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An overview of water saving investigations at the Menindee Lakes – the proposed changes under the Memorandum of Understanding between the Commonwealth and NSW to the lakes and water supply to Broken Hill

Leading policy and reform in sustainable water management

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The NSW Office of Water is a separate office within the Department of Environment, Climate Change and Water. The Office manages the policy and regulatory frameworks for the State's surface water and groundwater resources to provide a secure and sustainable water supply for all users. The Office also supports water utilities in the provision of water and sewerage services throughout New South Wales.

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1. Background

The Menindee Lakes was originally a series of natural ephemeral lakes situated in far west NSW and is part of the Travellers' Lakes system. In the 1950s and 1960s the NSW government constructed the Menindee Lakes water storage scheme, by connecting the natural ephemeral lakes and the Darling River by a series of weirs, regulators, channels and levees. The Menindee Lakes water storage system essentially consists of 4 major lakes and covers 453 square kilometres. It holds 1,730 gigalitres (GL) when full and can be surcharged to 2,050 GL during floods.

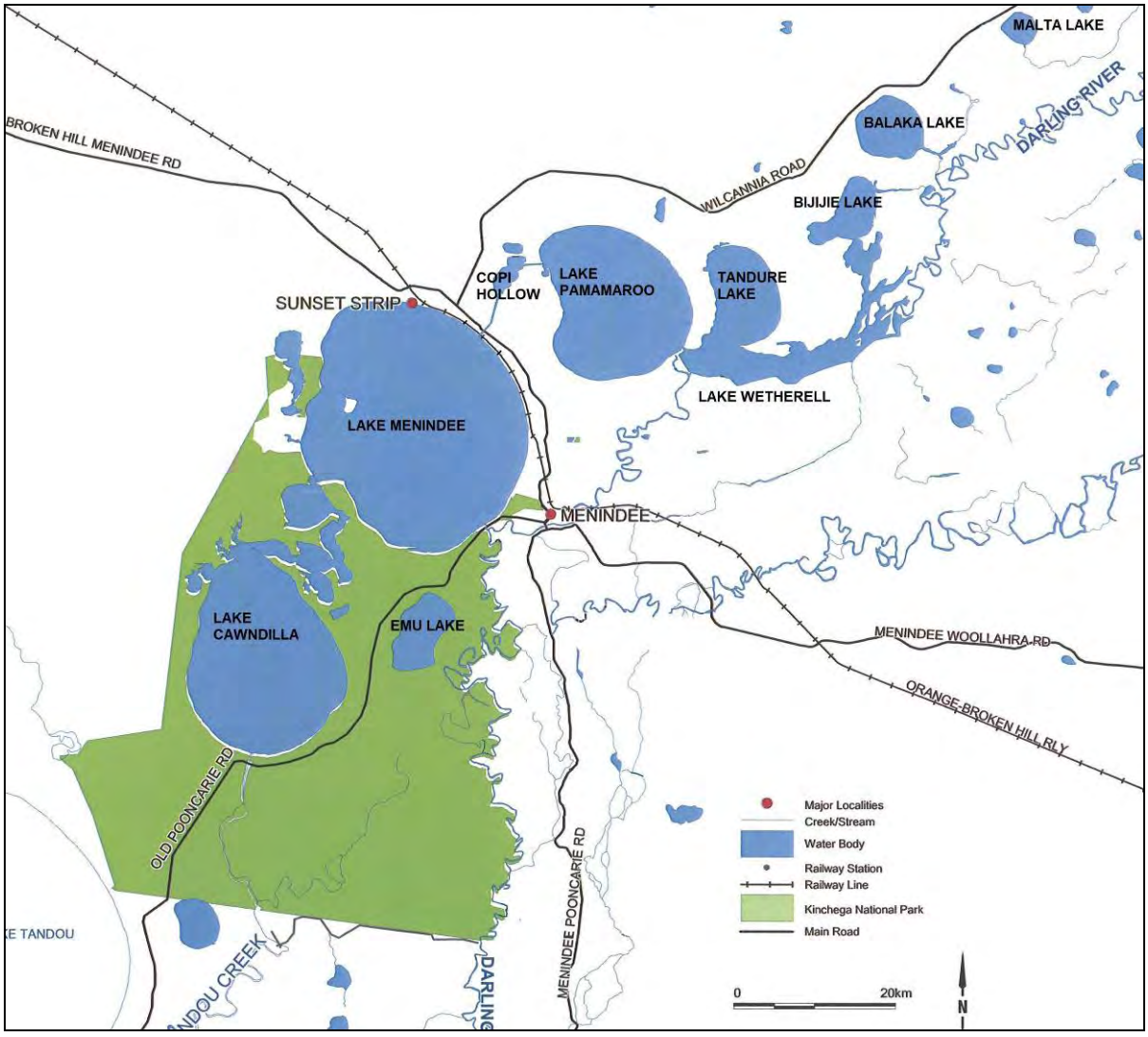


Fig 1. Map of the Menindee Lakes Storages

The water supply scheme is owned by NSW and managed under the Murray-Darling Basin Agreement.

Under the Murray-Darling Basin Agreement, when the volume stored in the lakes is greater than 640GL the water is managed by the Murray-Darling Basin Authority (MDBA) to supply NSW, Victoria and South Australia.

When volumes fall below 480 GL, all water remaining is managed by NSW to meet the needs of far-west NSW including Broken Hill's water supply and the irrigation needs in the

Lower Darling River Valley. This may include providing water to meet the needs of water users and the environment in the NSW Murray Valley. Control of the water in the lakes reverts again to the MDBA when the volume again exceeds 640GL. This is known as the 640/480 rule and effectively provides an additional 160GL for drought security.

