Bogan Shire Council

Nyngan and Cobar Water Security Project: Business Case

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Executive Summary

Introduction

This document presents a business case for a staged approach to providing water security for Nyngan and Cobar. A 700 megalitre offline storage for Nyngan is funded and is due to commence construction in 2017. An additional 700 megalitre storage is planned, immediately adjacent to this storage. The most significant component of the water security package is the construction of a pipeline to replace the Albert Priest Channel.

While these elements significantly improve water security over the current situation, they alone are insufficient to provide water security for the region based on the "5/10/10" rule, which defines the benchmark for water security in NSW. Therefore, the business case also includes investigation of a groundwater supply at Warren that could be connected to the pipeline, and an additional large storage.

Bogan Shire Council has resolved that priority be given to constructing the additional 700 ML and 3000 ML storages.

Regional Water Supply Security

The existing water supply of the Nyngan Cobar region is compromised and inadequate. In drought years, the availability of water in the towns is governed by allocation restrictions in the Macquarie River. Half of the existing supply is lost through evaporation, percolation and transpiration through the infrastructure needed to convey and store the water. Prolonged, severe water restrictions have been experienced by end users in the past and will again in the future unless water security is improved. Should a drought become severe enough, then it is possible that many in the towns may need to relocate out of the region until adequate water is again available.

The worst case scenario would occur if the Macquarie River was to totally run dry for a period of time and the towns were to have no access to any additional water supply. This would mean that the only water available was what was stored in the Nyngan Weir Pools, which may not be full at the start of this crisis, and will have ongoing losses due to both evaporation and percolation. For the stock and domestic users, they will reliant on what is available in their on farm dams. Such a scenario would result in the "mothballing" of most mining activity, with severe economic consequences. Many residents would be forced to relocate and may not elect to return.

The droughts that occurred in 1980-81, 2003-05, and 2007-08 resulted in severe water restrictions. In 2007 Burrendong Dam fell to just 2 – 3 percent of capacity. There was a real possibility of a worst case scenario if rain had not eventuated towards the end of 2007. Climate change modelling indicates that the likelihood of a worst case scenario will increase.

For the region to survive and prosper, then the water supplies of both Nyngan and Cobar must be brought to an adequate level of water security. This Business Case has been based upon the findings of the May 2016 NSW Urban Water Services (NUWS) Pty Ltd report, which has analysed a number of future options to determine the secure yield using the 5/10/10 rule.

Options Assessment

Secure yield modelling has examined various options to determine their effectiveness in improving the secure yield of the system. This has resulted in a number of stages being proposed including:

- Additional storage capacity (Stages 1a, 1b & 1c)
- Improvements to the water conveyance system (Stage 2)
- Additional water sources (Stage 3)
- Procurement of additional water (not viable).

These options are summarised below:

Water Security Option	Sub-Option	Description	Approx Capital Cost ($M)	Outcome of Assessment
Additional storage	**Storage 1a**	**Storage 1a - 700 ML off-line storage at Nyngan**	**10**	**Preferred Option – Funded and due for construction in 2017**
	Storage 1b	**Storage 1b - Additional 700 ML off-line storage at Nyngan adjacent to Storage 1a**	**6**	**Preferred Option**
	Storage 1c	**Storage 2 – Investigation of an additional 3000 ML off-line storage on a site to be determined**	**Not determined**	**Preferred Option**
Improvements to water transport system	Pipeline 1A	1200mm dia. 63 km long pipeline inside channel - Gravity flow of 55 ML/d	83.67	Not preferred
	Pipeline 1B	1200mm dia. 63 km long pipeline outside channel - Gravity flow of 55 ML/d	93.86	Not preferred
	Pipeline 2	**1000mm dia. 63km pipeline with a pumping station at Warren - Gravity flow of 32 ML/d and increasing to 55 ML/d via a new pumping station**	**75.21**	**Lowest life cycle pipeline cost option. Preferred pipeline option**
	Pipeline 3	750mm dia. 63km pipeline with two pumping stations - Pumping 32 ML/d with a single pumping station at Warren and then increasing to 55 ML/d with an additional intermediate pumping station near the Mitchell Highway crossing near Nevertire	63.33	Not preferred
	Pipeline 4A	1000mm dia. 63 km long pipeline inside the channel - Gravity flow of 32 ML/d	61.02	Not preferred

Water Security Option	Sub-Option	Description	Approx Capital Cost ($M)	Outcome of Assessment
	Pipeline 4B	1000mm dia. 63 km long pipeline outside the channel - Gravity flow of 32 ML/d	63.81	Not preferred
	Pipeline 5	750mm dia. 63km pipeline with a pumping station at Warren - Pumping 32 ML/d via a new pumping station	56.86	Not preferred
	Pipeline 6	900mm dia. 63km pipeline with a pumping station at Warren - Gravity flow of 25 ML/d and increasing to 44 ML/d via a new pumping station at the intake	68.31	Second highest priority pipeline option
	Pipeline 7	Pipeline along the channel and Mitchell Highway		Requires channel to be maintained. Option dismissed
	Channel Lining	HDPE Channel lining, fully fenced		Rejected – No impact on evaporation losses, lesser life cycle
Additional Water Sources	**Borefield – Stage 3**	Investigation of a borefield at Warren to connect to the future Albert Priest Channel pipeline	**Not determined**	**Preferred Option – - Subject to further investigation**
Procurement of additional water	Purchase of additional water entitlements	Secure water may not be available in drought scenarios, and if available, will be very expensive	Not determined	Not viable

The preferred option involves a staged approach to water security and is summarised below:

Stages (in order of priority)	Water Security Infrastructure	Current Status	Approximate Capital Cost (2016 $)
1a	Storage 1a - 700 Ml off-line storage at Nyngan	• Design and documentation complete, • Tenders early 2017 • Construction 2017	$10 M
1b	Storage 1b - Additional 700 Ml off-line storage at Nyngan on adjacent site to Storage 1a	• Environmental studies early 2017 • Tender late 2017 subject to funding approval • Construction 2018	$6 M
1c	Storage 1c - Additional 3000 ML off-line storage on a site to be determined	• Investigations scheduled for 2018	Capital cost not determined (could be up to $30M). $0.5M requested for investigation and preconstruction activities
2	Piping of the Albert Priest Channel	• Options report complete • 7 year project timeline	$75 M

Stages (in order of priority)	Water Security Infrastructure	Current Status	Approximate Capital Cost (2016 $)
3	Emergency bore supply at Warren and connection to pipeline	• Yields and locations not determined • Investigations scheduled for 2017	Capital cost not determined. $0.5M requested for investigation and preconstruction activities

Strategic Assessment

The staged approach to water security demonstrates excellent alignment with regional and local policies, including:

- Restart NSW Fund Act
- NSW 2021 Plan
- State Infrastructure Strategy December 2012
- RDA Orana Infrastructure Plan – Qualitative Infrastructure Assessment and Prioitorisation - June 2016
- Joint Integrated Water Cycle Management Evaluation Study, 2010
- Nyngan Community Strategic Plan
- Cobar Community Strategic Plan
- LMWUA Water and Drought Security Report – Bogan and Cobar Shire Councils

Affordability

The affordability of the project from the customer's perspective was analysed by calculating the long run cost per megalitre of various operating scenarios. This information was then used to assess the impact on net costs for Local Water Utilities and High Security licence holders.

Financial modelling based on NSWPW pipeline and storage concept designs indicates that the proposed system can transport and store water at a cost of about $67/ML (6.7c/kL) at current rates of demand, including providing funds for renewal. The unit cost of the pipeline and off-line storage varies strongly depending on how much the infrastructure is used. The full pumping scenario is about 10% more costly than the gravity dominated equivalent, which means it should be reasonable to rely on pumping for peak demand periods.

If the pipeline and off-line storage was constructed, high security water licence holders would effectively gain extra water as the evaporation and seepage losses of the Albert Priest Channel would be avoided. High security water licence holders may be able to offset their increased costs by trading the water saved, although they may gain greater benefits by using the water for their own production during years of high water availability. Local water utilities benefit through reduced water restrictions/ increased water security, leading to strong socioeconomic benefits.

The high capital cost of the water security project means that the project is sensitive to variations in financial parameters and the level of grant funding awarded. There is a significant risk that partial grant funding of the original project will result in the project becoming unaffordable to more sensitive end users, given that Bogan and Cobar Shires already have some of the most expensive potable water in NSW.

A Financial Plan has been prepared for Bogan Shire Council's water supply business, which meets the requirements of the NSW DPI Water July 2014 checklist. The plan assesses the impact of the ongoing costs associated with the water security projects, assuming a 100% grant is obtained. The water security infrastructure imposes additional operation, maintenance and depreciation costs, which are 32% attributable to Bogan Shire Council. If the water security infrastructure is constructed, the financial plan indicates that the current Typical Residential Bill for Bogan Shire Council can be maintained in real terms – i.e. only inflation-based increases are required. A similar assessment has not been undertaken on Cobar Shire Council's water supply business.

Economic Assessment

SGS Economics and Planning completed a quantitative cost-benefit analysis for the Project. This analysis focused on evaluating the following potential benefits of the project:

- Increased water for mining and agricultural uses, using a gross value added approach; and
- Increased water for environmental flows and recreational purposes, using a water market price of $200/ML as a proxy.

SGS found that a water price of $1300-$2600/ML was required for the Project to break even. While this is significantly above the (limited) market data for temporary trade water, the potential gross value add that could result from this additional water is substantially above these rates. Gross value adds vary from about $2,600/ML for agricultural purposes to over $170,000 for non-coal mining activities.

SGS then conducted a cost benefit assessment based on the difference between the current demand and future demand water supply scenarios based on 10% of the 'new' water being used for mining purposes and 90% for agricultural purposes. The impact of year-to-year variations in water availability was tested using Monte Carlo techniques. This approach yields a distribution of results with variances due to the particular water availability applying to the years randomly selected in each run.

The mean net present value calculated in this process was $29.3 million with a benefit cost ratio of 1.52. The lowest NPV recorded using this process was $19.7 million and the lowest BCR was 1.35.

The assessment of quantifiable benefits and costs shows that the Water Security Project will provide a net economic benefit as a result of increased production, using reasonably conservative assessment criteria. Other analyses in this business case indicate that the potential for expanded mining could result in a larger proportion of 'new' water being used for this purpose. As the highest GVA activity in the region, this will lead to higher net benefits for the Project.

The economic analysis does not quantify the avoided costs associated with avoiding a worst case scenario. Avoided costs include the social and economic consequences associated with a severe drought, when many in the towns may need to relocate out of the region until adequate water is again available. Quantifying the avoided costs will increase the benefit cost ratio.

Project Delivery Plan

The delivery of each stage of the water security projects will be managed as three major contracts, and a number of minor contracts for various components of the works. The major contracts are:

- a design contract, including preconstruction activities,
- a project management contract, to provide support to Council's internal project manager,
- a separate construction contract, including pipeline supply.

The preconstruction activities for these projects are extensive, and dominate the project timeline. In the case of the pipeline (Stage 2), a delivery timeframe of up to seven years is nominated, with up to four years of preconstruction activities, which include negotiation and agreement with channel users and landholders. There may be opportunities to reduce the delivery timeframe for the pipeline by accelerating the consultation and negotiations with landholders along the channel and cost sharing arrangements through a series of initial meetings. It is recommended that early funding be released to enable the commencement of consultation activities.

A rigorous project governance structure will be implemented to provide assurance to the funding partners that grant funding is applied in terms of the funding agreement. Liaison throughout the project will take place through a project steering committee, chaired by the General Manager of Bogan Shire Council.

Risk Management

The objective of the water security project is to provide a water supply that meets the 5/10/10 rule, which forms the government's minimum level of acceptable water security for an urban water supply. The baseline risk management case (Case 1) assesses the current situation against the 5/10/10 rule. The risk profile is then assessed as the various components are added to that system and secure yield increases. Five risk assessment cases have been analysed and are summarised below.

Risk Assessment Case	Risk Assessment Scenario	Very High Risk	High Risk	Moderate Risk	Low Risk
1	**Do nothing** - The existing system only (Base case)	7	4	3	0

Risk Assessment Case	Risk Assessment Scenario	Very High Risk	High Risk	Moderate Risk	Low Risk
2	**Stage 1a** - The existing system plus 700 ML storage (the latter having been already approved for funding) and represents what the base case will move to if no other works are undertaken).	5	5	3	1
3	**Stage 1a plus Stage 2** - The existing system plus both the new storage and a pipeline from the Macquarie River to Nyngan , replacing the Albert Priest Channel.	1	5	8	1
4	**Stage 1a plus Stage 2 plus Stage 1b** - The existing system plus 2 by 700 ML storages and a pipeline from the Macquarie River to Nyngan.	0	5	8	1
5	**Stage 1a plus Stage 2 plus Stage 1b plus Stage 3** - The system as set out in Case 4 plus a connection to a ground water supply in Warren. This represents the only solution that achieves the modelled secure yield identified.			3	12

The risk profile dramatically decreases as the various items of water security infrastructure are added. C**ase 1** carries with it far too adverse a risk profile to feel assured that the towns will be able to play the role required of them over the next century. **Cases 2 and 3** see this risk profile fall further but it would still be considered unacceptable. At **Case 4** based upon current loads the risk profile is becoming almost acceptable, but will alter as the demand grows. Overall risk is determined as being quite acceptable with the full water security solution, represented by **Case 5**.

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1 Introduction

1.1 Purpose of Report

This document presents a business case for a staged approach to water security for Nyngan and Cobar, as summarised in Table 1.

Table 1 – Staged approach to water security

Stages (in order of priority)	Water Security Infrastructure	Current Status	Approximate Capital Cost (2016 $)
1a	Storage 1a - 700 Ml off-line storage at Nyngan	• Design and documentation complete, • Tenders early 2017 • Construction 2017	$10 M
1b	Storage 1b - Additional 700 Ml off-line storage at Nyngan on adjacent site to Storage 1a	• Environmental studies early 2017 • Tender late 2017 subject to funding approval • Construction 2018	$6 M
1c	Storage 1c - Additional 3000 ML off-line storage on a site to be determined	• Investigations scheduled for 2018	Capital cost not determined (could be up to $30M). $0.5M requested for investigation and preconstruction activities
2	Piping of the Albert Priest Channel	• Options report complete • 7 year project timeline	$75 M
3	Emergency bore supply at Warren and connection to pipeline	• Yields and locations not determined • Investigations scheduled for 2017	Capital cost not determined. $0.5M requested for investigation and preconstruction activities

1.2 Overview

To gain some perspective on what is involved with this business case, it should be note that the Nyngan Cobar land area represents a total area of some 60,000 km^2 in central NSW. As such it represents approximately 7% of the NSW land area, is almost equivalent in size to Tasmania and is 25 times the size of the ACT. It has a low population density of around 0.12 persons per square kilometre. When coupled with an annual rainfall of the order of 400 mm and a very few water sources in the region, one has some scope of the difficulty in providing a viable long term water supply to the critical parts of the region.

Despite the difficulties associated with water supply, the region is a major contributor to both the NSW and Federal economies, particularly in the following manner:

- The region's **mineral deposits** which are extracted and transported to for processing or export overseas, contributing to the gross national product and offsetting imports.
- **Agricultural** activities which take on a number of different forms including some irrigation activities based on water allocations from the regulated Macquarie River.

The economic achievements to date has seen millions of dollars invested in water infrastructure by State, Federal and Local Government bodies to support Nyngan and Cobar. The towns have remained relatively stable in size with some fluctuations in population generally governed by the prosperity of the mining and agricultural industries. In the case of the agricultural activities, much of that prosperity is governed by drought, with some very significant droughts in recent years. Indeed it has been these droughts that have demonstrated that there are significant causes for concern in relation to water supply security.

Despite the static nature of the town's populations, it is reasonable to expect some change even expansion when taking a longer term perspective (100 years). Within this timeframe it is expected that this agricultural content will grow if Australia is to effectively exploit a role for itself as a "food bowl" supplier to a world whose population is increasing and in need of feeding. However if the region is to fulfil this role, it becomes critical to improve and secure the water supply to the towns of Nyngan and Cobar so that they can continue to support the activities of the region.

To do this requires some capital investment in the short term in terms of the construction of the pipeline, storages and transfer network. Further investment is required in a staged manner to meet the further expected demands on the system with the passage of time. Modelling undertaken indicates that the current supply system is only capable of delivering water during a critical drought that is 32% of the current need. This can have dire consequences on the towns and the contribution required of them towards the national economy.

The proposed Nyngan & Cobar Water Security project detailed in this business case not only will provide water security to these towns but also provides a model to be followed by other semi-arid regions. For example it allows stock and domestic users to avoid the need for wasteful practices on property dams that see most of the water evaporated, in favour of smart troughs and other efficient technologies. For irrigators they should eventually achieve much greater than 10 times the current yield from their water allocations as it is linked in with more efficient on-farm technologies. It is recognised that such yields may take some time to achieve, as farmers have traditionally been slow to change their practices but as the demand for production increases this change <u>will</u> occur. Change will not be possible with an open channel that is only available on a limited number of days per annum.

The 125 year time frame for the financial modelling is most appropriate, as the types of assets being discussed in this business case are expected to achieve or exceed these asset lives. Thus the business case is able to maximise the beneficial lives of these assets to achieve the desired regional outcomes. Indeed, with a 125 year time frame, additional investment will occur in industrial and agricultural practices as a result of a more secure water supply, and greater efficiencies will be possible. In terms of the economics of the proceeding with the project it can most certainly be expected the potential returns will be significantly greater than what is shown in this business case, where a more conservative approach has been adopted.

This Business Case concludes that a strong argument already exists to proceed with the Nyngan – Cobar Water Security Project based upon current returns from this region. Add to this the likely increases that should attach in the future along with the type of paradigm shifts that will occur once the assets are constructed and the business case only becomes stronger.

1.3 Acknowledgements

This Business Case has been based upon the extensive work carried out by the Department of Primary Industries as well as the NSW Public Works Department and the NSW Urban Water Services Pty Ltd (NUWS), and previously by CPE Associates. That work has resulted in a serious of technical reports that are heavily referenced in this business case and as such their efforts are duly acknowledged.

These studies have covered issues such as the investigation behind the works, the modelling of water security based upon acceptable levels of climate change, the staging of the works, options available to Council and the likely costs to be involved, etc. Indeed many of the tables, graphs and some of the technical sections have been reproduced in this report and this is noted here rather than constantly referencing the same sources. A detailed listing of these reports is contained in the References.

In addition to the above, acknowledgement is also provided to Mr Derek Francis (General Manager Bogan Shire), Mr Grahame Bourke (Manager Engineering Services), officers of DPI Water, and NSW Public Works for the additional background information that has allowed this Business Case to be drawn together.

1.4 Disclaimer

This Business case is based on the technical reports as set out above as well as the feedback from officers from Bogan Shire Council, DPI Water, NSW Public Works and NSW Urban Water Services Pty Ltd. The report has been compiled following a series of workshops wherein preliminary findings have been discussed, with feedback included in the documentation. However this business case contains no independent vetting of the findings of those reports rather it accepts as complete and accurate reports of the current water security and the best possible options to address any noted problems.

It should also be noted that this document has been prepared for a particular purpose, using information made available by the client in accordance with the client's instructions. Users of this document should note the assumptions and approximations used. Any use of the document outside of the stated purpose is at the user's risk.

2 Justification for the Project

The Nyngan and Cobar region is a particularly difficult region to provide with a long term secure water supply. The large geographical area requires systems that have expensive headworks requirements, but with only a small population to meet the costs of these headworks. Despite the difficulties with water security, it is a region that is a significant contributor to both the national and state economies with that role expected to grow over the next century. As such considerable effort must be applied to ensuring the region has a secure water supply over this period.

In Section 1.2, it has already been identified that the flexibility of a 365 day a year (24 hour a day) pipeline will, over time, increase productivity from the same water supply. Developing and delivering a secure water supply requires innovative approaches based on what is viable and affordable. The construction of a channel with only 20 metres of fall over around 70 kilometres in the 1940's is an example of what can be achieved with innovative thinking and limited funding. Water security infrastructure should be based on whole of life considerations rather than minimising up-front capital costs. Pipeline materials for example should be chosen based upon achieving the maximum possible life, with affordable renewal techniques. Civil structures should also be targeted at having 100 year lives at minimum and then be able to be renewed in an affordable manner. Even the adoption of solar power to augment daytime pumping with gravity flows at night should be considered as part of a longer term sustainable solution.

The region has been relatively static in terms of growth. This business case factors in modest growth.

2.1 General details in relation to the region

The region commences around 570 km north-west of Sydney and encompasses a total area of some 60,000 km^2. It comprises the local government areas of Nyngan and Cobar that are linked through the sharing of a common water headworks system that is required to move the water to Nyngan. The two councils, along with a number of stock and domestic users and irrigators along the Albert Priest Channel have formed the Albert Priest Channel User Association that transfers water from the Macquarie River. The ongoing supply to Cobar from Nyngan is then managed by the Cobar Water Board that comprises the local water utility and the mines in the township. Bogan Shire Council administers water orders for all of the Channel users to ensure that requests are appropriately co-ordinated, to keep the significant channel losses to a minimum.

The area is vast, with a population of around 10,000 persons. Overall the region is relatively dry and potentially best known for its mineral deposits that are mined at both Cobar and Nyngan. In 2012-13, the region produced a total of $879 million of output in Non-Ferrous Metal Ore mining, $96 million in output in Sheep, Grains, Beef and Dairy Cattle and $32 million in output in Exploration and Mining Support Services. Support industries such as Retail Trade and Construction are dependent on the income generated by these major industries (Refer Technical

Note – Appendix A). The economic activity is critical to both the federal government (taxes) and to the state government (mining royalties).

Factors that need to be considered in addressing water security issues include:

- Water needs to be conveyed up to 200 km, with losses of up to 50%.
- The high evaporation encountered in the region.
- Potential losses in the systems particularly as the host soils in the area do not generally contain large volumes of clay for waterproofing in ground storages.
- The larger property sizes and low population densities.
- The need to protect the Bogan Weir Pool and the Olive Perch that live within that weir pool system.
- The need to provide sufficient water for the mining activities to be viable.
- Climate change still contains many uncertainties and governments now require that this be factored into future security planning.

More specific details in respect to the regions townships are set out in the sections below:

2.1.1 The Town of Cobar

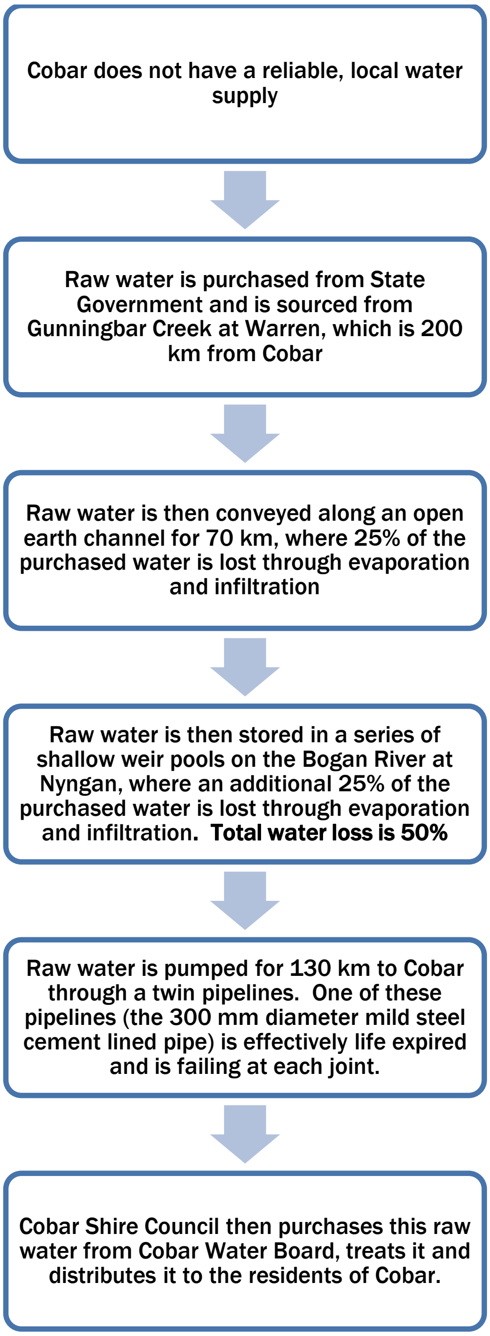
Cobar is around 700 km west of Sydney. It is on the intersection of the Barrier Highway (linking Broken Hill and South Australia) and Kidman Way (that links with Queensland). It also has a commercial airline service linking the town with Dubbo and Sydney.

It has a population of around 4500 persons many of which are mine employees and their families as the town is built around the mines past and present. As such it also has some tourist appeal, which is a contributor to the town's economy.

The town supports a resident population and maintains a minimal number of fly-in-fly-out arrangements. Reduced water allocations in the Macquarie River from time to time have meant that the mining activities have had to be curtailed for periods of time. Whilst there is always some other work that can be done for a period of time that is not normal production, these interruptions to the water supply if they occur too often or for too long a period will threaten the viability of the mines. The numbers of interruptions that have occurred since the year 2000 as set out in the next section of this business case are of concern, particularly given current downturns in the mining sector.

In general water consumption per tenement is relatively low once the harsh climate and the need for evaporative cooling are considered, but much of this can be attributed to the high cost of water. Cobar's water supply is unique and water costs are expensive, as illustrated in Figure 1.

Figure 1 - The unique nature of Cobar's water supply



2.1.2 The Town of Nyngan

Nyngan is around 130 km closer to Sydney than Cobar, being located at the junction of the Mitchell Highway and the Barrier Highway. The town is an entry point for not just the Cobar but also the north western corridor through Bourke and eventually on to Queensland. It has a population of around 3,000 persons and some growth is expected, because it also supports two newly opened mines that are located away from the township. These new mines do not specifically require water from the Nyngan Cobar supply other than to support the miner's families.

The town is on the rail link to the mineral loaders at Sydney and Newcastle for the export of the extracted materials from the region and the line is also used to link to a number of large grain silos in the region. The town has an airport but no commercial flights other than charter flights.

This town supports a greater agricultural base than Cobar at present and this is expected to increase in the future certainly over the life of this proposed improvement to water security.

