • | | | • | Refer SA Water's Long Term Plan |
| Communities not on network | How do communities apply to be connected to the system eg Emu Bay and American River? | • | • | | | • | • | | | | | • | | | Mains extension policy is applied to a community or development seeking to connect to the potable water supply. Augmentation fees are applied when additional work may be required to augment the system because of the new demand brought about by the new development |
| New residential developments | All future development should have a reticulated water system | | • | | | | | | | | | | | | Local Government process |
| Potential growth industries/areas | Grape growing is a growing industry on KI | • | • | | | | • | | | • | | | | • | Industry demand has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | Food production and agriculture are growth industries | | | • | | | | | | | | | | | Industry demand has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | American River and Island Beach are experiencing growth | | | | • | | | | | | | | • | | Urban growth has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | Arguable that the grapes growing is a growth industry on KI. Some contracts have failed recently. Unlikely to have new crops in next 10 years | | | | | | | • | | | | | | | Industry demand has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | Tourism is experiencing growth in short stay accommodation of about 15%. Tourism at Penneshaw is static. | | | | | | | | | | | | • | | Impact of tourism on demand for water has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | Kingscote is to be tourism base. Will be enhanced by new ferry service and wharf development if they proceed | | | | | | | | | | | | • | | Impact of tourism on demand for water has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |
| | At peak times (summer) room rate can be 100% occupancy | | | | | | | | | | | | • | | Impact of tourism on demand for water has been considered in investigations into future water demands in Kangaroo Island (KBR). Refer SA Water's Long Term Plan |

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New proposals may impact on demand eg Glenelg – Kingscote Ferry and Kingscote Wharf development | | | | | | | | | | | | • | | Noted |
| | Penneshaw not expecting an spikes in tourism growth in foreseeable future | | | | | | | | | | | | • | | Noted |
| **Sustainability** | | | | | | | | | | | | | | | |
| Environment and biodiversity | How will SA Water ensure environmental issues are addressed? | | • | • | • | • | | | | | | | | • | The formal assessment of the augmentation options considers environmental impacts. Preferred options may require statutory approvals |
| | | | | | | | | | | | | | | | |
| | Impacts of augmentation on glossy black cockatoos | | | | • | • | | | | | | | | • | The formal assessment of the augmentation options considers environmental impacts. Preferred options may require statutory approvals |
| | Marine Park being established from Cape Willoughby to Point Marsden | | | | • | | | | | | | | | | The formal assessment of the augmentation options considers environmental impacts. Preferred options may require statutory approvals |
| | EPBC Act will need to be considered with affect on downstream pools | | | | | • | | | | | | | | | The formal assessment of the augmentation options considers environmental impacts. Preferred options may require statutory approvals |
| Power & energy | Existing power supply may not be able to cope with additional demand | • | • | | | | • | | | • | | | | • | Procurement of an appropriate power source will be considered if desalination is a viable option |
| | Clear preference is for green energy/alternative energy solutions in line with KI's green credentials | • | | | • | | | | • | • | | | | | Desalination, as with any other infrastructure project will require all the necessary investigations should it be considered a viable option |
| Climate | How will impact of climate change be accounted for in assessing options? | • | • | | | | • | | | | | | | | Refer SA Water's Long Term Plan |
| | 10% in reduction in rainfall could convert to 30% runoff in catchments | | | | | | | | | | • | | | | As above |
| | What is rainfall based on | | | | | | | | | | • | | | | Rainfall based on average rainfall from records dating back approximately 100 years |