This volume was originally determined to be the volume required to meet the needs of far-west NSW during the two-year drought (1915-1917).

On average 426 GL of water is lost in evaporation from the lakes system each year. This represents 24.62% of the total volume when the lakes are full, or proportionally more if the lakes are less than full.

The water in the lakes contributes significantly to the security of water supply in the Lower Darling River Valley in NSW and the Murray Valley in NSW, Victoria and South Australia

When management of the lakes is with NSW, the water in the lakes is not only important to the Lower Darling River but also to users and the environment in the NSW Murray Valley.

In 2008-09 and again in 2009-10, water from the Menindee Lakes has been used by NSW to contribute to water in the Murray Valley, where water supply has been reduced due to drought, and to provide water into the Wakool River system to meet critical human needs and for environmental purposes.

The lakes provide significant tourism and recreation benefits to far-west NSW and are of high environmental and cultural value. Part of the lakes scheme is located within Kinchega National Park, and support more diversity of bird life than Kakadu.

Notwithstanding the significance of current operational arrangements at Menindee Lakes to irrigators and the community, in the light of the recent prolonged drought it has been suggested that substantial water savings could be made by operational changes that, together with infrastructure changes, would reduce the surface area and reduce evaporation losses.

Similarly, it has been suggested that if an alternative water supply for Broken Hill could be provided this would further reduce the need to maintain such high drought reserves.

2. Menindee Lakes Water Efficiency Investigations

Since 1995, a number of investigations have been undertaken to identify options to improve the operational efficiency of the Menindee Lakes water storage system.

2.1 Menindee Lakes Ecological Sustainable Development Project

In 2002, the Menindee Lakes Ecological Sustainable Development Project identified that relatively minor efficiency improvements, of approximately 10,000ML (10 GL) per year could be achieved through structural works costing about $30M. These included;

- Improving the outlet capacity of Lake Menindee to the Darling River,

- Installation of a small block bank and regulator between Lake Menindee and Lake Cawndilla to retain small and medium inflows in Lake Menindee,
- Pumping the residual pool of Lake Menindee to Lake Pamamaroo

An Environmental Impact Statement was completed for these works in 2005; however, no further progress has been made.

2.2 Darling River Water Saving Project

In 2007, at the direction of the NSW Minister for Natural Resources and Commonwealth Minister for Water, the NSW Department of Natural Resources commenced a jointly funded feasibility study known as *The Darling River Water Saving Project*. The purpose of this project was to identify opportunities for substantial water savings in the Darling River system, including the Menindee Lakes.

The drive to explore opportunities for improvement in water use efficiency and water savings was a consequence of prolonged drought and the growing consensus for a whole-of-basin approach to the management of the water resources of the Murray-Darling Basin.

The '*Darling River Water Savings Project'* (DRWSP) study focused on achieving water savings based on an integrated approach of structural works, river and storage operating strategies and water market activities. Within this overall purpose, the following sub-objectives were considered important;

- To improve the overall flexibility in river and water storage management to better meet the needs of water users and the environment,
- To protect the environment and riverine ecology,
- To protect water quality and water security for water users,
- To contribute to economic development in the region.

Part A of the *Darling River Water Saving Project* was completed in 2007 and identified, but did not test, six water saving options for the Menindee Lakes system.

Part B of the *Darling River Water Saving Project* commenced in 2008 and published in August 2010 builds on the Part A work completed in 2007.

Darling River Water saving Project – Part A

Part A of the '*Darling River Water Savings Project'* that was undertaken by Maunsell Aust. identified six (6) potential structural works options, and included the option of a more rapid drawdown of the volume in the Lakes when under NSW control coupled, with an alternative water supply for Broken Hill.