Like Cobar, water consumption per tenement is considered quite modest in the harsh climate, given the property sizes and overall low population density. The town is relatively picturesque in nature and has considerable potential for ongoing growth.

Nyngan was established initially on the banks of a river, at a point in the river where there was a natural weir pool that allowed a water resource to exist when the river was not flowing, a routine situation in the case of the Bogan River. The weir pool was augmented in the 1920's and improved further over time to increase the security afforded by the weir pool storage. However as the region entered the then record drought conditions back in the 1940's the reduced security afforded by the weir pool storage arrangements was recognised. The Albert Priest Channel was subsequently constructed from the Macquarie River (near Warren) to boost supply and guarantee water would continue to flow into this weir pool storages when there was no flow in the Bogan River.

Figure 2 – Albert Priest – Shire Clerk of Bogan Shire Council in the 1940's

The Bogan River does not regularly flow except in significant rainfall events but nevertheless the township did need evacuation in 1990 when most of the town was flooded.

The Albert Priest Channel has been significantly improved over time such that it now has the potential to deliver sufficient water to the weir pool, however around 50% of this water is lost along the channel and from the weir pools.

10 kilometres west of Nyngan is the largest photovoltaic power supply arrangement in Australia at around 155 Megawatts. When fully augmented it is expected to become the largest solar power station in the Southern Hemisphere.

2.1.3 The Town of Warren

This town is around 80 km from Nyngan on the Oxley Highway (off the Mitchell Highway), adjacent to the Macquarie River. The town is of a similar size to Nyngan and given its river location is attractive in nature. It has become the support base for large cotton gins as well as other agricultural activities. Like the Nyngan Cobar region, Warren will become more important as the need for increased agricultural activities increases in the next century.

The town has its own water supply and sewerage collection systems. The water supply is not currently linked to the Cobar /Nyngan Water Supply but the town is mentioned here as it is the only real source of groundwater in the region. The current water supply and security is provided from these groundwater sources that are directly recharged from the Macquarie River with that recharge dependent on the flows in the river.

The aquifers near Warren are used exclusively for the water supply to the town. It is not considered at this time that there is sufficient capacity in these aquifers to provide any additional water for Cobar and or Nyngan. However it is understood that there are a number of deeper aquifers that may be able to provide some water to augment the Cobar /Nyngan supply in the longer term.

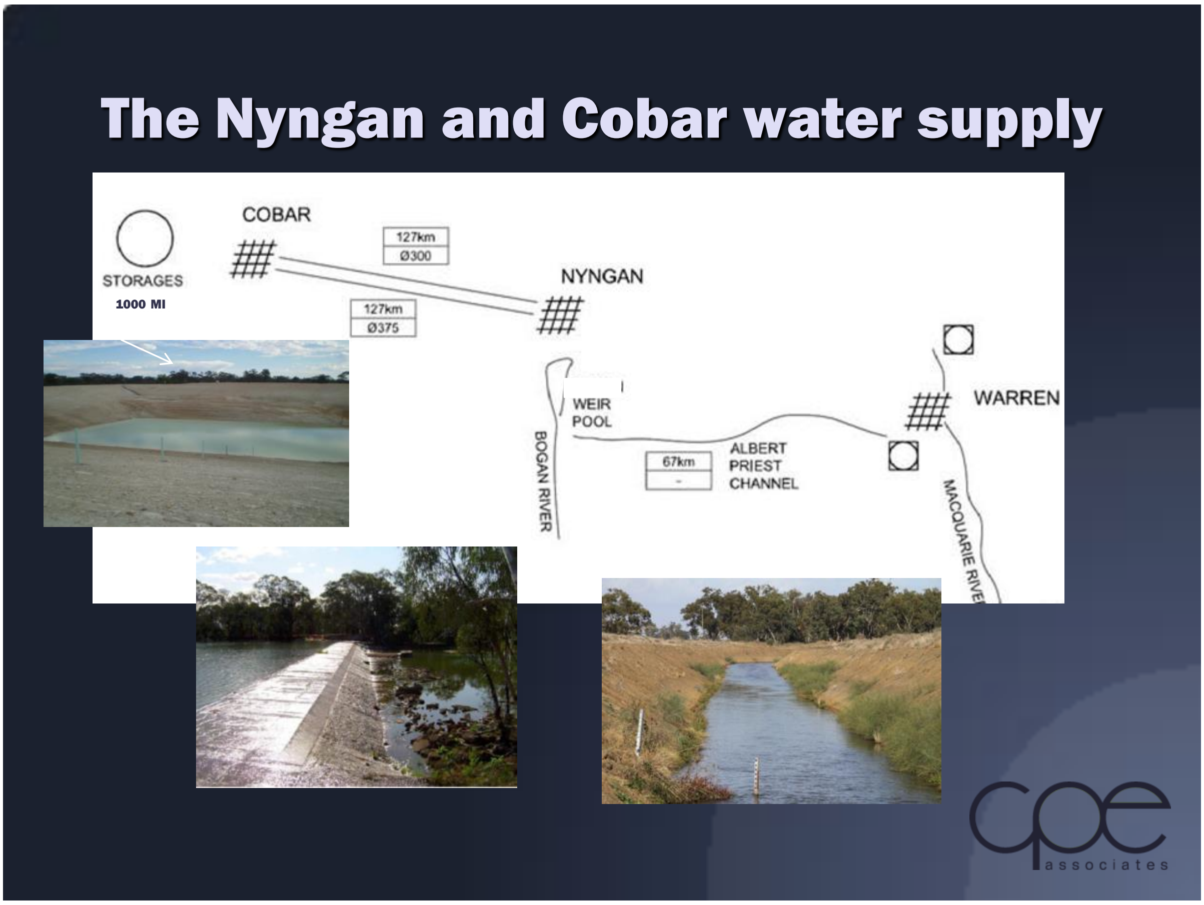
2.2 Description of the current Nyngan – Cobar water supply

Water is currently supplied from the Macquarie River via the Albert Priest Channel to a common weir pool in Nyngan on the Bogan River. From there, water is extracted by separate pumping stations that deliver that water to the two respective towns. In addition to the town users there are around 30 stock and domestic users as well as irrigators located directly on the channel that are also supplied and these are mostly for the properties the channel flows through. It should be noted that the channel is located on private land.

The channel is operated for a period of some weeks to fill the weir pool with most of the individual users simultaneously filling their own storages. The channel is then isolated from the

Macquarie River until it is time to top up the storage again. Typically the channel is operated in this manner 4 times a year in what might be termed average rainfall years, but this will increase to six or more times in the particularly dry years. Similarly in those more average years there may be some topping up of the stored water from flows in the Bogan River.

Figure 3 – Schematic diagram of the Nyngan & Cobar Water Supply



(Source: Lower Macquarie Water Utilities Alliance - Regional Drought Management Plan, May 2010 – Hydroscience Consulting.)

Storages at Cobar allow for the peak instantaneous demands that occur on the hot summer days or when there high production in the mines. These storages allow for the more average daily demands being supplied by the pipelines

A number of studies on the current water supply arrangements have been conducted that show that effectively, Nyngan and Cobar can only use around 50% of the water they allocated due to system losses in the channel and storages. The studies have concluded that:

- In excess of 25% of all water extracted from the Macquarie River is lost in the Albert Priest Channel per annum in dry years and slightly less in cooler wetter years.
- Similar levels of losses occur in the shallow weir pools at Nyngan, both through evaporation and infiltration
- The actual storage volume of the weir pool is decreasing with successive floods. For example studies between 1983 and 2007 found a decrease in capacity of 23% due to silt deposits from floods and there have been subsequent floods in 2010 and 2012. Dredging the weir pool would not only be costly but would also upset a number of ecosystems.

Historically, the weir pool was the original security for a much smaller Nyngan. The droughts of the 1940's required that an emergency solution be found. The channel was negotiated by the then Shire Clerk of Bogan Shire Council and was constructed shortly thereafter. The channel has been improved a little over time and Cobar has subsequently been added to the system.

If one was to build a water supply system to the towns in this modern age, it is unlikely that a scheme involving an unlined open channel with wide shallow weir pool storages would be approved or constructed. In making this statement however it needs to be remembered that this system was implemented when there were no fixed river allocations, water trading, indeed even issues such as water losses and the need to retain water in the rivers paled into insignificance in comparison to the fundamental requirement of water for survival.

Flows in the Albert Priest Channel are metered at the Warren end of the channel and the users are charged on the basis of that meter's readings. However as indicated before **local water authorities are effectively only able to utilise around half of the water they pay for**. A more recent direction has been to regulate both water authorities in terms of the water they are now able to extract from the Bogan River.

Figure 4 – Western weir pool, Nyngan

2.3 Regional water sources.

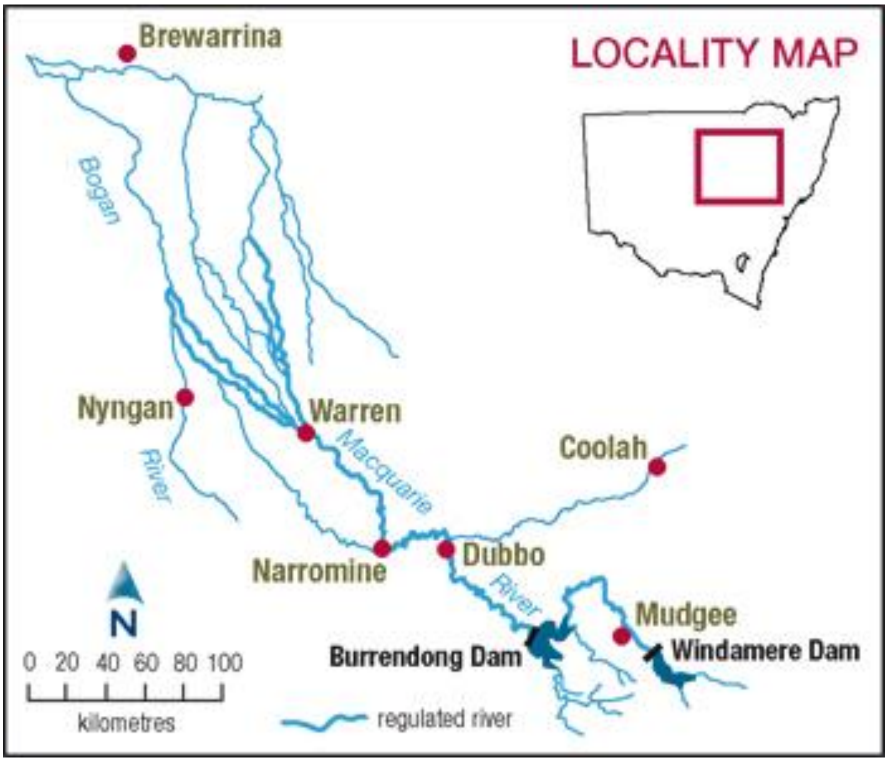
The Nyngan – Cobar Region like many parts of western NSW suffers from a lack of secure water sources as set out below.

2.3.1 Macquarie River

The Macquarie River is formed near Bathurst following the joining of the Fish and Campbells Rivers and extends north-west to the Barwon River upstream of Bourke. A considerable proportion of the water from this river enters the Macquarie Marshes and is responsible for the maintenance of that wetland. Water in this river system is regulated in terms of releases from Lake Burrendong near Wellington NSW, which was created by the construction of a dam to form this lake. It is also supported in the upper reaches by Lake Windermere.

The regulated section of this river extends a distance of approximately 850 km from the upper reaches of the Lake Burrendong water storage area to the confluence of the Bulgeraga and Monkeygar Creeks. It also includes sections of Gunningbar, Duck, Crooked and Bulgeragar Creeks and extends to include releases of flows to improve the environmental health of the Macquarie Marshes even though these marshes are covered by their own specific plan.

Figure 5 - Macquarie and Cudgegong River Catchments



(Source Macquarie River Website)

The river has an annual average flow of nearly 1,450,000 ML and is supported by a further storage capacity in two dams of 1,544,000 ML (Lake Burrendong 1,188,000 ML and Lake Windamere 368,000 ML) plus some capacity for flood mitigation. These dams allow for some control over this water flow and some ability to traverse dry periods and still retain flow in the river system. This flow regulation is controlled under a water sharing plan for the river that sees around 70% of the flows preserved for preserving river health system. Set allocations from this water source as per section 2.4 have been provided for the Nyngan Cobar supplies and the towns will extract water from this source up to the full entitlement of these allocations depending upon conditions being experienced and if there are any flows in the Bogan River.

The major difficulty with this water supply source is that it is not convenient to either town. Rather it requires that the water be transported some 67 km to Nyngan initially via the Albert Priest Channel, and then a further 130 km to Cobar by pipeline.

Historically since the construction of Lake Burrendong in 1967 there has been some water available at the offtake point from the Macquarie River just north of Warren to supply the towns and it is normal practice to regulate the flows in the river system to ensure that there is a minimal flow of 500 ML/day past Morebone Weir (50 km north of Warren) This is not always possible and flow has dropped below this requirement on a number of occasions and this has led to reductions in allocations, such the reductions in allocations detailed in section 3.1.

2.3.2 Additional water procurement

The Macquarie River is the only real source of secure water to the region and when demand exceeds allocations as can happen in particularly dry years or when full allocations are not available then addition water needs to be procured from this source and this is what has historically happened. Water procurement is covered in greater detail in section 2.5.

2.3.3 The Bogan River

This is a perennial river within the Murray Darling system that rises near Parkes NSW and flows for about 620 km before flowing into the Darling River near Bourke. Unlike the other main rivers in inland NSW this river does not have its headwaters in the higher rainfall highland areas with the result that flows in this river system are low and erratic making it of minimal use for either town water supply or irrigation.

The Bogan River forms the other river water source in the region with flows historically ranging from around the 10,000 ML per day to nil flows. In 1990, flows greatly exceed even those figures. Levees were overtopped and the town of Nyngan needed to be evacuated. Modelling undertaken by the NSW Urban Water Services Pty Ltd indicates that for 75% of the time flows produced are less than 0.1 ML per day with the result that essentially no flow enters the weir pool. Hence as a water source that is meant to protect during these dry periods this source does not contribute and cannot be factored into any real water security plans.

This river flows through Nyngan. Unlike the Macquarie River, the Bogan River is not a secure water source for the towns. Despite this not being a formally regulated river allocations have been set for the two towns from this water source (Refer Section 2.4). The river also does not significantly contribute to groundwater sources.

2.3.4 Groundwater sources

There are no significant groundwater sources in either Nyngan or Cobar with the only known groundwater sources in this region being at Warren, as part of the overall groundwater system supported by the Macquarie River. These ground water sources provide the current water supply to the Warren township but these sources have only a limited capacity and are not able to provide additional water for Nyngan and Cobar. However it is thought from preliminary studies that there may be additional groundwater sources in the vicinity of Warren and these may be available as a component of the water security solution.

This potential groundwater supply will require further exploration before any decisions are made. This source, if sustainable, will require additional deeper bores and other headworks to be constructed, for connection to a new pipeline that is proposed to replace the Albert Priest Channel.

2.3.5 Storages at Nyngan and Cobar

A series of storages at Nyngan that form the weir pool arrangement and also at Cobar provide security for the towns during those periods when the channel is not operating and in the case of Cobar when peak day demands exceed the pumped pipe capacity. They also provide some security for when allocations are reduced or if the Macquarie River should stop flowing for a period of time. They are however relatively limited in capacity and studies have shown this capacity to be reducing due to siltation.

A new 700 ML storage offstream storage at Nyngan will be constructed in 2017, to provide additional security as well as a means to reduce the losses from the current weir pool. The weir pools in general at Nyngan can be described as relatively shallow with losses both by evaporation and percolation.

2.4 Nyngan – Cobar water supply limits

Limits on this water supply are imposed by a number of factors which include:

- Designated allocations from the government in terms of the volumes of water that can be extracted from the Macquarie River

- Designated allocations from the government in terms of the volumes of water that can be extracted from the Bogan River
- Water losses in the system (already discussed)
- Available water in either of the rivers, and potential governmental reductions in allocations.
- The ability to purchase additional water under current water trading arrangements if particular year water consumption was to exceed the average current demands.

2.4.1 Allocations from the Macquarie River

At present the allocations from this highly regulated river system are as set out in Figure 6. These allocations are fixed by the NSW Government through bodies such as DPI Water.

Figure 6 – Existing water allocations

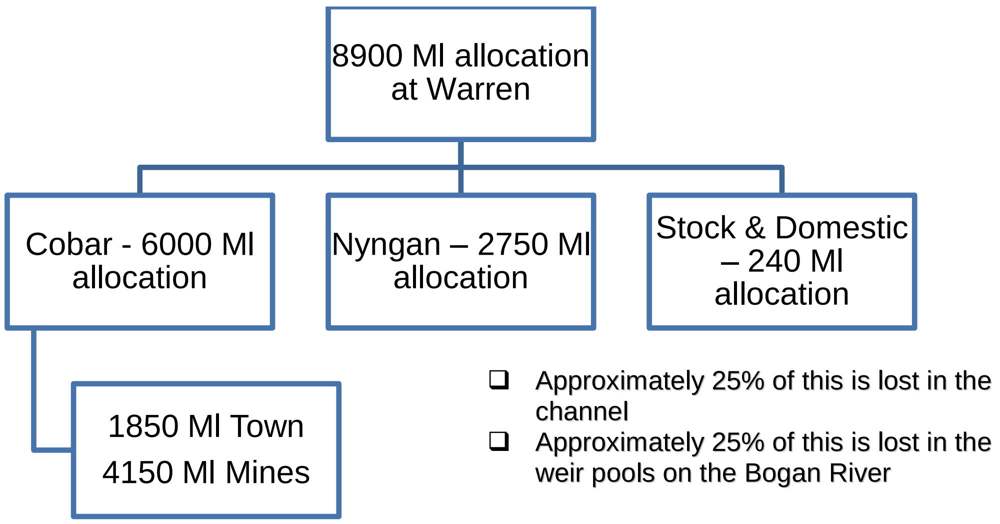


Table 2 - Summary of current water allocations and demands – Macquarie River

Water User	Water Licences (Allocations) ML/annum	Typical Current Demand ML/annum)	Future Demand ML/annum
Cobar Town	2,750	700	650
Nyngan Town	1,850	1,200	1,200
Cobar Mines	4,150	2,490	4,000
Sub Total	**8,750**	**4,390**	**5,850**
APC Stock and Domestic	240	240	240
APC Irrigators [1]	2,592	2,592	2,592

[1] NOTE: Irrigation water as a lower security water can be readily cut in any particular year when water levels in Lake Burrendong are lower than desired.

2.4.2 Allocations from the Bogan River

Unlike the Macquarie River, the Bogan River is not a formally regulated river. Attempts are still directed at ensuring that flows (when they occur) can be shared more equitably by all those on the Bogan River whilst still attempting to protect the Bogan Weir Pool. However, the variable or intermittent nature of this water source is acknowledged allowing the town to take up to three times the water allocation in any calendar year proving the totals do not exceed the allowances at the end of the three year period. In this manner the integrity of the higher needing townships is best protected.

Table 3 - Summary of current water allocations – Bogan River

Water User	Water Licences (Allocations) ML/annum
Cobar Town	1,324
Nyngan Town	600
Cobar Mines	Nil
Sub Total	1,924

2.5 Water supply procurement arrangements

Clearly in a year where there is flow in the Bogan River there is a reduced need to use the Albert Priest Channel other than for the irrigators along its course as well as the stock and domestic users. In past years before the allocations were affixed to the Bogan River, then it may have been possible to avoid significant use of the channel for town water supply. Water allocations from the Bogan River are not subjected to the 25% transport losses that are inherent with the use of Macquarie River. When both are sources available then the current allocations are generally more than sufficient to meet needs. Similarly, when the Bogan River flows, demand is not at its peak because there has been rainfall.

In those years where there is no such flow in the Bogan River, then the reverse tends to apply. Demand can be above the suggested typical current demand and with the system losses there is a need to secure additional water. There are also periods when allocations will be reduced due to the availability of water in Lake Burrendong. In this situation, the water utilities are forced to try and make up the short fall by procuring water under the current water trading arrangements.

The flows generated when water is purchased are measured at the Warren end of the channel. The water extraction is ongoing over a period of weeks as the weir pool and the storages of the individual channel users are topped up. The volumes of water consumed in this manner are tallied until the full allocation for the two councils and the other channel users is reached. After this additional water has been historically purchased through the water trading procedures that exist at the time paying the price for this water that is applicable at the time as the price is subject to market forces.

When reviewed in 2014/2015 the costs of purchasing water under the allocations were of the order of $14/ML whereas this additional water purchases occur ear figures of around $160 -180

/ML placing considerable strain to the operational budget in those years where additional purchases need to be made. To date water has been available and the consequences have been monetary. The great concern is that in a severe drought, there may be no water available to purchase. As set out in Section 3 there is good reason to fear this scenario.

Figure 7 – Albert Priest Channel and regulator flow meter

2.6 Additional factors to be considered in the water security project

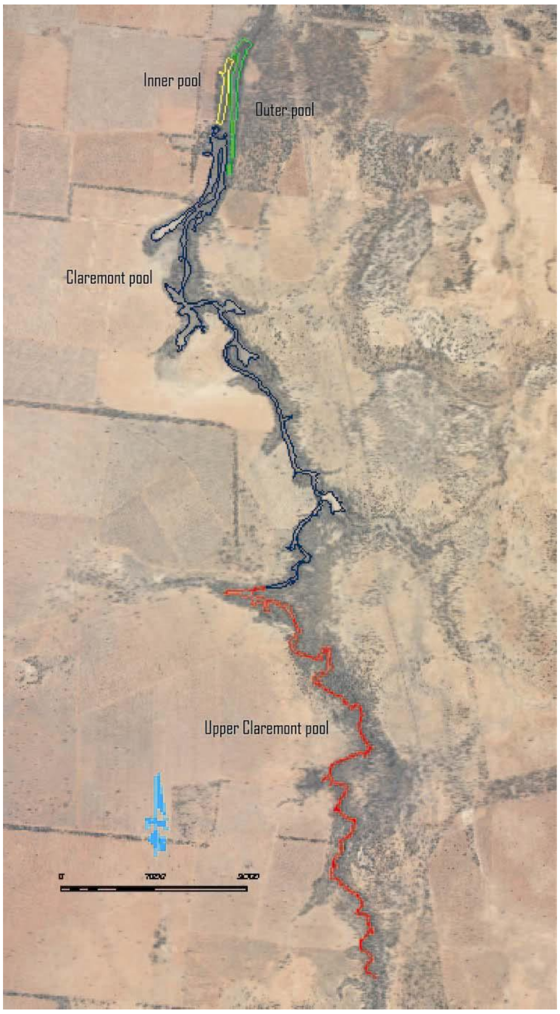
Some of the additional factors to be considered in relation to the water supply include:

- **Endangered fish species.** The current Nyngan weir pool is home to the olive perchlet *(Ambassis agassizii)*, which was discovered as a result of a survey of the few water holes that survived the millennium drought. The existing Nyngan-Cobar Water Supply has maintained these endangered fish species, which by themselves form a deserving reason for keeping water in the weir pool. The towns have however done this without any environmental flow entitlement for this role. This would seem inappropriate given the large volumes of water already set aside for environmental flows in this river system.
- **Social importance -** The wetland and weir pool arrangement is very important to both towns. It is the only standing body of water in the region and has considerable social value to the communities.
- **Siltation.** The weir pool comprises some four pools namely the Inner Pool, the Outer Pool, the Claremont and Upper Claremont pools. WaterBiz in its 2007 Bogan River Weir Pool Assessment Report noted that the overall storage had decreased by some 23% with the surface area decreasing by 35% between 1083 and 2007. In addition to this there have been additional floods in 2010 and 2012 which most probably have decreased that capacity further. Whilst in the first

instance some form of dredging would seem appropriate this could have significant consequences in terms of the environment and increasing the effectiveness of the storages and needs investigation before any recommendations are made.

- **Impacts of regulation of flows** - The Bogan River is now regulated. A review on how this water source is best used is recommended.
- **Electricity costs and greenhouse impacts** - As power will be one of the larger components of the operating costs, it may be possible to determine if the longer term economics favour inclusion of a mini solar power station to eliminate the overall green house footprint and reduce costs. Whilst this is not included in the current project, it is worthy of longer term consideration.

Figure 8 – Bogan River Weir Pools



Source: Waterbiz 2006

The document "Aquatic Ecology Management Plan" (Cardno 2016), documents a management plan for aquatic ecology in the weir pools. This document could be developed into a simplistic Weir Pool Management Plan to assist Council's operators, as one of the deliverables under this project.

3 Current Status of Regional Water Supply Security

The current water supply of the Nyngan Cobar region could best be described as compromised and inadequate. In drought years, the water security is subject to the availability of water in the Macquarie River. Half of the existing supply is lost through evaporation, percolation and transpiration through the transportation and storage mechanisms needed to convey and store the water. Prolonged severe water restrictions have occurred in the past and will again in the future. Should a drought become severe enough, then it is possible that many in the towns may need to relocate out of the region until adequate water is again available.

For the region to survive then the water supplies of both Nyngan and Cobar must be brought to an adequate level of water security.

3.1 What is Water Security for a Western Region?

In NSW the 5/10/10 rule is used by the NSW Government as the target /s for minimal water security for an urban water supply in Country NSW. This rule requires that the water supply should:

- The duration of the water restrictions should not exceed 5% of the time. For example if one was to look at a 20 year period then one would expect that water restrictions should not have been in place for over one year in that period of time.
- The frequency of water restriction should not exceed 10% of the time (i.e. water restrictions will not be applied more than once every 10 years).
- Severity of restrictions does not exceed 10%. That is the water supply systems must be able to meet 90% of the unrestricted water demand (i.e. 10% average reduction in consumption due to water restrictions). This would be through a repetition of the worst recorded drought, commencing with the storage drawn down to the level at which, restrictions need to be imposed.

This rule has been established for some time now as a guide to what will be required in relation to the planning for most urban water supply headworks. It was developed as a guide to providing cost effective storage capacity to manage a town's water supply in future droughts of greater severity than that experienced over the past 100 years. It also recognises that water restrictions (or at least reasonable levels of water restrictions) are part of the overall water security package. They are required given the highly variability of water supply sources in such western areas. This rule also provides for greater consistency for the government when looking at regions, particularly with the possibility of change in these rural areas over the future.

