BROKEN HILL DROUGHT WATER SUPPLY

December 2014

Preliminary Submission – Drought Water Supply
PRELIMINARY DRAFT

Broken Hill Drought Water Supply

VERSION CONTROL

Version	Date	Issued to	Remarks	Issued by
1	7 Nov. 2014	DJ	Preliminary draft – For discussion	LF
2	11/122014		Updated Draft – for Submission	AL/GP
File Location:				

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS & ACRONYMS

ANZECC	Australian and New Zealand Environment and Conservation Council
AHD	Australian Height Datum
BSMS	Basin Salinity Management Strategy
DOC	Dissolved Organic Carbon
EC	Electrical Conductivity – a measure of salinity
Environmental watering	Provision of water, authorised by an access entitlement, to a location for the achievement of ecological targets and objectives.
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
DN	Diameter Nominal (internal diameter of a pipe)
GL	Gigalitres
mg/L	Milligram per Litre
ML	Megalitres
MLS	Menindee Lakes Scheme
Murray Darling Basin (MDB)	Comprises the catchment of the Murray and Darling Rivers and their many tributaries, extending from north of Roma in Queensland to Goolwa in South Australia.
Murray Darling Basin Authority (MDBA)	The authority responsible for managing the Basin's water resources in the national interest, in cooperation with state authorities, with the aim of ensuring reliable water supplies for all users. (Formerly Murray Darlin Basin Commission – MDBC)
NOW	NSW Office of Water
OEH	Office of Environment & Heritage (NSW).
ppm	Parts per Million
RL	Reference Level
Water year	An accounting period from 1 July to 30 June, seasonally aligned and corresponding to water allocation policy in the River Murray system.

1.0 INTRODUCTION

1.1 Introduction

Water NSW is proposing to undertake works to secure the Broken Hill township and surrounds drought water supply. This submission has been prepared as a preliminary proposal for Broken Hill Drought Water Supply project (henceforth the Project). Owing to the approaching water supply crises for Broken Hill and time available, the submission provides a description of the preferred project and an overview of initial and potential environmental investigations in order to assist the NSW Planning & Environment to determine the level and scope required for a detailed environmental assessment. It is considered the project is essential for the State and as such, is seeking that the project be deemed Critical State Significant Infrastructure.

1.2 Project Proponent

The Proponent of the Project is Water NSW, C/- Mr Adrian Langdon, GPO Box 1604, Sydney NSW 2000, (phone 02 8245 2003, mobile 0437392613).

Approval will be sought for construction and operation of the Project.

1.3 Project Background

Broken Hill is located in far west New South Wales (NSW), approximately 1,100 km west of Sydney and 500 km east of Adelaide. Broken Hill City Council encompasses over 17,000 hectares, and is considered the most remote centre in NSW, contributing to one of the lowest SEIFA (Socio-Economic Index for Areas – an index of socio-economic disadvantage) in the state. Most of the 19,150 population live in Broken Hill city.

Essential Water, a division of Essential Energy, supplies treated water to Broken Hill, Menindee and Sunset Strip, and chlorinated (but presently unfiltered) water to Silverton. Essential Water supplies a total of 5,200 ML of water per year to around 10,000 residential customers and around 600 non-residential customers. Essential Water also provides non-potable water to rural users along the Menindee to Broken Hill pipeline for stock and domestic purposes. The largest non-residential customer is the mining company, Perilya Ltd (Perilya), which uses approximately 20% to 25% of the total water supplied. CBH Resources, a second mine, also operates in Broken Hill.

Essential Water's service area is the most arid in the state, experiencing extreme climatic variations. This includes more frequent drought than coastal areas. Eight in every 10 years, the town water supply is dependent on water sourced from the Darling River off-take at the Menindee Lakes Scheme. Water is pumped over 116km of pipeline to Broken Hill. These unique operational circumstances, combined with drought, cause salinity and other water quality problems in the raw water that Essential Water must treat.

During drought, the management of the Menindee Lakes Scheme, and hence the availability of Essential Water's water licence entitlements, rests with the NSW Office of Water (NOW). At all other times, the management of the lakes scheme rests with the Murray Darling Basin Authority.

Modelling of historical Menindee inflows shows that with current water supply demand of Broken Hill and associated industries, water in the lakes will be exhausted one year in every ten.

In February 2014, following release of water from the Lakes, storages reached the trigger value of 480GL and control of releases reverted to the NSW government, rather than MDBA. A significant amount of the 480GL storage was effectively dead storages to the Darling River, not available except via pumping. Modelling from NOW in November 2014 shows that with little or no flows down the Darling River, Menindee Lakes supply to Broken Hill will expire during the summer of 2015/16. December 2014 storage volume available for Broken Hill has decreased to 220GL. By November 2015, salinity in the Darling River is expected to reach in excess of 4,000 EC and continue to climb when Broken Hill reverts back from Copi Hollow Lake to the Darling River.

The only way the situation will improve for Broken Hill water supply is to have significant flows down the Darling River, as minor flows along the Darling are likely to increase salinity in Lake Wetherell.

Modelling also shows we are 13 months into a little or no flow event. History shows the recent Millennium Drought lasted for 33 months of little or no flow. Long range forecasts predict 45% chance of receiving average rainfall during the 2014/15 summer. Much of the Darling catchment is in drought meaning significant rain events are required to allow flows to reach Menindee Lakes. NOW intends to maintain releases from Menindee Lakes downstream until the Autumn of 2015 when flows down stream of weir 32 will cease.

Broken Hill's main storage dams Umberumberka 8GL and Stephens Creek 19GL are effectively dry.

Emergency water supplies require significant time. Through drought history water has been trained from Menindee Lakes to Broken Hill. Unfortunately modelling shows when the lakes will expire.

Without Menindee Lake inflow, it is predicted that by March 2015, water would be supplied (from Lake Wetherell) resulting in a marked increase in salinity of 2,000 EC, and by June 2015 Menindee Lakes will no longer be able to supply water to Broken Hill. Emergency works at Copi Hollow, is currently being undertaken to protect better quality water from evaporation which is predicted to buy some time to December 2015.

Since July 2014 no flow has passed Mungandi causing escalation of the supplementary water supply for Broken Hill project.

1.4 Project Objectives

The Project Objective is to resolve the current emergency of securing water supply security to Broken Hill, and to safeguard a secure drought water supply to Broken Hill into the future.

Key principles of the project:

- The project needs to meet the critical water supply needs of Broken Hill by Spring 2015
- The project should aim towards the greatest capital and operating cost efficiency;
- The emergency water supply should aim to provide for average summer demand 25 ML/d (approximately 77% of Peak Day Demand (31 ML/d)); and,

1.5 Options Discussion

A number of options have been investigated to resolve the current emergency of securing supply to Broken Hill, including:

1. Rail carting;
2. Road carting;
3. Murray River pipeline;

4. Managed Aquifer Recharge Scheme; and,
5. Groundwater supply & Reverse Osmosis Plant.

A summary of options is presented below.

TABLE 1: OPTIONS ANALYSIS

Option	Advantages	Disadvantages	Direct Costs
Do Nothing		• Evacuation of significant proportion of the Broken Hill population. • Closure of mining operations. • Option is not viable and not acceptable. • Does not contribute to the Menindee Lakes Water Saving Project.	Potential costs in loss of significant revenue for Broken Hill & evacuation costs
Rail Option	• Will meet program of December 2015.	• Will not meet demand (7.4 ML/d compared with 24 ML/d) • Significant environmental cost for transport. • Does not contribute to the Menindee Lakes Water Saving Project	NPV @ 7% estimated at $876M over 50 years, assuming 20 ML/d supply, but practically would only supply a significantly lower demand of 7.4 ML/d.
Road Option	• Will meet program of December 2015.	• Will not meet demand (4.8 ML/d compared with 24 ML/d) • Significant environmental cost for transport. •	NPV @ 7% estimated at $2,088M over 50 years, assuming 20 ML/d supply but practically would only supply a significantly lower demand of 4.7 ML/d.
Murray River Pipeline	• Resolves drought water supply security in the longer term.	• Unlikely to meet program by December 2015 • Significant land & easement issues. • Impacts on Murray River access. •	NPV @ 7% estimated at $532M over 50 years, assuming 20 ML/d supply
Managed Aquifer Scheme	• Resolves drought water supply security in the longer term. •	• Loss of amenity & tourism if used as a permanent supply for Broken Hill. • Unlikely to meet Program by December 2015.	NPV @ 7% estimated at $329M over 50 years, assuming 20 ML/d supply
Groundwater &/or	• Resolves drought water	• Negative public	NPV @ 7% estimated at

Option	Advantages	Disadvantages	Direct Costs
Reverse Osmosis Plant	supply security in the longer term • Secures summer daily demand for Broken Hill	perception that project represents permanent supply (& therefore loss of Menindee Lakes) • Tight program requires investment & program risk.	$216M over 50 years, assuming 20 ML/d supply

1.6 Description of Preferred Option

The Groundwater and Reverse Osmosis Plant is the preferred option as it meets all objectives listed in section 1.4 and it's the most cost effective option.

The poor condition of the existing pipeline between Menindee and Broken Hill generally favours Menindee as the preferred location for the Reverse Osmosis Plant. It is likely that the replacement of the existing Menindee to Stephen's Creek pipeline would need to be bought forward (at an estimated cost of $160 million) should the plant be located in Broken Hill and the pipeline required to carry brackish water.

In addition, current infrastructure limitations (Interconnecting Channel pump station maximum capacity of 31 ML/d and Menindee to Stephen's Creek pipeline maximum capacity of 36 ML/d) would potentially limit the supply, particularly when the efficiency of the reverse osmosis plant is likely to be between 60-85% resulting in a waste brine volume of between 15-40% from operation of the Reverse Osmosis Plant

A summary of the preferred option is as follows:

- A borefield comprising of between 12 to 30 bores every 500 metres along the length of existing power & water supply easements, east of the interconnecting channel. The pipeline could extend up to 15 km within the current easement.
- A Reverse Osmosis plant with up to 24 ML/d production capacity, comprising pre-treatment.
- Two balance tanks – one raw water balance tank & one clearwater balance tank. The size of these tanks need to be determined as part of the detailed project design.
- A rising main along the borefield to the Reverse Osmosis plant and modification to the existing interconnecting channel to Menindee rising main.
- Disposal basin(s) to dispose brine effluent.
- Associated electrical, telemetry and ancillary works.

- Potential additional works to source water from Lake Wetherell (high salinity) which may include changes to the Menindee pipeline to enable the transfer of water from Menindee to Copi Hollow using the Broken hill pipeline.

1.7 Capital Investment Value

The project is a fast moving project and is a work in progress, costings are still being refined and are dependent on a number of factors including:

- Results of the test bores determine pumping arrangements, and electricity needs at the borefield.
- Results of the test bores will determine the sizing of the Reverse Osmosis Plant and associated disposal basin(s).
- Further investigation is currently being undertaken into disposal basin options which include evaporation/infiltration options – which has a significant influence of the sizing of the basin.

Capital cost to deliver the Groundwater and RO plant is estimated at $156.511 million, which includes the cost of leasing the Reverse Osmosis Plant for the first operation. The estimated cost of operation over 12 months is estimated at $8.291 million (or $22,716/day) required for the Preferred Option.

1.8 Groundwater bore investigations

Importantly, test bores are currently being developed, so yield and quality results at this stage are assumptions only. The results of these test bores have a large bearing on the strategy of the Groundwater and RO plant particularly when considering available supply, limitations of existing infrastructure and therefore concept design of all elements of the Scheme. Further refinement and optimisation of the Concept will take place during Concept Design. However, without clear and decisive action now, there is considerable risk that Broken Hill will be without a water supply by December 2015.

NSW Office of Water is currently in the process of installing test production bores on the margin of Lake Menindee to investigate the potential of sourcing 24 ML/d groundwater supply. The proposed drilling program is due to commence in November 2014 and be completed by early 2015.

The concept design of the project elements is highly dependent on results of the test bores, both in terms of yield and water quality. A Review of Environmental Factors has been prepared to undertake the investigations, and is provided in Appendix A for information.

The project is looking to include potential additional works to source water from Lake Wetherell (high salinity) from December 2015, which will secure water supply only to April 2016, before groundwater would be required.