Table 1 – Part A Options

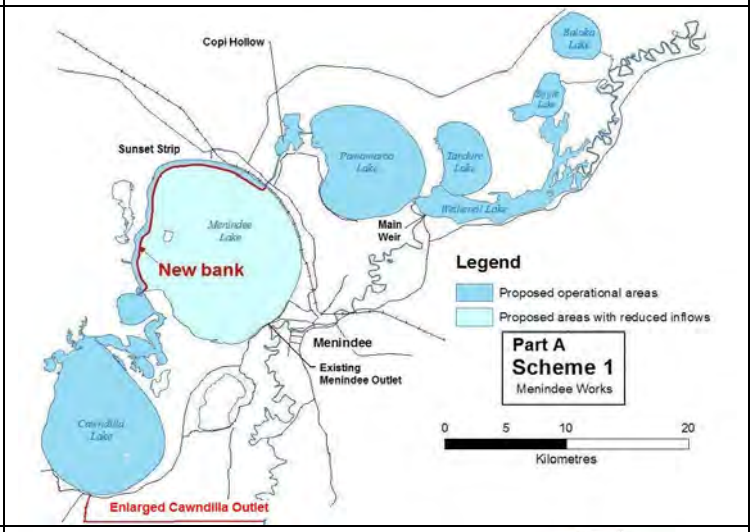
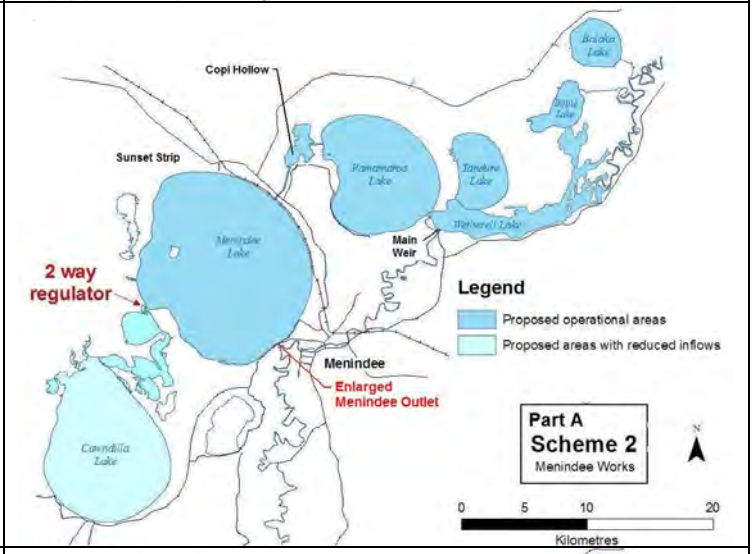
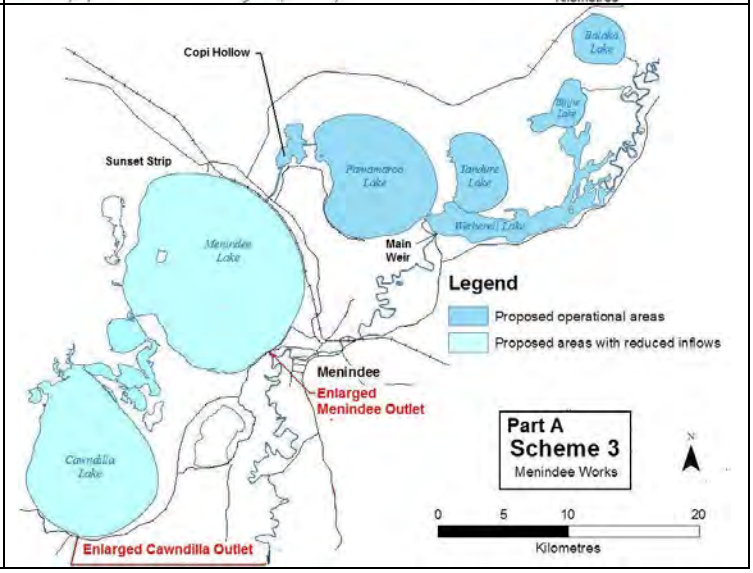
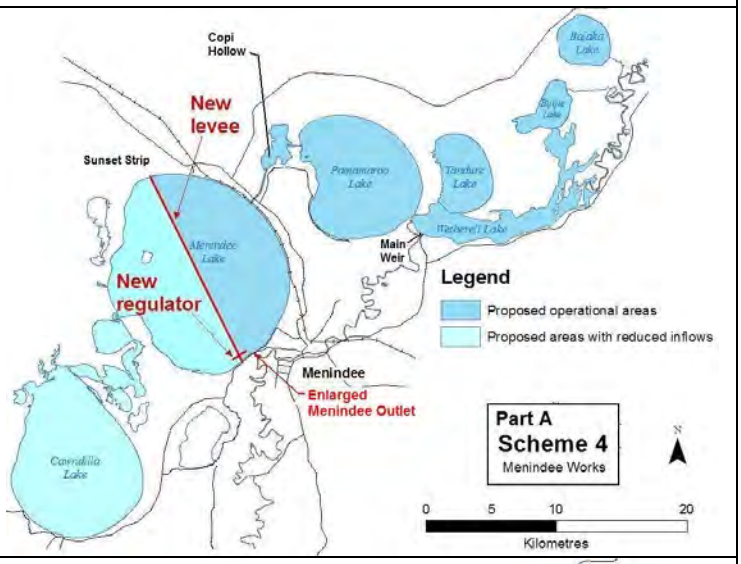
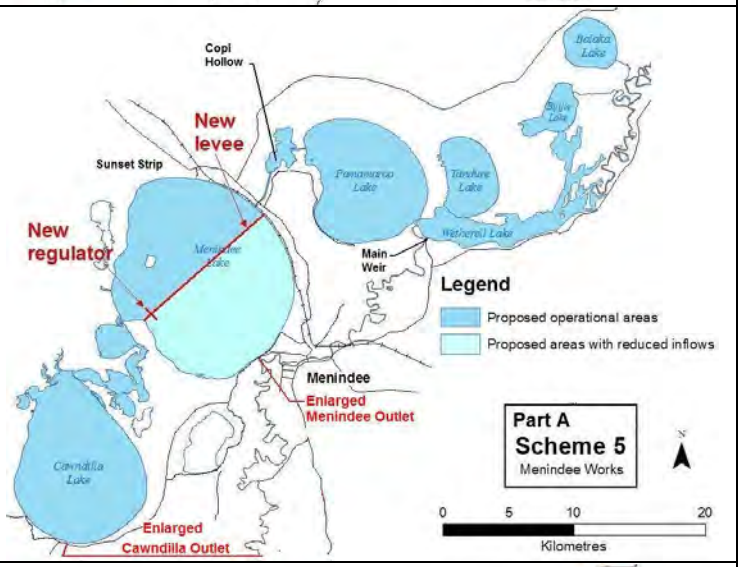
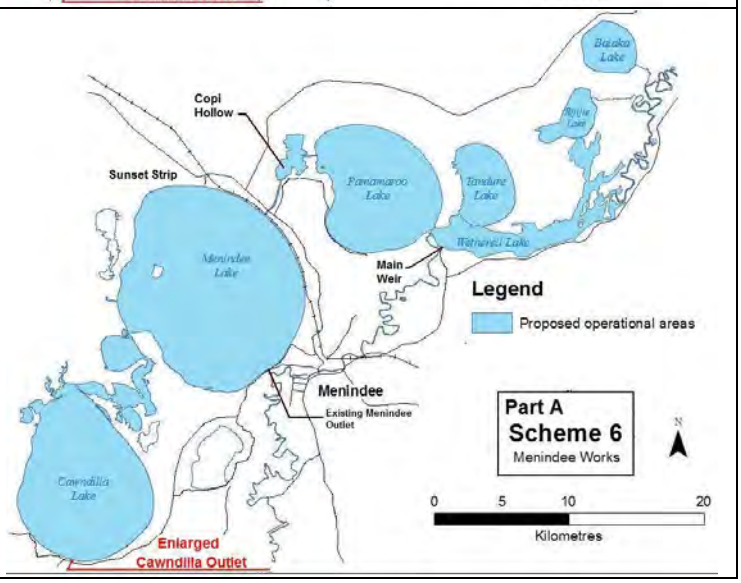
Option	Description	
A1	**Decreased use of Lake Menindee.** Bypass channel in Lake Menindee Improve outlet regulator at Lake Cawndilla, Access to residual pools, Est. cost: $25m*, Est. water saving: 147GL. *(Actual saving will be lower as environmental filling was not considered in Part A modelling)*	
A2	**Decreased use of Lake Cawndilla** Levee and regulator separating Lake Menindee and Lake Cawndilla, Increased Menindee outlet capacity, Access to residual pools, Est. cost: $18m*, Est. water saving: 59GL. *(Actual saving will be lower as environmental filling was not considered in Part A modelling)*	
A3	**Decreased use of Lakes Menindee and Cawndilla** Increased Menindee outlet capacity and new channel to Darling River, or Increased Cawndilla outlet capacity and new channel to Darling River, Est. cost: $26m*, Est. water saving: 180GL. *(Actual saving will be lower as environmental filling was not considered in Part A modelling)*	