This Business Case has been based upon the findings of the May 2016 NSW Urban Water Services (NUWS) Pty Ltd report, which has analysed the system yield using the 5/10/10 rule.

3.2 Current levels of water security - historical component.

Table 4 demonstrates the performance of the Macquarie River (identified as the only true secure water source) over the last 100 years or so in terms of reductions in allocations in the Macquarie River. However it is stressed that figures prior to 1967 are less significant, as that is when the

1,188 GL Burrendong Dam was constructed on the Macquarie River just upstream of Wellington, which improved water security. The 368 GL Windamere Dam was subsequently added in 1984 just upstream of Mudgee to further enhance water security. Even the 1966 - 67 drought figures are considered irrelevant due to the time it would have taken to fill the dam.

Table 4 – Monthly Drought Allocations - Reprint of Table 3.7 from the NSW Urban Water Services Report

Table 3.7: Monthly Drought Allocations

No	Drought	Month	Local Water Utility (LWU)	Domestic and Stock (D&S)	High Security (HS)
1	1902/03	Jul-02	50%	30%	10%
		Aug-02	70%	505	30%
		Sep-02	70%	50%	30%
		Oct-02	70%	50%	30%
		Nov-02	70%	50%	30%
		Dec-02	70%	50%	30%
		Jan-03	70%	50%	30%
		Feb-03	70%	50%	30%
		Mar-03	70%	50%	30%
		Apr-03	70%	50%	30%
		May-03	100%	100%	100%
2	1929/30	Jul-29	70%	50%	30%
		Aug-29	70%	50%	30%
		Sep-29	70%	50%	30%
		Oct-29	70%	50%	30%
		Nov-29	70%	50%	30%
		Dec-29	70%	50%	30%
		Jan-30	80%	60%	50%
		Feb-30	90%	75%	50%
		Mar-30	90%	75%	50%
		Apr-30	90%	75%	50%
		May-30	90%	75%	50%
		Jun-30	90%	75%	50%
		Jul-30	90%	75%	50%
		Aug-30	100%	100%	100%
3	1938/39	Jul-38	70%	50%	30%
		Aug-38	70%	50%	30%
		Sep-38	85%	75%	50%
		Oct-38	85%	75%	50%
		Nov-38	100%	100%	100%
4	1947/48	Jul-47	50%	30%	10%
		Aug-47	70%	50%	30%
		Sep-47	70%	50%	30%
		Oct-47	100%	100%	100%
5	1966/67	Jul-66	70%	50%	10%
		Aug-66	70%	50%	10%
		Sep-66	80%	60%	30%
		Oct-66	80%	60%	30%
		Nov-66	100%	100%	100%
6	1980/81	Jul-80	50%	30%	10%
		Aug-80	50%	30%	10%
		Sep-80	50%	30%	10%
		Oct-80	50%	30%	10%
		Nov-80	50%	30%	10%
		Dec-80	50%	30%	10%
		Jan-81	50%	30%	10%
		Feb-81	50%	30%	10%
		Mar-81	50%	30%	10%
		Apr-81	50%	30%	10%
		May-81	50%	30%	10%
		Jun-81	50%	30%	10%
		Jul-81	50%	30%	10%
		Aug-81	100%	100%	100%
7	2003/04	Jul-03	70%	50%	30%
		Aug-03	85%	65%	50%
		Sep-03	100%	100%	100%
8	2004/05	Jul-04	70%	50%	30%
		Aug-04	85%	65%	50%
		Sep-04	85%	65%	50%
		Oct-04	100%	100%	100%
9	2007/08	Jul-07	70%	50%	30%
		Aug-07	85%	65%	50%
		Sep-07	85%	65%	50%
		Oct-07	85%	65%	50%
		Nov-07	85%	65%	50%
		Dec-07	100%	100%	100%

There have been four occasions in the 49 years since the construction of Lake Burrendong when the Macquarie River has failed to meet its water security requirements those being:

- The 1980/81 drought
- 2003 /2004
- 2004 /2005
- 2007 /2008

Table 4 details the extent to which the Macquarie River allocations needed to be reduced with the 1980/81 drought having by far the greatest consequences. Each of these reductions in allocations has led to the introduction of water restrictions with those restrictions exceeding the periods of reduced allocation.

Water restrictions will also have been introduced outside of these periods when the demand has risen due to reduced rainfall and constant high temperatures as these will have been necessitated for the town's to have stayed inside their allocations before water trading procedures were in place, and afterwards because that water was too expensive or could not be procured.

Of particular concern is the frequency with which the allocations have been reduced since 2000. Each of these periods is discussed in more detail below.

3.2.1 Overall

The reduced allocations in the Macquarie River have occurred at times when there is no flow in the Bogan River and when demands have increased due to the fact that this is happening in years of reduced rainfall and increased temperatures, also leading to increased demands and higher evaporation losses. Typically in a year when there is no Bogan River flow the channel will be used four times but in those particularly dry years that need may rise to 6 times to offset the increases in demand. In so doing, it introduces further pre-wetting losses into the channel operation.

It needs to be remembered that of the 8,750 ML allocation typically only 4,375 ML is available to meet a typical demand of 4,390 ML in any year but this is based on average figures with drift into those more severe years. When that demand has short term increases and the system losses similarly increase and the only way to offset the application of water restrictions is to procure additional water. This is discussed in Section 4.1.3.

In the period 1990 – 2010 overall there are a significant number of years when average rainfall is below what would be termed average rainfall, necessitating the application of water restrictions of differing levels to offset the shortfall in those years. The years between 2002 and 2010 effectively saw all of these years in this category and the fact that there were so little a number of reductions in allocations is an effective demonstration of the increased security the two dams have provided to the region.

When one reviews these droughts in particular and the overall applications of water restrictions in this period since 1967 it becomes apparent that the region's current water supplies have not historically meet or come close to meeting the 5/10/10 rule set by the NSW Government as the minimum for adequate water security.

3.2.2 The 1980 /81 drought

In terms of the water allocations the NUWS report notes that in the 1980 /81 drought (the most significant of those modelled) actual water supply fell to:

- 50% for the Local Water Utilities (i.e. town water supplies)
- 30% for the stock and domestic users from the channel
- 10% high security water which is used for the mining activities in Cobar. At this level, most of these mining activities have had to be shut down running the risk that such mining may not be recommenced.

These reduced allocations were in place for some 13 months which clearly lies outside of the 5/10/10 rule. In addition the hot dry conditions saw both demand increase beyond what is considered normal demand and losses increase predominantly due to evaporation and the need to use the channel more often with significant start-up losses.

Droughts of this severity see water restrictions of a very severe level for duration in excess of the period of reduced allocation. In this situation, it is possible some businesses within the town may close and some individuals /families may elect to leave town for a short or longer term. For the stock and domestic users much of the stock may need to be sold off as feed is difficult to and costly to procure at these times and thus animal breeders depending upon these stock and domestic allocations will take many years to recover. For the mines this allocation is insufficient and the mines effectively need to be put into mothballs for some time after all of that other work has been completed. Thus the towns will have a number of individuals that will be unemployed for a period of time and with limited job prospects, many leave the towns in search of other work. In times of uncertainty in the minerals industry such interruptions could lead to the closing of one or more of the mines.

The irrigators using general security will effectively have no water and they too will have limited income during these years with the towns having to provide major support roles for the families given the general state of the nation.

3.2.3 The 2003/2004 and 2004/2005 droughts

Here the drops in available allocations are relatively short term. This would have resulted in a reduction of confidence in the mining and agricultural industries due to the frequency of drought. Again water restrictions are extended beyond the reduced allocation periods depending upon how successful Bogan Council was in procuring additional water to offset these shortfalls.

3.2.4 The 2007/2008 drought

Of particular concern is this drought. In addition to the reduced allocations, Burrendong Dam fell to just 2 – 3 percent of its stored capacity. This happened after a prolonged period when effectively no rain fell in the earlier parts 2007 and there was no replenishment of supplies over the cooler months. This total lack of rainfall is somewhat unusual historically and was difficult to plan around. However relief came with some more sustained rain in the second half of 2007 that allowed the restrictions to be trimmed back a little and then removed in December of 2007.

However, had these rains not eventuated for say a further 3 – 6 months then a worst case scenario of the Macquarie River running totally dry at the offtake (discussed in Section 4.1.3) would have resulted with the towns effectively running out of water except for the most stringent of emergency supplies. Whilst State Water has indicated that there is some capacity to pump pooled water that remains in the dam when it falls below the normal release levels, it is difficult to perceive that water making it past Wellington and Dubbo to the Warren draw off point.

The 2007 drought highlighted the importance of increased secure storage at Nyngan to protect the towns.

3.3 Potential Climate Change

Under the NSW Government's *Best-Practice Management of Water Supply and Sewerage Guidelines*, local water utilities in non-metropolitan NSW are required to prepare and implement a comprehensive 30-year integrated water cycle management (IWCM) strategy. Such a strategy is also required to be updated every 8 years. A key element in these strategies is to factor in the potential impacts of climate change on the water security. As such all are required to submit a yield analysis study as part of the compilation of that IWCM..

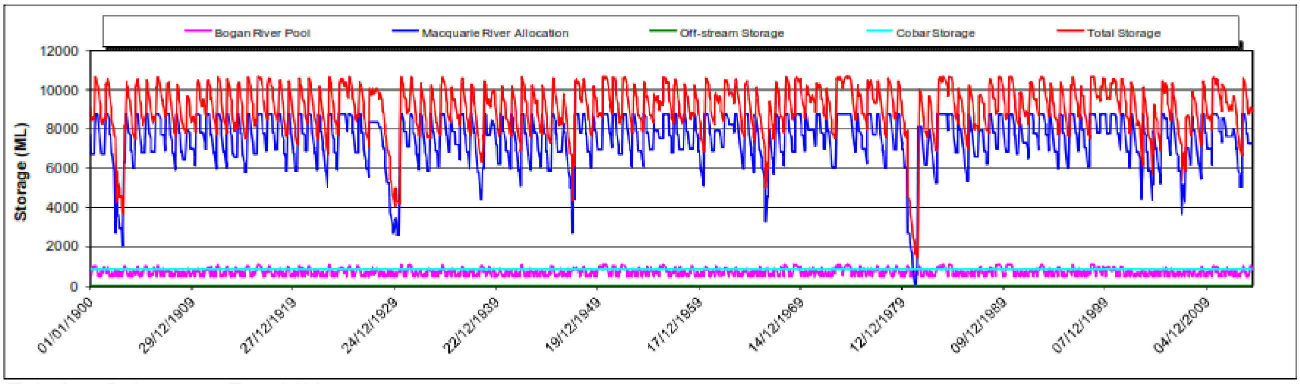
To provide a basis for a yield analysis, a pilot study for 11 non-metropolitan NSW water supplies utilising 112 years of downscaled daily hydrometeorological data from 15 global climate models for climate change projections for the year 2030 using the A1B medium warming emissions scenario was compiled. The yield studies required for these IWCM need to factor the findings of that pilot study into them so that the government again has a consistency of approach into these yield analysis it needs to make appropriate decisions in terms of assisting with longer term water security.

This was undertaken by NSW Urban Water Services (NUWS) and documented in their May 2016 report. The report demonstrates the need to considerably upgrade the existing system to meet the 5/10/10 rule.

3.4 The Water Supply under Climate Change

The NUWS modelling of the existing water supply water security documents that the existing water supply **has a secure yield of only 1440 ML/a,** which is well short of the identified current requirement of 4390 ML/a and even less than the likely future secure yield requirement of 5850 ML/a.

Figure 9 – Storage behaviour for secure yield of 1440 ML/a (NUWS May 2016)



Existing Scheme – Run14H
Secure Yield 1440 ML/a

Figure 11: Storage Behaviour Diagrams (Case 1)

Clearly the region's current water supply system does not even come close to meeting the current 5/10/10 requirements that designate an acceptable level of water security under the revised climate modelling arrangements.

3.5 Worst Case Scenario

The worst case scenario for the Nyngan Cobar Water Supply would be if the Macquarie River was to totally run dry for a period of time and the towns were to have no access to any additional water supply. This would mean that the only water available was what was stored in the Nyngan Weir Pool arrangement, which may not be full at this time, and will have ongoing losses due to both evaporation and percolation. For the stock and domestic users, they will reliant on what is available in their on farm dams.

This worst case scenario has not occurred within the recorded period since the supporting dams were constructed, however there is only 49 years of history, and 2007 certainly indicated that a worst case scenario is possible. Climate change modelling increases the likelihood of a worst case scenario.

Should a worst case scenario occur, then the towns will have between 100 – 200 days of water supply available provided that the most severe restrictions are applied and that most industry (particularly the mines) are shut as soon as possible. This time span will also depend upon the time of the year and what level of storage is available in the weir pools remembering that these have been decreasing in volume since 1983 and with additional floods adding more silt in 2010 and 2012.

Under this worst case scenario, if there are no changes to the current system, then there will need to be a significant evacuation of personnel from the town and a closure of the mines and any other significant water using industry. The new 700 ML storage will extend the time available to the towns for flows to again arrive at the offtake point but as with the above, this will need to be managed.

Council has previously explored the potential for water to be brought in from other sources for such a worst case scenario, with Dubbo the most likely secure water. However, there are limitations. There is a four hour turn around for any tankers and the railway no longer carries sufficient rolling stock for transport of water. It is unlikely that sufficient road tankers will be available to sustain any more than a skeleton crew in either town and even then it is likely to cost in excess of ten thousand dollars for every day that carting of water needs to occur.

Such a scenario will potentially result in the long term closure of some or all of the mines and the loss of revenue to the region as well as to respective governments in terms of royalties and taxes estimated to be in the order of tens of millions of dollars per annum. Similarly many of the residents may elect not to return and this may impact longer term roles that see the region as an important cog in the region becoming a primary agricultural basin.

Clearly part of the management of the system is to closely monitor Lake Burrendong. When it falls below say 15%, and forecasts are for continuing drought, procedures could be implemented to top up storages. Construction of a pipeline and more secure storages will assist here with much reduced losses. Governments would be looking to future IWCMs to detail more formalised procedures in relation to this Burrendong Dam drawn down arrangement.

3.6 Procurement of additional water from the Macquarie River

Recognising that the current water supply is insufficient in drier years and in particular in years when allocations have been reduced, then the local water utilities have been forced to procure additional water under water trading arrangements that apply to the Macquarie River. Thus the current water security is in part maintained by this additional water procurement, and reviewing its role in the region's water security is a key element in the business case.

When water is procured, water prices (costs per ML) will vary depending upon:

- time when the water is sought
- the market price of water at the time
- the general availability of water in the river
- the willingness of a nominated owner to sell and the amount they will be asking.

In short, a free trade market will apply, including the impact of supply and demand on the cost of the water. When Council last procured water the unit costs were typically of the order of $160 - $180 /ML to procure, therefore purchase of an extra GL or two rapidly adds say $170,000 to $340,000 to the annual operational budget for that year. Unfortunately, half of this additional procurement will be lost by the current transportation and storage arrangements.

In looking at future options, a best case/ worst case scenario was developed in the 2013 business case over what likely costs would be incurred in the period 2015 – 2050. This was compiled to assist Council with decision making over what needed to be done in relation to improving water security. That review indicated that water authorities could in this period expend between $5.8 M-$8.3 M in additional purchases depending upon what scenario prevailed, assuming a unit cost of $170/ML. These costs however range up to $24.5 M if costs rose to $500/ML. It is therefore conceivable that somewhere between $10 M and $15 M would be spent in additional water purchases in this period. The numbers were a guide only and are dependent on a number of factors, and could change if Council and the mines elect to purchase additional water allocations when they become available.

It is stressed that procurement of additional water is not a solution if a worst case scenario was to occur. In this case there would be simply no water in the river at the draw off point to purchase and 2007 highlighted this is a very real possibility, which will be exacerbated by climate change predictions. Similarly, where allocations in the Macquarie River are severely limited, it is unlikely that additional water will be available to procured for long periods. In the past, water has been procured only been when there were short term medium reductions in place.

Current water allocations are insufficient to meet future demand. Under a do nothing scenario, a far greater need for procuring additional water will become imperative over time. Given the inefficiencies of the current system (losses inherent in that system) then the cost sand volumes required will become extensive, and the financial consequences will be far worse that those indicated above.

The reliance on purchase of additional water is a high risk scenario. In a worst case scenario, water may not be available to purchase, and the impacts on the towns and industry could be catastrophic. This option is therefore not evaluated further.

4 Options Assessment

4.1 Analysis of options to increase water security

Having identified in the previous sections that the existing water supply systems that make up the Nyngan Cobar water supply do not meet the governments minimum mandated requirements for a secure water supply, it is imperative in to identify options to increase the levels of security. Typically in any semi-arid region this will involve:

- **Additional Storage capacity-** Additional storage capacity given that the worst case scenario is all about the Macquarie River running dry for a period of time (potentially up to six months).
- **Improvements to the water transport system**- Making improvements to the existing system to overcome the losses in that system and extend the amount of water available to the towns. For example if there were minimal losses in the current system then the current allocations should be sufficient to meet the town's needs including those of the mines and allow for the proposed expansion in demand. This includes options such as replacing the channel with a pipeline or lining the channel to minimise transportation losses, dredging the existing weir pool to ensure there is sufficient storage capacity.
- **Additional water sources** - Finding additional water sources in a region that has already been identified as having few such sources.
- **Operational improvements** - Other minor operation matters that contribute to the overall package that will need to be delivered under this business case.

Each of these is explored in greater detail below.

4.1.1 Additional Storage

Clearly the more water secured in a storage facility then the greater the capacity of the system to have sufficient water to withstand a scenario when there is no water available from the river. This additional storage capacity also includes the ability to reduce the severity of any water restrictions when there is a reduction in water allocations.

Nyngan and Cobar have already recognised the need to better protect them against a worst case scenario where the consequences would potentially be catastrophic and secured $10 million funding for an initial 700 ML storage (Stage 1a). This storage will have less losses than the weir pool arrangements where it is estimated that 25% of the current water supply is lost in evaporation and percolation.

Construction of this additional storage alone increases the modelled water security from the 1440 ML /annum to around 2000 ML/annum which represents a 42% increase in current security. However to achieve the required 4,390 ML/annum identified as the current typical demand will require a total of some 4,400 ML of additional storage be constructed if the shortcoming in current security were to be addressed simply by adding additional storage capacity to the current supply system. Attainment of the 5,980 ML future demand would require that a total of 8,590 ML of storage capacity be built.

Strengths of this Option

The following are suggested as the strengths of this option that would favour pursuing this option further to attain a more secure water supply:

- Additional storage is the only real protection for Nyngan and Cobar should there be no flow in the Macquarie River as a result of some extremely dry period wherein Lake Burrendong becomes exhausted. Once the Nyngan storage draws low, worst case scenario protocols will need to be enacted.
- More commonly the additional storage capacity will reduce the severity of water restrictions when water allocations to the towns are cut as a result of the storages in Lake Burrendong drawing low but not empty as would occur under the worst case scenario.
- The new storages minimise system losses and will potentially free up some 1500ML/annum of the current allocation for usage by the towns' water supply.
- The storages add increased flexibility in terms of how the channel (or whatever other transport mechanism is used) may be operated. For example it will take longer to fill the additional storage capacity and it will mean that the channel can be operated less frequently and potentially at a minimum in the peak evaporation periods although the latter would require most of this additional storage capacity be built.
- They provide some protection if there was to be a major blue green algae outbreak in the river or some other reason that may deny short term access to the river, such as a failure of the channel.
- The current weir pool arrangement is silting up with a significant decrease in capacity since 1983 as identified by other independent expert studies on this water supply system. It is possible that some dredging of the storages on a semi regular basis will assist with increasing storage volume. However the losses inherent in the weir pools will remain.

Weakness of this Option

The following factors mitigate against pursuing this option as the single solution:

- The soils in the likely areas around Nyngan may not be ideal for water storage and may require additional provisions to ensure that the water tightness of the ground materials and avoid percolation of the water into the subsoils. Hence this will add to the costs of the storages options.
- It is difficult to procure sufficient area near where the current transfer headworks for the ultimate levels of water storage required and further headworks will be required with these additional storages which will also add to the cost.

- 5,890 ML of in ground storage will not necessarily be a cost effective solution.
- The total reliance on the storages will still see significant losses occurring in the channel and as such there will still exist the problem of getting the water to the much improved storage component.
- The storages have a significant surface area when they are full and are prone to significant evaporation in the warmer months.
- In a prolonged drought allocations may be cut significantly for a long period of time before a worst case scenario occurs and it may prove difficult if not impossible to secure additional water through water trading. As such the storages may not be full when required reducing the security they were meant to provide, although this should be overcome by developing effective operating protocols and monitoring longer term weather indicators such as the Southern Oscillation Index.
- Cleaning, operating and maintain these storages along with the costs of operating the headworks will add to the overall costs of operating the bulk headworks on an annual basis.

The NSW Urban Water Service Report on potential secure yields for the region concluded that additional storages needed to be part of the final solution but that it was not the only solution to providing greater security for the Nyngan – Cobar Water Supply.

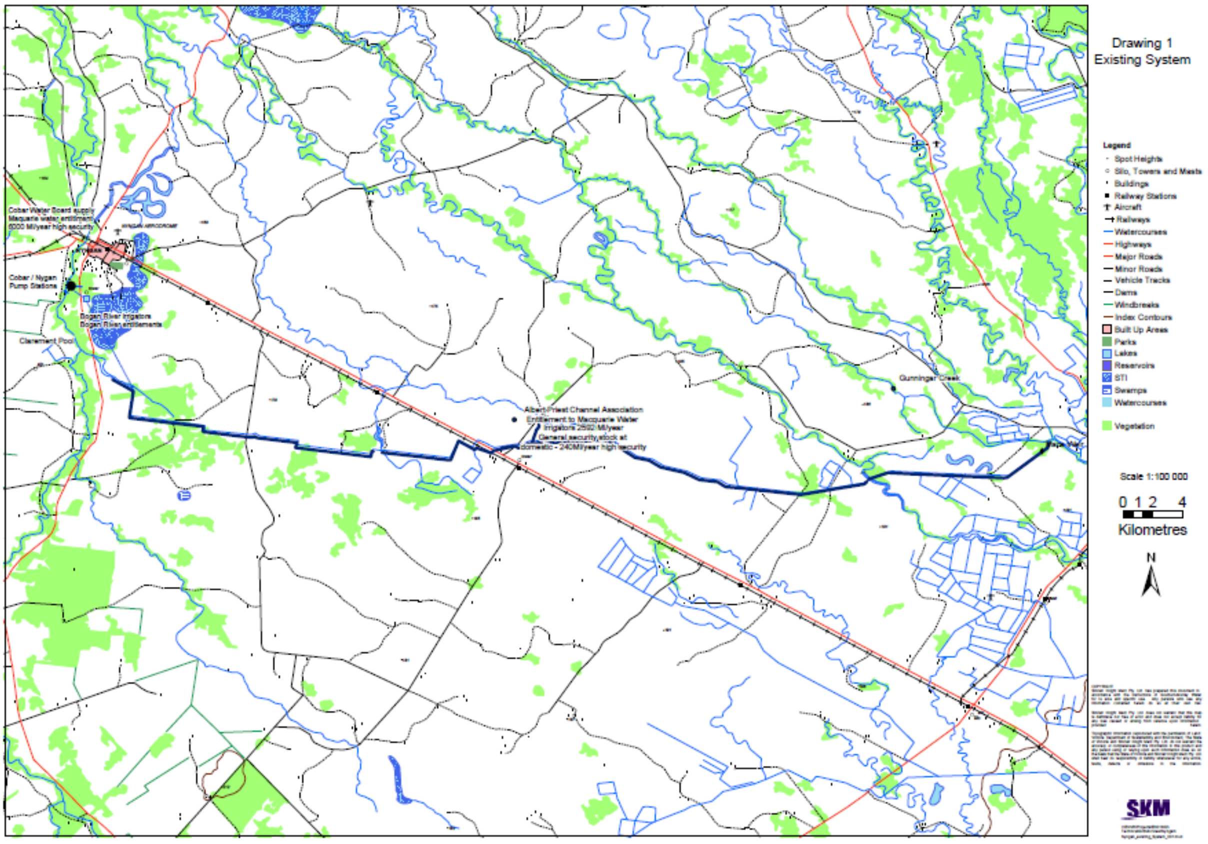
4.1.2 Improvements to the Water Transport System

Improvements to the water transport system include:

- Line the channel
- Replace the channel with a pipeline.
- Purchase further water allocations from the Macquarie River as they become available.
- Maintenance and renewal of pipework to minimise the risk of pipe failures.
- Minimise the number of times the channel is utilised each year and if possible avoid the use of the channel in the warmer months when evaporation is at its highest.
- Secure an easement over the channel or pipeline.
- Potential solar power addition station addition to the pipeline pumping station to offset the Greenhouse Footprint and power costs.

It is recognised that in a region where water is so scarce, many operational aspects are already being implemented, nevertheless they are listed here to ensure this is a more complete business case.

Figure 10 – Route of the Albert Priest Channel (Source SKM 2005)



4.1.2.1 Line the Albert Priest Channel

This option includes the complete reconstruction and lining of the channel with a HDPE liner, similar to the treatment for irrigation channels. This option was examined in the 2013 business and was seen to having too many weaknesses in comparison to the few benefits offered and was rejected as a meaningful option. As a result this option is not evaluated in this business case.

A brief summary of these strengths and weakness are set out below for the purpose of record within this business case.

Strengths of this option

- Reduced infiltration losses in the channel particularly when the channel is brought back on line again after a period of non-usage.
- Liners are a much lower cost than concrete, which would be unaffordable.
- Reduced maintenance in terms of grass/weed growth in the channel.

Weaknesses of this option

- This is an expensive option with less benefits than a pipeline.
- Australian native animals have the capacity to great damage to the liner material and as such the channel has to be fully fenced on both sides.