1.9 Proposal Justification

The key aim of this project is to provide a secure drought water supply to Broken Hill, during periods where the Menindee Lakes Scheme is unable to provide an adequate water supply, which on current forecasts represents on average 1 year in 10 for a period of 12 months. Without which, the town of Broken Hill will effectively have no water supply to support the population or industries starting Spring 2015.

The project proponent has examined a number of options including the 'do nothing' option which would be unfeasible. Other options would not supply the required demand and/or are unfeasible, would not meet required program and are cost excessive.

The proposal includes development of a borefield and integral Reverse Osmosis Plant / Water Filtration Facility to treat water prior to being pumped into the 120 km long pipeline to Broken Hill.

2.0 BACKGROUND

2.1 Lower Darling & Menindee Lakes

The Lower Darling River System is located in south-western New South Wales at the lower end of the Darling River, upstream of its junction with the River Murray at Wentworth. The extent and main features of the Lower Darling region are shown in Figure 1.

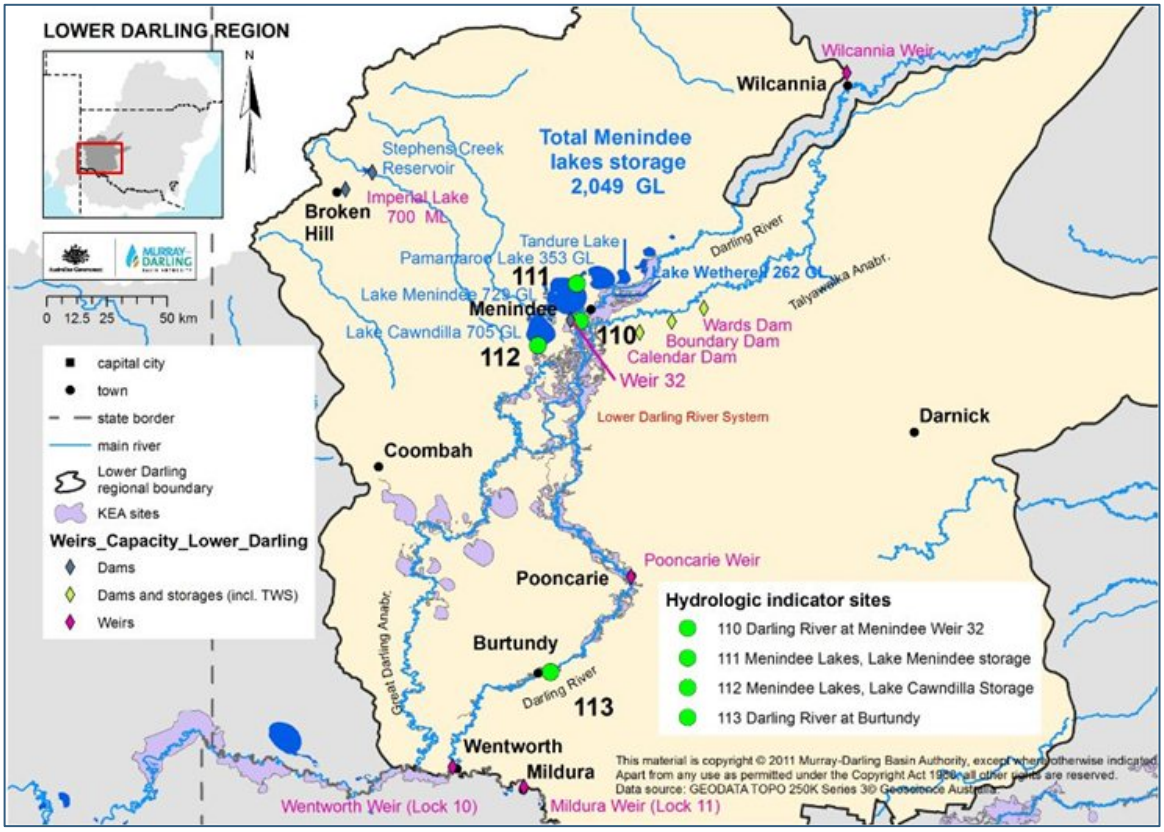


FIGURE 1: LOWER DARLING REGION

The region contains a number of important environmental assets as described by MDBA (2012), and outlined in Figure 2. These include:

- Menindee Lakes— a system of lakes covering an area of 45,000 ha.
- Lower Darling River — the main channel, and adjacent billabongs and wetlands.
- Great Darling Anabranch— a series of lakes and floodplains adjacent to the anabranch channel.

The Menindee Lakes system originally consisted of a series of natural depressions that filled only during flood events. After a flood event, water would drain from the lakes back into the main river channel, while some would be retained in the lowest parts of the depressions and would eventually evaporate or be absorbed into the ground.

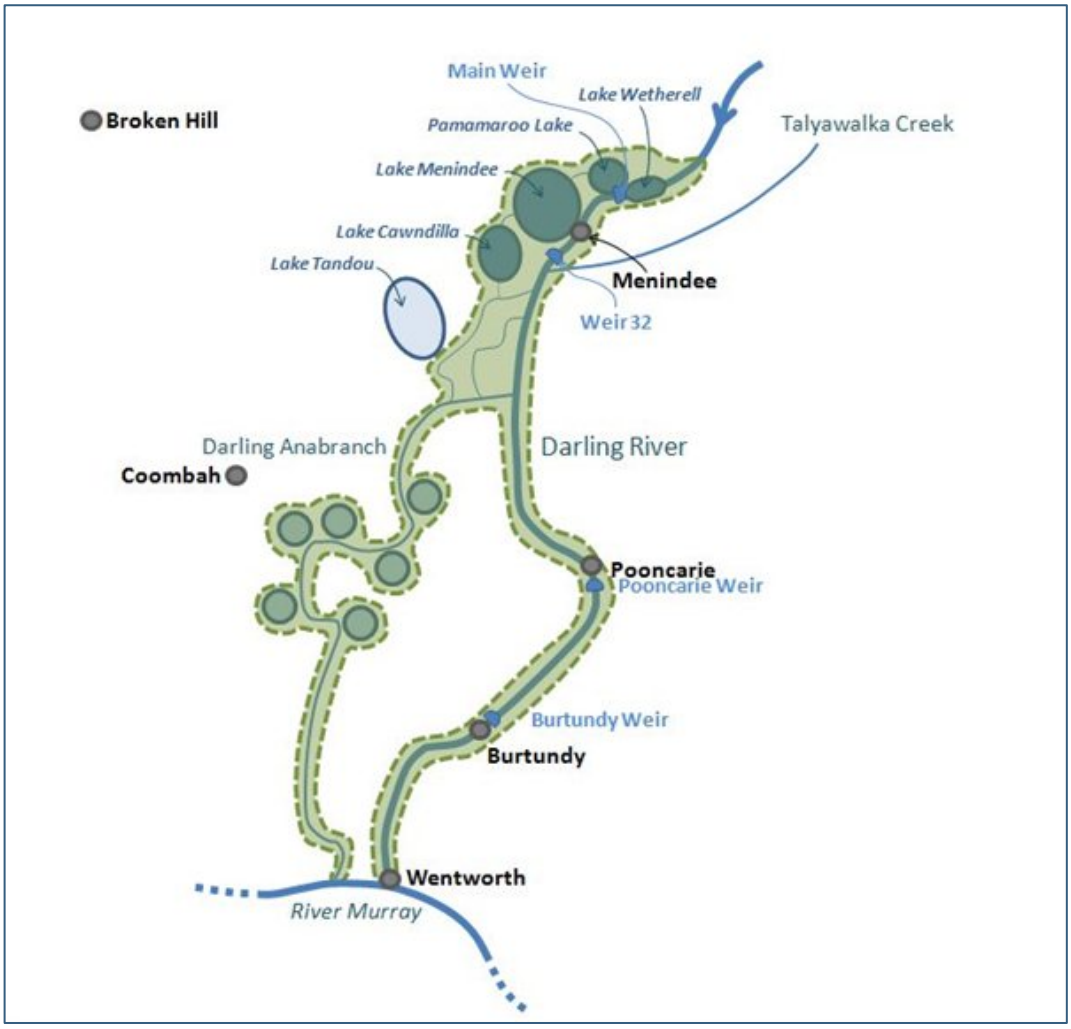


FIGURE 2: SCHEMATIC DIAGRAM SUMMARISING THE KEY STRUCTURAL FEATURES AND FLOW CONSTRAINTS IN THE LOWER DARLING REGION

In the 1960s the Menindee Lakes were modified to act as a water resource storage to supply users in the Lower Darling and Lower Murray Regions. A series of small dams, weirs, regulators, channels and levees were constructed to store large upstream events. The townships of Menindee, Broken Hill and Pooncarie are all supplied with water from the Lower Darling system. There are also a number of private irrigators located south of Menindee Lakes who extract water directly from the river.

The regulated system consists of four main interconnected lakes. Of these, three are modified natural depressions (Lakes Pamamaroo, Menindee and Cawndilla), while the fourth (Lake Wetherell) is an artificial lake along the main river channel formed by the construction of Main Weir. A channel was built to connect Lakes Pamamaroo and Menindee (via Copi Hollow), while the other interconnections are modified natural channels. In total there are seven main regulating structures, as shown in Figure 3.

The lakes have a nominal full supply volume of 1,730 GL and can be surcharged to hold up to 2,050 GL during floods. However, the Menindee Lakes are shallow and are located in a hot, windy, semi-arid environment, and experience average annual evaporation losses of over 420 GL of water per year, which is significantly higher than other public storages throughout the Murray–Darling Basin.

TABLE 2: THE SEVEN MAIN REGULATING STRUCTURES IN THE MENINDEE LAKES SYSTEM

Regulator	Capacity (ML/d)
Main Weir (and associated levees)	70,000 (Main Weir gates) 110,000 (Main Weir spillway)
Lake Wetherell outlet	5,000
Lake Pamamaroo inlet	33,000
Lake Pamamaroo outlet	5,000
Lake Menindee inlet	25,000
Lake Menindee outlet	4,000
Lake Cawndilla outlet	2,000

These structures allow water to be transferred both between the lakes and to the main Darling River channel. Releases to the river can be made independently from Lakes Wetherell, Pamamaroo and Menindee — water cannot be released directly from Lake Cawndilla to the Darling River, instead it must first pass through Lake Menindee. The release rates listed in Table 2 for Lakes Wetherell, Pamamaroo and Menindee are available when storage levels are high and the Darling River level is low. At other times, the available release rates is lower.

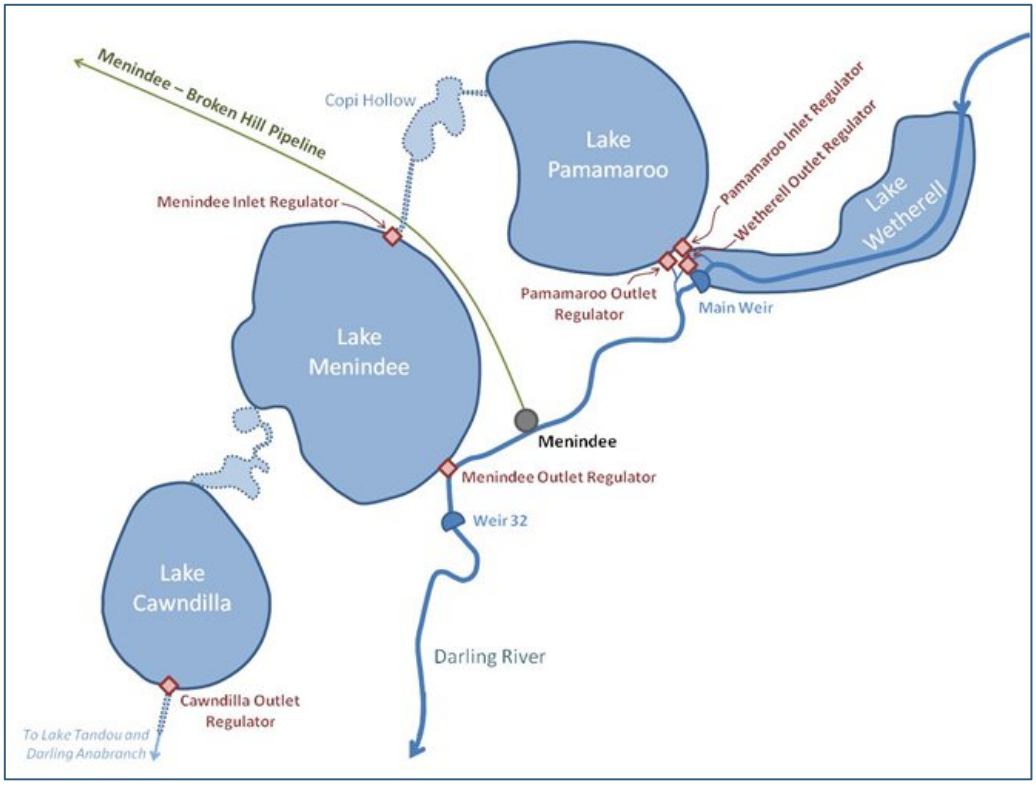


FIGURE 3: SCHEMATIC DIAGRAM SHOWING REGULATING STRUCTURES – MENINDEE LAKES SYSTEM

Total releases from Menindee Lakes to the Darling River are measured at Weir 32, located downstream of all lake outlet locations (Figure 3). Weir 32 was constructed in 1958 to provide additional security for the Broken Hill and Menindee town water supplies, and has a capacity of approximately 4 GL.