Table 1 – Part A Options (Continued)

Option	Description	
A4	**Reduced use of Lake Menindee and half of Lake Menindee** Partition Lake Menindee (NW-SE), Additional Menindee outlet regulator, Access to residual pools, Est. cost: $97m*, Est. water saving: 128GL. *(Actual saving will be lower as environmental filling was not considered in Part A modelling)*	
A5	**Reduced use of half of Lake Menindee** Partition Lake Menindee (NE-SW), Additional Menindee outlet regulator New Cawndilla outlet regulator and channel to Darling River, Access to residual pools, Est. cost: $87m*, Est. water saving: 60GL *(Actual saving will be lower as environmental filling was not considered in Part A modelling)*	
A6	**More rapid drawdown of volumes when in NSW control,** New Cawndilla outlet regulator and channel to Darling River, Access to residual pools, Est. cost: $26m*, Est. water saving: up to 138GL. * As at 2007 when the report was completed.	

For each option it was estimated, that structural works would be required to provide for Broken Hill and other high security water users, costing between $85M and $400M.

Darling River Water Saving Project – Part B

Part B of the *Darling River Water Saving Project* was undertaken by Sinclair Knight Merz, and preliminary findings presented in July 2009. The final report was published in August 2010 and is available on the NSW Office of Water and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities websites.

Part B was undertaken in three stages, which generally involved refinement and elimination of options at each stage. This is summarised as follows;

Part B – Stage 1

Stage 1 considered the six options as presented in the Part A study and determined that:

- Option A1 was eliminated due to high costs and concerns for sedimentation
- Option A4 was eliminated due to prohibitive costs and poor quality soils
- Option A5 was eliminated due to prohibitive costs and poor quality soils

Part B – Stage 2

The Stage 2 study found that substantial savings could be generated by either;

a. Storing less water by reducing the use of Lake Menindee and/or Lake Cawndilla, and/or
b. More rapid drawdown of the volumes in the Menindee Lakes when they would have been in NSW control.

Options that involve the more rapid drawdown of volumes in the Menindee Lakes when in NSW control will result in a reduction in the water stored in the lakes when compared to current operating strategies and an increased frequency when the lakes are potentially dry.

The impacts on the water availability to users in the Murray Valley were not assessed in detail.

The Stage 2 report identified potential alternative water supply arrangements for Broken Hill, but has not identified any alternative supplies for consumptive users in the Lower Darling Valley.

Broken Hill Water Supply Options	**Estimated Lifecycle Costs**
Managed Aquifer Recharge	$31.0M
Use of Lake Tandure including additional 5GL storage	$36.9 - $50.4M
18GL uncovered storage	$36.4M

The estimated cost of $220M for a pipeline from the River Murray to Broken Hill with a capacity to deliver 33ML/d was considered prohibitively high.

Part B - Final Report

The investigations have identified that the potential for greatest water savings, mostly culminating in increased downstream river flows, may be achieved by changes to the current operations of the Menindee Lakes.

Generally the options involving significant operational changes depend less on structural works to achieve savings and present a higher benefit-cost ratio and better value for money, based purely on the cost of achieving water savings.

In the Final Report, a set of six (6) options were presented for further consideration by Government.

The investigations have proved that major structural works have a limited capacity to deliver large water savings at the Menindee Lakes. Options which include major operational changes could potentially achieve large water savings but would potentially involve extreme changes to the filling frequency of both Lake Menindee and Lake Cawndilla.

The hydrologic modelling adopted an environmental filling pattern that would require either Lake Menindee and/or Lake Cawndilla to be filled periodically once in every 5 to 7 years on average in order to maintain the existing environmental values of these two lakes. The watering regime would move towards the more ephemeral watering regime which existed prior to the storage scheme works in the 50s and 60s. The 'Basin Plan', being developed by the Murray Darling Basin Authority, will further develop the environmental watering requirements for these lakes and these will be incorporated before a final proposal is developed.