- Maintenance costs (particularly those associated with maintaining the fences) will be extremely high and potentially unaffordable for the small rate base attached to this region.
- The liner does not address the evaporation losses in the 67 km kms of channel which are potentially just as high as any percolation loses
- The fabric potentially only has about a thirty year useful lifespan in Australian conditions and as such does not meet the requirements of what is wanted in the project that is seeking assets that will have closer to a 100 year life span.

Figure 11 – Example of a channel liner near Trangie. Full fencing is essential

4.1.2.2 Replace the Albert Priest Channel with a pipeline

Under this option a pipeline would be laid near the existing channel as the channel would need to be left in operation until the new pipeline was constructed. The pipeline could be either gravity based or fully pumped or some combination of the same.

The adoption of a pipeline offers 365 day a year 24 hour a day flexibility in terms water availability and the potential to alter the way water has been used both in terms of the town water supplies but also in terms of the irrigators and the stock and domestic users. As such it has the potential for this latter group to increase their water based output significantly but this will require some change in practices as part of the future or longer term benefits associated with the pipeline option.

Strengths of this option

- The construction of pipeline will allow a small water source such as a ground water supply to be pumped to Nyngan. Such a small supply would not be able to be conveyed in an open channel.
- The pipeline would effectively eliminate all but very small loses in the transportation of the water to Nyngan potentially giving back a further 2,000 ML/annum of the existing water allocation from the Macquarie River.
- Modelling by NUWS including the new storage shows that when a pipeline is added, water security rises to around 2,900 ML/annum. When the second 700 ML storage is constructed the secure water yield will rise further to around 3,500 ML/annum. This initial increase results in an increase of over 100% over the existing system and the second representing an increase of 143%.
- The pipeline allows for greater flexibility in the usage component for both the urban water supplies and the landholders, who also currently draw from the channel.
- Correct choice of pipe materials and good pipelaying should see an asset with a 100 year type of time frame avoiding the need for to frequent capital replacement or high depreciation rates that make the scheme unaffordable to the residents.
- A pipeline's capacity can be increased with greater pumping capacity if there was to be a greater than expected growth. Indeed the flows through the pipeline can be moderated to ensure water is always available in the pipeline and after any period of nil flow in the Macquarie River the increased pumping capacity will assist to more rapidly fill the storages.
- The operating costs for a pipeline that is appropriately designed should be affordable to the existing communities.
- If the channel was to be filled in then the landholders should be able to reclaim some of their property for farming purposes and as such it is anticipated that it should prove easier to get landholder signoff on an easement over the pipeline than over a channel.
- It should allow flows from the Macquarie River to be transferred when only very small amounts of water are available in terms of flow down the Macquarie River, without the wetting and percolation losses associated with the channel.
- The pipeline will be available to the landholders to meet their needs when the town storages are full, further contributing to this more efficient use of water by this sector. At present they need Bogan City Council as the channel operators to order water on behalf of all channel users with the Nyngan storages taking priority.
- The pipeline should avoid the current operational need to drive the length of the pipeline twice a week when it is operating to ensure the channel is operating as it should.

Weaknesses of this option

- The high cost to construct a pipeline and any supporting pumping facilities. A new pipeline is beyond the capacity of the current ratepayers to fund and can only proceed with funding assistance.
- Any pipe breaks may not be visible given the route and length of the pipeline and some water could be wasted if there was a pipe break. However pressure gauges on the pipelines as well as flow gauges should indicate such a break and this weakness should be easily overcome.
- There will need to be a small store of pipes maintained to ensure that any break in the pipeline can be rapidly fixed.

The NUWS report saw a pipeline as part of the longer term water security as it significantly increased water security and released a significant proportion of the current allocation, minimising the need to procure additional water.

This business case strongly supports the need for the construction of a pipeline, not only from the benefit of the water saved, but from the perspective of:

- The much increased water security with a workable long term solution to security for a difficult to serve region, particularly when coupled with the additional storage being suggested.
- The potential paradigm shift in terms of water use efficiency for the land holders and the longer term ability to increase productivity with the same volume of water.
- It allows the element of a ground water source near the Macquarie River to add further to the overall water security package for the region as this would not be possible without a pipeline.
- It allows the storages to be filled more easily without loses and as such is part of a composite solution.
- It gives back to the towns a significant part of their current allocations.

The adoption of a pipeline rather than a channel represents a significant change for the landholders. In this process there will be a need to explain to the landholder how the pipeline will work and take on board their feedback in this process. This consultation can commence immediately.

Subject to funding assistance being secured to construct the pipeline, the negotiations with the landholders will continue throughout the entire process and even after the construction is completed as set out in the project management plan.

4.1.2.3 Operational Improvements

Minimise pipeline breakages

One of the current Cobar pipelines is reaching the end of its physical life with a high number of pipe breaks in relatively remote areas given this is a 130 km pipeline. Clearly any break has the potential to discharge water for some time and waste the current allocation. Cobar Water Board has secured funding to replace part the worst section of this main and will be looking to secure further funding to replace other critical sections in the future. It is also improving its operational procedures to ensure all such breaks are dealt with as quickly as possible to minimise any water losses. As such all would appear to be in hand in respect to this matter.

Minimise any Channel Failures Blockages

Bogan Shire Council already has an extensive program in place to maintain the channel with spending of up to $200,000 per annum to ensure that the channel is well maintained. If funding is achieved for a pipeline then these funds will be moved into maintaining and operating the pipeline with the potential energy costs being the highest element.

Minimise the Number of Channel Operations each Year

Bogan Shire Council, as the channel operator, currently minimises the number of times the channel is operated to avoid pre-wetting losses. The ability to do this is constrained by the limited storage capacity at Nyngan and the need to also meet the needs of other channel users. When the storages are near full water extractions from the river are ceased to avoid overflowing the current weir pool with the remainder of the water in the channel catered for at the time of ceasing the extraction.

It should be noted that these extractions are pre ordered from Water NSW so that flows in the Macquarie River (to accommodate these extractions) are appropriately modulated.

The new 700 ML storage (Stage 1a) will require fewer operations of the channel, as each operation of the channel will run longer in order to fill the storage. The limited capacity, however, may mean that storage needs to refilled over the hot summer period. New operation protocols will need to be implemented.

Secure an Easement over the Pipeline

The current operation of the channel has occurred amicably through mutual interest but landholders have traditionally been somewhat reluctant to provide agreement to a full easement being taken over such a large structure which involves much of their land. A deeper pipeline that allows some farming activities above the pipeline may assist in acquiring an easement. Ideally, the easement should be acquired prior to construction, however, if this becomes protracted, entry to properties may be facilitated through a permit to enter.

Optimal Operation of the Pipeline

The pipeline will be sized to meet known future flow requirements and will be designed to allow for some gravity operation when pumping is not required to minimise the greenhouse footprint and overall operational cost. In those initial years operation of the pipeline may be able to minimise the power costs but it is recognised that some pumped operation will be required to ensure an appropriate self-cleaning velocity in the pipe is achieved

Knowing when to extract water into the pipeline to minimise sediment transport is another element that requires consideration and will be a key component of an operation manual for the new system.

It may be possible to pump the pipeline during the daylight hours and allow gravity overnight and such an arrangement would be ideal for a mini solar array to generate the power required to operate the pumps. It is proposed to review the operation of the pipeline over the first few years and determine if there is value in pursuing such a solar arrangement.

4.1.3 Purchase Further Water Allocations when they Become Available

Under this option the local water utilities and the mines would collectively purchase additional water allocation when it becomes available recognising that this could take some time.

Strengths of this option

- This would mean that if there was in any year to be decreased Water NSW allocations for the Macquarie River water then the Councils will have collectively increased the water available to them. This would result in less need to pursue additional water under water trading arrangements when these allocations were reduced.
- The additional allocations may reduce the levels of water restriction the towns are likely to face, in any initial reductions if the longer term forecasts indicated this was likely to be a relatively temporary situation and thus sort term restrictions other than at minor levels could be avoided.
- The vagaries of the availability of water on the water trading market would be reduced particularly if the size of the allocations were decreased for an extended period of time.
- The increased allocations may make it easier to fill the new storages when required as there will be more allocation available in the scenario where these storages are critical, and the purchasing of additional water may be more difficult if not impossible such as in critical drought years,

Weakness of this option

The following factors would seem to argue against pursuing this option further:

- The cost of the additional allocations are significant for the type of water security being sought. The water utilities may need to procure lower security water and have it converted to a higher security which will see the purchased volumes shrink considerably.

- If the pipeline and storages options are constructed, then much more of the current river allocation will be available to the Council's for use and this may be sufficient to meet the demand in most years. Hence the additional allocations will represent wasted expenditure.

- It will only be those years when there is a prolonged reduction in allocations when these additional allocations will be required and as such Council will have unused allocation that arguably could have been used for economic benefit elsewhere.

- In those years when the increased allocations are not needed then the water can be traded or on sold but the government generally frowns on local water utilities trading in water. The on-selling of the water will mean that in those better years is available for agricultural production so that the region derives the maximum possible benefit.

- The availability of these allocations is somewhat limited and the collection of additional allocation will take a considerable time. Potentially there may be some commercial arrangements that the Local Water Utility can enter into with other high levels of water security but this is considered unlikely at this time.

This business case proposes that the need for additional allocations will be pursued by the channel users after the pipeline and storages are constructed as part of their ongoing contribution to regional water security. It is proposed that a separate financial and risk study will be completed by appropriate experts in this area to better quantify the costs risks involved and make further recommendations to licence holders.

4.1.4 Additional Water Sources

4.1.4.1 Groundwater

Studies to date have indicated that there may be additional ground water available near Warren at much deeper levels that the current aquifer that supplies the township. $500,000 in funding is sought to enable this possibility to be confirmed. These studies will establish a cost estimate for additional bores and the pipework required to join this supply to the new pipeline to Nyngan.

Flows from this source are not likely to be large but under emergency conditions will provide sufficient flows particularly with the additional storages to avoid a worst case scenario. For example the NUWS modelling indicates that under flows on 4.1 ML per day when added to the pipeline and the additional storages should provide 4,390 ML of secure yield. Increasing that extraction to 9.5 ML/day should increase this secure yield for the overall system to 5850 ML/annum thereby meeting future requirement needs. However this is subject to confirmation that these flows can be sustained from a deeper aquifer and that such an aquifer can be readily recharged in sufficient time for it to be available when called upon. Some of the aquifers represent quite old water and the proposed study should clarify all of this.

A pipeline is essential to convey water obtained from the borefield. Without a pipeline, the borefield will be of limited value because only a small percentage of the extracted flow would make it along the channel to Nyngan. Most of the water will be lost along the channel route if this is the only flow in the channel. This will certainly be the case with the 4.1 ML /day extraction and possible the same with the 9.5 ML per day extraction.

This water would not often be required and the bore would need to periodically pump into the Nyngan or to supplement the Warren Systems system just to ensure that both the pumps and the bores will be operational when required.

4.1.4.2 Recycled water

Reuse of effluent is not at this time considered a viable option due to the small volumes involved and the distances it needs to be transported to be successfully reused in the urban areas. It would be better if that effluent could be redirect to an adjacent agricultural reuse that accommodated for the quality of effluent produced. Cotton growing is one example of where this source may be reuses or potentially other non-consumable type crops. Similar comments would apply to stormwater reusd given the flat nature of Nyngan and the very high costs associated with harvesting this water. There is some harvesting occurring in Cobar but again that is limited and these aspects will be considered on site specific basis over the next century to better define the roles they will play.

4.1.5 Other matters to be considered – Environmental flows and the Bogan Weir Pools

Background studies in support of this business case have identified that the Nyngan Weir Pool is home to the endangered olive perchlet and every reasonable effort must be made to protect these fish. Similarly the overall weir pool has considerable wetland value as well as social value in terms of community desire to see these pools/wetlands protected.

This "protection" has historically been done through the town's water supply and it should be readily argued that this is inappropriate in a river where over 70% of the 1,450,000 ML of annual flow is reserved for environmental flows. It would seem appropriate that up to 500 ML of the Macquarie River environmental flows should be set aside for this environmental protection in Nyngan. This allocation represents only 0.04% of the total environmental flows in the Macquarie River and as such is hardly significant. In those years where the Bogan River does flow this water would not be used and would simply flow into the Macquarie Marshes as part of the overall environmental allocation for that body of water.

The 500 ML figure represents around 56% of the evaporation from the Nyngan Storages in a significant drought year (as noted in the NUWS Report) and this figure is thus a conservative estimate of what should be sufficient to provide enough water to protect the olive perchlet for these short term emergencies. Increased water flows in other years should allow the weir pools to gain further depth and better protect the fish as well as preserving the overall wet lands.

Studies have also established that the current storages are suffering siltation problems and some periodic dredging to ensure that this storage capacity remains would seem appropriate, However these are sensitive wetland areas, there are endanger fish species involved and there is also the potential that inappropriate dredging could lead to increase seepage losses. Thus before any dredging is done it is recommended that a detailed study be carried out by an appropriately skilled and experienced organisation to determine just what can be achieved to address this problem. It is therefore recommended that $150,000 be set aside for such a study (with this cost covering some soil sampling that may be required).

4.2 Preferred Option – A staged approach to water security

4.2.1 Findings of the NUWS Water Supply System Modelling Report

The NUWS report nominates a hydrological solution to meet the future demand for 5,850 ML/annum. This solution includes

STAGE 1 – STORAGES - 1400 ML of off stream storage (including the 700 ML storage that is funded and is scheduled for construction in 2017). Three storages are discussed in this business case:

- **Storage 1a -** 700 Ml off-line storage at Nyngan
- **Storage 1b -** Additional 700 Ml off-line storage at Nyngan on adjacent site to Storage 1a
- **Storage 1c -** Additional off-line storage on a site to be determined

STAGE 2 – PIPELINE - A new pipeline to transfer up to 25 ML per day to replace the Albert Priest Channel

STAGE 3 – BOREFIELD - A new borefield at Warren to deliver 9.5 ML/ day via the Albert Priest Pipeline.

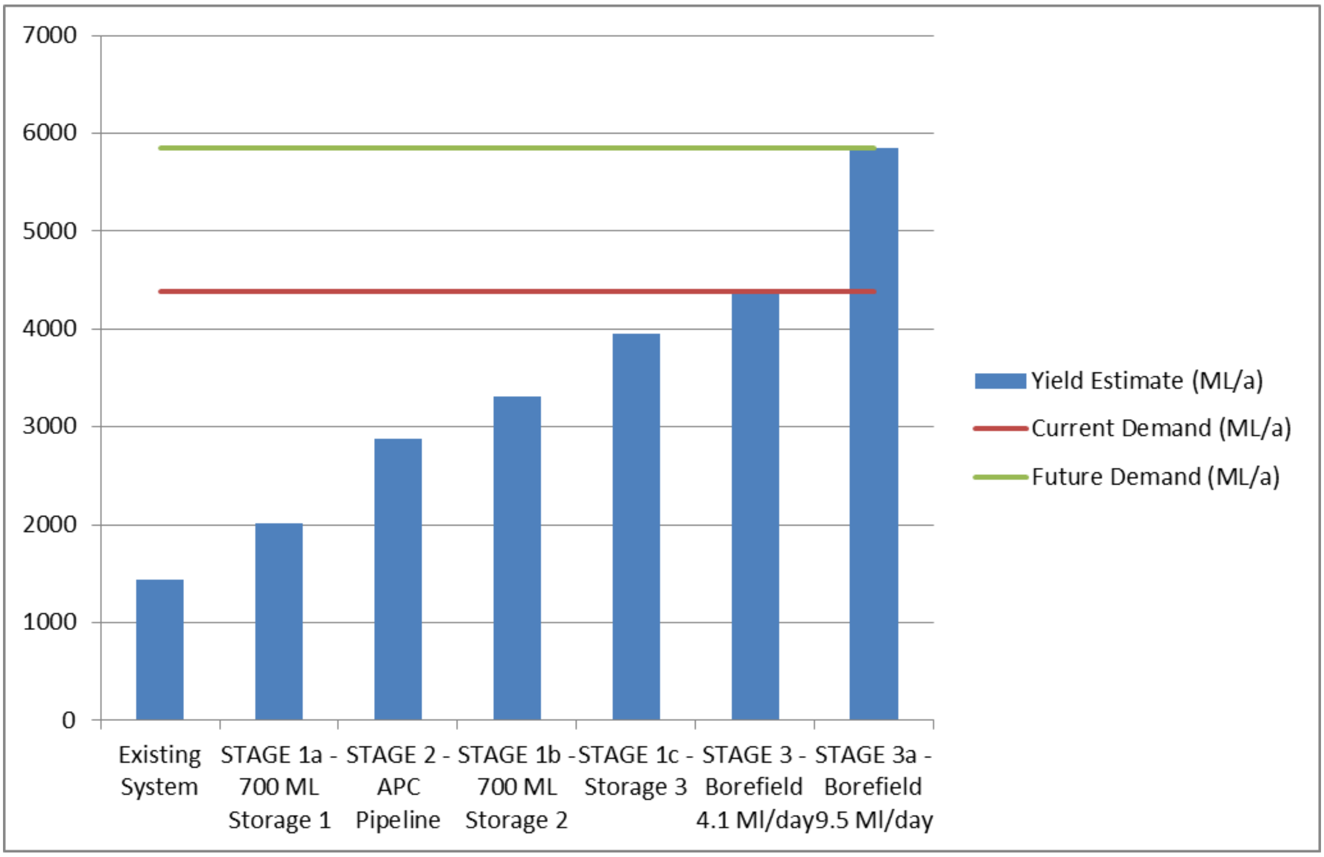
The proposed storages seek to provide 1,400 ML of off-line storage. An arbitrary storage of 2000ML was used in the modelling exercise. The report comments on Page 12 that even with three proposed storages totalling 2,000 Ml, this is well short of providing the future or current demands on a secure yield basis (defined by the 5/10/10 rule).

The estimated storages to meet the current and future demands on a secure yield basis were 4,440 and 8,590 ML respectively. A further option is therefore to construct an **additional** 3,000 ML storage, on a site to be determined. Large storages (to satisfy the secure yield for current and future demands) may not provide the optimum solution due to seepage and evaporation losses, and may not provide water security if the drought continues much longer than the modelling assumed. Therefore, piping the Albert Priest Channel and bores near Warren are essential elements of the total water security solution.

The water security solution requires a staged approach. This business case examines five stages, as shown in Table 1.

The secure yields[2] from each stage are illustrated in Figure 12. The information is sourced from Table S1 of the Urban Water Services Report, and excludes greenhouse effects and installation of a temporary weir in the Bogan weir pool.

Figure 12 – Secure yield estimates for each stage (source Table S1 Urban Water Services Report)



The economic analysis closely examines Stages 1a, 1b and 2, however does not include the capital costs associated with a borefield at Warren or the third storage on a new site (Stages 1c & 3). The merits of these future options are discussed and a recommendation is included to allocate funding to undertake further investigations on them to include them in the economic analysis. There is insufficient information to include any capital costs associated with Stages 1c & 3.

[2] Note that the secure yield is the amount of water that can be reliably delivered in the majority of years according to the '5/10/10' rule. In some years significantly more water may be available for use.

4.2.2 Description of Stage 1a

The 700 ML off stream storage is considered as Stage 1a. This storage is expected to supply water to the towns and mines of Nyngan and Cobar in the event of low allocations in the Macquarie River. The Concept Design Report from Public Works (October 2015) describes the project as follows:

> *A 700ML off river storage is proposed for Nyngan to secure the town water supply. Site 1 has been selected finally based on economic, engineering and environmental factors. Site 1 has been subject to a moderate level of disturbance with tree clearing and a history of grazing. There are a few scattered trees on the site and vegetation clearing would be dependent on the final dimensions of the storage. Ecological studies have determined that many of the larger trees on and around Site 1 are "significant" which means that they are to be mostly preserved.*
>
> *Geotechnical investigations have indicated that generally at Site 1 the upper 7m of the profile comprises silty clays and clayey silts of hard consistency. These sediments are considered to be practically impervious both, in-situ and in a remoulded state. The site is considered most suitable for construction an in ground storage of the cut and fill type.*
>
> *The preferred storage arrangement incorporates a rectangular floor plan area of 340m by 225m and water depth of 8 metres. A 20m wide spillway is provided with sill at full supply level. Internal and external embankment slopes are 1v to 3h. A 4m wide gravel pavement is proposed on the embankment crest, the external slopes are topsoiled and grassed while the internal slopes are protected with rip rap. The embankment is generally homogeneous in section, constructed with clays and silty clays obtained from onsite excavations. Gypsum stabilisation will be applied to the embankment inner slopes and storage floor.*
>
> *The spillway and downstream slope areas are lined with rockfilled mattressing as is the toe drain that extends around the storage at the base of the external embankment slope. .*
>
> *A DN 800 pipeline passes under the storage embankment and is concrete encased. The pipeline leads to a new water transfer pumping station (wet well type) adjacent to the existing Nyngan Raw Water Pump Station.*
>
> *A cost estimate for construction of the in ground storage and associated works has been prepared based on site survey, geotechnical investigations and concept design. Cost savings*
> *have been achieved by:*
>
> - *The use of locally available materials and optimisation of cut and fill volumes in*
> - *construction of the in ground storage;*
> - *Provision of a single inlet/outlet pipeline and one wet well type pump station and pump*
> - *arrangement that allows transfer of water from the Bogan River to the storage and return*
> - *the flows back to the river by gravity;*
> - *No requirement for power supply to the proposed storage site;*

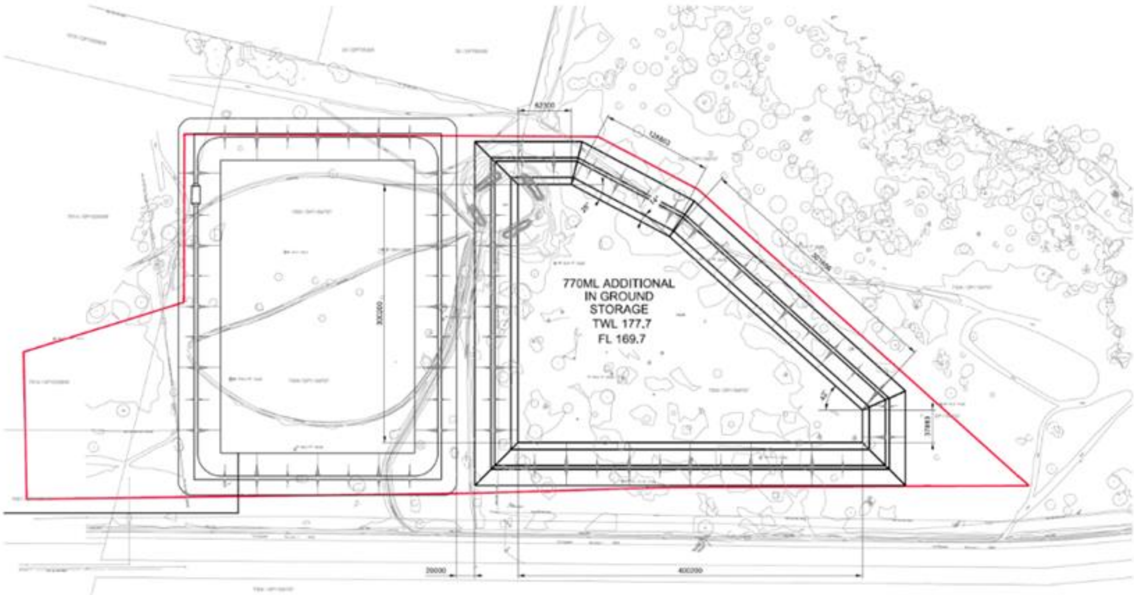
- *Alignment of the inlet/outlet pipeline mostly in open road reserve;*
- *Use of the existing Nyngan Raw Water Pump Station building to house the new switchboard.*

Figure 13 – Locality Plan of Storage 1a (Source Public Works)

4.2.3 Storage 1b

The additional 700 ML off stream storage is considered as Stage 1b. The storage will be located adjacent to Storage 1a and is shown in Figure 14. Headworks for this storage will be constructed as part of Stage 1a, and minimal extensions to pipework will be required.

Figure 14 – Locality Plan Storage 1b (Source: Public Works Concept Design Report)



4.2.4 Storage 1c

An option for an additional 3,000 ML of storage is recommended as part of the water security package. A location of this storage has yet to be considered, and it is possible it could be located on private land along the pipeline route. The storage may best be located near the borefield in order to reduce costs of transporting this water to Nyngan except when needed during the worst of droughts. In this way, evaporation could be replenished using the borefield pumps.

This business case includes a request for $500,000 funding for further investigation of the additional large storage option. Construction costs have not been determined, but could be as high as $30M. Extensive consultation with landowners and environmental studies will be required.

4.2.5 Stage 2 – Piping of the Albert Priest Channel

The May 2016 report from NSW Public Works analyses seven options, with variances on several of the options. The options are summarised in .