2.2 Menindee Lakes - Operation

Current operation rules dictates that when the stored volume in Menindee Lakes drops below 480 GL, control of the Menindee Lakes system is ceded to the New South Wales Government to maintain the town water supply in the Lower Darling (including Broken Hill and Menindee) and for stock and domestic users located along the river channel. Control of the Lakes reverts to MDBA when the stored volume increases above 640 GL.

The operating strategy for Menindee Lakes seeks to satisfy several criteria:

- **User Supply -** Ensure supply for users in the Lower Darling, Lower Murray, and town water supplies including the nearby towns of Broken Hill and Menindee, and for stock and domestic users located along the river channel. Most significantly up to 300 GL must be stored in the Lakes to adequately supply Broken Hill's annual

demand of 10 GL/year due to unpredictable inflows from the Northern Basin, very high evaporative losses, and the volume of inaccessible water — 'dead storage' — in each lake.

- **Lake Level Coordination -** The relative levels of each lake in the Menindee system are coordinated to minimise evaporative and seepage losses, to minimise negative environmental impacts along the lake edges, and to reduce the risk of shoreline erosion, particularly of Aboriginal burial and cultural sites. Generally, water is preferentially stored in Lakes Wetherell and Pamamaroo to minimise evaporative and seepage losses. During periods of substantial inflow, the lakes are filled sequentially.

- **'Harmony Operation' with Lake Victoria –** Under the process of 'Harmony Operation' water can be transferred from Menindee Lakes to Lake Victoria (located in the Lower Murray) if flows in the River Murray are insufficient to maintain a suitable storage level. This process requires Menindee Lakes to be under MDBA control and balances the advantages of reduced evaporation (evaporation rates at Menindee Lakes are higher than at Lake Victoria) against the increased risk of loss of water as a result of spill from Lake Victoria. These transfers are typically made in late spring or summer.

- **Flood Mitigation -** Menindee Lakes can act as a flood mitigation structure during high flow events from upstream catchments, reducing damage to downstream private holdings, notably those in the township of Menindee, located immediately downstream of Lake Wetherell.

- Larger magnitude flood events can trigger pre-releases from Lake Wetherell to mitigate the effects of the predicted event on downstream landholders.

- **Channel Capacity Downstream of Weir 32 -** One of the main factors determining the operation of Menindee Lakes is the channel capacity downstream of Weir 32. Under normal conditions releases are limited to ensure the flow does not exceed 9,000 ML/d downstream of Weir 32. This operating practice is designed to minimise losses, as flows above this threshold can lead to water entering the Great Darling Anabranch. The anabranch system is itself an important environmental asset, however, this system does not require environmental flows every year. Flows in the range 9,000 – 20,000 ML/d can cause inconvenience for

river-adjacent landholders, such as access issues or the requirement to remove water pumps.

Other considerations include:

- **Lower Darling Floodplain -** the characteristics of overbank flow events in this region have been greatly altered. Flow seasonality in the Lower Darling has been reversed (higher flows now occur in summer rather than the natural spring/autumn periodicity) and the frequency of high flow events has significantly decreased. Furthermore, the frequency and volume of inundation events in the Great Darling Anabranch have both reduced as a result of upstream regulation and extraction (MDBA 2012l). A number of ecological targets relating to flow regime for the Lower Darling Floodplain have been established relating to sustaining native vegetation, supporting habitat of waterbirds and supporting ecosystem functions. Some targets are limited by existing operational constraints – including Regulator capacities, channel capacity, inundation of private land creating access issues, operational policy and ensuring reliability of water supply to Broken Hill and Menindee townships.
- **Darling Anabranch -** The existing practice to limit regulated releases from Menindee Lakes to 9,000 ML/d when possible is based on the commence-to-flow threshold for the Great Darling Anabranch — a flow greater than this rate would result in water passing into the anabranch. Therefore, increasing the release rate would not produce a proportional increase in flows to the River Murray. A significant portion of these extra releases would pass into the anabranch, and only a small fraction of the increased water entering the anabranch would reach the Lower Murray system. Furthermore, due to the meandering nature of the channel, these anabranch flows would have a significantly longer travel time than those through the main channel, and their arrival would therefore not contribute to the peak flow of the downstream inundation event.

- **Lower Darling Irrigators –** The Lower Darling supports grazing and dryland and irrigated cropping including grapes, citrus and almonds. The catchment faces many environmental challenges, including salinity, blue-green algal blooms and reduced biodiversity. The Lower Darling was subject to severe drought between 2001 and 2010, where river flows reached record lows. A number of the Lower Darling

Irrigators have recently voiced frustration with management of the Darling River as low flows again continue to threaten permanent plantings. A major irrigator, Tandou Pty Ltd has a landholding of 79,000 hectares is a major Australian Agribusiness and major local employer.

3.0 BROKEN HILL WATER SUPPLY

3.1 Broken Hill Water Supply - History

In 1883 a rich mineral deposit (silver, lead and zinc) was discovered on what now is known as the city of Broken Hill. During the first sixty nine years of its life, Broken Hill was plagued by water shortages. Permanent natural waterholes were almost non-existent, local water courses only ran for short periods after rain, and shallow depressions holding precious water dried up quickly through soakage and evaporation.

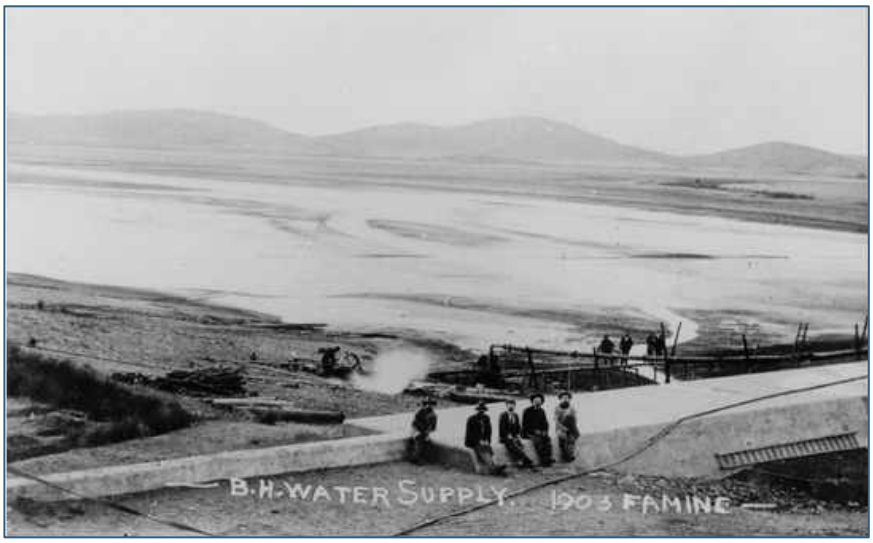


FIGURE 4: 1903 BROKEN HILL FAMINE – LOW WATER LEVEL

In the 1890's water was shipped by rail from the Darling River to address severe water shortages. In 1891, Stephens Creek Reservoir was constructed, however, variable rainfall meant supplemental supplies by rail and rationing was still required. A further reservoir at Umberumberka was completed in 1914, and water was first pumped to Broken Hill, some 28 kilometres away.

In 1952, a 110 km steel, cement-lined pipeline was constructed from the Darling River at Menindee with a capacity of 32 ML/d. In addition, the Menindee Lakes storage project was built throughout the 1950s and 1960s to store and conserve water for domestic, stock and irrigation water supply, including water storage for South Australia. The Scheme consisted of a series of weirs, regulators and banks on the lakes. A dam on the Darling River at the inflow to Lake Pamamaroo forms the artificial Lake Wetherell under high water conditions.

In 1958 Weir 32 on the Darling River at Menindee was completed, and the entire Menindee Lakes storage project was opened in November 1960.

Although the supply area has suffered a number of droughts over the past 50 years, little historical information has been kept. During the drought of 1982-83 it has been reported that restrictions were in place in the Broken Hill region. These restrictions were based on an 'Odds and Evens' scheme. There are no details recorded in the reduction of demand for this period.

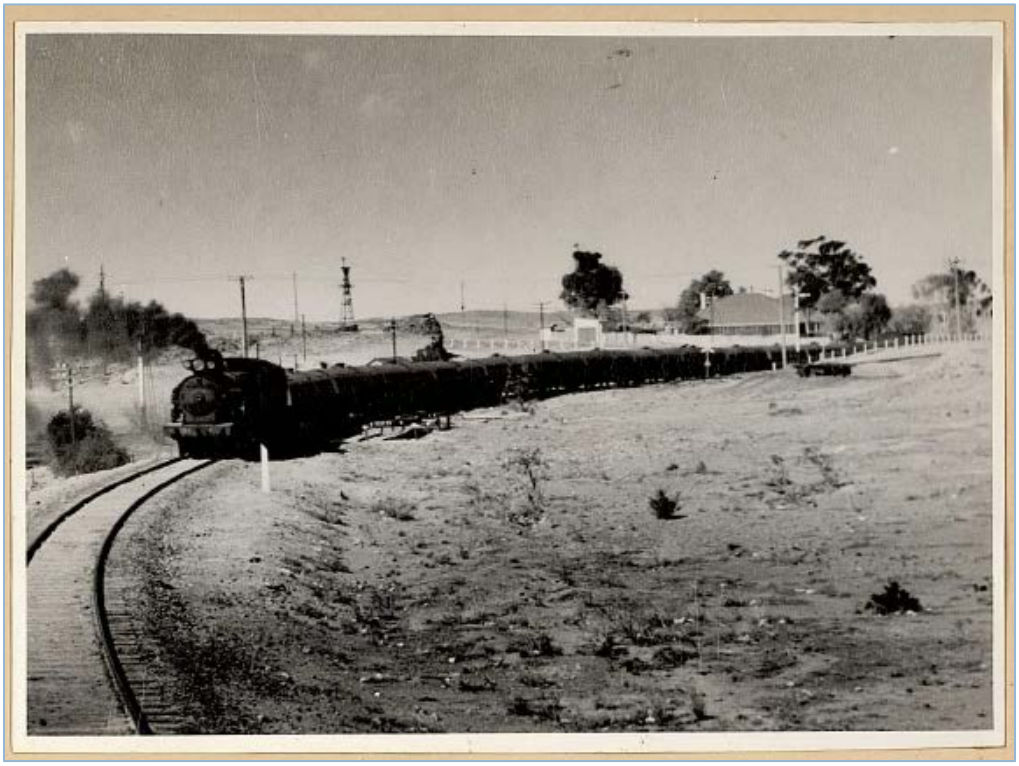


FIGURE 5: AUGUST 1944 – EMERGENCY WATER SCHEME – MENINDEE – BROKEN HILL

During the Millennium Drought , the Darling failed to flow to Menindee for longer than 12 months. Salinity in Broken Hill rose to more than 2000EC along with DOC's of well above 5mg/L in the treated peaking at 18mg/L. DOCs required very high chlorine dosing to maintain a chlorine residual in potable water which also creates issues. Water quality issues and resultant public protest in Broken Hill at that time included:

- Generally, people could not drink water and gardens, trees and lawns and vegetation on public ovals died, owing to high salinity. Evaporative air coolers salted up and bleed-offs from air coolers increased to maximum. A large number of hot water services and electric

kettles failed. High organics were deposited within the reticulation and scoured off causing a significant dirty water event throughout Broken Hill.