The Part B report noted that as environmental health is a prerequisite for achieving social, cultural and economic objectives on a regional and national scale, managers need to incorporate environmental information into their management decision making framework.

The Part B options are summarised in Table 2. The six options represented a range of potential change at the Menindee Lakes, ranging from;

- Option B1, which could achieve in excess of 200GL of average savings, but would involve lowering the threshold for NSW control of the Lakes, and keeping Lakes Menindee and Cawndilla effectively dry, to
- Option B6, which would achieve more modest evaporation savings of about 34GL on average, would keep the current threshold for NSW control of the Lakes, but would keep Lake Cawndilla effectively dry except for periodic environmental filling.

Cost effectiveness

All options included a cost for an alternative water supply for Broken Hill, assuming that the need for an alternate water supply would be the same for all options. It was understood that the next stage of modelling would undertake a more detailed analysis of the Broken Hill requirements and more closely focus on the future operating regimes at the Lakes.

If the 640/480 rule is maintained (as in Option B6), the need for an alternative Broken Hill water supply would be reduced and potentially eliminated. The economic viability of Option B6 would also be significantly improved if the operational need to an enlarged Cawndilla outlet is waived. The cost would reduce to $40.4M with an indicative value for money being $1,190/ML.

System Risk

As part of the assessment of potential impacts, the number of months that the volume in the Menindee Lakes would be below 100GL was used as an indicator. When the total lakes volume drops below 100GL there would be potential reduction in;

a. the security of supply for water users in the Lower Darling River valley,

b. the capacity to use water to meet the environmental and consumptive needs in the NSW Murray valley.

Table 2 - Time Lakes Volumes are below 100GL for Options

MLS Scheme	% of time lakes Volume less than 100GL
B1	18%
B2 – B5	7%
B6	2%
Current Operations	2%

Table 2 – Part B Schemes

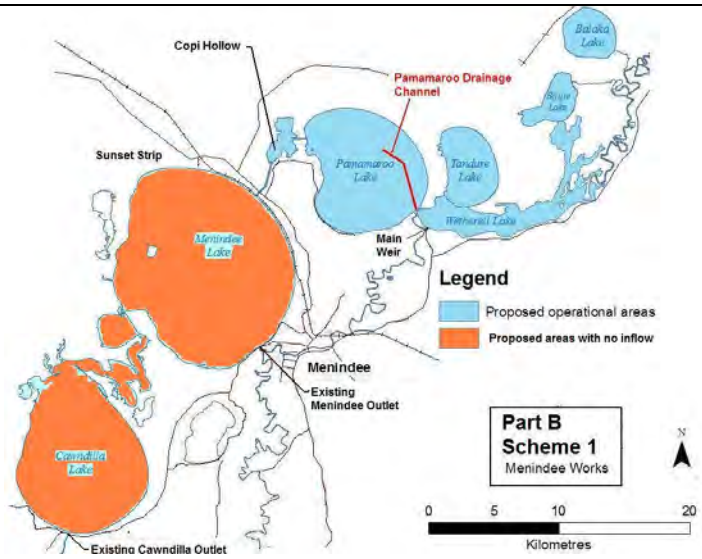
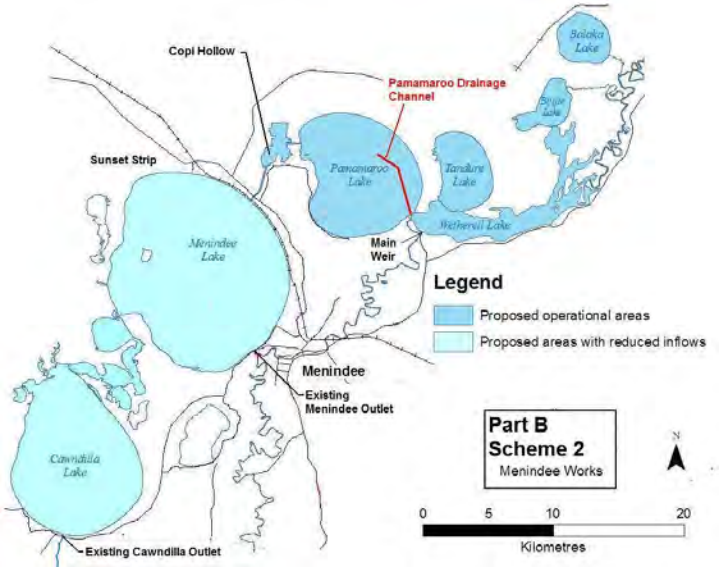
Scheme	Description	
B1	**Scheme 1** Do not fill Lake Menindee and Cawndilla, Including:- ▪ Pamamaroo drainage channel ▪ Rapid drawdown to 150GL ▪ Alternative supply for Broken Hill **Estimated Lifecycle Cost** Menindee Lakes $2.9m Broken Hill W.Supply $31.0m $32.9m **Water Savings** Estimated Savings 248GL Cost / ML $ 137 **Net Social Benefit (Cost) $ 103m** **Operational Risk** Time < 100GL 18%	
B2	**Scheme 2** Environmental fill of Menindee and Cawndilla, Including:- ▪ Pamamaroo drainage channel ▪ Rapid drawdown to 200GL ▪ Alternative supply for Broken Hill **Estimated Lifecycle Cost** Menindee Lakes $ 2.9m Broken Hill W.Supply $ 31.0m $ 32.9m **Water Savings** Estimated Savings 125GL Cost / ML $ 272 **Net Social Benefit (Cost) $ 26m** **Operational Risk** Time < 100GL 7%	