Table 5 – Summary of pipeline options

Pipeline Option	Description	Delivery Capacity	Capital Cost $M
1A	1200mm dia. 63 km long pipeline inside channel	Gravity flow of 55 ML/d	83.67
1B	1200mm dia. 63 km long pipeline outside channel	Gravity flow of 55 ML/d	93.86
2	1000mm dia. 63km pipeline with a pumping station at Warren	Gravity flow of 32 ML/d and increasing to 55 ML/d via a new pumping station	75.21

Pipeline Option	Description	Delivery Capacity	Capital Cost $M
3	750mm dia. 63km pipeline with two pumping stations	Pumping 32 ML/d with a single pumping station at Warren and then increasing to 55 ML/d with an additional intermediate pumping station near the Mitchell Highway crossing near Nevertire	63.33
4A	1000mm dia. 63 km long pipeline inside the channel	Gravity flow of 32 ML/d	61.02
4B	1000mm dia. 63 km long pipeline outside the channel	Gravity flow of 32 ML/d	63.81
5	750mm dia. 63km pipeline with a pumping station at Warren	Pumping 32 ML/d via a new pumping station	56.86
6	900mm dia. 63km pipeline with a pumping station at Warren	Gravity flow of 25 ML/d and increasing to 44 ML/d via a new pumping station at the intake	68.31
7	Pipeline along the APC and Mitchell Highway	Option dismissed	

The Public Works Report provides technical commentary of each option. Commentary on the preferred options 2 and 6 is reprinted below:

> ***Option 2*** *- Gravity flow of 32 ML/d and increasing to 55 ML/d via a new pumping station (1000mm dia. 63km pipeline with a pumping station at Warren). Capital Cost $75.21 M.*
>
> *Option 2 has the lowest NPV at a 7% discount rate for a 50 year period and the second lowest annual operating cost. The annual costs in Option 2 are based on gravitating 6,000 ML/yr at a maximum rate of 32 ML/d and pumping the remaining 3,000 ML at a rate of 55 ML/d. Siltation is a significant problem in raw water gravity pipelines and de-silting or flushing of large pipelines is a difficult and expensive task. However, in Option 2, the pumps could operate regularly avoiding siltation of the pipeline. The pumping rate of 55 ML/d would ensure a velocity of 0.8 m/s which is higher than the self-cleansing velocity requirement of 0.6 m/s.*
>
> ***Option 6*** *- Gravity flow of 25 ML/d and increasing to 44 ML/d via a new pumping station at the intake (900mm dia. 63km pipeline with a pumping station at Warren). Capital Cost $68.31 M.*
>
> *Option 6 assessed the implications of providing a smaller diameter pipeline than that adopted in Option 2. Option 2 requires a 1000mm diameter pipeline to discharge 32 ML/d by gravity with a single pumping station at the intake to increase the flow to 55ML/d. A 900mm diameter gravity pipeline can deliver 25 ML/d by gravity and the flow can be increased to 44ML/d with a single pumping station at the intake. The 44 ML/d represents a velocity of 0.8 m/s allowing the self- cleansing of the pipeline during pumping.*

The Affordability Analysis in Section 6 of this business case loosely evaluates the life cycle costs of these options. **Appendix B details the analysis of the long run costs for both pipeline options 2 and 6 and demonstrates that Option 2 has the lowest long run cost for pipeline users. Option 2 is the preferred pipeline option.**

4.2.6 Stage 3 – Borefield at Warren

The Public Works Report on Page 27 comments briefly on the groundwater option:

> *During a severe drought situation, if the supply from the Macquarie River into the APC is limited, then the feasibility of connecting a bore water supply into the proposed APC replacement pipeline has been investigated. Hydro-geological studies to identify potential bores and yields etc. have not been conducted yet and hence for this assessment a hypothetical bore field has been assumed to obtain 9ML/d (as advised by the Client). The bores are assumed as located 0.5km apart and in the vicinity of the Macquarie River. The existing bores in the Warren area are approximately 30m deep yielding about 1 – 1.5ML/d and therefore the hypothetical bores have also been assumed as 30m deep with a yield of 1ML/d each.*

Anecdotal information supplied by DPI Water indicates that to obtain 9.6 ML/day, a string of bores at 2 km intervals will be required. To test this, it is recommended that two test production bores and two additional observation bores be installed.

This business case includes a request for $500,000 funding for further investigation of the borefield option.

5 Strategic Assessment

5.1 Consistency with Government Policy and Strategic Plans

The staged water security projects align with national, state and regional polices and strategic plans. Table 6 is an assessment of this project that demonstrates excellent alignment and consistency with government policy and state, regional and local plans.

Table 6: Alignment with Government Policy and Strategic Plans

	Objectives and purpose	Statement demonstrating consistency with the objectives and purpose
STATE Restart NSW Fund Act	Section 6 of the Restart NSW Fund Act 2011 states the purpose of the Restart NSW Fund is to improve economic growth and productivity in the State. For that purpose it includes infrastructure projects that will improve the economic competitiveness of the State (including the movement of freight, inter-modal facilities and access to water).	The application is for the construction of water security infrastructure, including two 700 ML storages and a 65 km pipeline to replace the Albert Priest Channel. The project is essential and will improve water security in an important region of the state that contribute $415M of gross regional product to the state and nation's economy. The economy of Nyngan and Cobar is reliant on the following industries: • Mining (46% of value added and 35% of FTE employment) • Agriculture (7% of value added and 15% of FTE employment) • Public Administration (5% of value added and 6% of FTE employment) The economic opportunities that will be enhanced will be: • Continued development of mining and agriculture. • Value-adding to agricultural output through the Food & Beverage Manufacturing sector.
STATE Water Security	Compliance with the 5/10/10 water security guideline that requires ▪ Restrictions should not be applied for longer than 5% of the time; ▪ Restrictions should not be imposed more often than once every 10 years on average;	The staged approach to water security is designed to meet the 5/10/10 rule. The May 2016 NSW Urban Water Services Pty Ltd report ("Nyngan and Cobar Water Security Project – Water Supply System Modelling" Report No 14009) nominates a hydrological solution to meet the future demand for 5850 ML/annum. This solution includes STAGE 1 – STORAGES - 1300 ML of off stream storage (including the 700 ML

	Objectives and purpose	Statement demonstrating consistency with the objectives and purpose
	▪ The water supply system should be able to supply 90% of normal demand.	storage that is funded and is scheduled for construction in 2017). Three storages are discussed in this business case: • Storage 1a - 700 Ml off-line storage at Nyngan • Storage 1b - Additional 700 Ml off-line storage at Nyngan on adjacent site to Storage 1a • Storage 1c - Additional off-line storage on a site to be determined STAGE 2 – PIPELINE - A new pipeline to transfer up to 25 ML per day to replace the Albert Priest Channel STAGE 3 – BOREFIELD - A new borefield at Warren to deliver 9.5 ML/ day via the Albert Priest Pipeline.
STATE Alignment with NSW 2021 Plan	**Goal 3 - Drive economic growth in regional NSW.** **Target**- Increase the share of jobs in Regional NSW. **Priority action** Invest in regional infrastructure. **Goal 19 - Invest in critical infrastructure.** **Target** – Increase investment in regional infrastructure. **Priority Action** – Major strategic infrastructure delivered as a priority as promised. **Goal 21 - Secure potable water supplies.** **Target** - Secure long term potable water supplies for towns and cities supported by effective effluent management. **Priority Action** - Improve the long term security of town water supplies	Nyngan and Cobar The region has a GRP of around $415M and contributes a labour force of 4,519 persons to the economy. The economy of Nyngan and Cobar is reliant on the following industries: • Mining (46% of value added and 35% of FTE employment) • Agriculture (7% of value added and 15% of FTE employment) • Public Administration (5% of value added and 6% of FTE employment) The economic opportunities that will be enhanced will be: • Continued development of mining and agriculture. • Value-adding to agricultural output through the Food & Beverage Manufacturing sector. Secure water supply is critical to this ongoing growth and development, and that water is provided through the Albert Priest Channel. 25% of water is lost along this channel, and failure to provide water in a severe drought with have catastrophic consequences on the regional economy, because mining activities may need to be mothballed.
STATE State Infrastructure Strategy December 2012	Page 4 of the document discusses short-term initiatives (years 0-5) *The NSW Government currently plans capital spending of $74.9 billion across the general government sector and public trading enterprises over the five years from 2011/12. Of this … $23.9 billion (32 percent) is for electricity and water.*	The business case supports the objectives of expenditure on water infrastructure.

	Objectives and purpose	Statement demonstrating consistency with the objectives and purpose
	Infrastructure NSW does not make specific spending recommendations for this period. Page 5 of the document discusses the importance of targeting infrastructure to meet needs in each region *Regional NSW is the largest and most diversified regional economy of any State in Australia. Over a third of the NSW population lives and works in the regions, contributing around a quarter of the State's economic output. The continued development and support of regional infrastructure benefits the NSW economy as a whole and should not be looked at in isolation from metropolitan infrastructure. Low population densities and ageing demographics make infrastructure investments more challenging in some areas than others. The NSW Government has identified the following infrastructure priorities for regional NSW…• improve water quality and security.* Page 18 of this document discusses strategic priorities: *"Over the next 20 years, the Government's strategic priorities will focus on* *• Continuing to support and invest in non-metropolitan urban water supply: Ensuring that our regional and rural communities have a safe, affordable water supply that meets necessary health and environmental standards, and examining options to reform the current governance structure.* *• Maintaining and securing infrastructure for water storage and delivery: Ensuring that communities and water users have access to adequate and secure water supplies.*	The staged approach to water security for Nyngan and Cobar is essential to secure the future of the regional economies. This project is essential to the ongoing viability of Nyngan and Cobar
REGIONAL RDA Orana Infrastructure Plan – Qualitative Infrastructure Assessment and Prioitorisation -	The RDA Orana Infrastructure Plan, completed in June 2106 analyses infrastructure prioirties across the Orana: *"The purpose of the project is to provide RDAO with information on the issues and development priorities for the Orana region, identify a shortlist of possible infrastructure investments and undertake an analysis of their relative merit. This would support funding decisions and enable RDAO to articulate the infrastructure priorities for the region to stakeholders and key decision makers."*	The plan identified water reliability and security as a key priority for Orana. This aligns with the priority that NSW gave water supply and security in its 2014 State Infrastructure Strategy. The Government has committed to a $1 billion program of investment based on economic need for enhanced water security across the state. The Albert Priest Channel water supply Pipeline is ranked as the highest "strategic fit" ranked water infrastructure priority in the Orana

	Objectives and purpose	Statement demonstrating consistency with the objectives and purpose
June 2016		
REGIONAL Joint Integrated Water Cycle Management Evaluation Study, 2010	The Joint IWCM Regional study identifies strategies for Bogan Shire Council and Cobar Shire Councils: A detailed strategy is recommended for Bogan Shire Council. *To address their IWCM issues, the following recommended actions are expected to be adopted by Council within the next 10 years.* • *To address water supply security to Nyngan due to water losses in the Albert Priest Channel (APC) and weir pool and infrequency of flows in the Bogan River piping of the APC is the desired option.* • *To address limited potable water storage at Nyngan to cover emergencies, the likely options will involve investigation of construction of an additional service reservoir and a local ground tank in conjunction with the APC pipeline project.* A detailed strategy is recommended for Cobar Shire Council. *To address their IWCM issues, the following recommended actions are expected to be adopted by Council within the next 10 years.* • *The Cobar water entitlement is inadequate. The estimated water transfer loss in the APC is approximately 50%. Historical water production at Cobar has exceeded 50% of entitlement for several years. To address this issue Council will work with the NSW Office of Water to increase the water access licence entitlement and/or Council will work with Bogan Shire Council and NSW Office of Water to implement piping of the APC.*	The staged water security projects detailed in the business case are essential to the region's Integrated Water Cycle Management. The importance of a collaborative approach between Bogan Shire Council, Cobar Water Board, and governments is highlighted in the Lint IWCM evaluation study.
LOCAL Nyngan Community Strategic Plan	Section 3.5 of Bogan Shire Council" "Community Strategic Business Plan discusses the importance of water infrastructure strategies and emphasises the importance of the water security. *Section 3.5.1 "Provide a financially viable, efficient, permanent potable water supply that has sufficient capacity for current and projected growth requirements"*	Water security is a high priority for Bogan Shire Council.
LOCAL Cobar Community Strategic Plan	Section 4 of the Cobar Shire Council's Community Strategic Plan, "Cobar Shire 2025" discusses infrastructure strategies and emphasises the importance of the water supply: *"Access to an adequate, good water supply is critical for our community, from a*	The project is top priority in the Cobar Shire Council's Community Strategic Plan, "Cobar Shire 2025".

	Objectives and purpose	Statement demonstrating consistency with the objectives and purpose
	social and health perspective, and for industry operations. We live in a dry climate, where water restrictions significantly impact on our quality of life and our infrastructure." Strategy 4.1.4 nominates the piping of the Albert Priest Channel as the highest ranked strategy to achieve a community outcome of "a clean and reliable water supply".	
LOCAL LMWUA: Water and Drought Security Report – Bogan and Cobar Shire Councils	Recommendations: ***In order to improve emergency supplies:-*** *a. Investigate Macquarie River and GAB recharge zone aquifers in the Warren area to establish quantity and reliability of supply for a potential emergency supply for Nyngan and Cobar (for when the APC is piped).* *b. Carry out preliminary design and environmental studies for the construction of a pipeline from Warren to Nyngan.* *c. Obtain funding to construct a pipeline from Warren to Nyngan* ***In order to improve reliability of supply in normal drought periods:-*** *a. Investigate and construct water storage facilities at Nyngan adjacent to the existing weir pools using the $10 million in Water Security for Regions Funding* b. *Further investigate the feasibility and any environmental impacts of establishing a drought time operating water level in the weir pool at Nyngan in order to reduce evaporation and seepage losses.*	This business case proposes a strategy that aligns with the recommendations of the LMWUA studies.

6 Affordability

6.1 Introduction

This section examines issues of this proposal's affordability, from the customer's perspective. It does this by calculating the long run cost per megalitre of various operating scenarios. This information is then used to assess the impact on net costs for Local Water Utilities and High Security licence holders.

This section heavily relies on the data provided in:

1. the reports titled *Albert Priest Channel Replacement Pipeline: Options Report* and *Nyngan Cobar Water Security Project: Nyngan In Ground Storage and Associated Works: Concept Design Report*, prepared by NSW Public Works; and
2. the report titled *Nyngan and Cobar Water Security Project: Water Supply System Modelling*, NSW Urban Water Services Pty Ltd and dated May 2016.

The most notable difference between this affordability analysis and those studies is perspective- the above reports focus on the provision of water during periods of limited availability (ie water security), whist this discussion paper focuses on the long term cost of supply, it is more concerned with typical water availability conditions.

The range of scenarios provides an indication of how costs would change during particularly dry or wet conditions.

6.2 Financial Modelling

6.2.1 *Modelling approach*

The main purpose of the model is to estimate the **long run cost** of the pipeline and storage is to the water customers. Long run costs include the funding of replacement equipment such as pumps and valves, and ultimately, the pipeline and storage.

Because of this the pipeline and storage projects have been treated as a separate business, which accumulates funds, earns interest from savings and could pay off loans. **In practice, it would be more appropriate for the replacement of pipeline and storage assets to be directly funded by the major customers. This model provides an indication for those customers as to how much funding they should set aside for their component of future renewals.**

A previous assessment[3] explored the cost of two pipeline configurations, one of which traded lower capital costs for higher pumping costs. The results indicated that, from a customer's perspective, the larger pipeline with a lower pumping requirement (Option 2) was preferred. A

[3] *Albert Priest Pipeline Business Case: Affordability Discussion Paper*, CPE Associates, version 1.0, June 2016.

copy of this assessment is provided as Appendix B. The affordability assessment reported in this chapter is based on the Option 2 pipeline.

A 125 year spreadsheet model was developed to model operating results, cash flows and balance sheets[4]. A 125 year model period was adopted to ensure a full life cycle of asset renewals was considered (100 years), and financial viability was proven beyond the renewal of the pipeline at year 100.

6.2.2 Key assumptions

The financial model assumes that the capital cost of the pipeline and off-line storage system will be fully funded by grants, with the customers responsible for operations, maintenance and renewals. Consequently the affordability analysis considers the effects of depreciation, offset by interest income from reserves. During the 125 year period, assets are renewed at the projected end of life.

A summary of the base financial parameters is provided in Table 7.

Table 7: Financial model key assumptions

Parameter	Assumed value (125 year average)	Sensitivity tests (scenario B)
Inflation (general)	2.5%pa	1948-2015 average of 5.08%pa
Inflation (capital works)	2.5%pa	1948-2015 average of 3.98%pa[5]
Interest rate for new borrowings	No borrowings were required	-
Interest rate for investments	5.5%pa	4.5% pa, 3.5%pa
Capital works	Renewals based on schedule Depreciation fully accounted	Pipeline life increased to 200 years
Loading	Variable, spanning 'current' and 'future' projected demand scenarios by NSWPW.	
Growth	Nil	Nil

6.2.3 Demand and operating scenarios

The long term affordability of the Albert Priest pipeline and off-line storage project is subject to a range of variables, leading to a degree of uncertainty. Some key variables are:

1. The long term demand for water by human users;
2. The quantity of water effectively consumed by the Upper Nyngan Weir pool and off-line storage with pipeline replenishing losses due to evapotranspiration, and at times, reduced losses as a result of inflows from the Bogan River catchment;
3. Who pays the pipeline running costs associated with the replenishment of the Bogan Weir pool.

These variables are in turn affected by the economic circumstances of the community, broader economic circumstances and the effects of climate change.

[4] Previous attempts to use FINMOD over 100 year model period resulted in nonsensical results, apparently driven by a miscalculation of interest income in later years

[5] Based on Attachment 1 to the NSW Reference Rates Manual for Water Supply, Sewerage and Stormwater Assets

Consequently we prepared a long term financial model based on a series of scenarios which cover a range of consumptive activity, from lower than current usage to full utilisation of the pipeline, assuming that customers are able to procure additional water on the market. The scenarios are summarised in Table 8.

Table 8: Financial model scenarios- Albert Priest Pipeline and Off-line Storage

Scenario	Comment	% year gravity	% year pumped	Water transported (GL/a)	Weir pool and storage losses (GL/a)	Water for other customers (GL/a)
A0	Maximum pumped delivery allowing 10% downtime. Exceeds current water licence limits.		90%	18.1 GL/a	0.5 GL/a	17.6 GL/a
A1	NSWPW future demand. Pumped only.		46%	9.2 GL/a	0.5 GL/a	8.7 GL/a
A2	NSWPW current demand. Pumped only.		38%	7.7 GL/a	0.5 GL/a	7.2 GL/a
A3	50% current licence. Pumped only.		21%	4.2 GL/a	0.5 GL/a	3.7 GL/a
B0	Maximum gravity operation, 10% pump time to scour. Exceeds current water licence limits.	82%	8%	11.2 GL/a	0.5 GL/a	10.7 GL/a
B1	NSWPW future demand. Gravity operation, 10% pump time to scour.	67%	7%	9.2 GL/a	0.5 GL/a	8.7 GL/a
B2	NSWPW current demand. Gravity operation, 10% pump time to scour.	56%	6%	7.7 GL/a	0.5 GL/a	7.2 GL/a
B3	50% current licence. Gravity operation, 10% pump time to scour.	31%	3%	4.2 GL/a	0.5 GL/a	3.7 GL/a
C0	Maximum gravity operation, 10% pump time to scour. High weir pool losses.	82%	8%	11.2 GL/a	1.0 GL/a	10.2 GL/a
C1	NSWPW future demand. Gravity operation, 10% pump time to scour. High weir pool losses.	71%	7%	9.7 GL/a	1.0 GL/a	8.7 GL/a
C2	NSWPW current demand. Gravity operation, 10% pump time to scour. High weir pool losses.	60%	6%	8.2 GL/a	1.0 GL/a	7.2 GL/a
C3	50% current licence. Gravity operation, 10% pump time to scour. High weir pool losses.	34%	3%	4.7 GL/a	1.0 GL/a	3.7 GL/a

6.2.4 Capital works

The affordability assessment is based on the capital works proposed under **Option 2** of pipeline options report and **Option 2** of the storage options report. The off-stream storage is based on the costing for a 700ML storage, extrapolated to a 1,470ML storage, the maximum size recommended by the report for the site. Extrapolations are based on a combination of expansions based on increased perimeters or increased areas. Plant such as pipelines and pumps has not been extrapolated as it is assumed that the storages will be hydraulically linked.

The tables also provide proposed asset lives for the purposes of depreciation and renewals scheduling. Note that for the pipeline pumps two possible determinants of life were allowed for. Under lower demand scenarios the pipeline pumps are only operated for the purposes of scouring the pipeline- however as demand increases, pumping operations become more significant. Therefore **the frequency of pipeline pump renewal (and hence the rate of depreciation) varies by scenario.** The nature of off-stream storage operations means that in a typical year, there will be minimal pumping to and from the storage and renewals will be triggered by asset age.

The aggregated costs and reduced replacement costs are provided in Table 9.

Table 9: New asset and renewed asset costings, asset life determinants – Pipeline Option 2, Storage Option 2

Asset Group	Capital cost	Renewal cost	Max Life (GL)	Max Life (years)	Note
Pipeline	$70,994,483	$63,277,280k		100	End of life independent of usage
Air Valves	$728,000	$672,000			Non-depreciable components
Scour Valves	$520,000	$480,000		30	End of life independent of usage
Pumping Station - Civil works	$2,467,409	$2,277,609k		30	End of life independent of usage
Pumping Station – Pumps	$676,000	$624,000		50	End of life independent of usage
Pumping Station - Mech/Elec General	$3,067,987	$2,831,988	240	50	Assume a 80% utilisation pumpset achieves 15 years
Off-stream storage	$12,266,319	$2,767,610		20	Renewal is bank & fence work
Pumping Station - Pumps (Storage)	$167,800	$154,892		50	Minimal usage
TOTAL	**$90,888,000**	**$73,086,000**			

6.2.4.1 Albert Priest Pipeline Option 2

The preferred pipeline configuration consists of:

1. A 63.1km length, 1000mm diameter pipeline, capable of delivering 33 megalitres of water per day under gravity, and 55 megalitres of water per day with pumping.
2. A pumping station at Gunningbar Creek capable of pumping 55 megalitres of water per day, including the associated upgraded to electrical supply, control and monitoring equipment.

The Public Works pipeline options report costs these assets at $75.2m. For depreciation and renewals costing purposes, the replacement value of the assets have been slightly reduced to reflect the non-depreciable nature of certain tasks such as survey, investigations and design, directional drilling and thrust boring.

6.2.4.2 Off-line storage options 1a & 1b

The preferred off-line storage configuration consists of:

1. A storage consisting of a 700ML earth wall pond and a 770ML earth wall pond, hydraulically linked with a common wall, as per Figure 2.2 of the Public Works storage report.
2. A new inlet/outlet structure at the Upper Nyngan Weir Pool.
3. A new water pumping station configured to pump water to and from the storage, as well allow gravity drainage from the storage to the Upper Nyngan Weir Pool at lower flow rates. The station is provided with two pumps with a combined pumping capacity of 600L/s at 12.2m head.
4. 800mm diameter pipelines linking the inlet/outlet structure, pumping station and storage, including valve arrangements.

The Public Works storage report costs these assets at $9.9m. This has been extrapolated to $15.7m to allow for the larger storage which has been identified as necessary for water security purposes. For depreciation and renewals costing purposes, the replacement value of the assets have been slightly reduced to reflect the non-depreciable nature of certain items.

6.2.5 Maintenance costs

The models will be based on the Public Works approach of a percentages based maintenance regime. The resulting maintenance cost used in the model is summarised in Table 10.

Table 10: Maintenance costs – Pipeline Option 2

Item	CRC ($'000)	Rate (%pa)	Maintenance ($'000 pa)
Air Valves	672	3%	20.2
Pipeline	63,278	0%	0.0
Pumping Station - Civil works	2,278	0.2%	4.6
Pumping Station - Mech/Elec General	2,832	3%	85
Pumping Station – Pumps	779	3%	23.4
Scour Valves	480	3%	14.4
Storage	2768	0.2%	5.5
TOTAL	**73,087**		**153**

6.2.6 Operations costs

The Public Works assessment only considers the cost of electricity for operations, which appears reasonable given that other costs such as overheads will be comparable to the current Albert Priest Channel operation.

Option 2 assumes that 3GL per annum of water needs to be pumped at a cost of $0.18/kWh. No pump efficiency calculation is documented. As the affordability scenarios vary significantly from this assumption, electricity costs have been re-estimated based on the Nyngan raw water offtake pump station. The tariffs applying at this station result in an annual cost of $8,940 per annum plus $0.115 per kWh. The electrical power required for a 55ML/d (637L/s) station at 15m head is about 130kW, allowing 80% motor efficiency and a pipe tolerance of 1.1. **This results in an electricity cost of about $8,940/annum plus $6.59/ML.**

Electricity costs associated with off-line storage operations are assumed to be negligible in most years as pumps will only be required replenish evaporation losses.

6.2.7 Modelling objective

The financial models sought to minimise long-run price of the pipeline, subject to the following constraints[6]:

- Cash and investments in any year were not less than one year of operating payments (ie the business was solvent);
- The return on assets was greater than zero for at least 50% of modelled years (indicator of financial sustainability);
- The return on assets was zero or greater in model year 125 (indicator that the business is financially viable at the end of the model run).

6.3 Results

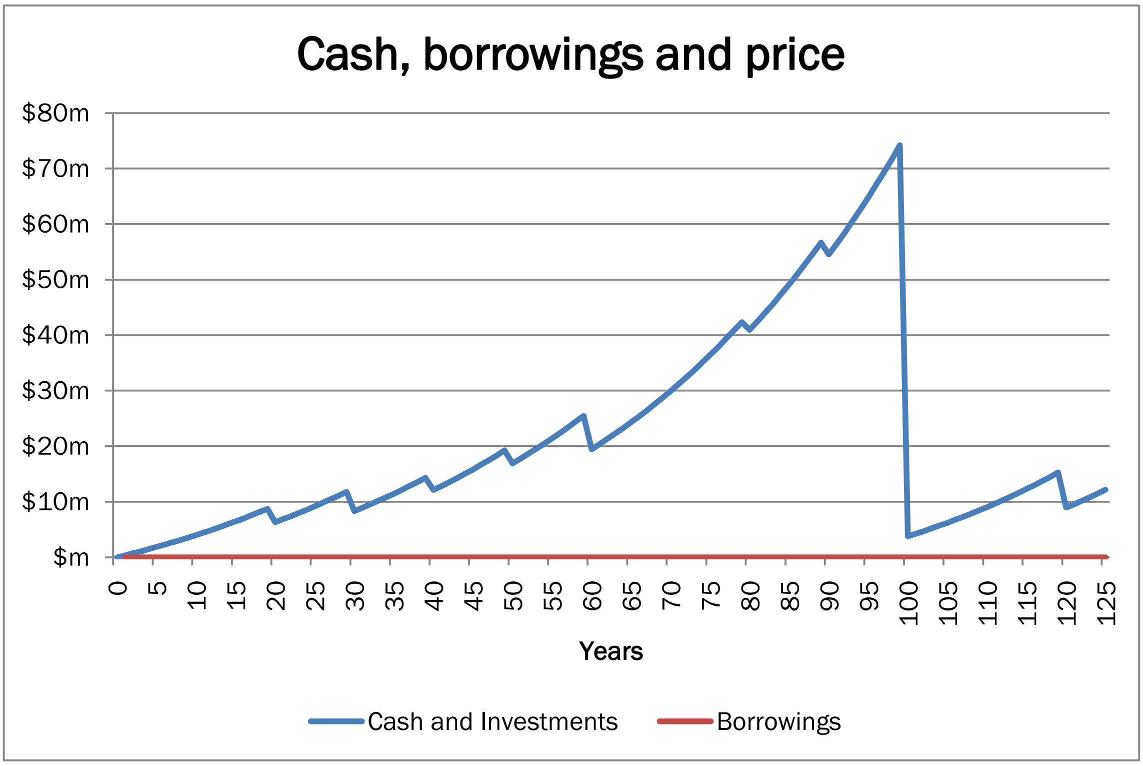
Summary financial results for each scenario are provided as **Appendix C.**

6.3.1 Financial profile

Figure 15 and Figure 16 provide an illustration of the financial performance of pipeline option 2 and storage option 2. These parameters do not significantly vary between demand scenarios.