- Health issues - Sodium levels were over 200 mg/L and becoming a health issue. High hardness (over 200mg/L) caused skin problems, especially with the very young and elderly. Home dialysis was abandoned and dialysis patients were being prepared to evacuate. There was an emerging need to dose chlorine beyond the health limit of 5 mg/L to maintain chlorine residual.
- Commercial impact - Tourists could not drink water. Commercial ice making was impossible, this affected clubs, hotels, households and take away food outlets. Ice was imported from Mildura. Commercial coffee machines were failing. Commercial garden suppliers suffered financially and protested. Dry cleaning businesses could not operate. Concrete manufacture also suffered.

3.2 Current Status

The Menindee Lakes Scheme has been managed by NSW since February 2014, to conserve the remaining water in the lakes for local towns, water users and the environment of the regulated lower Darling River. Since August 2014, flows along the Barwon-Darling have been very low as a result of minimal rainfall in the catchment and rising temperatures through Spring 2014.

Inflows to the Menindee Lakes fell to a total of less than 1,000 ML during September 2014, which is half the 2,000 ML received in August. Total storage at Menindee Lakes has fallen to 13 % of capacity (December 2014). Losses due to evaporation are increasing to approximately 25,000 ML in September 2014 and releases to the Lower Darling totaled 5,670 ML in September.

TABLE 3: STORAGE VOLUMES – MENINDEE LAKES – DECEMBER 2014

	Storage Volume		Outlet flow
	%	ML	(ML/d)
Lake Wetherell	34	57,493	0
Lake Pamamaroo	45	100,266	250
Lake Menindee	<1	0	0
Lake Cawndilla	16	72,863	0
TOTAL	**17**	**230,622**	**250**

Lake Wetherell currently retains high levels of salt from previously captured inflows. In late-September 2014, salinity within Lake Wetherell ranged from 1,100 to 2,300 EC. Lake Pamamaroo has recently recorded salinity readings of greater than 700 EC. Additionally, the Sunraysia Regional Algal Coordinating Committee has issued a red alert warning for toxic blue green algae in the lower Darling River in October 2014.

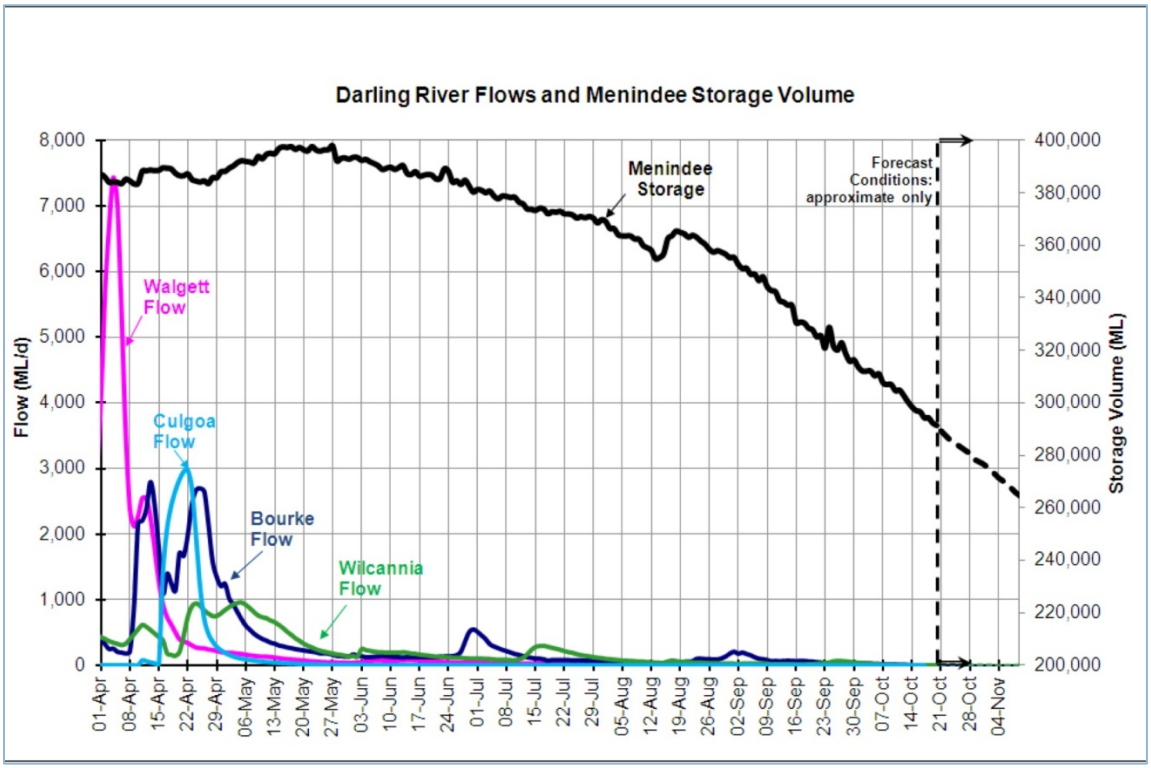


FIGURE 6: DARLING RIVER FLOWS AND MENINDEE STORAGE VOLUME - 2014

3.3 Forecast Operations & Availability

As of September 2014 Broken Hill's forecast water supply had fallen below the critical 18-month target. Without significant inflows, water users will effectively be competing against evaporation – the largest 'water user' by far in the Lower Darling, for access to water during the latter stages of this water year. It is predicted that toward the end of summer 2014-15 (March 2015), and as such water deliverability will be limited to critical human needs, essential town water, stock and domestic purposes and permanent plantings.

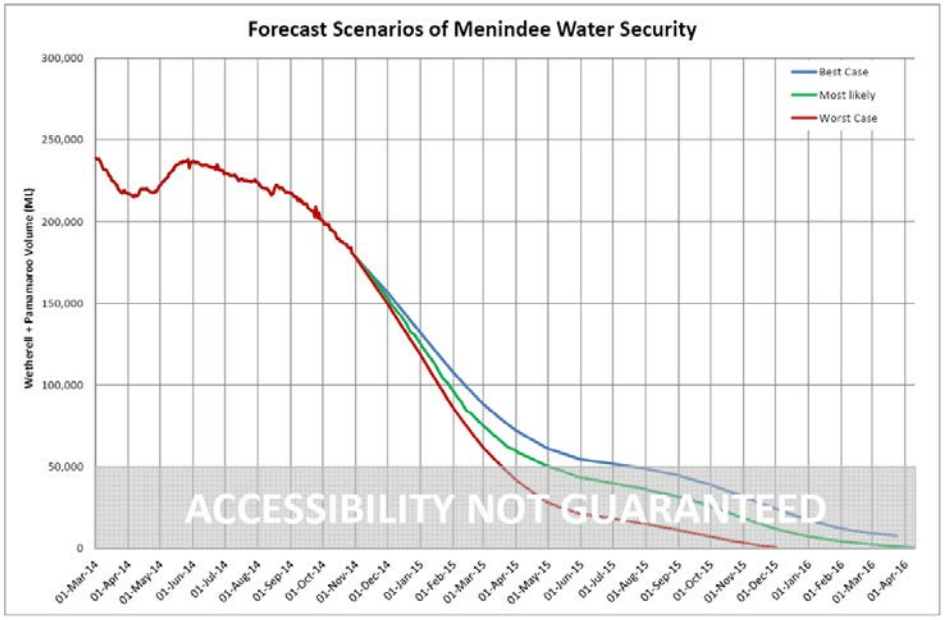


FIGURE 7: FORECAST MENINDEE STORAGE

As Lake Pamamaroo draws down the supply into Weir 32 pool is gradually provided by storage in Lake Wetherell which will result in increasing salinity in the Weir 32 pool supplying Broken Hill. It is estimated by March 2015, water would need to be sourced from Wetherell and will result in a marked increase in salinity to over 2,000 EC.

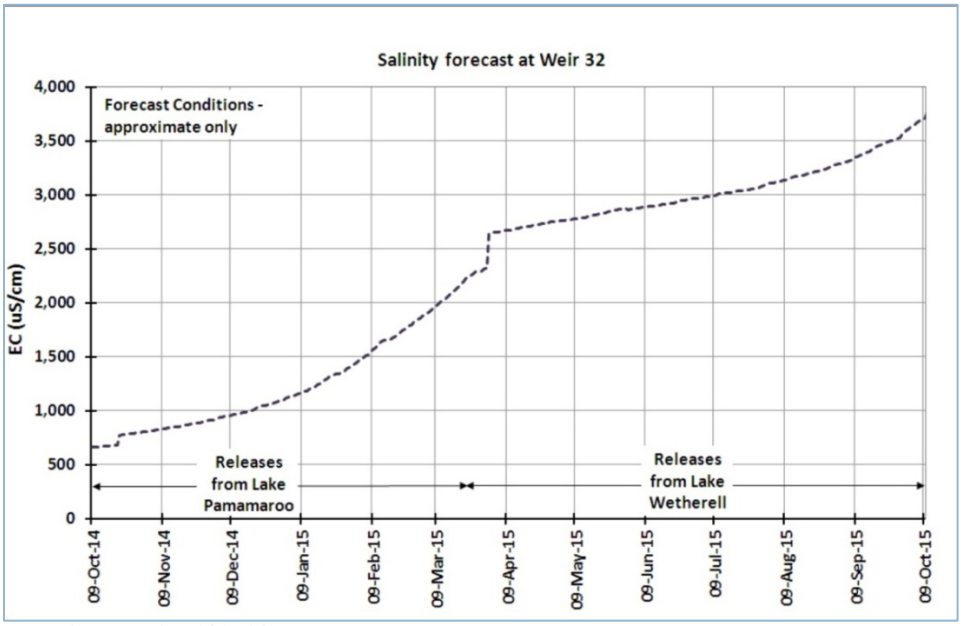


FIGURE 8: FORECAST SALINITY

It is predicted that the current (2013-14) Menindee drought inflows will surpass previous events, extending beyond 30 months without significant inflow.

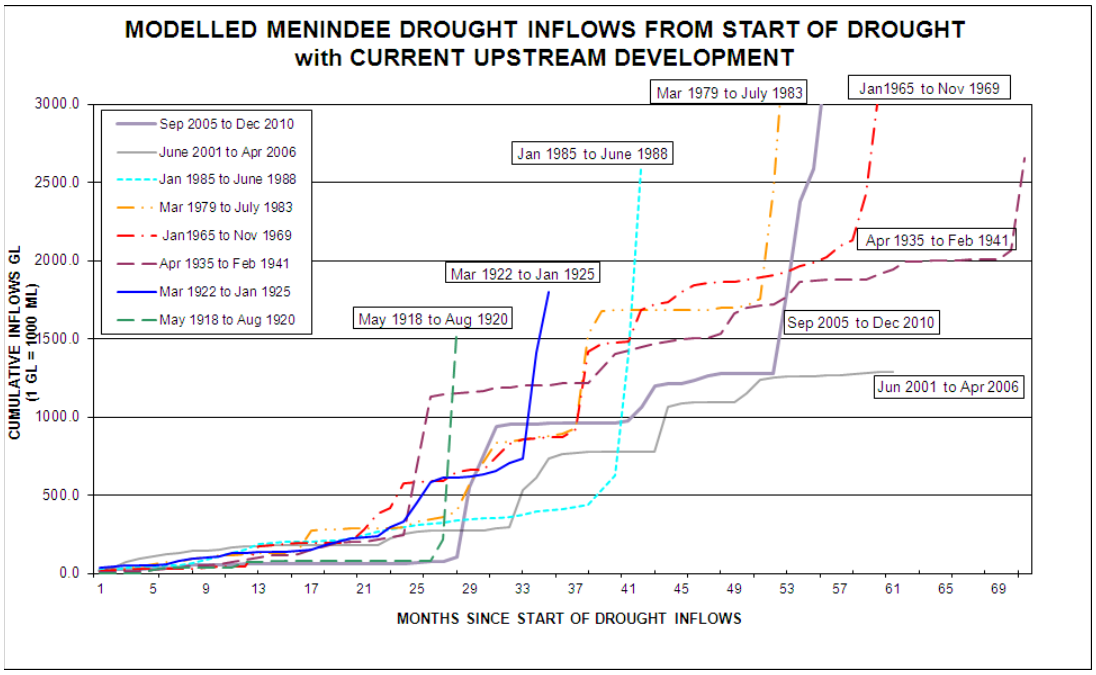


FIGURE 9: FORECAST MENINDEE DROUGHT INFLOWS COMPARISON WITH OTHER DROUGHT EVENTS

In October 2014, State Water Corporation (SWC) (now Water NSW) commenced construction of Copi Hollow Works which is designed to transfer water from Lake Pamamaroo to Copi Hollow to protect the higher quality water (lower EC value) in Lake Pamamaroo from high evaporation rates.