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Infrastructure** | | | | | | | | | | | | | | | |
| Middle River system | What is age, condition and capacity of pipeline from Middle River to Kingscote? | | • | • | | | | | | • | | • | | • | The pipe was constructed after 1965 and has undergone regular maintenance. The pipeline is generally in good condition, fair in some locations |
| | An average of 12000ML per annum is spilled | • | • | | | | | | • | | | | | | Spill is considerably less in dry years |
| | Will the potential benefit of relinquishing Middle River Reservoir be considered in assessing options? | | | | | | | | | • | | | | | The benefit of relinquishing Middle River will be considered in the MCA process in the context of public/private benefit or loss |
| | How will remediation of area be managed if the reservoir is relinquished? | | | | | • | | | | | | • | | | Clean up of the reservoir area will be required to meet current standards. Approvals will be sought for remediation should it be relinquished |
| | Middle River catchment is reaching sustainable limits | | | | | • | | | | | | | | | KINRMB is responsible for catchment management |
| | Would SA Water consider installing a streamflow gauging station? | | | | | • | | | | | | | | | A gauging station is to be installed as part of the upgrade |
| | Could water be boosted to Kingscote rather than duplicating the main? | | | | | | | | | | | • | | | Good suggestion but not be a viable option of meeting future demand due to capacity limitations |
| | What is the potential to use 3rd party/private infrastructure to supplement supply eg Wandell's or Magill's dams | • | • | | | | | | | | | | | | It is recognised that there are other storage facilities on KI however these may not be suitable for public water supply purposes due to condition, legality or technical reasons |
| | Kingscote tanks shouldn't have been sold | | • | | | | | | | | | | | | Kingscote tanks would only supply a limited additional storage volume |
| | Could Cygnet River be used for water storage? | | | | | | | | | | | | | | Extractions from the upper reaches of the Cygnet River exceed sustainable limits. Salinity may also be an issue |
| | | | | | | | | | | | | | | | |
| Forestry | Forestry could slightly impact on inflow although the impact is likely to be marginal | • | • | | | • | • | | | | | | | | Refer SA Water's Long Term Plan |
| | Blue gums use more water than | | • | | | | | | | | | | | | Noted |

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pine trees. Will impact on catchments | | | | | | | | | | | | | | |
| | Forestry on KI has increased from 3000ha to 20000ha | | | | | • | | | | | | | | | Refer SA Water's Long Term Plan |
| Standpipes | Flow rate at standpipes is too slow | • | • | | | | | | | | | | | | SA Water will consider whether this issue can be addressed with augmentation of the water supply system |
| | Theft of water from standpipes is an issue | | | | | | • | | | | | | | | See above. Council is responsible for the operation of the standpipes |
| Waste management | Wastewater at American River and Pelican Reserve is an issue | | | | • | | | | | | | | | | Wastewater is managed by KI Council |
| **Resource** | | | | | | | | | | | | | | | |
| Water | Could fluoride be added to water supply? | | • | | | | | | | | | | | | SA Health determines whether fluoride should be added to regional water supply |
| | Storing water on KI has water quality issues | | | • | | | • | | | | | | | | Refer SA Water's Long Term Plan |
| | Township v rural consumption | | | | | | • | | | | | | | | Refer SA Water's Long Term Plan |
| | Local community would be aware that in average years there is sufficient water in Middle River however this is not the case in dry years | | | | | • | | | | | | | | | Noted |
| | Much of the KI community does not use Middle River or Penneshaw water for drinking or domestic purposes. Most use rainwater for drinking | | | • | | | • | • | | | | | | • | Noted |
| | Rather than sourcing additional water the community should be encouraged to use existing resource eg is irrigation the best use of filtered water? | | | | | | • | | | | | | | • | Cost of water should prohibit the use of mains water for large scale irrigation |
| | Water restrictions for specific industries should be considered | | | | | | • | | | | | | | | SA Water is working with industry to prepare and implement water efficiency plans |
| | Interest in the cost of water for country users | | | | | | • | | | | | | | | Country users do not pay a higher rate for water than metropolitan users due to CSO funding |
| | Has SA Water considered dual | | | | | | • | • | | | | | | • | Will be considered as a potential way of delivering option 3 but is likely to be cost prohibitive given the high cost of laying mains |