[6] These constraints are described in terms of year zero dollars.

Figure 15: Typical cash and borrowings - pipeline option 2, storage option 2

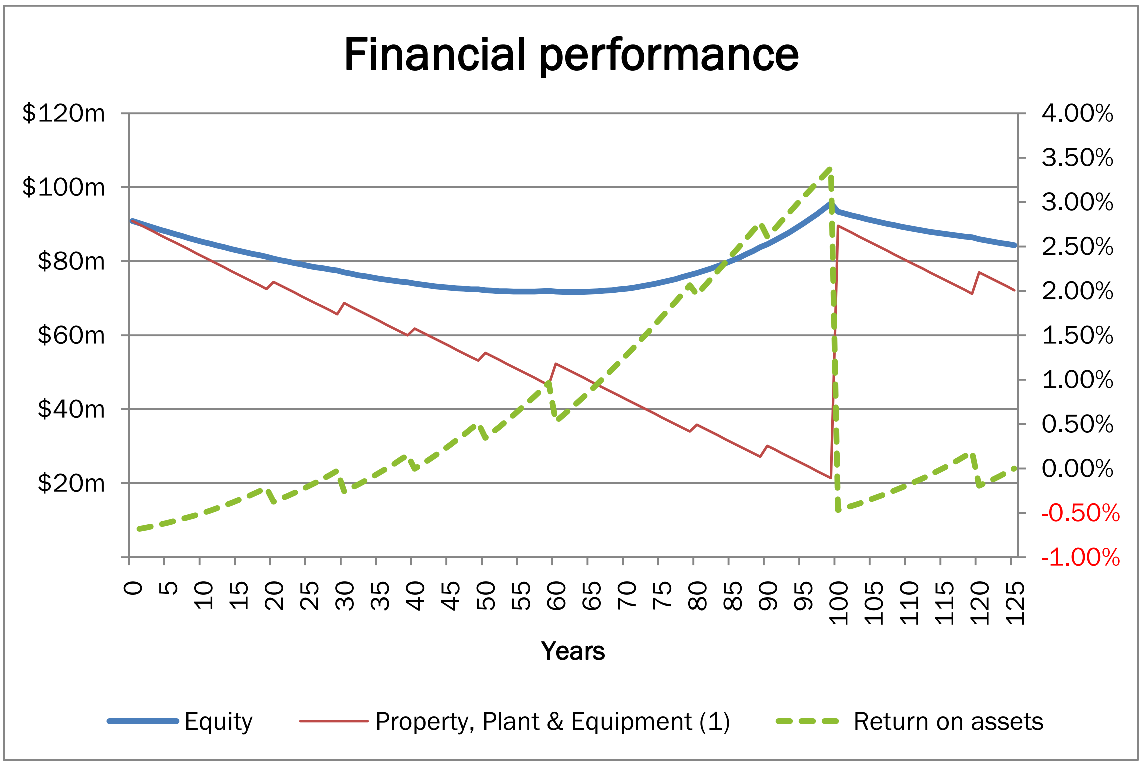


As the original pipeline and off-line storage is assumed to be 100% grant funded, the theoretical business does not need to service debt. Instead the business accumulates reserves, earning interest in a similar manner to a superannuation scheme, until pipeline renewal occurs at year 100, when the funds are almost completely depleted.

Slight variations in reserves over the rest of the years are the result of valve and pump renewals, and maintenance of the storage.

The price point for customers is controlled by the objective to achieve a positive return on assets by year 125. Figure 16 does show that a positive rate of return over most years, although returns are generally negative for the first 30 years due to the concentration of the asset base on one very long life asset.

Figure 16: Typical financial performance - pipeline option 2, storage option 2



6.3.2 Unit cost of pipeline and off-line storage services

The unit cost of the pipeline and storage services for the various options are shown in Table 11 for the NSWPW 'current demand' and Table 12 for the NSWPW 'future demand'. Costs have been broken up into an operations and maintenance (O&M) cost, borne every year, and a capital component, that needs to be saved and invested for future renewals.

Table 11: Long-run cost of pipeline and storage to customers, NSWPW 'current demand'

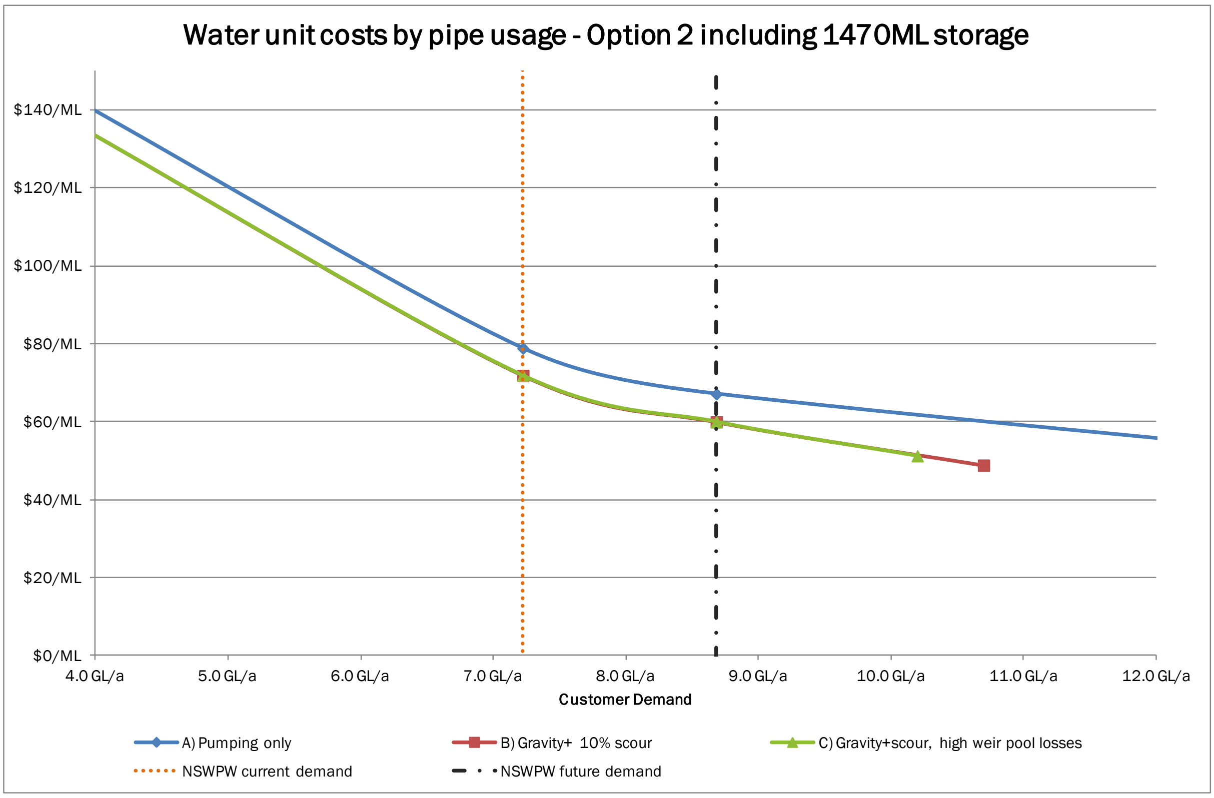
Scenario	O&M component	+	Capital component	=	Long run cost
Option 2 pumping	$28/ML		$46/ML		$74/ML
Option 2 gravity with scour	**$22/ML**		**$45/ML**		**$67/ML**

Table 12: Long-run cost of pipeline to customers, NSWPW 'future demand'

Scenario	O&M component	+	Capital component	=	Long run cost
Option 2 pumping	$25/ML		$39/ML		$63/ML
Option 2 gravity with scour	**$19/ML**		**$38/ML**		**$57/ML**

These results are also plotted as Figure 17. The unit cost of the pipeline varies strongly depending on how much the pipeline is used. The full pumping scenarios are about 10% more costly than the gravity dominated equivalent, which means it should be reasonable to rely on pumping for peak demand periods.

Figure 17: Pipeline and storage costs for various usage options



6.3.2.1 Effect of weir pool

Figure 17 shows that variations to the level of water losses is almost completely insignificant for most scenarios. This is because the cost to customers is driven by the need to fund renewals. The main impact of weir pool losses is the reduced water availability for customers.

6.3.3 Net cost to customers

6.3.3.1 High security licence holders

If the pipeline was constructed, high security water licence holders would effectively gain extra water as the evaporation and seepage losses of the Albert Priest Channel would be avoided. High security water licence users in most years would then have the option of using the extra water, or selling the water. There is minimal temporary trade data available for the Macquarie River system, however the limited data suggests this water may typically be worth in the order of $200/ML.

For the sake of this assessment it is assumed that high security water users would sell the water as a temporary trade in most years. Based on NSWPW's estimate of about 1.3GL of water per year being lost through the Albert Priest Channel, high security licence holders could gain about 0.5GL/a in water, worth approximately $95,000/a, or about $38/ML of water actually delivered. This means that the pipeline and storage could effectively be costing only about $30/ML to these users.

6.3.3.2 Local water utilities

Local water utility licence holders are not able to trade water, so cannot achieve savings by selling excess water allocation. However because less water is lost to seepage and evaporation, the need for water restrictions is reduced and the water security of the town is increased, leading to strong socioeconomic benefits.

Bogan Shire Council

A 30 year Financial Plan has been prepared for Bogan Shire Council's water supply fund that meets the requirements of the NSW DPI Water July 2014 checklist. The FINMOD financial planning model has been used for this assessment. The plan assesses the current renewal needs of the Shire's water supply assets, and determines the impact of the ongoing costs associated with the water security projects.

The financial modelling undertaken for Bogan Shire's Water Supply Fund is based on a number of assumptions, which are documented in the "Bogan Shire Council Water Supply and Sewerage Business Financial Plan Version 1.0, January 2017"

The key modelling results for Bogan Shire Council's water supply fund are summarised in Table 13 below. The water security infrastructure imposes additional operation, maintenance and depreciation costs, which are 32% attributable to Bogan Shire Council. Bogan Shire Council's current Typical Residential Bill (TRB) for Water Supply is one of the highest in NSW, at $1,169. The Financial Plan documents possible reductions in the TRB if no additional water security infrastructure is constructed. Council will consider applying reductions by holding tariffs at their current value, and allowing inflation to discount its future value.

If the water security infrastructure is constructed, the modelling indicates that the current Typical Residential Bill can be maintained in real terms – i.e. only inflation-based increases are required. Accordingly, there will effectively be no cost impact on Bogan Shire residents.

Table 13 - Summary of modelling scenarios , Bogan Shire water supply business, 2016-2046

Capital works item	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E
2016 Water Fund Capital Works Plan including Stage 1a - 700 ML Storage 1a	×	×	×	×	×
Stage 1b - 700 ML Storage 1b - adjacent to Storage 1a		×	×	×	×
Stage 1c - 3000ML Storage 1c			×		×
Stage 2 - Piping of Albert Priest Channel				×	×
Stage 3 - Warren Borefield Investigation					×
TRB required for ERRR positive in at least 50% of years	**$1004**	**$1030**	**$1083**	**$1125**	**$1169**

Cobar Shire Council

A similar assessment has not been undertaken on Cobar Shire Council's water supply fund, and it is not possible to predict the impact on Cobar Shire residents.

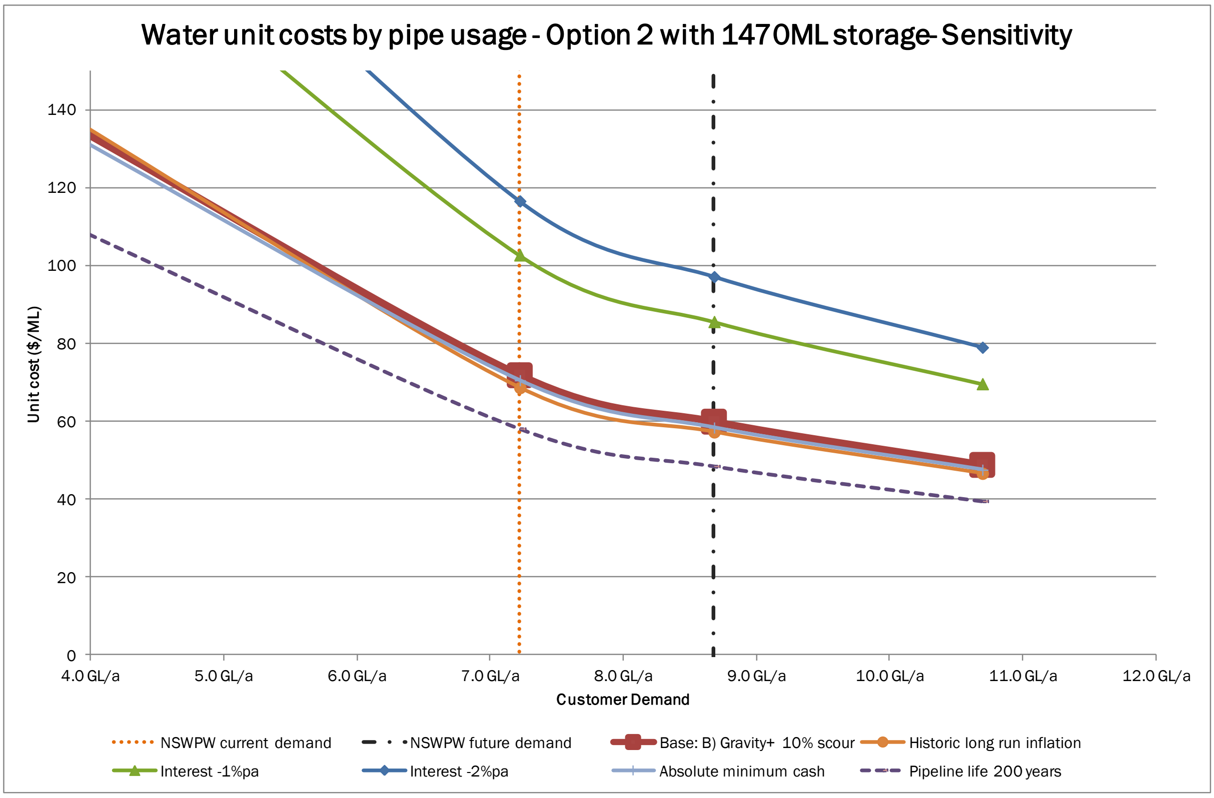
6.3.4 Sensitivity testing

6.3.4.1 Financial parameters

Figure 18 illustrates the results of a series of sensitivity tests relating to financial inputs. Given the large proportion of funds needed for very long term renewals, changes in investment returns have a significant effect on the long run cost of the pipeline. This reinforces the need for the major customers to direct fund capital renewals instead of contributing through the unit rate of water.

Other parameters are less significant to the business. Historic long run capital works inflation rates actually benefit the price, as the time scale allows the incorporation of technological advances. Doubling the assumed life of the pipeline only reduces unit costs by about $10/ML, while considerably increasing the risk of the pipe failing before funds are available for its replacement.

Figure 18: Price sensitivity to variations in financial assumptions – pipeline option 2, storage option 2



6.3.4.2 Variations in grant funding

A core assumption for the above modelling is that the initial capital investment for the pipeline and storage is fully funded by an external agency. This allows customers to fund the substantial reinvestment in the pipeline over its life cycle, such that borrowings are not necessary. If some funding is required for the initial capital works, customers will need to service debt and/or sacrifice future investments income. The business becomes characterised by borrowings over much of the asset life cycle, which also governs the long-run cost to customers.

Figure 19 and Figure 20 show the cash profile of the business under 75% grant and 50% grant profiles respectively. Both scenarios result in significant borrowings for at least the first 50 years of project.

The need to service debt over much of the life cycle of the assets has a substantial impact on the long-run cost to customers. Figure 21 and Table 14 show that the reduction in grant funding results in rapid increases in costs to customers which probably are not able to be borne by at least some of the customer base, given that Bogan and Cobar Shires already have some of the most expensive potable water in NSW.

Figure 19: Typical cash and borrowings – 75% grant funding/25% customer funding

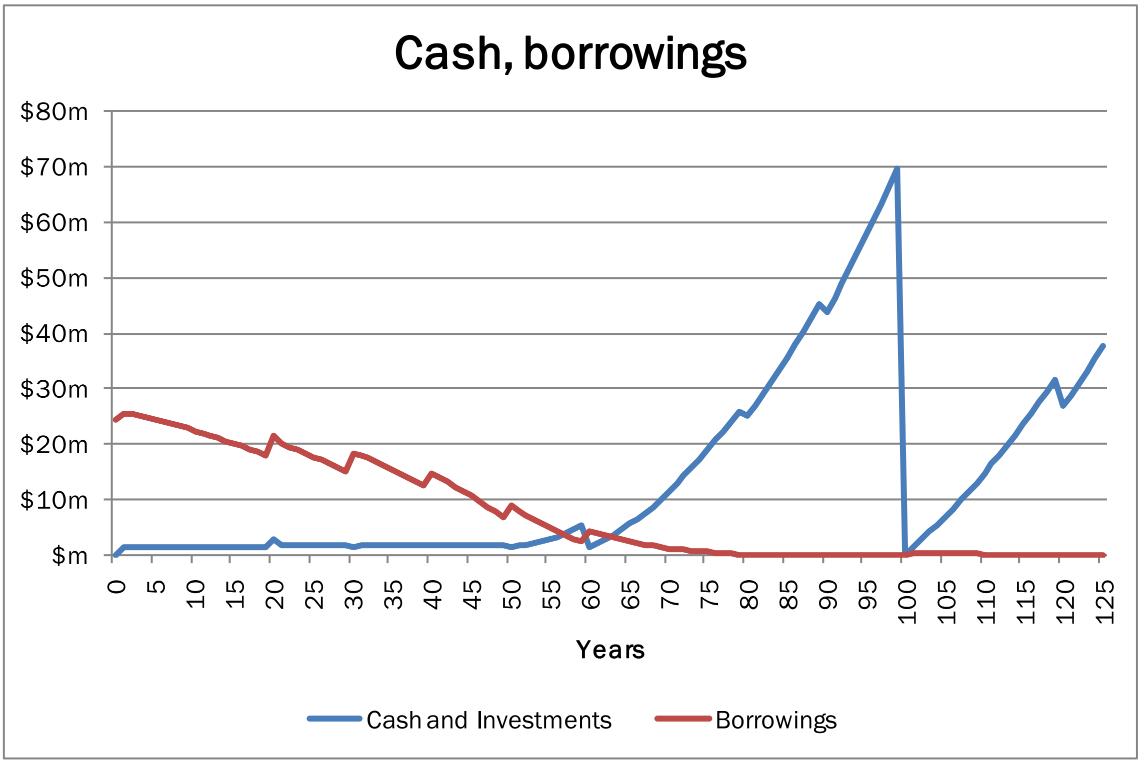


Figure 20: Typical cash and borrowings – 50% grant funding/50% customer funding

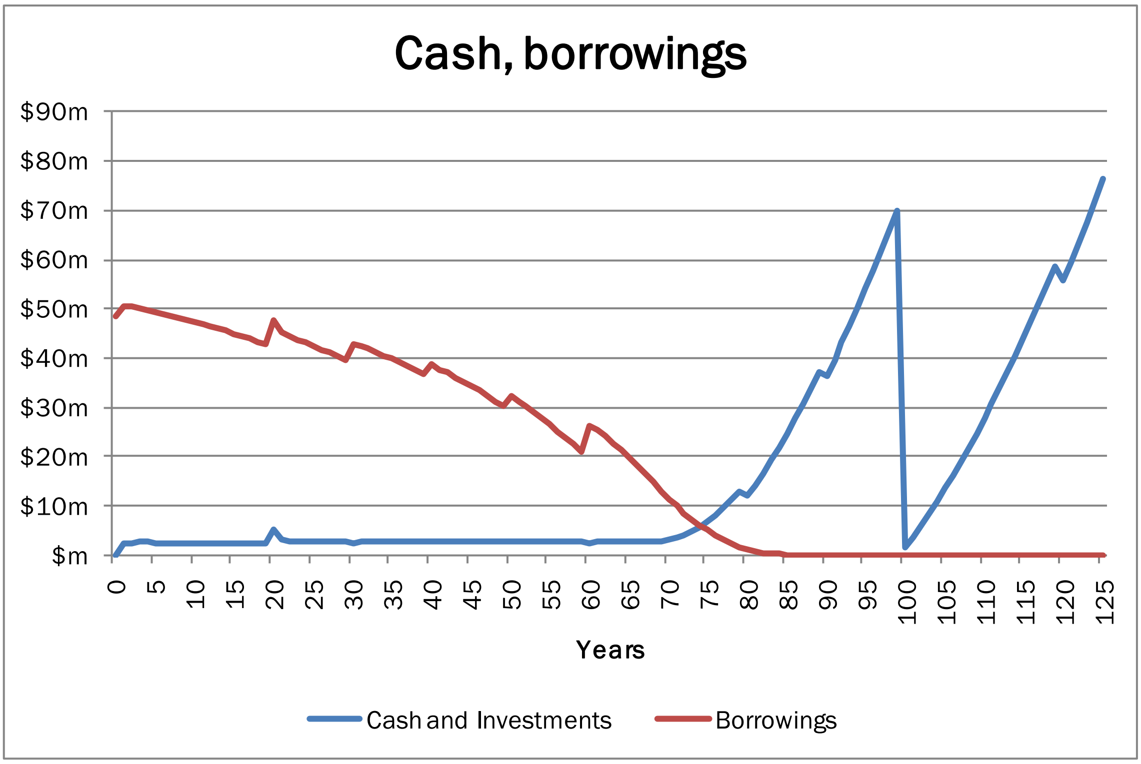


Figure 21: Price sensitivity to variations in grant funding– pipeline option 2, storage option 2

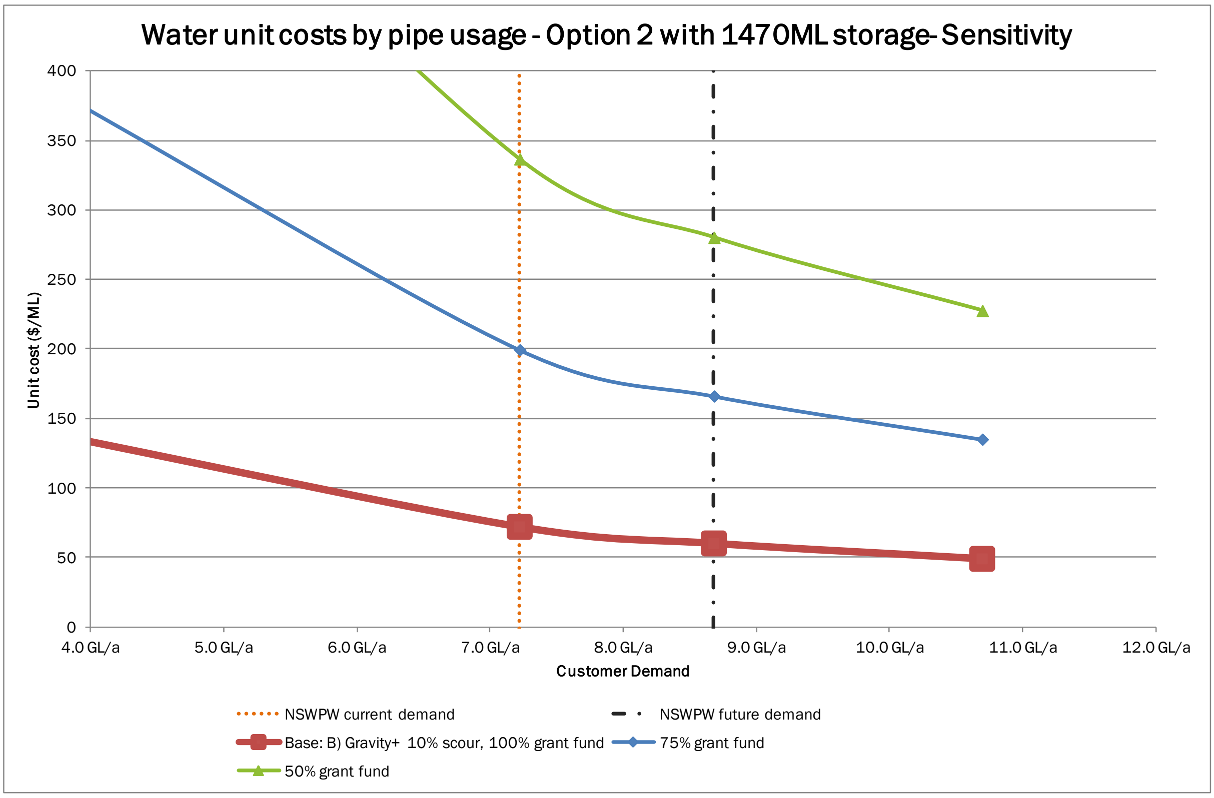


Table 14: Price sensitivity to variations in grant funding– pipeline option 2, storage option 2

Grant funding	NSWPW current demand	NSWPW future demand	Variation
100%	$72/ML	$60/ML	-
75%	$200/ML	$166/ML	2.7 times
50%	$337/ML	$280/ML	4.7 times

6.4 Conclusions

Financial modelling based on NSW Public Works concept designs indicates that, with full grant funding, the pipeline and storage can transport water and provide drought protection at a cost of about $67/ML (6.7c/kL) at current rates of demand, including providing funds for renewal. High security water licence holders may be able to offset their increased costs by trading the water saved, although they may gain greater benefits by using the water for their own production during years of high water availability.