With the works complete Copi Hollow has a storage capacity of about 12,000 ML and has a much lower evaporation rate. It is proposed that water would be pumped at 300 ML/d, and commenced in mid-November secure the Lake Pamamaroo water source to augment Broken Hill town supply. These measures are intended to protect the quality of water set aside for Broken Hill as well as improve available volumes.

FIGURE 10: ANTICIPATED STORAGE & SALINITY – COPI HOLLOW WORKS

The works will effectively buy an additional eight to twelve months supply up to December 2015 for Broken Hill.

TABLE 4: FORECAST CRITICAL DATES

	Without Copi Hollow works	With Copi Hollow Works
Insufficient supply at Lake Pamamaroo & supply from Lake Wetherell @ over 2,000 EC	March 2015	NA
Supply from Copi Hollow	NA	March 2015
Supply exhausted to Broken Hill	April 2015	December 2015
Forecast inflows to Menindee sufficient to re-commence supply to Broken Hill	unknown	unknown

4.0 DESCRIPTION OF EXISTING BROKEN HILL WATER SUPPLY SCHEME

Essential Water is an operating division of Essential Energy - a NSW Government owned corporation. Essential Water provides water supply services to Broken Hill, Menindee, Sunset Strip and Silverton.

4.1 Description of existing Broken Hill Water Supply Scheme

The Darling River off-take at the Menindee Lakes Scheme is the main source of water for Essential Energy. The river is partly regulated through release of water from Lake Wetherell, part of the Menindee Lakes Scheme. Essential Water uses an intake structure in the river at Menindee and a pump station to pump water to Broken Hill. The licensed entitlement is 9.975 Gigalitres (GL) per year of high security water. Essential Water also has a licence for 29 ML per year for raw water for Menindee. The water has to be pumped a height of 287 metres over a distance of 116 kilometres from its source at the Darling River to the Stephens Creek reservoir.

PUMP STATIONS

Four pump stations pump water from Menindee to Broken Hill as follows:

- Menindee pump station
- Menindee booster pump station
- Kinalung pump station
- Kinalung booster pump station

Stephens Creek also has a pump station that pumps to the Mica Street Water Treatment Plant.

The decision to pump from Menindee is based on a broad range of factors, including, but not limited to:

- Water demand in Broken Hill
- The time of year (summer versus winter)
- Efficiency gains and reduction of costs of pumping in off-peak times
- Overall efficient balance of supply between Broken Hill and Stephens Creek
- Maintenance of pumping stations and the pipeline
- Responding to supply outages and the need to catch-up supply in local storages

- Refreshing the pipeline to maintain water quality in the pipeline
- Maintaining supply to pipeline customers, including those at Sunset Strip.

This matrix of issues impacts on the quantity of water required from Menindee and the rate at which the supply is moved between Menindee and Stephens Creek and then on to Broken Hill. Eight in every ten years water supply to Broken Hill is reliant on pumping from the Darling River.

RAW WATER RESERVOIRS

Essential Water owns and operates:

Stephens Creek Reservoir (capacity 18,800 megalitres (ML) has a large surface area and a shallow depth, meaning evaporative losses from the storage have historically been high and the reservoir's efficiency low. A levee was placed in the reservoir in 2003, which has significantly reduced the evaporative losses when inflow occurs. Stephens Creek reservoir receives water from its own catchment, as well as water pumped from the Darling River. The quality of water in this reservoir tends to be controlled by the quality of the water transferred to it from the Darling River. Stephen's Creek reservoir plays an important role in providing an emergency storage (up to 3 days storage) in case of emergency pipeline breaks or pump station failure which can take up to 30 hours to locate and repair;

Umberumberka Reservoir (capacity 7,800 ML) is located 28 kilometres northwest of Broken Hill on Umberumberka Creek. Water is pumped to Blue Anchor tank using diesel pumps, and then gravity fed to Broken Hill, supplying Silverton as it passes by. The quality of water from this source is generally very good and tends to be the best of all the available sources. Umberumberka Dam is a deep, efficient storage, but its catchment is unreliable as a sustainable water source – filling only once every 15 years; and,

Imperial Lake Reservoir (capacity 670ML) is a small, 670 ML reservoir that collects water from its own small catchment which includes part of the Broken Hill urban area. Water can be transferred to Imperial Lake from Stephens Creek and Umberumberka via the Mica Street water treatment plant. Imperial Lake provides emergency supply should the pipeline from Stephen's Creek Weir to Mica Street Water Treatment Plan fail. The lake is used as an emergency storage only. The quality of water from this source is highly variable not only because of its urban catchment, but also the

fact that as it is only used in emergency situations, the salt, organic and metals concentrations of the stored water can be high.

WATER TREA ATMENT

The Broken Hill Mica Street water treatment plant was commissioned in 2010, replacing the original plant which was constructed in 1952. The new water treatment plant has a design capacity of 31.5ML/day of treated water. The water treatment plant is relatively unique in Australia due to its need to treat a wide range of varying raw water qualities.

The water treatment processes includes pre and post chlorine in conjunction with UV disinfection for control of Naegleria Fowleri and pathogens. Potassium Permanganate is added for iron and manganese removal. Enhanced powdered activated carbon contact is added for removal of dissolved organics, toxins and taste and order. Sulphuric acid is used for optimal flocculation pH. Aluminum Sulphate (Alum) is added as the primary coagulant with Polyacrylamide or PolyDADMAC as flocculant aids.

Water is then delivered to a three parallel train; two stage flocculation and clarification process. The settled water is polished via dual media filters where Polyacrylamide can be added as a filter aid. The filter backwash process includes both air scour and water. A Reverse Osmosis plant is integrated into the plant as a side stream process to control salinity and hardness when required. Fluoride is added to meet health standards. Lime is used for final pH correction, followed by the addition of post chlorine to ensure residual chlorine levels at the extremities of the reticulation system comply with the Australian Drinking Water Guidelines.

The treated water is stored at Mica Street water treatment plant and then pumped to service reservoirs located at Block 10 (services Central and South Broken Hill) and Wyman and Rocky Hill (services North and West Broken Hill).

Menindee Water Treatment Plant

The Menindee water treatment plant uses a similar process, with the exception of the use of polyelectrolyte as a flocculation enhancer.

Sunset Strip Micro-Filtration Plant

Sunset Strip is currently a non-potable water supply. Raw water is taken off the Menindee to Kinalung pipeline. A micro filtration process takes place with a filter of 0.2 microns. The raw water

then passes through a carbon filter, and is chlorinated and distributed to the residents of Sunset Strip.

Silverton Chlorination Plant

The Silverton water supply is also non-potable. Raw water is taken off the Umberumberka to Broken Hill pipeline, chlorinated and then distributed to the residents of Silverton.

RESERVOIRS & RETICULATION

Treated water is stored in a number of service reservoirs (tanks) strategically located in and around Broken Hill. These tanks are of steel or concrete construction and require maintenance on a periodic basis to prevent corrosion and degradation to maintain the reliability and quality of the water supplied.

The total storage from summer levels is 16.4ML although in theory, the tanks can hold just over 40 ML, however, this figure is not operationally accessible. There are four pressure zones due to the hills and changing relative levels in each district, Essential Water's operations balances storage capacity to reduce main bursts. During summer when demand permits flow within the reticulation all day, an effective maximum storage of 16.4ML prior to low pressure complaints, and importantly draws down between high and low operating levels to ensure fresh water containing chlorine is cycled in the tanks. During winter, this storage has to be reduced to a maximum of 10.6ML prior to poor water pressure complaints and increased main bursts The Broken Hill water reticulation system was originally built over a 30 year period commencing 1937 and comprises 220 kilometres of pipework of various diameters and ages.

4.2 Deficiencies of the Existing Scheme

Essential Water's service area is the most arid in the state and experiences extreme variable conditions including low rainfall, distances to water, ageing infrastructure and high evaporation. The unique operational circumstances combined with dry conditions cause salinity and other water quality problems in the raw water.

SECURITY OF SUPPLY

The most critical issue facing Broken Hill, is security of water supply. In prolonged periods of drought, the Menindee Lakes System has proven insufficient to provide security of supply for Broken Hill. In 2002-2003, reservoirs at Broken Hill were empty, and there was insufficient storage in Lake Wetherell in the MLS. This led to sourcing of water from the residual pool of water at Lake Menindee. This water was of poor quality (2,300 EC), yet was supplied to the residents of Broken Hill, despite being significantly above the 1500 EC limit deemed acceptable for human consumption. With even that source in danger of running dry, plans were made to bring in water supplies by train at significant cost, while a Reverse Osmosis (RO) plant was constructed (but never commissioned). The situation was only saved when floodwaters came down the Darling River in 2010/11.

RAW WATER RESERVOIRS

Approximately 25 per cent of the reservoir capacity at Stephens Creek has been lost to sedimentation over the past century. Order of magnitude estimates indicate that sediment is continuing to move slowly towards the reservoir. Stephens Creek is not compliant with NSW Dam Safety Committee (DSC) guidelines and requires extensive capital works in order to comply.

Evaporation in Stephens Creek Dam is high relative to the storage volume of the reservoir. For this reason the best use for the reservoir is to obtain opportunistic savings in the cost of pumping water from the Darling River during rain events. Umberumberka Dam has lost approximately 40 per cent of its capacity due to siltation over the past century. Imperial Lake is not compliant with NSW Dam Safety Committee (DSC) guidelines and requires extensive capital works in order to comply.

WATER QUALITY

A major threat to the adequacy of water storages is an increasing number of blue green algae events. Recently, both Umberumberka and Stephens Creek reservoirs experienced high algal levels concurrently, requiring water to be sourced from the poorer quality Imperial Lake for a short time until supply could be established directly from the Darling River to the Mica St water treatment plant.

During the water crisis of 2002/03, at the end of an extreme drought event, the Darling River ceased to flow for around 12 months resulting in dangerously low water storages in Menindee

Lakes with high salinity and organic carbons. At that time the water supplied to residents led to significant public protest.

5.0 OPTIONS ANALYSIS

5.1 Project Objective & Key Principles

The Project Objective is to resolve the current emergency of securing water supply security to Broken Hill, while complimenting a key objective of the Menindee Lakes Water Savings project, which is to safeguard a secure drought water supply to Broken Hill into the future.

Key principles of the project:

- The project needs to meet the critical water supply needs of Broken Hill if the drought continues past Spring 2015
- The project should aim towards the greatest capital and operating cost efficiency;
- The emergency water supply should aim to provide for average summer demand 25 ML/d (approximately 77% of Peak Day Demand (31 ML/d)); and,
- The project should aim to compliment the broader Menindee Water Savings Project;

5.2 Options Development

DO NOTHING OPTION

Broken Hill supports a population of 19,048, two mines Periliya and CBG Resources. The two mines utilise represent approximately 1/3 of water supply demand and support local employment of 624 people.

On current forecasts, it is almost certainty this option would result in poor water quality (>2000 EC) being delivered at least one year every ten. It is also expected that Broken Hill would have no water supply security at least one year out of every ten, potentially resulting in the town's population being evacuated, and an estimated loss of Gross Regional Product of $936 million (June 2013) for at least one year in every ten years. Additional emergency costs would include housing, transport and other emergency support for residents. As such, the do nothing option is impalpable, and does not meet the project objective.

RAIL

In 2003 and 2007, Essential Water engaged Arup to undertake investigation into the feasibility of delivering water by rail to Broken Hill from the Murray River in times of severe drought. The investigation encompassed loading and offloading locations and systems, train requirements, rail schedules, cycle times and costs. The investigation found that to supply a maximum of 7.4 ML/d, the least cost option would translate to $19.43 per kL supplied.

Most of the report findings and assumptions remain applicable and costings have been updated. The costs of leasing rail stock has been confirmed with Chicago Freight Australia, and summarised in Table 5 (12 month supply). Practically a maximum of 7.4 ML/d would be the maximum limit available via rail owing to rail limitations. However, in order to compare with all other options, costs have also been calculated on the basis of 7.4 ML/d as well as 20 ML/d.