| Topic | Issue/Comment | AgKI | AK | KIC | DEH | DWLBC | EA KI | GGKI | KIDB | NRMB | PIRSA | PPA | TKI | Field Day | Direction/Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | supply, filtered for drinking and non-filtered for irrigation etc? Farmers could use their own 'turkey nests' for storage | | | | | | | | | | | | | | |
| | Option of treating water at Kingscote and supplying non potable water to Country Land Users should be looked at. Compensation (eg with rainwater tanks) could be offered | | | | | | | • | | | | | | | To be considered as a potential way of delivering option 3 if it is selected as the preferred option. There is an existing rebate for rainwater tanks plumbed into the house |
| | Do wastewater schemes affect water consumption? | | | | | | • | | | | | | | | Kangaroo Island's wastewater system is managed by Council |
| | Changing standard of water to non-potable would not adversely impact in property values | | | | | | | • | | | | | | | Noted |
| | Use of rain and recycled water should be encouraged | | | | | | | | | • | | | | | Local Government manage waste and stormwater |
| Land | Shift in land management practices from cropping to livestock or less till could impact on catchments | | | | | | | | | | • | | | | Noted |
| **Options** | | | | | | | | | | | | | | | |
| Cost and feasibility of options | Would KI customers be required to pay for any upgrade? | • | | | | | | | | | | | | | The cost of upgrading the infrastructure will be factored into SA Water's capital budget not directly passed onto Kangaroo Island customers |
| | Laying mains is very expensive | | | • | | | | | | | | | | | Noted |
| Option preference | Option 3 could provide flexibility should a desalination plant be constructed in future | | | • | | | | | • | • | • | | | | Noted |
| | Options 2 & 3 look to have least impact and maximise existing infrastructure subject to further investigations | | | • | | | | | | | | | | | Noted |
| | Preference to use existing resources eg Middle River rather than introducing a desalination plant | | | • | | | | • | | | | | | • | Noted |

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Options should align with KI's 'green' credentials | | | | | | | | | | | | • | | Noted |
| Desalination | Abalone farm at Emu Bay could be potential site a desalination plant | | • | | | | | | | | | | | | Noted |
| | How does cost of desalinated water compare to other water | | | • | | | | | | | | | | | The cost to produce desalinated water is comparable to supplying water from Middle River Reservoir if significant augmentation is required.<br><br>Refer SA Water's Long Term Plan |
| | Option must have regard for the environment eg dispersion rates, mixing etc | | | • | • | | | | | | | | | | The assessment process will have regard for the options potential impact on the environment. Statutory approvals will also be sought prior to construction |
| | Could a desalination plant be located at American River? | | | | | | • | | | | | | | | There is unlikely to be sufficient tidal movement for sufficient dispersion of the brine. If a desal plant is constructed on KI it is considered that the area between Emu Bay and North Cape would be the most preferred |
| Land | Requirement and availability of land for large storage option | | | • | | | • | | | • | • | | | | The land area required would depend on how the facility is constructed eg depth etc. As an example, the 125ML storage at Nettle Hill is approx 17,000m2 (130m x 130m) |
| Timing | When will the KI public water supply system need to be augmented | | | | | | | | | | | • | • | • | It is anticipated that the system will be augmented by 2012 |
| **Multi Criteria Analysis** | | | | | | | | | | | | | | | |
| Process | Are recurrent costs factored into assessment? | | | | | | • | | | | | | | | Yes, the assessment has regard for recurrent costs |
| | Criteria should have minimum weighting. Also concern that stakeholders couldn't be asked to make an assessment of the options without further information | | | | | | | | | • | | | | | The four criteria are equally weighted.<br><br>The MCA process is high level risk assessment used to narrow the field of options to undertake a more detailed analysis. Stakeholders are asked to confirm the sub-criteria and weighting for the social and environmental criteria. The sub-criteria are things that are important to the stakeholder that should be considered in their view in any broad high level assessment |
| **Other Issues** | | | | | | | | | | | | | | | |
| 25% rule | May impact on options that involve retaining the reservoir | | | • | | • | | | | • | | | | • | Noted |
| Prescription | What is SA Water's role with prescription of catchments | | • | | | | | | | | | | | | The water resource manager is the Department for Water Land and Biodiversity Conservation (DWLBC). DWLBC manages issues such as prescription of catchment areas in its portfolio. SA Water manages the public water supply system |