Table 2 – Part B Schemes

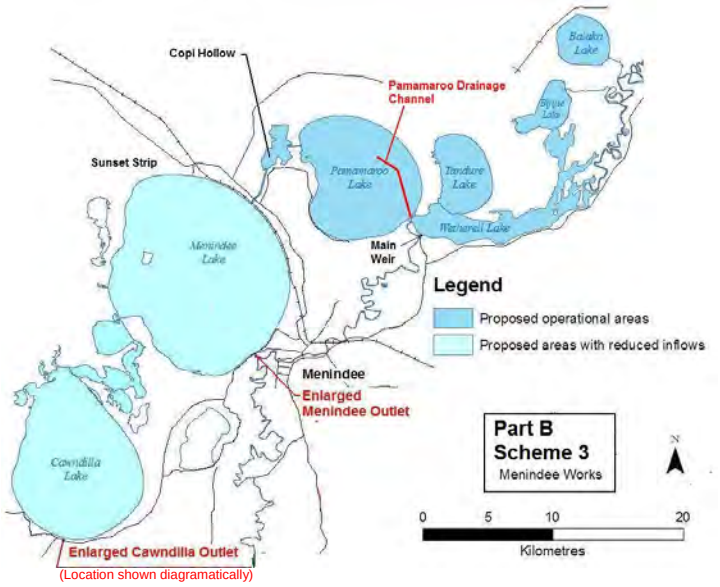
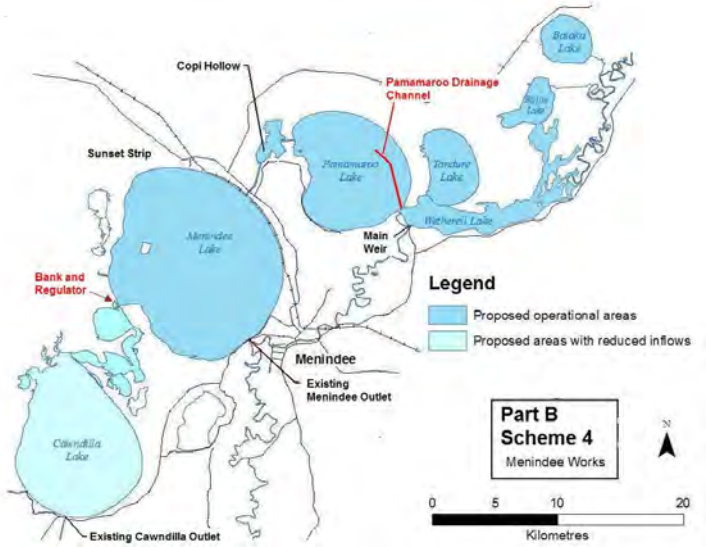
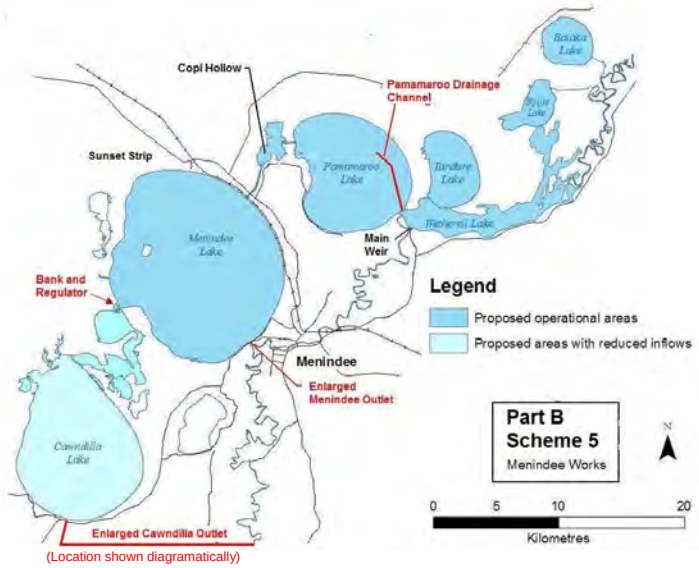
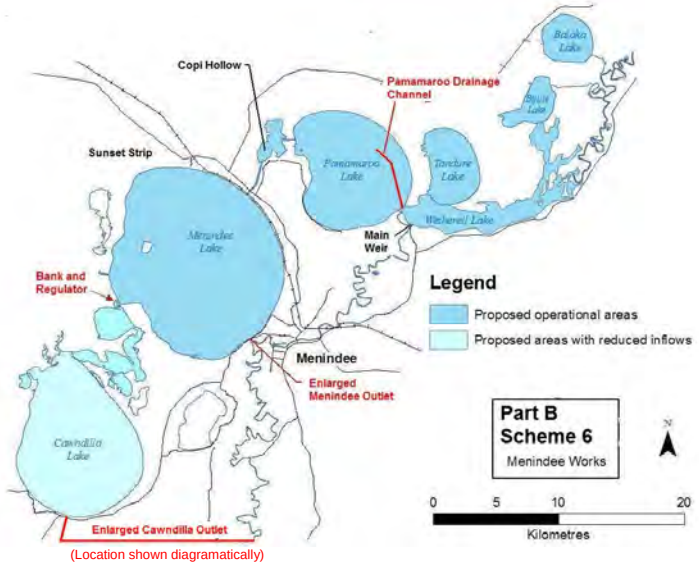
Scheme	Description	
B3	**Scheme 3 (Scheme 2 + Enlarged Outlets)** Environmental fill of Menindee and Cawndilla Including:- ▪ Alternative supply for Broken Hill ▪ Pamamaroo drainage channel ▪ Increased outlet capacity of Menindee/Cawndilla (optional) ▪ Rapid drawdown to 200GL **Estimated Lifecycle Cost** Menindee Lakes $ 70.9m Broken Hill W.Supply $ 31.0m $ 101.9m **Water Savings** Estimated Savings[1] 125GL Cost / ML $ 840 **Net Social Benefit (Cost) ($ 25m)** **Operational Risk** Time < 100GL 7%	 [1] The increased outlet capacity included in Scheme 3 was not specifically modelled. The model run for Scheme 2 was adopted for the purpose of this analysis as this provided a conservative estimate of water savings and downstream impacts. In actuality water savings for this option are likely up to 10GL greater (as indicated by comparison of Schemes 4 and 5).
B4	**Scheme 4** Environmental fill of Cawndilla Including:- ▪ Menindee/Cawndilla bank & regulator ▪ Pamamaroo drainage channel ▪ Rapid drawdown to 200GL ▪ Alternative supply for Broken Hill **Estimated Lifecycle Cost** Menindee Lakes $ 18.6m Broken Hill W.Supply $ 31.0m $ 49.6m **Water Savings** Estimated Savings 61GL Cost / ML $ 820 **Net Social Benefit (Cost) ($ 4m)** **Operational Risk** Time < 100GL 7%	