A high proportion of the cost of the pipeline and storage service is the funding of asset renewals generations into the future. This would create significant financial risks to the holding entity of the pipeline if it was responsible for collecting and investing the capital component of the price. It is recommended that any pricing model for the pipeline be based on recovering operating and maintenance costs on a usage basis, with major customers directly funding capital renewals.

Sensitivity testing for partial grant scenarios results in substantial increases in long-run customer costs, due to the need to service debt over a much of the asset's life cycle. The level of price increase to fund these scenarios may be unaffordable for more sensitive customers.

7 Economic Analysis

7.1 Introduction

The Water Security Project is primarily designed to provide for critical human needs during a critical drought event. However the measures required to provide this security offer significant economic benefits during non-drought years as a result of reduced losses and increased reliability of supply. In most years, this 'new' water can be dedicated to productive uses such as mining, agriculture and increased environmental flows.

7.2 General economic information

The document "Profile and Opportunities", prepared by Regional Development Australia Orana NSW and Western Research Institute Ltd in September 2013 identifies economic information regarding the Local Government Areas in the Orana district (Table 15).

Table 15 – Background economic data provided by Bogan and Cobar Councils

	Bogan	Cobar	Bogan and Cobar Cluster
Population	2,900	4,710	7,610
Gross Regional Product	$131.33 M	$283.8 M	$415.01 M
Key Sectors	• Other Mining (35% of value added and 21% of FTE employment). • Agriculture (12% of value added and 26% of FTE employment). • Health & Community (6% of value added and 9% of FTE employment)	• Other mining (51% of value added and 42% of FTE employment) • Agriculture (5% of value added and 9% of FTE employment) • Public administration (5% of value added and 6% of FTE employment)	• Other Mining (46% of value added and 35% of FTE employment) • Agriculture (7% of value added and 15% of FTE employment) • Public Administration (5% of value added and 6% of FTE employment)
Opportunities	• Continued development of mining and agriculture. • Value-adding to agricultural output through the Food & Beverage Manufacturing sector.	• Continued development of mining and agriculture • Value-adding to agricultural output through the Food & Beverage Manufacturing sector	• Continued development of mining and agriculture • Value-adding to agricultural output through the Food & Beverage Manufacturing sector.

7.3 The role of water security in the local economy

The economy of Bogan and Cobar Local Government Areas is highly dependent on the secure supply of water.

In general **water security** could simply be described as having sufficient water to be able to span possible droughts (or other losses of supply). The drought of 2002 to 2010 placed significant strains on that water supply. The results observed were:

- Council exceeding their reduced water allocation limit on three occasions.
- In one year Local Water Utility allocations were reduced to 70% for part of the year. These allocations are generally managed as 'super high' security water, and this level of restriction previously had not been applied.
- Had there not been significant rain in the latter part of 2007 then potentially the security of the Macquarie River may have been challenged to the point where Lake Burrendong may have effectively emptied.

It should be noted that secure water yield analysis reported in this business case has identified that the most critical drought was in the early 1980s, a time when there was less mining activity and less demand for water than currently is the case. A repeat of the early 1980s drought would lead to more severe impacts than described above.

In this worst case scenario, the impacts on the economies of Bogan and Cobar Shires would be:

- Mines would place their operations into mothballs. Operations would only recommence once the combination of ore price and water availability was sufficiently attractive to justify the cost of recommissioning the mine; and
- A significant part of the population would need to relocate until water availability improved and the local economy recovered.

In risk management terms, the consequences of a worst case scenario are catastrophic, however the likelihood is rare. There are significant social and economic benefits associated with avoiding this worst case scenario. In economic terms, this is referred to as avoided costs. Even though the avoided costs are large, these costs would occur with a very low probability. Avoided costs have not been quantified and are not included in this economic analysis.

7.4 Cost benefit analysis

SGS Economics and Planning has prepared a cost benefit analysis based on the following information presented in this business case:

- Capital and operating cost estimates, as outlined in sections 6.2.4, 6.2.5 and 6.2.6,
- Maintenance cost estimates for the existing Albert Priest Channel;
- (limited) information regarding temporary water trades.
- A distribution of increased water availability

Their technical note is provided as **Appendix A**.

7.5 Quantifying the costs

The costs of constructing, operating and maintaining the infrastructure associated with the Water Security Project are common with the affordability analysis, with the exception that for the assessment of economic impacts, the original capital cost has been incorporated into the analysis. The project is anticipated to take several years to construct prior to becoming sufficiently operational to accrue benefits.

The capital and operating cost profile for the Project is provided as Table 16.

Table 16: Capital, operating and maintenance cost profile used in cost-benefit analysis – current demand ($'000)

Year	1	2	3	4	5	6	7	8	9	10
Capital	$0	$1,906	$5,085	$1,034	$2,068	$2,068	$67,687	$564	$564	$0
O&M									$130	$130
Savings									-$200	-$200
Total	$0	$1,906	$5,085	$1,034	$2,068	$2,068	$67,687	$564	$494	-$70
Assets operational			Additional storage					Pipeline		

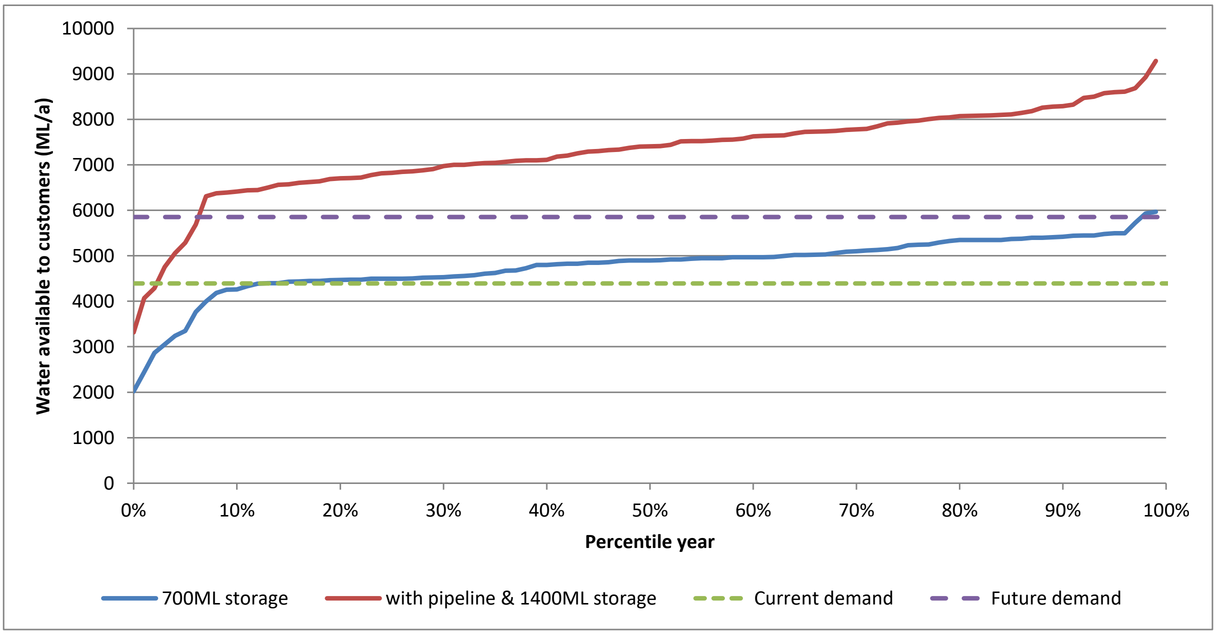
7.6 Quantifying the benefits

A number of benefits have been identified for the project. These include the following:

- **Increased water availability during critical periods** leading to the following:
  - A reduction in the impacts of drought on productivity in the mining and agricultural sectors;
  - A reduced risk profile for new investments due to greater reliability of supply; and
  - A reduced social and psychological impacts of droughts on towns.
- A **net saving in maintenance costs associated with replacing the Albert Priest Channel with a pipeline.** Bogan Shire Council estimates an annual maintenance cost of $200,000 per year. The estimated annual maintenance cost for the Water Security Project infrastructure $130,000 per year.
- **Increased water availability during non-drought periods leading to new investment**. The Lower Macquarie River water market is characterised by minimal trades due to the scarcity of water. This prevents the mining and agricultural industry from expanding due to the inability to buy enough permanent water. During non-drought years the reduced losses in the water transport system will make more water available to end users from the existing licences. This additional water could be used by the existing holder or traded to a new industry. A distribution illustrating the additional water available to customers is provided in Figure 22.

While the critical drought defines the design of the Water Security Project, the low frequency of droughts means the 'normal year' benefits are more significant from an economic perspective.

Figure 22: Distribution of water availability with and without the Water Security Project



Based on modelling completed by NSW Urban Water Solutions

7.7 Quantitative cost benefit analysis

SGS Economics and Planning completed a quantitative cost-benefit analysis for the Project. This analysis focused on evaluating the following potential benefits of the project:

- Increased water for mining and agricultural uses, using a gross value added approach
- Increased water for environmental flows and recreational purposes, using a water market price of $200/ML as a proxy.

SGS found that a water price of $1300-$2600/ML was required for the Project to break even Table 17.

Table 17: Water values required for investment to break even ($/ML)

Discount rate	25th percentile water flows	50th percentile water flows	70th percentile water flows
2.5%	1,356	1,258	1,145
5%	2,109	1,956	1,780
7.5%	3,027	2,807	2,554

While this is significantly above the (limited) market data for temporary trade water, the potential gross value add that could result from this additional water is substantially above these rates. Gross value adds vary from about $2,600/ML for agricultural purposes to over $170,000/ML for non-coal mining activities.

SGS then conducted a cost benefit assessment based on the difference between the current demand and future demand water supply scenarios based on 10% of the 'new' water being used for mining purposes and 90% for agricultural purposes. The impact of year-to-year variations in water availability (Figure 22) were tested using Monte Carlo techniques. This approach yields a distribution of results with variances due to the particular water availability applying to the years randomly selected in each run.

The mean net present value calculated in this process was $29.3 million with a benefit cost ratio of 1.52. The lowest NPV recorded using this process was $19.7 million and the lowest BCR was 1.35.

7.8 Conclusions

The assessment of quantifiable benefits and costs shows that the Water Security Project will provide a net economic benefit as a result of increased production, using reasonably conservative assessment criteria. Other analyses in this business case indicate that the potential for expanded mining could result in a larger proportion of 'new' water being used for this purpose. As the highest GVA activity in the region, this will lead to higher net benefits for the Project.

The economic analysis does not quantify the avoided costs associated with avoiding a worst case scenario. Avoided costs include the social and economic consequences associated with a severe drought, when many in the towns may need to relocate out of the region until adequate water is again available. Quantifying the avoided costs will increase the benefit cost ratio.

8 Project Delivery Plan

8.1 Overview

This project management plan covers all activities associated with Stages 1a, 1b and 2, and investigation activities associated with Stages 1c and 3. Table 18, below, summarises the status of each stage at the time of writing.

Table 18 – Infrastructure included in project delivery plan

Stages (in order of priority)	Water Security Infrastructure	Elements included in this Project Plan	Project Delivery Status	Funding Status
1a	Storage 1a - 700 Ml off-line storage at Nyngan	Full project delivery	• Design and documentation complete, • Tenders late 2016 • Construction 2017	**Grant funding approved** - $10 M
1b	Storage 1b - Additional 700 Ml off-line storage at Nyngan on adjacent site to Storage 1a	Full project delivery	• Environmental studies late 2016 • Tender 2017 • Construction 2018	**Grant funding not yet approved** – Approx $6 M
1c	Storage 1c - Additional 3000 ML off-line storage on a site to be determined	Investigations only	• Investigations scheduled for 2018	**Grant funding not yet approved** – Capital costs not determined (Possibly up to $30 M)
2	Piping of the Albert Priest Channel	Full project delivery	• Options report complete • Funding approval anticipated early 2017 • 7 year project timeline	**Grant funding not yet approved** - $75 M
3	Emergency bore supply at Warren and connection to pipeline	Investigations only	• Yields and locations not determined • Investigations scheduled for 2017	**Grant funding not yet approved** – Costs not determined

8.2 Preconstruction Activities

The overall timeline for the projects will be determined by the preconstruction activities that need to occur. It is imperative to identify all of the requirements for the project; particularly any difficult issues before contracts are entered into, as this reduce the financial risk associated with variations. Good project management is about the resolution of as many details and issues as possible before the works commence.

Preconstruction activities associated with Stage 2 (pipeline) are extensive and are anticipated to take up to 4 years. These preconstruction activities include the following. It is stressed these are representative and not an exhaustive listing.

Landholder Consultation – The Albert Priest Channel is located on private land without an easement. An early meeting with the landholders along the channel and the Albert Priest Channel Association is recommended. The purpose of the initial meetings will be to gain some feedback on the proposed pipeline and general landholder reaction to it.

Formal negotiations would follow the initial meetings. It would be proposed that Council officers who are known to the landholders will lead these negotiations. The Council officers will engage appropriate specialist assistance as required. The landholders may have some specific requirements that need to be incorporated in the design. Council will need to work closely with the landholders throughout the course of the project to overcome all issues as they arise.

This initial consultation should not be a costly exercise as it predominantly is about a series of meetings and the engagement of experts to assist with these meetings.

- **Establishment of Easement -** Commencement of the establishment of an easement for the pipeline, which may include some land acquisition. This would follow on from the initial meetings with the landholders and ideally would be completed before construction commences, however construction could commence through a "permit to enter" if the landholders have given formal approval.

- **Landowner Relationships -** Follow up meetings with the landholders to assist them to derive the maximum possible value form the availability of the pipeline. To some extent this is not a preconstruction activity as it more easily conducted as a post construction activity.

- **Survey of the proposed pipeline route.** Briefing documents for this survey work will be based upon a concept design on the likely pipeline route developed by Council from the landholder discussions. Council would draft a tender document for this survey work using specialist assistance and will submit the results back to the steering committee for comment before finalising this contract.

- **Geotechnical Studies** - Geotechnical studies are an important input into the design. This would occur along the route of the concept design. As the geotechnical structure is not anticipated to vary significantly along the pipeline route any small deviations in the final design are not likely to have significant impacts on the design tender document. Council would draft a tender document for this geotechnical work using specialist assistance and will submit the results back to the steering committee for comment before finalising this contract.

- **Environmental Studies** - Environmental studies are required for both the pipeline route and the new storage and transfer headworks as well as the potential larger storage along the pipeline route. Council would draft a tender document for the environmental studies using specialist assistance and will submit the results back to the steering committee for comment before finalising this contract.

- **Design and Contract Documentation** - The preparation of the main design and construction documents will be prepared by Council utilising specialist (contract) resources as appropriate with the documents to be tabled before the steering committee before calling for the tenders.

Ideally these preconstruction activities should commence in early 2017. It is recommended that small release of funding of around $500,000 be granted to allow these preconstruction activities to commence.

8.3 Project Delivery Model

It is proposed to deliver these projects through three specific contracts for each of the works stages for the new storage and the pipeline. For the new 700 ML storage and the potential for groundwater from Warren then simple tenders would be let to carry out this investigation work. Any subsequent works would be the subject of further business cases to be built on this business case.

i. **A separate Design Contract**, which will include a series of design review steps at various stages of the project to ensure that the final product delivered, is in accordance with the steering committees requirements.(Lump sum contract). The design consultant will be provided with copies of the environmental and technical studies carried out under the preconstruction estimates involved here.

   The design contract should also produce an independently review list of quantities that can be included in the construction contract.

ii. **A separate Project Management Contract**, including management of the construction tender process and construction phase (Lump sum contract). This person will report directly to the Bogan Shire Project Manager and will be the assistant to the Project Manager. They will in close consultation with the Project Manager oversee the site works as well as providing input into the design phases.

iii. **A separate Construction Contract** (Lump Sum Contract) for the construction of the infrastructure. This will be based upon the complete designs for the respective works with again copies of the environmental and technical studies provided to the tenderers to assist them with their tendering process and to avoid the potential for variations being built into the tender documents.

Note:

A separate supply tender for the pipeline will also be considered. This may have the following advantages:

- *Council needs to be the body to choose the pipe material that gives the best long term return. This choice should not be left to the contractor.*
- *To get the best possible price it is suggested that pipe materials not be mandated and that the tenders be evaluated on their own merits based upon the appropriate selection criteria that include expected life of the pipe in this location.*
- *If there was a direct contract between Council and the Pipe supplier then it is suggested that the best possible prices will be attained as the pipe supplier will be far more confident of the client and far more eager to please them than a contractor.*
- *67 km of pipeline will attract a good unit price. Under a supply and construct contract, the construction contractor will profit from the supply pricing. Under a separate supply contract, Council will benefit from the savings*

All contracts will be based upon payments for completed milestones as specified in the tender documents, as a means of avoiding argument over quantities and ensuring that payment is tied to progress on the project, which is in accordance with sound project management practice.

Table 19 - Reasons Supporting the Choice of Project Delivery

Delivery	Reasons
Separate Design Contract	It allows for the findings of the REF to be built into the design hence there is a need to complete the REF and geotechnical studies before this work proceeds.
	Council will have greater input in the design under this format and it will be less contractually restrained than it may be under a Design & Construct Contract. It will include formal reviews at different stages of the design process to ensure there should be few problems when the final design is delivered
	It allows for specialist designers without a construction party to be engaged and potentially avoid addition fees associated with a joint venture.
Separate Project Management Contract	Council has insufficient resources to totally manage a project of this size internally but does not want to abdicate its responsibility, particularly in terms project management and project cost control. Specialist project management expertise will be procured to provide the additional resources required and will work closely with the Council project Manager as well as being a regular report to the steering committee.
	An external project manager engaged under a contract can also provide specialist support to Council. Council may elect to bring in other specific specialists on an as required basis to participate in the
	Council in close conjunction with the steering committee will have control over contractual decisions during construction as is appropriate.
	It allows for specialist to be engaged with no affiliation to either the designer of the constructor.
	This company can do much of the leg work involved with reviewing the tenders and preparing a submission to the steering committee as well as providing independent review of any proposed contract documentation before it is let.
	The need for a full time project manager over around three years to supervise a pipeline is difficult to justify and thus the need for this contract beyond the initial work will be reviewed

Delivery	Reasons
Separate Construction Contract	All required pre-construction activities and environmental studies will be completed and approved before this tender is let and Council will not be subject to unexpected prolongation claims from the construction tenderer.
	The construction contractor will be fully aware of what is required of them with a completed design and as such should offer the best possible process.
	The risk of variations is controlled because of the design documentation that is in place.

The different separate delivery contracts are expected to provide the maximum flexibility for Council, the minimum risk and hopefully the best prices. The need for a full time project manager when the pipeline is to be constructed will be reviewed as it will not require a full time onsite presence given the likely time to be taken to construct this pipeline.

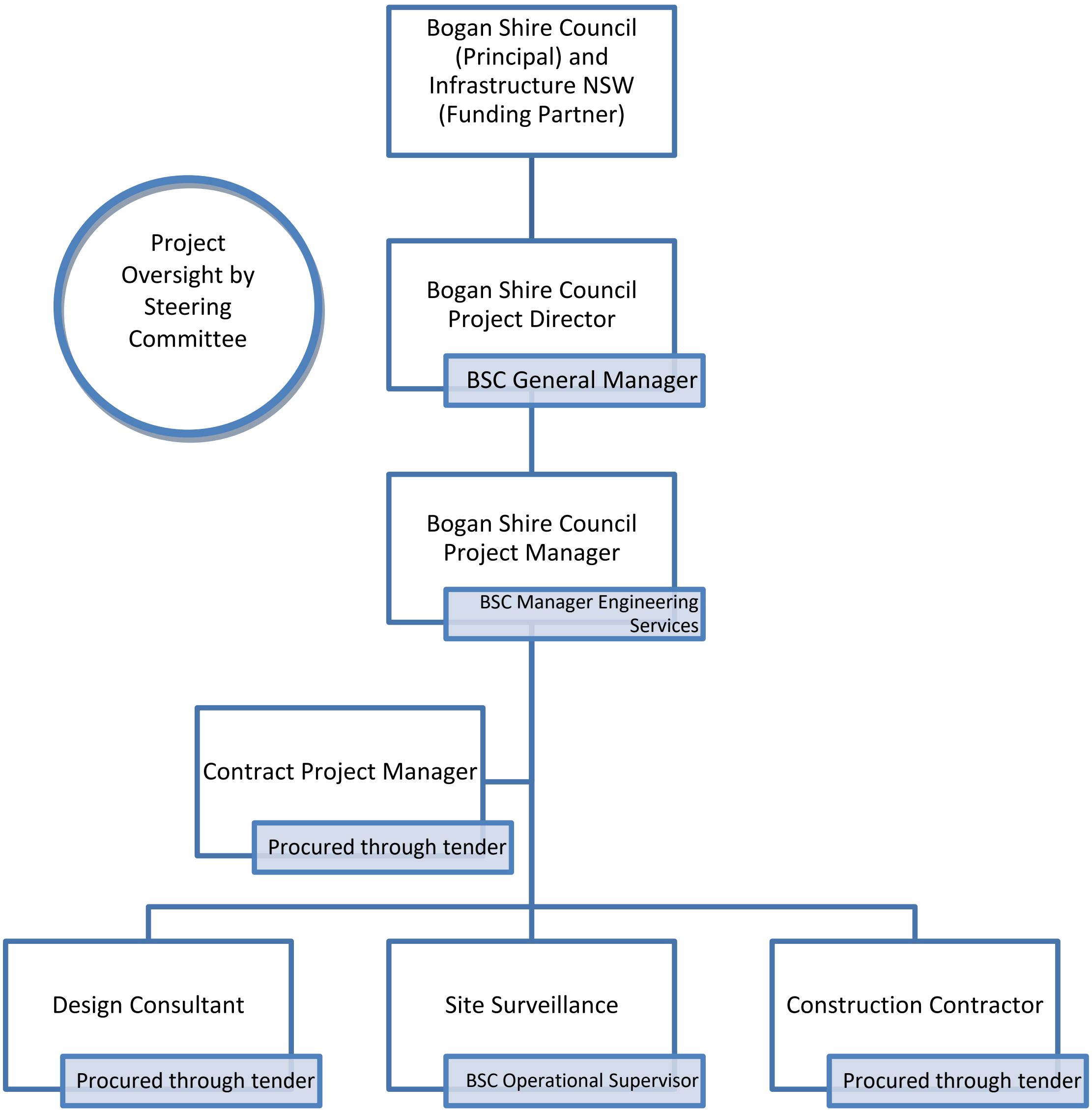
8.4 Project Delivery Structure

The multiple stages of this project require extensive project management expertise and appropriate specialist advice based upon track record and experience. This will include bodies such as the NSW Public Works. These typical phases in project delivery are illustrated below:

Figure 23 – Typical phases of each project

The overall project delivery structure is set out in Figure 24. The Principal is Bogan Shire Council, who will administer the relationship with the funding partner in terms of the funding agreement. The Project Director will have overall responsibility for the running of the project on behalf of Bogan Shire Council. Council will engage an external contractor to provide the resources required to support the Council Project Manager.

Figure 24 – Nyngan Cobar Water Security Project Delivery Structure



8.5 Project Governance

Oversight of the project is managed through a Steering Committee, chaired by the General Manager of Bogan Shire Council. The steering committee will meet on a regular basis and discussion will be minuted.

The steering committee structure:

- enables the key stakeholders to understand and have input to important elements in the project
- provides assurance to the funding partners that grant funding is applied in terms of the funding agreement
- provides assurance to the funding partners that the project governance is to the required standard.

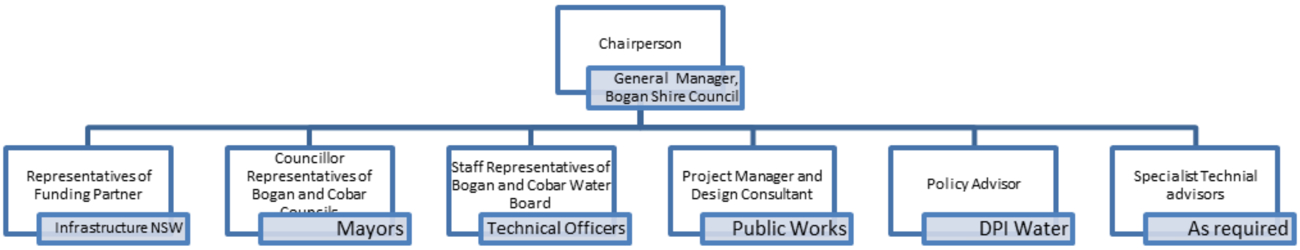
- enables any issues to be resolved promptly, with the input of key stakeholders.

The agenda of the steering committee meeting includes:

- Welcome and apologies
- Previous minutes
- Progress to date and comment against the works program
- Expenditure profile
- Any proposed variations or extensions of time
- Forward program and status against the project
- Corrective actions
- Particular site issues
- Contractor issues and report.
- Community consultation
- Review of actions
- Other matters
- Next meeting

As the projects move into the construction phase, additional agenda items will include a progress report from the project manager on the construction contract and other contractual elements

Figure 25 – Governance Structure - Steering Committee



8.6 Procurement Plan

Procurement of all contracts will be in accordance with the Local Government Act and General Regulations (2005), and Council's internal procurement policy. Part 7 of the Local Government General Regulations2005 provides the requirements for tendering for local governments.

As each of the major construction contracts will be over $150,000 they will require a formal tendering process and a Council resolution prior to engaging that service. A similar approach will also be adopted for the smaller preconstruction activities. To obtain a Council resolution, a report including a tender recommendation will be endorsed by the steering committee and submitted to a Council meeting for approval.

The selection criteria will be documented in the request for tender and be used to assess submissions. A panel (usually a minimum of three people) will be established and an evaluation plan created to assess submissions. All personnel assessing tenders will confirm that there is no conflict of interest in assessing tenders.

One of the first contracts will be the engagement of specialist project management assistance and those individuals will then take part in the overall assessment of other tenders as required and indeed this skill base will be one of the skills sought from that group.