| *Topic* | *Issue/Comment* | *AgKI* | *AK* | *KIC* | *DEH* | *DWLBC* | *EA KI* | *GGKI* | *KIDB* | *NRMB* | *PIRSA* | *PPA* | *TKI* | *Field Day* | *Direction/Comment* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concern about prescription and the impact on primary industries | | | | | | | | • | | | | | | See above |
| NRM Plan | NRM Plan is in draft and due to be released | • | • | • | | | | | | | | | | | Noted |
| Community engagement | What are plans to involve the KI community | • | • | • | | | | | | | | | | | SA Water has engaged with Kangaroo Island's key stakeholder groups throughout the Long Term Plan process. SA Water also attended the KI Field Day to provide the broader community with an opportunity to comment on the Long Term Plan |
| | The long term plan should consider how the system will be augmented at the time the Middle River dam needs replacing. Will the dam be replaced or will another source be introduced. There is a positive benefit to the adjoining land users if Middle River is relinquished. | • | | • | | | | | | • | | | | | At this stage it is anticipated that the dam may need replacing in 10-15 years. The Long Term Plan recommends a 12 month review process. Any changes to demand or resources will be addressed in the annual review |

**AgKI** – Agricultural Kangaroo Island

**AK** – Advance Kingscote

**KIC** – Kangaroo Island Council

**DEH** – Department of Environment and Heritage

**DWLBC** – Department of Water Land and Biodiversity Conservation

**EA KI** - Eco-Action KI

**GGKI** - Kangaroo Island Grape and Wine Growers Association

**KIDB** - Kangaroo Island Development Board

**NRMB** - Kangaroo Island Natural Resource Management Board

**PIRSA** - Department of Primary Industries and Resources of South Australia

**PPA** - Parndana Progress Association

**TKI** - Tourism KI

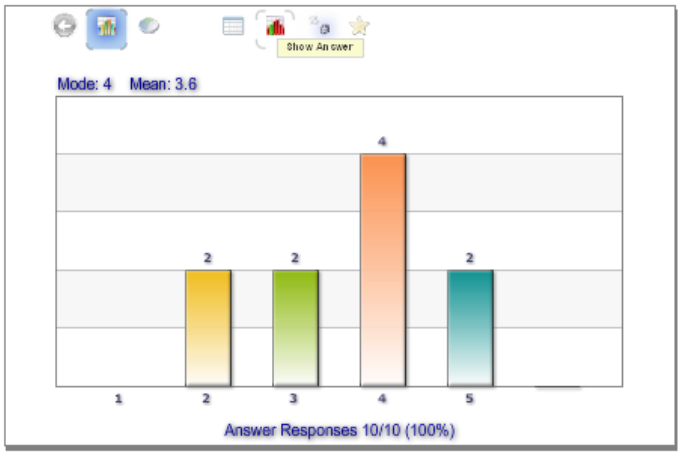
**Field Day** - Kangaroo Island Field Day

## Appendix B

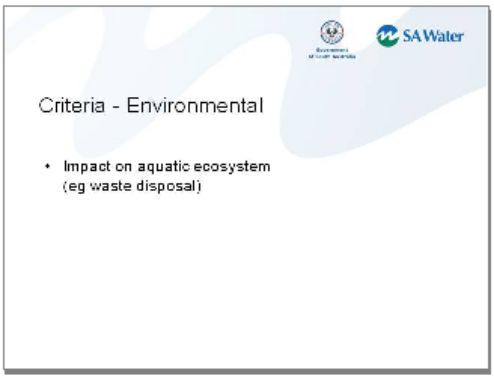
Results of Stakeholder voting for weighting of MCA environmental and social criteria