Table 2 – Part B Schemes (Continued)

Scheme	Description	
B5	**Scheme 5 (Scheme 4 + Enlarged Outlets)** Environmental fill of Cawndilla Including:- ▪ Menindee/Cawndilla bank and regulator, ▪ Pamamaroo drainage channel, ▪ Increased outlet capacity of Menindee/Cawndilla (optional) ▪ Rapid drawdown to 200GL ▪ Alternative supply for Broken Hill **Estimated Lifecycle Cost** Menindee Lakes $ 70.9m Broken Hill W.Supply $ 31.0m $ 101.9m **Water Savings** Estimated Savings 74GL Cost / ML $ 1,390 **Net Social Benefit (Cost) ($ 50m)** **Operational Risk** Time < 100GL 7%	 (Location shown diagramatically)
B6	**Scheme 6** Environmental fill of Cawndilla Including:- ▪ Menindee/Cawndilla bank and regulator, ▪ Pamamaroo drainage channel, ▪ increased outlet capacity of Menindee/Cawndilla (opt) ▪ No change to NSW drawdown ▪ Alternative supply for Broken Hill **Estimated Lifecycle Cost** Menindee Lakes $ 70.9m Broken Hill W.Supply[1] $ 31.0m $ 101.9m **Water Savings** Estimated Savings 34GL Cost / ML $ 2,997 **Net Social Benefit (Cost) ($ 61m)** **Operational Risk** Time < 100GL 2%	 (Location shown diagramatically) [1] While the Part B economic analysis included the cost of a Broken Hill water supply in Option B6, this option retains the current 640/480 rule, and augmentation of the BH water supply may not be required in this circumstance.

3. Menindee Lakes MOU

In July 2010, the Commonwealth and NSW Governments signed a Memorandum of Understanding for the cooperative investigation and subsequent implementation of key water reform initiatives in New South Wales, including Broken Hill's urban water supply and Menindee Lakes operational arrangements.

Both governments are agreed that any changes to the current operations must consider three major issues;

- must ensure security of town water supply for Broken Hill
- must not reduce the environmental and heritage values of the Menindee Lakes or other significant regional wetlands, and
- must not reduce the reliability of water supply in the Lower Darling or Murray Rivers.

A central proposition behind the MOU is that changes to the existing operating rules at the Menindee lakes, in conjunction with any infrastructure investment, can reduce the large evaporative losses currently incurred, thereby allowing additional water to be made available for other uses in the Murray-Darling Basin.

A precursor to achieving these savings is the provision of an alternate, secure water supply for Broken Hill (thereby making it less reliant on the Menindee Lakes), and the demonstration that neither existing entitlement holders water security nor the environment will be adversely affected as a result of the changes operations at Menindee Lakes.

The MoU also states that any operational changes at Menindee Lakes must be shown to have no directly attributable adverse impact on the water security of existing water entitlement holders at Menindee Lakes and the Lower Darling, or the Murray River.

The *Darling River Water Savings Project* reports, together with the Memorandum of Understanding and other background information, are available of the NSW office of Water website at www.water.nsw.gov.au and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities website at http://www.environment.gov.au/water/policy-programs/srwui/menindee-lakes/index.html

As the project develops, there will be ongoing consultation with communities, industry and stakeholder groups.

Under the MOU, the NSW and Commonwealth governments have committed to actively investigating a particular approach to changes at Menindee Lakes, that is, considering an alternative water supply for Broken Hill by means of a managed aquifer recharge scheme and hydrological work that aims to achieve savings of up to 200GL at Menindee Lakes by returning Lake Cawndilla and Lake Menindee to more natural conditions. Significant work is

underway to consider the viability of that approach. If ultimately that approach is not able to be implemented, the NSW government is committed to considering other options.

4. Issues to be considered

4.1 Broken Hill water supply

Broken Hill's water supply is currently provided by water from the Darling River at Menindee and is fed by the Menindee Lakes. This supply is supplemented by two water storages (Stevens Creek and Umberumberka) near Broken Hill that fill from local rainfall and runoff.