TABLE 8: SUMMARY OF COSTS - RAIL CARTING 12 MONTHS– 2007 (CPI ADDED)

Cost	Cost of providing7.4 ML/d **($k)**	Cost of providing 20 ML/d **($k)**
Cost of purchasing allocation	$1,976,400	$6,409,945.95
Capital Cost ($)	$ 13,427,608.33	$43,549,000
Annual operating cost ($/12 months)	$45,150,000	$43,930,000.00
SA Water charge (2.7 GL/y)	$3,590,000	$3,590,000.00
Unit cost of water allocation	$0.98	$0.98
Unit capital cost ($/kL)	$4.97	$4.97
Unit operating cost ($/kL)	$16.71	$16.26
SA Water Unit cost ($/kL)	$1.33	$1.33
Total Unit cost ($/kL)	**$23.99**	**$23.54**
Total Cost	**$64,781,068**	**$171,840,153**

In addition to not securing water supply for the town to function effectively, other significant disadvantages of this option include the lack of availability of water allocations, availability of rolling stock and 12 months to build and procure required infrastructure. This option would also not contribute to the broader Menindee Lakes Water Saving Project.

ROAD

Road tankers with an average capacity of 27 kL could be hired. Site infrastructure required would include standpipe (150 mm would take 9 minutes to fill each tanker) and about 12 minutes under gravity diameter standpipe on average would take about 9 minutes to fill a tanker and it would take about 12 minutes to unload the tanker under gravity into an open tank.

It is estimated that delivery of 4.8ML/d would require 178 tanker loads equating to a tanker load every 8 minutes. Assuming the filling location would be Mildura (297km) and one complete cycle time would be 9 hours. Depending on the distance of the filling location and the average tanker cycle speed, the 24 hour 7 days per week carting operation, would need up to 89 tankers each making at 2 trips per day.

Practically a maximum of 4.8 ML/d would be the maximum limit available via road – owing to road and plant limitations. However, in order to compare with all other options, costs have also been calculated on the basis of 4.8 ML/d as well as 20 ML/d contained in Table 9.

In addition to not securing water supply for the town to function effectively, other considerations include the lack of availability of water allocations and availability of the number of water trucks. This option would also not contribute to the broader Menindee Lakes Water Saving Project.

TABLE 9: SUMMARY OF COSTS ROAD CARTING

Cost	Cost of providing7.4 ML/d **($k)**	Cost of providing 20 ML/d **($k)**
Cost of purchasing $732/ML	$ 1,281,000	$ 5,337,500
Loading/Unloading Facilities	$ 10,000,000	$ 10,000,000
Total Capital Costs ($)	$ 11,281,000	$ 15,337,500
OPERATING COSTS		
Truck Hire ($125/hour)	$ 97,455,000	$ 406,062,500
Loading/Unloading Site Supervision	$ 3,504,000	$ 3,504,000
Total operating cost	$ 100,959,000	$ 409,566,500
Total Unit cost ($/kL)	$ 64.06	$ 468.08
Total Cost	**$ 112,111,872**	**$ 409,566,500**

PIPELINE – MURRAY RIVER

A pipeline from the Murray River would require approximately 300 km of pipeline as well as booster pump stations along the length. The likely cost estimate of this option is in the order of $350 - $400 million. However this cost estimate is highly unreliable, as the pipeline route and location of booster pump stations would depend very much on acquiring land and/or easements. It is estimated the timeframe to undertake this project would be at least 4-5 years.

BROKEN HILL MANAGED AQUIFER RECHARGE

In 2008, Geoscience Australia conducted hydrogeological investigations throughout Menindee to assess whether groundwater extraction was a viable option. The investigation identified a priority site (Jimargil). The investigation found that a shift to a reliance on groundwater-related options

during drought would provide significant water quality benefits to the Darling River system and water supplies for Broken Hill and Menindee during drought periods.

The 2008 investigation (*Broken Hill Managed Aquifer Recharge project)* focussed on the Jimargil site quite a distance down stream of Menindee Pumping Station (MPS). The proposal there was to treat the water and store it as a MAR system during high flows and provide town supply from the bores during dry seasons. The cost of the infrastructure at an estimated $175 million ($212.5 million in 2014 dollars) was considered prohibitive, and was subject to public protest over the risk of losing the lakes as an amenity, loss of tourism as well as impact to cultural heritage.

REVERSE OSMOSIS PLANT

In November 2014, as part of the Menindee Lakes Water Saving Project, the NSW Office of Water (NOW) will commence construction of test production bores on the margin of Lake Menindee to investigate the potential of sourcing a 24 ML/d groundwater supply.

Groundwater investigations will extend to depths of 240 m (Renmark Group) and 60 m (Calivil Formation). The proposal would include sourcing approximately 20-30 ML/d groundwater with salinity expected to be 600-2000 EC (Calivil) and 8000-20,000 (Renmark Group), and as such would require desalinisation.

Should establishment of the borefield prove difficult to achieve in the time available, the construction of the Reverse Osmosis Plant could treat water from Lake Wetherell which may provide a robust contingency plan. It is expected that Copi Hollow storage will be exhausted in November 2015, at which time Lake Wetherell will have a storage volume of approximately 10,000 ML and salinity of water will be approximately 5000 EC increasing to 9000 EC by April 2016. This contingency plan would provide a water supply to Broken Hill until April 2016. Water would need to be released from Lake Wetherell into weir 32 and pumped up the Menindee to Broken Hill to Copi Hollow where the water would be discharged into the interconnecting channel and then pumped through the reverse osmosis treatment plant.

Additional works would include construction of 2 banks in the interconnecting channel and pumps to raw water balance tank, for treatment in the Reverse Osmosis Plant. Provision of a water supply to Menindee would need to be considered as the pipeline normally supplying Menindee would be utilised by the high saline Lake Wetherell water. However, there are many options that can be explored, including provision of a separate smaller Reverse Osmosis Plant at Menindee.

TABLE 10: SUMMARY OF COSTS – GROUNDWATER & REVERSE OSMOSIS PLANT

Cost ($k)	Purchase	Combination Purchase & Hire
Borefield	$ 17,991,600	$ 17,991,600
Earthworks - RO Plant & Tanks	$ 285,150	$ 285,150
Reverse Osmosis Plant - Purchase 24 ML/d supplying 20 ML/d to Broken Hill with transfer losses	$ 55,700,000	
Reverse Osmosis Plant - Hire (15 ML/d) + Purchase (9 ML/d)		$ 42,150,000
Balance/Storage Tanks & Brine Evaporation Basin	$ 31,002,500	$ 31,002,500
Modification interconnecting Pumping Station	$ 500,000	$ 500,000
Electrical	$ 15,700,000	$ 15,700,000
Telemetry	$ 1,000,000	$ 1,000,000
Amenities Building	$ 100,000	$ 100,000
Contingency (20%)	$ 24,455,850	$ 21,745,850
Total Direct Capital Costs	$ 146,735,100	$ 130,475,100
OPERATING COSTS $/day		
RO operating plant	$32,368	$32,368
Borefield	$3,576	$3,576
Total Operating Costs (assuming 12 month operation)	**13,119,507.86**	**13,119,507.86**
Total Unit cost ($/kL) for one operation	**$ 31.76**	**$ 28.53**

Key benefits of groundwater and Reverse Osmosis plant as the preferred option for Broken Hill Drought Water Supply includes:

- Long-term solution to the recurring problem of security of drought water supply to Broken Hill;
- With prioritisation of the construction of the Reverse Osmosis Plant, and addition of other minor works, the option allows water supply to Broken Hill till approximately April 2016;
- Minimal land and easement issues, the option provides the greatest opportunity to meet the key program date of providing a drought water supply to Broken Hill by December 2015 (forecast date for exhaustion of Copi Hollow supply);
- Provides the lowest cost option over 50 year period based on utilizing once every ten years for a period of 12 months;
- It is envisaged the option would achieve a good raw water quality, which potentially reduces operational cost for Mica Street Plant.

6.0 PROPOSAL DESCRIPTION

6.1 Site Location

The location of the proposed works is adjacent to Lake Menindee which is approximately 120 km from Broken Hill and generally shown in Figure 11. Works have been sited to deliberately make use of existing easements (Essential Water & Essential Energy), proximity to existing power & water infrastructure and previously disturbed land to minimise potential cultural heritage impacts.

FIGURE 11: LOCATION MAP

6.2 Current Investigation

In November 2014, as part of the Menindee Lakes Water Saving Project, the NSW Office of Water (NOW) will commence construction of test production bores on the margin of Lake Menindee to investigate the potential of sourcing a 24 ML/d groundwater supply. Groundwater investigations will extend to depths of 240 m (Renmark Group) and 60 m (Calivil Formation).

Should establishment of the borefield prove difficult to achieve in the time available, the construction of the Reverse Osmosis Plant to treat Lake Wetherell reserve provides a robust contingency plan. It is expected that Copi Hollow storage will be exhausted in November 2015, at which time Lake Wetherell will have a storage volume of approximately 10,000 ML and salinity of water will be approximately 5000 EC increasing to 9000 EC by April 2016. This contingency plan would provide a water supply to Broken Hill until April 2016.

Additional works would include construction of 2 banks in the interconnecting channel and pumps to raw water balance tank, for treatment in the Reverse Osmosis Plant. Provision of a water supply to Menindee would need to be considered as the pipeline normally supplying Menindee would be utilised by the high saline Lake Wetherell water. However, there are many options that can be explored, including provision of a separate smaller Reverse Osmosis Plant at Menindee.

6.3 Description of the Works

Concept Design is in progress, so sizing of various elements has not yet been confirmed. The following description of works provides best prediction of the Works.

BOREFIELD

The proposal includes sourcing approximately 20-30 ML/d groundwater with salinity expected to be 600-2000 EC (Calivil) and 8000-20,000 (Renmark Group), and as such would require de-salinisation. Over time it is envisaged the borefield could be optimized to provide maximum yield of high security water with the best water quality attainable. The final location of the borefield is dependent upon results from test bore investigations being completed. The borefield would include:

- A borefield is proposed comprising up to 30 bores east of the interconnecting channel. The length of the borefield will make use of the existing Essential Energy easements (power & water) to source power as well as make use of the line of easement.
- A pipeline will traverse across the length of the borefield up to 15km, crossing the existing interconnecting channel bridge to the Reverse Osmosis Plant.

REVERSE OSMOSIS PLANT

A Reverse Osmosis Plant / Water Filtration Facility will be located at previously disturbed area adjacent to the Interconnecting Channel. Investigations are continuing on the capacity of the Reverse Osmosis Plant and whether the Plant would be Permanent, Modular or a combination of both. Options involving modular would allow leasing of plant when not in use, and in time potentially allow opportunity to take advantage of new technology. It is likely that the plant would be a mix of both permanent and leased Reverse Osmosis Plant. Approval is being sought for operation of each event into the future.

There may be a need for pre-treatment for iron and probably other elements. The pre-treatment process will depend on the type of iron (eg organic/inorganic) and whether iron and other elements can be removed by simple aeration or a more elaborate process of aeration followed by chlorine oxidation and de-chlorination. The water may also need to be filtered either through convention sand filtration or membrane filtration.

BALANCE TANKS

- A raw water balance tank for feed to the Reverse Osmosis Plant.
- A clearwater balance tank to feed existing pump station at interconnecting channel.

DISPOSAL BASIN

Disposal of effluent from the Reverse Osmosis plant is currently being investigated. However, the preliminary concept is that the effluent would be disposed into a disposal basin to be evaporated and potentially some managed infiltration. Transfer of effluent would be by the Reverse Osmosis system pressure through a pipeline generally located on existing easements and previously disturbed land.

Without test bore results, it is difficult to predict the quality of brine. In addition, given more time, the project will look to optimise bores, through investigating options to source less saline groundwater sources. However, a conservative estimate is that the brine would be up to 70,000 EC.

If some infiltration is pursued, it is expected that salt impacts to land would be minimised, with the more saline water being recharged and sinking to the bottom of the aquifer. Should the disposal basin be evaporation only, it is expected that salt would need to be managed either through appropriate disposal or application of an adhesive (which is common practice in mining operations) to reduce the impact to surrounding land.

The disposal basin will only be utilised during each event. It will be permanent infrastructure, however, will only be in operation when the Reverse Osmosis Plant is in operation.