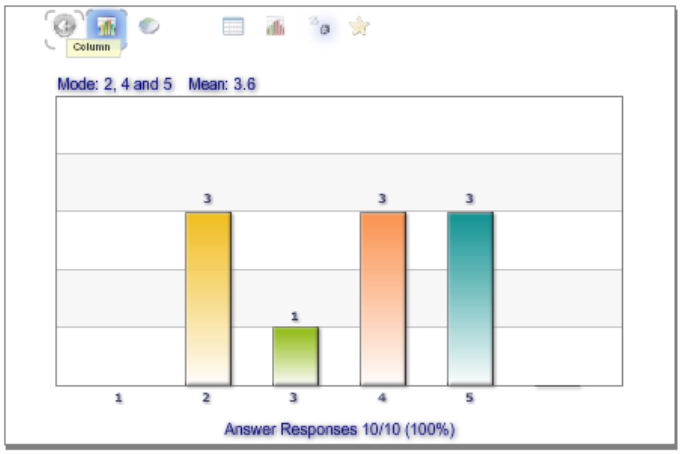
Environmental Criteria

## Question Number 1

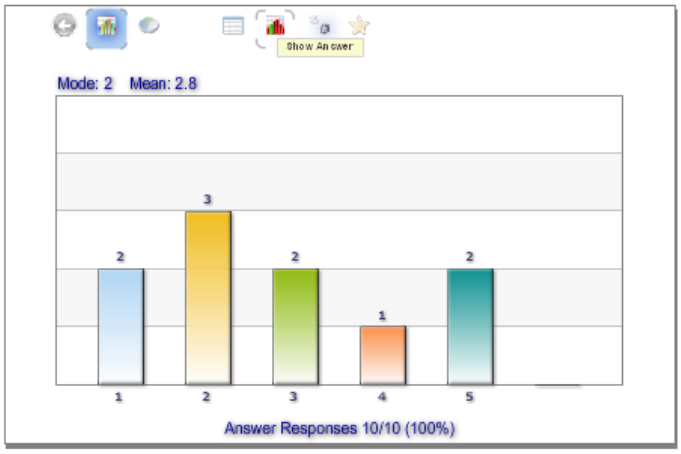




## Question Number 2



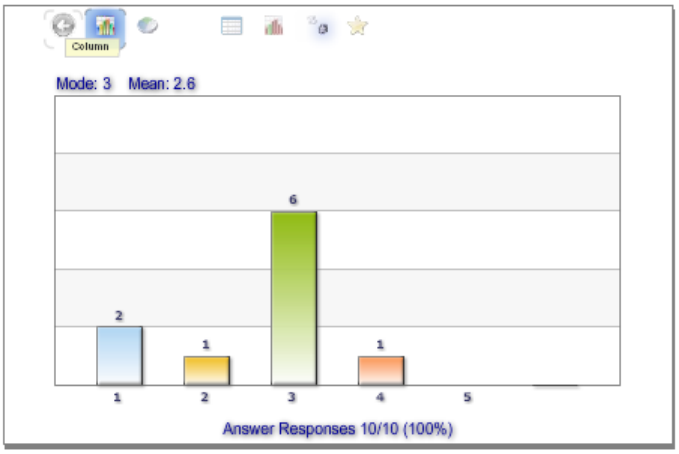




## Question Number 3

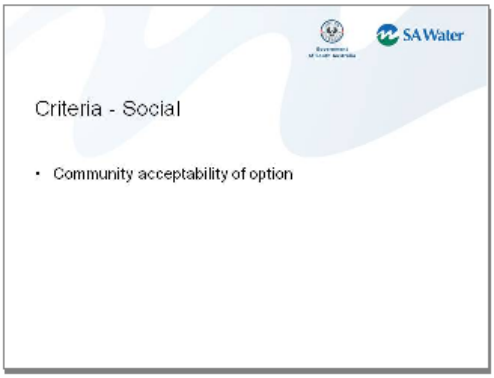



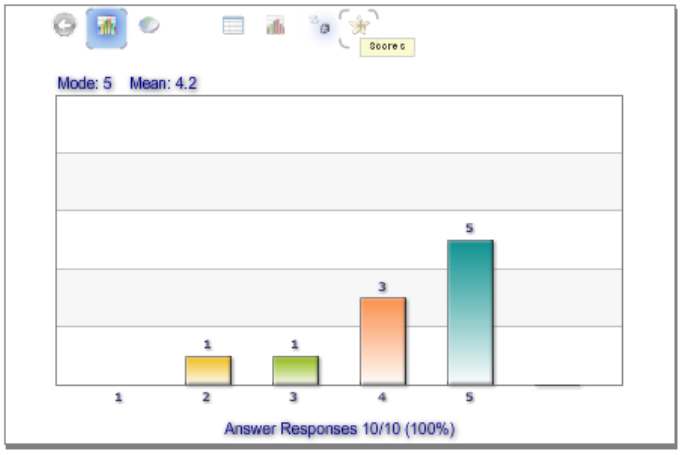
Social Criteria

## Question Number 4


## Question Number 5




## Question Number 6