Since the construction of the Menindee Lakes, the security of water supply to Broken Hill has never been seriously threatened, although in 2005-2006, security of supply was reduced to an estimated 12 months, and water quality was poor due to high levels of salinity.

Studies by CSIRO (CSIRO 2008) have shown that the effects of climate change on future water availability within the Darling River Basin are uncertain, but water availability is likely to decline, especially in the southern portion of the Basin. Average water availability in the NSW portion of the Darling River Basin is expected to decline by 5-10 per cent by the year 2030.

Flows in the Darling River will also be impacted by the Basin Plan. The reduction in upstream diversions that is expected to be part of the Commonwealth's Basin Plan, together with purchases of water for the environment upstream of the Menindee Lakes will counter the long term reduction to some extent.

This would suggest that, under existing management arrangements, there may be a minor reduction in water reaching the Menindee Lakes, on average, and therefore the threat to the long term security of water supply to Broken Hill is not significant.

The current investigations into the future management of the Menindee Lakes are considering changes to the filling regimes of the two largest lakes in the system, Lake Menindee and Lake Cawndilla, and enabling the rapid draw-down of the lakes below the current 480GL trigger.

Such management arrangements may reduce the existing security of supply to Broken Hill and the Commonwealth government is investing in the assessment of Managed Aquifer Recharge as an alternative drought supply for Broken Hill as part of the work being done under the MOU.

4.2 Other town water supply and high security users

Broken Hill is not the only town dependent on their water supply from the Menindee Lakes. Similarly, Pooncarie and the small settlement at Ellerslie, rely on water from the Darling River downstream of Menindee.

Under current water management, if Broken Hill and Pooncarie's supply are secure, then high security entitlements, including domestic and stock supply for downstream properties and supply for permanent plantings (horticulture and viticulture) are also secure.

The NSW and Commonwealth governments have committed that any management changes proposed under the Menindee Lakes Project should not reduce the reliability of supply to downstream users in the Lower Darling or Murray valleys.

4.3 Menindee Lakes Environmental Values

The Menindee Lakes are natural ephemeral lakes with high environmental values, and are listed in the Directory of Important Wetlands in Australia.

Lake Cawndilla and the southern portion of Lake Menindee are within Kinchega National Park that was gazetted in 1968.

Under NSW legislation, any changes to the management of these lakes must consider environmental, social and economic issues. The lakes are also rich in their Aboriginal heritage values.

Similarly, Commonwealth environmental legislation *(the Environment Protection and Biodiversity Conservation Act 1999 (Cth))* requires assessment and approval of matters carried out by Commonwealth agencies and matters the Commonwealth considers are of national environmental significance. These include, for example, listed migratory species including species listed in JAMBA and CAMBA.

This means that the management of the Menindee Lakes for their environmental values must include consideration for maintaining habitat for migratory waterbirds under international conventions including JAMBA and CAMBA.

Further, in the past 20 years the NSW Government together with the (former) Murray-Darling Basin Commission, have managed the most upstream lake in the system, Lake Wetherell, for its significant environmental values.

Lake Wetherell is the inundated floodplain of the Darling River that connects four smaller lakes. To maintain the floodplain environment and to reduce evaporation, water is preferentially drawn down off the floodplain and into the main channel of the Darling River.

This operating strategy has prevented the extended inundation and drowning of the floodplain vegetation of Lake Wetherell.

Each of the options proposed in the Part B study will impact upon the frequency of filling of Lake Menindee and/or Lake Cawndilla, the two larger lakes in the system, and the length of time water remains within each of these lakes and potentially, Lake Wetherell.

Option B1, which generates most water savings, excludes water from passing into either of these lakes in the future.

Options B2 and B3 provide for environmental releases into Lake Menindee and Lake Cawndilla.

Option B4, B5 and B6 would have water flowing into Lake Cawndilla for environmental purposes, with large scale structural works that would enable Lake Menindee to be used as a storage without filling Lake Cawndilla. There will also be greater capacity for water to be released back to the Darling River on a flood recession.

The difference between these options is that options B4 and B5 also include changes to drawdown rules.

4.4 Rapid drawdown

Under the existing provisions of the Murray-Darling Basin Agreement, when the volume stored in the lakes has risen to 640 GL and until it reaches less than 480 GL the water is managed by the Murray-Darling Basin Authority (MDBA) to supply NSW, Vic and SA.

When volumes fall below 480 GL the remaining water is currently managed as drought reserve by NSW. The lakes return to management by the MDBA when they next exceed 640 GL.

The investigations completed to date demonstrate that only modest water savings can be generated by infrastructure works alone.

Significant water savings will only be achieved by passing additional flows downstream to the River Murray, which would otherwise be stored in the Menindee Lakes. In particular, this involves drawing down the volume retained in the lakes quickly, considerably below the current 480 GL trigger.

The analysis clearly demonstrates that the volume in the Lakes under rapid drawdown options will always be less than under the current rules (refer % time < 100GL) and the potential to run out of water will be significantly greater under a climate change scenario where the dry inflow sequence could be longer than previously recorded.

The drought security reserve has been invaluable in recent years, particularly;-

- In 2005-06 and again in 2007-08, NSW ceased flows to the Lower Darling River to protect water supply for Broken Hill, while licensed users had to rely on water remaining in residual pools.

- In 2008-09 and again in 2009-10, water available to NSW under the existing 640/480GL rule has been diverted into the River Murray, allowing additional water to be made available to NSW for both the environmental (Wakool flows) and consumptive use.

Again, the NSW and Commonwealth governments have committed that the any management changes proposed under the Menindee Lakes Project should not reduce the reliability of supply to downstream users in the Lower Darling or Murray valleys.