ELECTRICAL & TELEMETRY

- Each bore would require a separate transformer
- Upgrade to substation for Reverse Osmosis Plant operation
- Associated Telemetry works

ANCILIARY WORKS

- A small amenities building would be required at the Reverse Osmosis Plant.
- Associated roadworks and fencing.
- Potential additional works to source water from Lake Wetherell (high salinity) from December 2015, which will secure water supply to April 2016, before groundwater would be required.

LAKE WETHERELL SUPPLY (CONTINGENCY PLAN)

- Two banks constructed within the interconnecting channel.
- Pump station to lift water from the interconnecting channel to Raw water tank.
- Provision of water supply to Menindee – Potentially separate Reverse Osmosis Plant at Menindee to supply their much smaller demand.

6.4 Operation

The operation of the Boreholes and/or RO Plant would only commence when there is no alternative water source with acceptable water quality (<2000 EC) for Broken Hill. It is envisaged this could occur 1 in year in every 10, for a period of 12 months.

An operations plan will be prepared prior to operation.

The required production requirements of the Reverse Osmosis plant will be refined. However, consideration will need to be given to losses from the bulk water supply transfer system, reticulation system, treatment plant efficiency and evaporation at Stephens Creek. At present it is envisaged that up to 30 ML/d would be sourced from the bore field.

The Scheme would include automatic controls and telemetry to enable remote monitoring and operation.

FIGURE 12: PREFERRED CONCEPT

6.5 Determining the Proposed Option

The conclusion derived from the investigations undertaken to date overwhelmingly supports the proposal to undertake the drought water supply works. Key benefits of groundwater and Reverse Osmosis plant as the preferred option for Broken Hill Drought Water Supply include:

- Long-term solution to the recurring problem of security of drought water supply to Broken Hill;
- With prioritisation of the construction of the Reverse Osmosis Plant, and addition of other minor works, the option allows water supply to Broken Hill till approximately April 2016;
- Minimal land and easement issues, the option provides the greatest opportunity to meet the key program date of providing a drought water supply to Broken Hill by December 2015 (forecast date for exhaustion of Copi Hollow supply);
- Provides the lowest cost option over 50 year period based on utilizing once every ten years for a period of 12 months;
- It is envisaged the option would achieve a good raw water quality, which potentially reduces operational cost for Mica Street Plant.

6.6 Construction Issues

The proposed works are primarily located on previously disturbed land, with the aim of avoiding significant cultural heritage sites.

The concept design for the disposal basin is still being developed, however, initial calculations estimate that vegetation clearing of an area of at least 87.8 hectares in the first instance would be required to provide at least 6 months disposal of effluent for evaporation option only. Investigations are currently continuing into managed infiltration in combination with evaporation which would reduce the area required significantly.

6.7 Construction Timeframe

The proposed program aims to operate the Scheme by December 2015. The program is very ambitious and relies on procurement of the RO Plant prior to Environmental Assessment and approval, which presents significant potential procurement risk. Key project milestones are summarised in Table 5.

TABLE 5: KEY PROPOSED PROJECT MILESTONES

Key Project Milestones	Program Target Dates
Estimate of bore yield & quality	19 December 2014
Concept Design	3 March 2015
Detailed Design	7 April 2015
Environmental Assessment & Approval	7 April 2015
Site Acquisition & Easements	29 April 2015
Procurement & Contracts	20 July 2015
RO Plant procurement	4 February 2015
Completion & Commissioning	9 December 2015

To build and operate by December 2015, a number of supporting strategies will be required:

- Approval process – Without immediate approval and funding to proceed with the project, and therefore commencement of the Approvals process, it is unlikely that the construction will be completed by December 2015.
- Site investigation and acquisition for the disposal basin should proceed immediately. Historically land issues can involve lengthy negotiation and present high program risk.
- Procurement – options to procure early (i.e. prior to environmental assessment approval) long lead-time materials and RO plant should be considered.

6.8 Capital Costs

Capital costs are yet to be determined but will be over the $30 million trigger to deem State Significant Infrastructure.

7.0 STATUTORY AND PLANNING CONSIDERATIONS

The following section provides a summary of relevant legislation and environmental planning instruments applicable to the proposal.

7.1 NSW Environmental Planning & Assessment Act

The *Environmental Planning & Assessment Act 1979* (EP&A Act) provides the statutory framework for planning in NSW. Development controls for water treatment facilities, water reticulation systems and water storage systems are contained within the *State Environmental Planning Policy (Infrastructure) 2007* (SEPP (Infrastructure) and the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP).

These instruments provide that proposed development may be classified as "development permitted without consent", state significant development" or "state significant infrastructure" depending on the zoning of the land and the value of the construction works.

A preliminary investigation shows that the subject site is located within the Central Darling Local Government Area, and is zoned RU1 (or SP2) in the *Central Darling Local Environmental Plan 2012*. However, once the Lot and DP are available for the site the s149 Certificates can confirm the zoning.

Where proposed water treatment facilities, water reticulation systems and water storage systems (water supply system) are located within a RU2 or SP2 zone, and the proponent is a public authority, the proposal may be classified as development without consent under Part 5 of the EP&A Act. However where the proposed capital investment value is over $30 million the proposed works are classified as State Significant Infrastructure (SSI) (pursuant to Schedule 3 of the SRD SEPP).

SSI planning approval procedure is via an application to the Department of Planning & Environment. Secretary (former Director-General) requirements are obtained and an Environmental Impact Statement is prepared for determination by the Minister.

The Minister may declare any SSI to be critical SSI if it is considered essential for the State for economic, environmental or social reasons. In this case the Minister may not delegate the determination function.

7.2 NSW Legislation

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act, as amended) aims to conserve, develop and share the fishery resources of the State for the benefit of present and future generations including conserving fish stocks and fish habitat and promoting ecologically sustainable development.

The proposal is unlikely to result in significant impacts on any species, populations or ecological communities listed as 'threatened' in the schedules of the FM Act. Additionally, no marine vegetation, as defined under the FM Act, is likely to be affected by the Proposal.

Protection of the Environment Operations Act 1997

Protection of the Environment Operations Act 1997 (POEO Act) regulates noise, air, land and water pollution. The construction works will be managed to meet the requirements of the Act.

Dredging works as defined by Schedule 1 of the POEO Act, require licensing where they obtain more than 30,000 m^3 per year of bed, bank and foreshore material. Extractive industries that obtain, process or store for sale or re-use an intended quantity of more than 30, 000 m^3 of extractive material are required to be licensed by EPA. EPA would need to be consulted regarding the application of the Act and whether the construction of the disposal basin is considered to fall within the above definitions as the main characterisation of the project is not for dredging or extractive industries.

Water NSW would be obliged to notify EPA (the regulator of the POEO Act) when a "pollution incident" occurs that causes or threatens "material harm" to the environment.

Threatened Species Conservation Act 1995

Any potential impacts on threatened species, populations or ecological communities and their habitats listed in the *Threatened Species Conservation Act 1995* (TSC Act) would be required to be assessed using a seven part test under section 5A of the EP&A Act.

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the establishment, preservation and management of national parks, historic sites and certain other areas and the protection of certain fauna, native plants and Aboriginal objects.

As the proposal would not be located within a national park, it is not necessary to establish the permissibility of the proposal under the NPW Act. Investigation into whether the proposed operation is likely to draw down groundwater to the extent that vegetation within the national park would be impacted will need to be completed.

Aboriginal heritage

The implementation of the Aboriginal heritage provisions in the NPW Act is the responsibility of the NSW Office of Environment and Heritage. Permits under Section 87 to move or excavate an archaeological site and under Section 90 consent to destroy or damage a site under the NPW Act are not required for a project approved under State Significant Infrastructure.

Section 87 prescribes defences available under the Act which include:

- The harm or desecration was authorised by an Aboriginal heritage impact permit (Section 87(1) (a)).
- The defendant exercised due diligence to determine whether the act or omission constituting the alleged offence would harm an Aboriginal object and reasonably determined that no Aboriginal object would be harmed (Section 87(2)).
- That the act or omission constituting the alleged offence is prescribed by the regulations as a low impact act or omission (Section 87(4)).

However the impacts on any Aboriginal archaeological sites will need to be investigated as part of the environmental assessment process. The Menindee Lakes and surrounding areas include many sites of significance to Aboriginal heritage and culture, including burial grounds. The Lakes represent a significant natural, cultural and economic resource for Australia and partially fall within the borders of Kinchega National Park. The Kinchega National Park covers an

extensive area immediately to the south and west of the lakes, extending to the foreshores of Lakes Menindee and Cawndilla. The national park conserves many of the ecological values of the semi-arid environment and heritage of the area and is also a focal point for recreation and tourism.

An archaeological survey will be undertaken for the environmental assessment. The Aboriginal community will be consulted and the OEH consultation procedures followed.

Water Management Act 2000

The Water Management Act includes approvals for:

- Section 89 - water use approval,
- Section 90 - water management work approval,
- Section 91 – controlled activity approval,

NSW Office of Water requirements and approvals will be considered in the environmental assessment process.

Heritage Act 1977

No heritage items listed on the State Heritage register have been identified in the vicinity of the proposed works.

Other Legislation

Other NSW Legislation to be considered in the environmental assessment process includes:

- Native Vegetation Act 2003.
- Roads Act 1993.
- Waste Avoidance and Resource Recovery Act 2001.
- Crown Lands Act 1989

In addition consideration to any relevant State Environmental Planning Policies (SEPP) will need to be considered in the Environmental Assessment process.

7.3 Commonwealth Legislation

Environment Protection and Biodiversity Conservation (EPBC) Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for Commonwealth involvement in development assessment and approval in circumstances where 'matters of national environmental significance' (such as nationally listed

threatened species and ecological communities, migratory species and World Heritage properties) are involved and where there is potential for a significant impact.

Where the proponent considers that an action will have or is likely to have significant impacts on a NES matter or on Commonwealth land, a referral is made to the Commonwealth Department of the Environment. A proposal may also, but is not required to be referred to the Commonwealth Department of the Environment where an action will not have or is not likely to have a significant impact. If it is determined through the referral process by the Commonwealth Department of the Environment that a project is likely to have a significant impact on a NES matter, or on Commonwealth land, then the project is a 'controlled action' and approval from the Minister would be required.

A search of protected matters under the EPBC Act was undertaken as part of the Review of Environmental Factors for groundwater investigations. Three wetlands (Banrock Station Wetland Complex, Coorong and Lakes Alexandrina and Albert, and Riverland) were identified as being within the same catchment, however are located in South Australia and not within the study area of the Proposal and will not be impacted upon by the Proposal.

A number of threatened species and migratory species were identified within the study area. Additional assessment will be required, however, a preliminary analysis indicates that the proposal is not likely to significantly impact on any matter related to the EPBC Act.

7.4 Regional Environmental Plans

There are no Regional Environmental Plans that apply to the study area.

8.0 PRELIMINARY ENVIRONMENTAL ASSESSMENT

A preliminary environmental assessment of the potential key construction and operational impacts, based on investigation undertaken to date are provided below.

8.1 Risk Identification

Managing any risk associated with the proposed project of works requires first identifying and assessing all potential risks. This is difficult given the current status of concept design. However potential risks identified to date include:

- Impacts to cultural heritage sites.
- Impacts to adjoining properties.
- Clearing of vegetation for construction of disposal basin.
- Unforeseen salinity impacts.
- Failure of bores to yield required supply and water quality.
- Risk associated with delivering to a tight timeframe.
- Drawdown of groundwater potentially impacting on vegetation.

8.2 Cultural Heritage

Menindee Lakes is recognised as having cultural significance for the local Indigenous community. Menindee Lakes contains numerous Aboriginal sites, providing evidence of a past occupation.

The Environmental Assessment process will include a detailed cultural heritage study which will cover both indigenous and non-indigenous heritage. Initial consultation has been undertaken with Aboriginal representatives, as part of the groundwater investigations.

Construction Impacts

The main aim of the cultural heritage assessment will be to assist in the siting of engineering structures so as to avoid impacting on Aboriginal sites, where possible. The objective will be to avoid cultural heritage sites, however if this is not possible, management of any identified sites will be undertaken in consultation with the local community.

Operational Impacts

Once constructed, operation of the works is unlikely to impact on Aboriginal sites. However, the appropriate management of Aboriginal sites will be recommended by a qualified archaeologist in consultation with the local Aboriginal community.

8.3 Social

Menindee Lakes represents an important economic resource to the local area. The Lakes provides additional benefits through recreation and tourism. These support local industries such as accommodation, shops, restaurants and tourist based businesses.

Construction Impacts

It is estimated that 80 full-time-equivalent jobs over a year for construction. There is the potential that the project will generate direct employment for the Region as a result of the construction activities. Indirect economic benefits may also result due to the demand for local services during the construction period.

Operational Impacts

The Scheme would only operate during times when Menindee Lakes was unable to supply Broken Hill with water. The Project does not propose to impact upon the operation of the Menindee Lakes in any way, and thereby will not impact on the social and economic value of the Lakes.

8.4 Salinity, Groundwater drawdown, Soils and Erosion

Groundwater investigations are currently progressing.

Construction Impacts

Excavated spoil from the disposal basin will be used for the construction of the banks of the disposal basin. Spoil balance calculations will be undertaken as part of detailed design of the disposal basin.

Operational Impacts

Management of remaining dry salt loads within the disposal basin will need to be investigated as part of the environmental assessment process, to ensure adjoining

properties would not be affected. Additional assessment of groundwater drawdown will need to be completed as part of the environmental assessment process.

8.5 Ecological

Construction Impacts

The Menindee Lakes system contains a broad diversity of both terrestrial and aquatic habitats, and associated flora and fauna species. Five vegetation/habitat types predominate within the Menindee Lakes system: riparian woodland/trees, shrubland, herbfield/sedges/grasslands, freshwater wetlands and habitats with little or no vegetation (Biosis 2001).

The study area occurs within the boundaries of the Menindee IBRA sub-region of the Darling

Riverine Plains Bioregion, within the Lower Darling region. The main construction impact to vegetation would be through vegetation clearing to construct the disposal basin. The surrounding area is mostly remnant native vegetation. Typical communities and associated fauna habitat types include:

- Benson 139: Prickly Wattle tall open shrubland of dunes and sand plains of semi-arid regions;
- Benson 153. Black Bluebush low open shrubland of the alluvial plains and sand plains of the arid and semi-arid zones;
- Benson 151. Sandhill Cane Grass hummock grassland on siliceous sands on dune crests of the arid zone;
- Benson 15: Black Box open woodland with chenopod understorey mainly on the outer floodplains of the Riverina and Murray-Darling Depression Bioregions; and
- Benson 11: River Red Gum – Lignum very tall open forest or woodland on the floodplains of semi-arid (warm) climate zone.

Menindee Nightshade (*Solanum karsense*) is listed as Vulnerable at both State (TSC Act) and Commonwealth (EPBC Act) level. Menindee Nightshade is a small grey-green downy forb with purple flowers, and is the only species of Solanum endemic to NSW, being restricted to the far south-western plains, extending up the Darling River to the Menindee and Wilcannia districts. The species grows in occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man Saltbush, and open treeless plains with solonized brown soils.

It is unlikely the proposal would impact on Menindee Nightshade as habitat is generally on lake beds or floodplains of heavy grey clays with a highly self-mulching surface. The project would aim to avoid any impact.

The broader region surrounding the study area is known to contain the endangered ecological community *Acacia loderi* shrublands, a community dominated by the tall shrub or small tree, *Acacia loderi* (commonly known in some parts of its range as Nelia). The study area does not contain any regionally significant communities.

Clearing requirements will be further defined throughout detailed design, however, the project would aim to avoid impacts to flora and fauna.

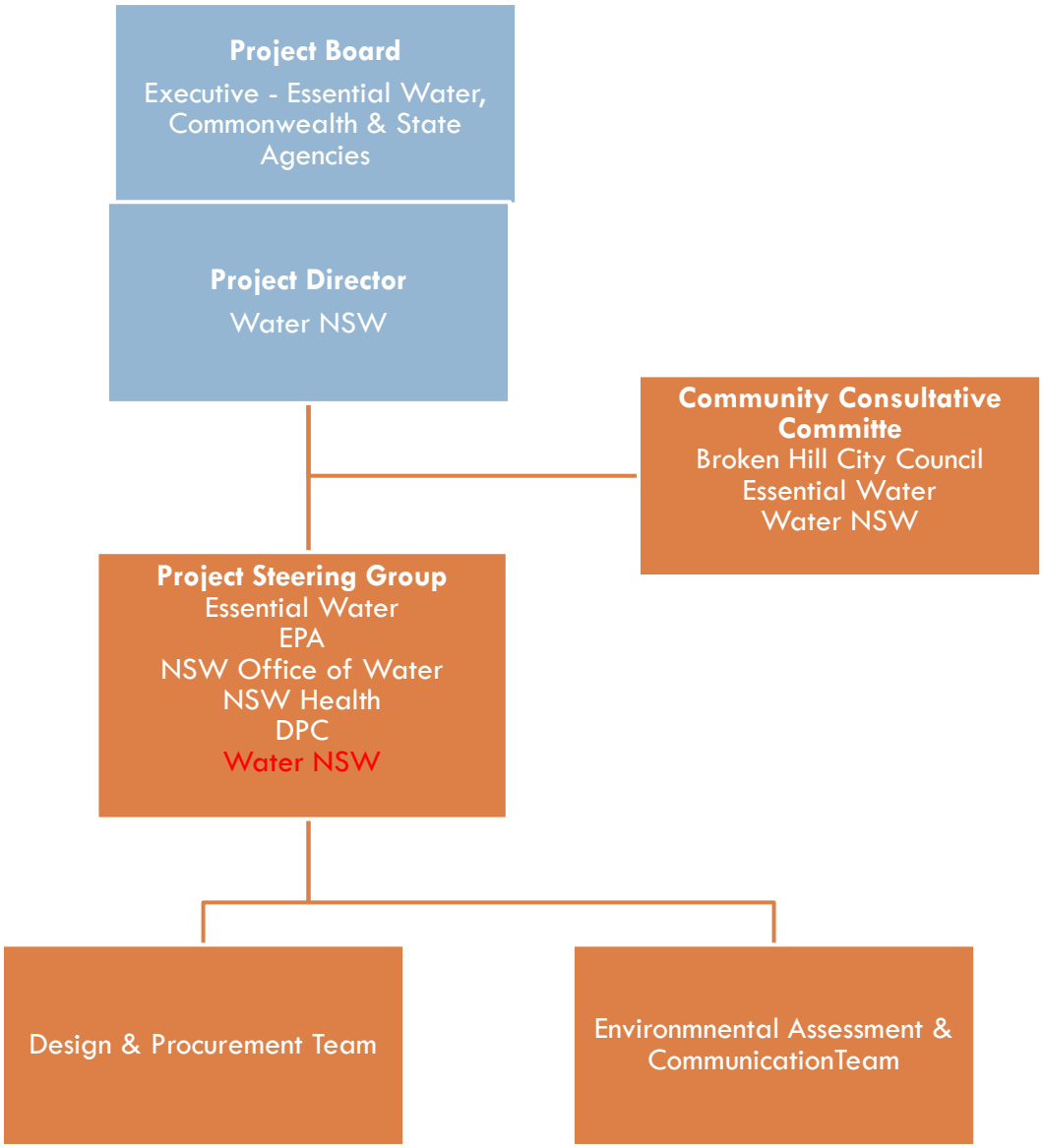
Operational Impacts

Management of the disposal basin represents the biggest potential risk to flora in operation. Further investigation will be required to ensure the resultant dry salt load does not impact on adjoining flora.

9.0 GOVERNANCE & COMMUNICATIONS

9.1 Governance

The Program is ambitious and will require senior level support as well as a coordinating agency responsible for the delivery of the project. The proposed project governance structure during project delivery is as follows:



A Project Board comprising senior representatives from each relevant Government agency is proposed to support the progress of the project to which the Project Director reports. In turn the Project Planning Team will report to the Project Director and will generally oversee the coordination of the project elements, and monitor progress of the project. The Project Planning Team would oversee delivery of the project and be responsible for coordinating progress of the project.

A Community Consultative Committee would be responsible for supporting community consultation for the project and coordinating engagement of the local community and relevant stakeholders. Appropriate community representatives will be identified to serve on the Consultative Committee.

9.2 Communication Strategy

Establishing sound mechanisms for consultation will be crucial for Project Delivery. Table 6 outlines the key stakeholders and engagement strategies to engage each stakeholder group.

TABLE 6: STAKEHOLDER MATRIX

Stakeholder	Communication Objective	Principal Communications / Engagement Strategy
Tier One: *Stakeholders directly involved in decision making processes during the project, they have the ability to influence decision making processes.*		
Funding Agency(s)	Seek funding and seek key approvals throughout project.	• Business Case. • Representation on Project Board. • Formal Presentations – key project milestones. • Monthly Reports. • Media Releases • Review key project documents.
NSW Office of Water	Inform, seek direction and approval	• Governance meetings including representation on Project Board • Monthly Reports. • Review key documents
NSW Premiers & Cabinet	Inform and seek support	• Formal Presentations – key project milestones.
Essential Energy	Inform and seek operational	• Governance meetings including representation on Project Board and Community Consultative Committee. • Review key documents
NSW Planning	Direct approval	• Formal Presentation

Stakeholder	Communication Objective	Principal Communications / Engagement Strategy
		• Meetings • Planning Focus meeting • Environmental Assessment
Office of Environment & Heritage, EPA	Inform and seek approvals	• Formal Presentations – key project milestones • Governance meetings
Tier Two: *Stakeholders who are important to the Project, will be engaged and will provide input which may influence the project outcomes, but who may not necessarily influence the decision making processes.*		
Aboriginal Community, Traditional Owners, Elders Groups	Inform and engage community, particularly during cultural heritage assessment in planning phase & cultural heritage monitoring during construction	• Briefing to community groups • Representative(s) on Community Consultative Committee. • Engagement during cultural heritage assessment & monitoring.
Broken Hill, Menindee Lakes, Sunset Strip & Silverton Communities	Inform and engage communities	• Media Releases • Council newsletters • Community Consultative Committee representation.
Local Tourist Industry & Mining Industry	Inform and engage tourist and mining industry	• Community Consultative Committee representation.
Broken Hill City Council	An informed community	• Community Consultative Committee representation. • Media Releases • Council briefings. • Open days at Portland at key milestones
Tier Three: ***Stakeholders who need to be kept informed of the Project.***		
Media -ABC Radio, Prime TV, WIN TV, The Land Newspaper	An informed community	• Manage external media opportunities to promote milestones • Manage external media enquiries regarding the project
Essential Energy	Approval of electrical design	• Formal correspondence

10.0 CONCLUSION/PROJECT JUSTIFICATION

The Menindee Lakes Scheme is recognised as a significant asset. The proposed project does not impact on operation of the Menindee Lakes Scheme. The key aim of the project is to provide Broken Hill with a water supply in times of drought when Menindee Lakes is unable to supply Broken Hill as well as securing their water supply by December 2015.

Broken Hill supports a population of 19,048, two mines Periliya and CBG Resources. The two mines utilise approximately 1/3 of water supply demand and support local employment of 624 people. On current forecasts, if nothing is done to secure drought water supply for Broken Hill then this would result in poor water quality (>2000 EC) being delivered at least one year every ten. It is also expected that Broken Hill would have no water supply security at least one year out of every ten, potentially resulting in the town's population being evacuated, and an estimated loss of Gross Regional Product of $936 million (June 2013) for at least one year in every ten years. Additional emergency costs would include housing, transport and other emergency support for residents.

Other options investigated are considered impractical and cost prohibitive over the long term. Key benefits of the proposal include:

- Long-term solution to the recurring problem of security of drought water supply to Broken Hill;
- Minimal land and easement issues, the option provides the least risk to cultural heritage and greatest opportunity to meet the key program date of providing a drought water supply to Broken Hill by December 2015 (forecast date for exhaustion of Copi Hollow supply);
- Provides the lowest cost option over 50 year period based on utilising once every ten years for a period of 12 months;
- It is envisaged the option would achieve a good raw water quality, which potentially reduces operational cost for Mica Street Plant.

This submission has been prepared to commence an environmental assessment process, and owing to the current water supply forecasts and status of design, does not include a complete preliminary environmental assessment. The document presents the preliminary outline of the proposal and an overview of potential environmental impacts in order to assist NSW Planning & Environment in determining the level and scope of the environmental assessment requirements.