8.7 Contract management and administration

Council will appoint a Contract Project Manager to assist Council's Project Manager, who will undertake the contract management and administration. Once a construction contract is awarded, Council will require the Project Manager to prepare and manage contractors and client meetings and reporting to the Steering Committee. Accordingly all meetings are to be minuted and formally chaired to a fixed agenda, with action sheets. This will allow for steering committee oversight as to how the project is proceeding and the effectiveness of communication between the project managers for the contractor and Council.

The Project Manager will also provide all details to Council for reporting to the funding partner in line with agreed funding milestones.

The construction contracts will include monthly (as a minimum) contract meetings that manage and document project deliverables such as; Safety, Administration and Communication, Requests for Information, Insurances, Site Security, Time, Construction Program, Cost, Quality, Environment and Contract Relations.

Contract Management will typically include:

- Monitoring and review of the works (including progress against the schedule by the Project Manager.
- Valuations of the works and prepare progress payments based upon completed milestones and
- Recommendations for Council to pay the contractor as Principal.
- Managing the contract to ensure time, cost and quality requirements are met.
- Managing Witness and Hold Points.
- Ensuring any variations are incorporated into the works.
- Ensuring any other variations required to complete the works are investigated and referred for approval.
- Managing extensions of time and variation details with the contractor.
- Providing advice on contractual matters and on the progress of the works.
- Completion of Contactor Performance reports.

- Monitoring of Contractor's Safety obligations and other reports.
- Management of contract disputes, should they arise.
- Management of the performance testing in accordance with the specification
- Management of the Defects Liability Period.
- Manage the project completion and handover to the client.
- Ensuring the delivery of all operational manuals
- Finalising any performance reports on the contractor and the project itself.

Prior to contract completion the complete pipeline will undergo rigorous performance testing to confirm specification compliance and this will be detailed in the construction contract. It is expected that the performance test period will be at least 3 months duration and the Contractor will have to prove compliance to the specification. Only after successful performance testing will contract completion be granted and the system handed over to Council. Depending upon the pipe material selected then an ongoing series of weld x-rays may also need to be submitted as they become available as part of that overall performance certification.

A key element to support the pipeline and the new storages will be the development of a new operational manual to ensure the maximum possible benefit is derived from the new assets. It will also serve as a guide for future operators in them gaining the relevant key competencies required to operate this water supply.

Council will submit to the funding partner a completion report and financial summary in accordance with the funding criteria for their acceptance and final grant payment.

8.8 Project Timeline

The tasks involved in multi-staged projects, totalling close to $90 million are substantial. An interim task list has been developed in consultation with DPI Water and NSW Public Works. This list is shown below in Table 20 and is shown graphically in Figure 26. Adjustment to the timeline will be necessary as preconstruction activities progress.[7]

[7] **Note Regarding delivery timeframe for pipeline (Stage 2)**:
The delivery timeframe for the pipeline is dominated by preconstruction activities, with this project estimated to take between 5 and 7 years. To this will need to be added any hold points for funding approval but hopefully this will be accommodated inside the timeline.

There may be opportunities to reduce the delivery timeframe for the pipeline by accelerating the negotiations with landholders along the channel and cost sharing arrangements through a series of initial meetings as stated. Council will consider undertaking these at an early stage of the project rather than commencing them after approval of funding and there is a strong case for the release of $500,000 in preconstruction activities to allow for these initial consultations with the land holders and some of the preliminary studies required to support these meetings to proceed. These costs would cover any need for additional studies in relation to matters raised in those meetings and would also include some of the environmental studies as these issues will need discussion with the landholders.

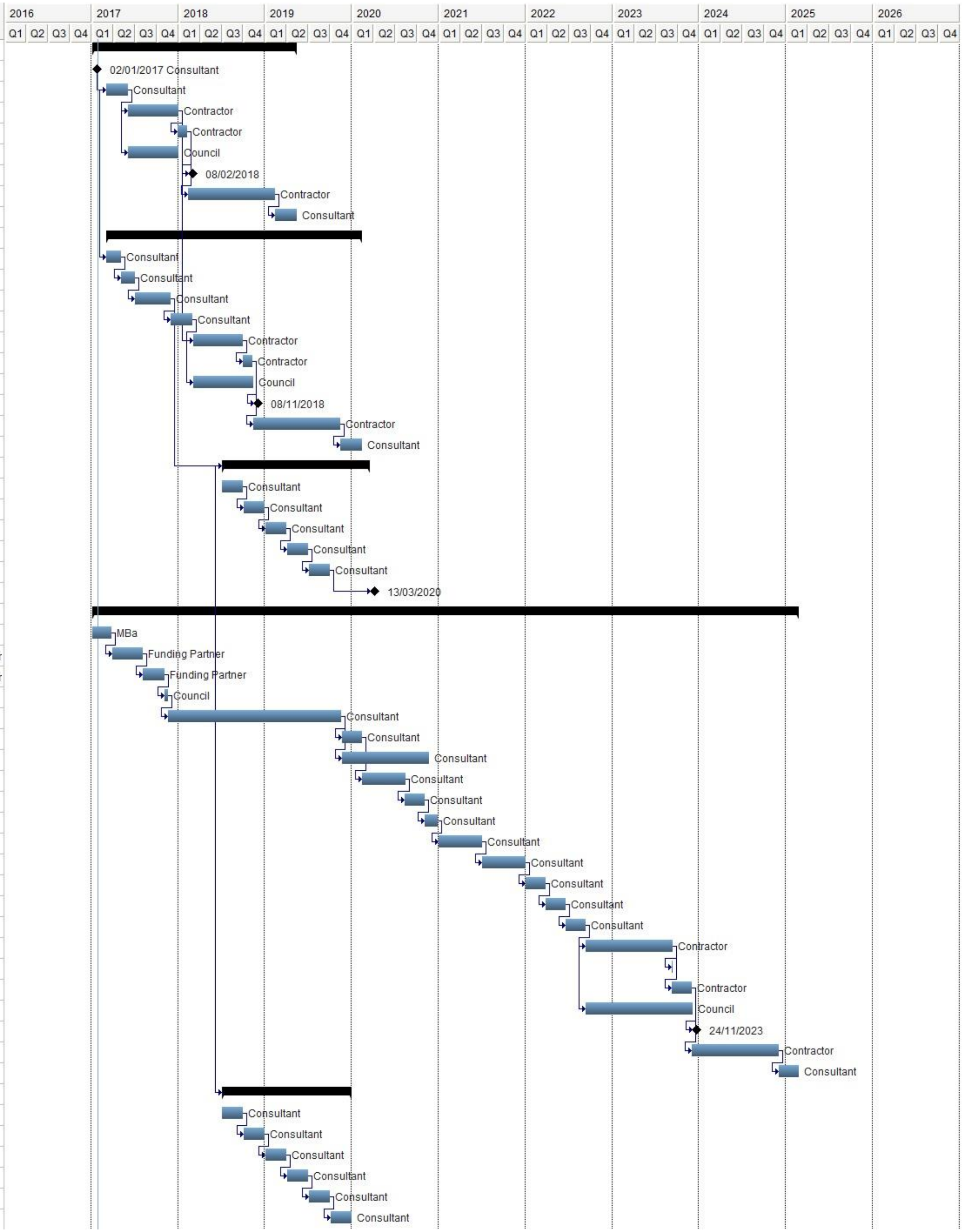
Table 20 – Project task list developed in consultation with DPI Water and Public Works

Project Stage	Tasks	Comment
Stage 1a – 700 ML Storage	a. Design Tender – 30/8/16 to 30/11/16 Construction – 30 weeks (suggest this may be 40 - 50weeks with the latter the more likely) b. Construction contingency – 6 weeks c. Defects Liability Period – 12 months d. Finalisation - 3 months	Design is complete and tenders will be invited in the second half of 2016. Construction is scheduled for 2017. Funding of $10 million is confirmed.
Stage 1b – 700 ML Storage adjacent to Stage 1a	a. Complete REF - 30/9/2016 b. Approve REF – 31/11/2016 c. Design & Contract Documentation – 30/4/2017 d. Tender 1/5/2017 – 1/8/2017 e. Construction – 30 weeks f. Construction contingency – 6 weeks g. Defects Liability Period – 12 months h. Finalisation - 3 months	Environmental studies and design will be completed in early 2017. Subject to confirmation of funding, construction can commence upon completion of Stage 1a
Stage 1c – 3,000 ML Storage along pipeline route	a. Site identification b. Preliminary Site assessment i. Geophysical survey ii. Ecological & Heritage Surveys iii. Cost estimate c. Select preferred site d. Detail assessment of preferred site i. Geophysical ii. Ecological & heritage Surveys iii. Flood impact assessment e. Options Assessment with cost estimates	Investigation only. Subject to availability of funding, site identification investigations can commence at locations along the pipeline route. An area of 50-60 hectares would be required for the 3,000MLstorage

Project Stage	Tasks	Comment
Stage 2 – Pipeline	a. Business Case b. Business Case endorsement c. Initial meetings with the landholders and feedback in relation to those meetings as a support document to the business case. d. Funding approval e. Engage Project Manager f. Cost sharing & service agreement for APC Water Users i. Cost benefit analysis for each water user group ii. Model a range of cost sharing scenarios iii. Community meetings iv. Individual meetings v. Draft & finalise service agreement g. Site Survey h. Legal matters, e.g. determine powers to construct, operate and maintain i. Land matters, e.g. construction leases, acquisitions and easements j. Landholder agreement, e.g. pipeline route, outlet locations k. Geotechnical investigations l. Concept Design m. Environmental Impact Assessment n. Approvals o. Detailed Design & Contract Documentation p. Tender and award q. Construction r. Commissioning s. Finalisation	Delivery of the pipeline project can take 5 to 7 years (depending on how well cost sharing arrangements progress). **NOTE. There may be opportunities to compress this timeline by accelerating task j prior to funding approval.**
Stage 3 – Warren Bore Field (Investigation only)	a. Regional Hydrogeological Assessment b. Preliminary Hydrogeological Studies c. Procurement Options Study d. Select preferred site e. Detailed Hydrogeological Study f. Options Assessment with cost estimates	**Investigation only** During a severe drought situation, if the supply from the Macquarie River into the APC is limited, then the feasibility of connecting a bore water supply into the pipeline is necessary. Hydro-geological studies to identify potential bores and yields etc. have not commenced.

Figure 26 – Indicative Project Timeline

	Name	Duration	Cost	Start	Finish	Predecessors	Resources
1	**STAGE 1a - 700 ML STORAGE 1a**	**613.5d?**	**$9911800**	**02/01/2017**	**09/05/2019**		
2	Design complete	0d	$904900	02/01/2017	02/01/2017		Consultant
3	Tender	13.3w	$0	01/03/2017	01/06/2017	2	Consultant
4	Construction	30w	$7679000	01/06/2017	28/12/2017	3	Contractor
5	Construction contingency	6w	$767900	28/12/2017	08/02/2018	4	Contractor
6	Supervision	150d?	$560000	01/06/2017	28/12/2017	4SS	Council
7	Storage commissioned	0d	$0	08/02/2018	08/02/2018	5	
8	Defects Liability Period	52w	$0	08/02/2018	07/02/2019	5	Contractor
9	Finalisation	13w	$0	07/02/2019	09/05/2019	8	Consultant
10	**STAGE 1b - 700 ML STORAGE 1b - ADJACENT TO STORAGE 1a**	**767d**	**$5770022**	**01/03/2017**	**06/02/2020**		
11	Complete REF	9w	$0	01/03/2017	02/05/2017	3SS	Consultant
12	Approve REF	8.4w	$0	03/05/2017	29/06/2017	11	Consultant
13	Design and contract documentation	21.6w	$526775	30/06/2017	28/11/2017	12	Consultant
14	Tender and award	13.4w	$0	29/11/2017	01/03/2018	13	Consultant
15	Construction	30w	$4470227	02/03/2018	27/09/2018	4,14	Contractor
16	Construction contingency	6w	$447023	28/09/2018	08/11/2018	15	Contractor
17	Supervision	36w	$325997	02/03/2018	08/11/2018	15SS	Council
18	Storage commissioned	0d	$0	08/11/2018	08/11/2018	16	
19	Defects Laibility Period	52w	$0	09/11/2018	07/11/2019	16	Contractor
20	Finalisation	13w	$0	08/11/2019	06/02/2020	19	Consultant
21	**STAGE 1c - 3000ML STORAGE 1c**	**445d**	**$30500000**	**02/07/2018**	**13/03/2020**	**13**	
22	Site identification	13w	$100000	02/07/2018	28/09/2018		Consultant
23	Preliminary site assessment	13w	$100000	01/10/2018	28/12/2018	22	Consultant
24	Select preferred site	13w	$50000	31/12/2018	29/03/2019	23	Consultant
25	Detail assessment of preferred site	13w	$150000	01/04/2019	28/06/2019	24	Consultant
26	Options assessment with cost estimates	13w	$100000	01/07/2019	27/09/2019	25	Consultant
27	Interim costing and construction	0d	$30000000	13/03/2020	13/03/2020	26FS 6m	
28	**STAGE 2 - PIPING OF ALBERT PRIEST CHANNEL**	**2119.5d**	**$75207600**	**02/01/2017**	**14/02/2025**		
29	Business Case	12w	$50000	02/01/2017	24/03/2017		MBa
30	Business Case Endorsement	18.4w	$0	27/03/2017	01/08/2017	29	Funding Partner
31	Funding Approval	13w	$0	02/08/2017	31/10/2017	30	Funding Partner
32	Engage Project Manager	2.5w	$200000	01/11/2017	17/11/2017	31	Council
33	Cost Sharing & Service Agreement for APC	104w	$50000	17/11/2017	15/11/2019	32	Consultant
34	Site Survey	12w	$200000	15/11/2019	07/02/2020	33	Consultant
35	Land Matters	52w	$200000	15/11/2019	13/11/2020	33	Consultant
36	Legal matters	26w	$50000	07/02/2020	07/08/2020	34	Consultant
37	Landholder agreement	12w	$50000	07/08/2020	30/10/2020	36	Consultant
38	Geotechnical investigation	8w	$200000	30/10/2020	25/12/2020	37	Consultant
39	Concept design	26w	$100000	25/12/2020	25/06/2021	38	Consultant
40	Environmental Impact Assessment	26w	$150000	25/06/2021	24/12/2021	39	Consultant
41	Approvals	12w	$0	24/12/2021	18/03/2022	40	Consultant
42	Detail design and contract documentation	12w	$1622600	18/03/2022	10/06/2022	41	Consultant
43	Tender and award	12w	$20000	10/06/2022	02/09/2022	42	Consultant
44	CONSTRUCTION	52w	$5785200	02/09/2022	01/09/2023	43	Contractor
45	Construction contingency	1d	$1157040	01/09/2023	04/09/2023	44	
46	Commissioning	12w	$0	01/09/2023	24/11/2023	44	Contractor
47	Supervision	64w	$2892600	02/09/2022	24/11/2023	44SS	Council
48	Pipeline operational	0d	$0	24/11/2023	24/11/2023	46	
49	Defects Liability Period	52w	$0	24/11/2023	22/11/2024	46	Contractor
50	Finalisation	12w	$0	22/11/2024	14/02/2025	49	Consultant
51	**STAGE 3 - WARREN BOREFIELD INVESTIGATION**	**390d**	**$500000**	**02/07/2018**	**27/12/2019**	**21SS**	
52	Regional Hydrogeological assessment	13w	$50000	02/07/2018	28/09/2018		Consultant
53	Preliminary hydrogeological studies	13w	$100000	01/10/2018	28/12/2018	52	Consultant
54	Procurement options study	13w	$50000	31/12/2018	29/03/2019	53	Consultant
55	Select preferred site	13w	$0	01/04/2019	28/06/2019	54	Consultant
56	Detailed hydrogeological study	13w	$250000	01/07/2019	27/09/2019	55	Consultant
57	Options assessment with cost estimates	13w	$50000	30/09/2019	27/12/2019	56	Consultant



8.9 Expenditure Profile

The project timeline has been used to predict an annual expenditure profile for the total water security project. The expenditure profile is heavily dominated by the capital cost of the pipeline construction (Stage 2), and the bulk of the expenditure may not occur until 2022, depending on the duration of preconstruction activities. As discussed in Section 8.8, there may be opportunities to compress the timeline for preconstruction activities for the pipeline.

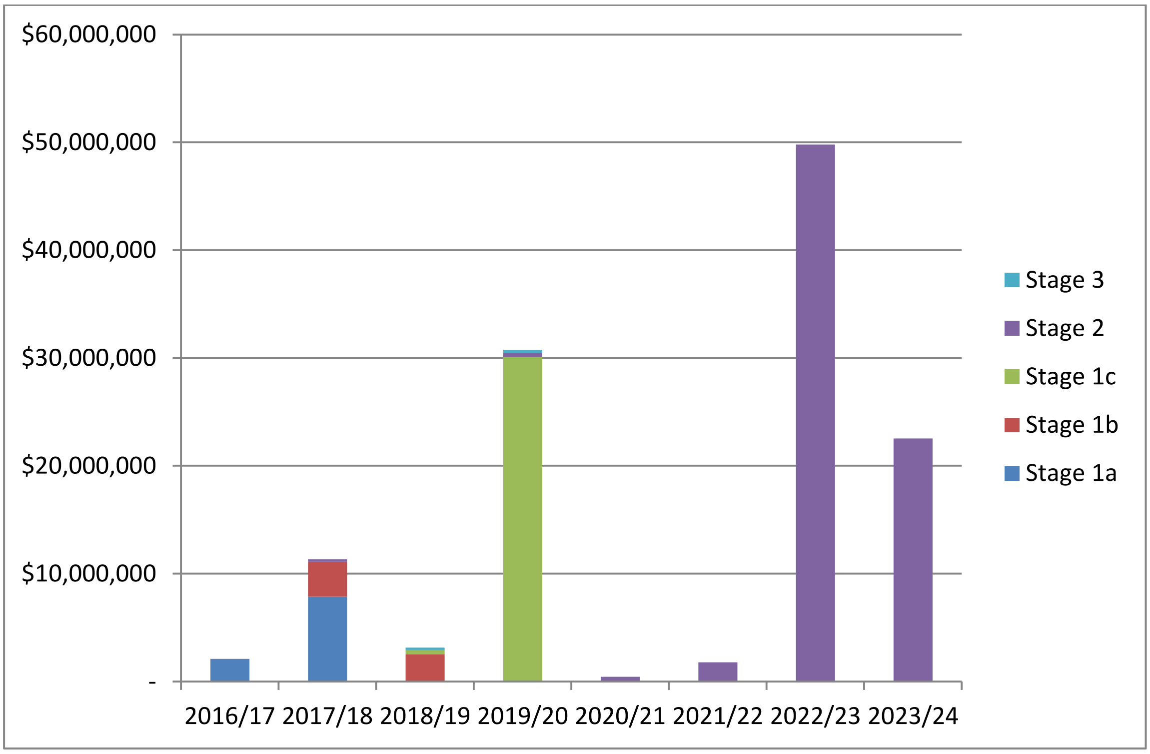
Adjustment to the expenditure profile will occur as the project timeline is refined. A preliminary expenditure profile is shown in tabular form and graphical form below:

Figure 27 – Preliminary expenditure profile

	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	TOTALS
Stage 1a	$2,042,667	$7,869,133							**$9,911,800**
Stage 1b		$3,249,268	$2,520,754						**$5,770,022**
Stage 1c[8]			$400,000	$30,100,000					**$30,500,000**
Stage 2	$50,000	$215,453	$25,069	$374,313	$439,286	$1,773,241	$49,797,858	$22,532,381	**$75,207,600**
Stage 3			$200,000	$300,000					**$500,000**
TOTAL	**$2,092,667**	**$11,333,854**	**$3,145,823**	**$30,774,313**	**$439,286**	**$1,773,241**	**$49,797,858**	**$22,532,381**	**$108,462,901**

[8] NOTE – For the purposes of determining an expenditure profile for the total water security project, this tabulation and the following graph includes an indicative construction cost of $30M for Stage 1c (3000 ML storage). The construction costs associated with Stages 1c (3000 ML storage) and 3 (borefield) are NOT included in the affordability analysis.

Figure 28 –Preliminary expenditure profile



8.10 Potential for Partnerships

Bogan Shire Council is the water authority for Nyngan, and Cobar Water Board is the bulk raw water authority that conveys raw water to Cobar. Although Bogan Shire Council is the agency responsible for these projects, Cobar Water Board will be providing approximately two-thirds of the ongoing funding costs.

Cobar Water Board is a form of a Private Public partnership. The Board is part funded by private companies (mines) and is administered by two levels of government. The most significant beneficiary of the project is the Cobar mining industry, which is dependent on this water supply. The involvement of the mining partners is vital to this project. There is limited potential for a partnership with other parties.

The levels of operational flows would not offer significant benefits for a private party to take on the operation of the scheme. It is anticipated that if a private party arrangement was considered, there would be considerable concern form the landholders involved along the pipeline route.

9 Risk Management Plan

9.1 General Risk Management-Nyngan Cobar Water Supply

The provision of a water supply to any urban population is by its very nature a risk management exercise. One of the largest risks is attaining a water source that is sufficiently secure to meet the needs of the particular system over time. Thereafter, the risks include the reliability of delivery mechanisms and finally, the ability to produce the quality of the water required when delivered as a potable water supply. In terms of this Business Case, the risk assessment focuses on the headworks associated with transporting water to the Nyngan Weir Pools, recognising the water security aspects of the Nyngan Cobar water supply system. The water delivery to customers and water quality aspects are outside the scope of this business case.

Clearly the target of such a water supply system is to provide a water supply that meets the 5/10/10 rule (as defined in Section 3 of this Business Case) and which forms the government's minimum level of acceptable water security for an urban water supply. Thus any determination of the risks involved with the Nyngan Cobar- Water Supply would start by understanding how the existing system performs against that minimum water security rule. This establishes the base line from a risk management perspective and set out in Table 26.

After this base line is established there is the need to then examine how the risk matrix changes as the various components are added to that system and secure yield increases. The levels of risk associated with each component are demonstrated in Table 27 to Table 30. In the case of these latter tables, additional risks associated with project management become involved. Table 26 essentially represents the do nothing case.

A more complete discussion follows.

9.2 Risk Assessment Methodology

The actual risks or hazardous events have been identified and discussed through internal workshops. To ensure consistency in the assessment process, this assessment is in accordance with the methodology set out in the Australia Standards for Risk Management. The actual ranking for each risk identified is based around determining the likelihood of one of the risk event occurring and understanding the consequences of the risk event. These individual rankings are then entered into the risk evaluation matrix as set out in Table 23 and a final assessment for each risk determined and listed in the tables that follow.

Table 21 - Likelihood of a particular hazardous event occurring

Level	Descriptor	Examples of how to apply the Description
A	Almost certain	Is expected to occur in most circumstances.
B	Likely	Will probably occur in most circumstances.

Level	Descriptor	Examples of how to apply the Description
C	Possible	Might occur or should occur at some time.
D	Unlikely	Could occur at some time.
E	Rare	May occur only in exceptional circumstances.

Table 22 - Likely consequences if the hazardous event occurs

Level	Descriptor	Examples of how to apply the Description
1	Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs.
2	Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs.
3	Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring.
4	Major	Major impact for small population systems, significantly compromised and abnormal operation if at all, in addition a high level of monitoring will be required.
5	Catastrophic	Major impact for large population, complete failure of systems.

Table 23 - Risk ranking based upon the Likelihood and Consequences

Likelihood	Consequences				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very High	Very High	Very High
B (likely)	Moderate	High	High	Very High	Very High
C (possible)	Low	Moderate	High	Very High	Very High
D (unlikely)	Low	Low	Moderate	High	Very High
E (rare)	Low	Low	Moderate	High	High

To allow the risk rankings to be more readily understood in terms of the risks associated with each identified risk the tables are coloured in accordance with the legend below

Table 24 – Colour legend

Low	(grey)
Moderate	(green)
High	(orange)
Very high	(red)
Risk No longer applicable	(white)

Note:

1. *Risks associated with the current Albert Priest Channel become no longer relevant if a pipeline was built as the channel no longer is part of the water supply scheme. If some others want to make use of the channel or it is filled in after the pipeline is completed sit somewhat outside this business case.*

9.3 Overall Risk Assessment

Council is required to submit an overall risk ranking in relation to its application for funding so that the funding body may gain some appreciation of:

- How the injection of different levels of funding will reduce the risks to the region in relation to the water supply system. Each stage will reduce as each new investment further increases regional water security.
- What level of residual risk may be associated with any of the stages.

One event that was not ranked in the overall risk assessment was the potential for flooding such as occurred in 1990 when Nyngan had to be evacuated. This would have the impact of stopping any works but the event is so rare that it is doubted that any of the construction contractors would even factor it into their pricing. For example it would tend to have an E2 to E3 ranking based on the tables above.

The analysis was done on the progressive basis of:

Table 25 – Risk Assessment Scenarios

Risk Assessment Case	Risk Assessment Scenario
1	The existing system only (Base case)
2	The existing system plus 700 ML storage (the latter having been already approved for funding) and represents what the base case will move to if no other works are undertaken.
3	The existing system plus both the new storage and a pipeline from the Macquarie River to Nyngan , replacing the Channel as the water carrier.
4	The existing system plus 2 by 700 ML storages and a pipeline from the Macquarie River to Nyngan.
5	The system as set out in point 4 plus a connection to a ground water supply in Warren if that is determined to have such a supply. This represents the only solution that achieves the modelled secure yield identified.

Case 1 is analysed as having 7 very high risks, 4 high risks and far too few moderate and low risks. As such it carries with it far too adverse a risk profile to feel assured that the towns will be able to play the role required of them over the next century. **Cases 2 and 3** see this risk profile fall further but it would still be considered unacceptable. At **case 4** based upon current loads the risk profile is becoming almost acceptable but that will alter as the demand grows. Overall risk is determined as being quite acceptable with the preferred solution suggested in the NNUWS yield analysis, represented by **case 5**.

9.4 Risk Assessment Case 1 - Existing system without improvement

The studies carried out as part of identifying needs and compiling this business case have already indicated that the secure yield of the existing system is only 32% of the identified needs based upon current demand. This drops to around 24% of the estimated final demand. These figures would tend to indicate that the probability of risk events occurring will grow further with time and that the risk associated with the water supply must be assessed as being very high.

In the 13 areas of primary risks associated with the existing water supply security listed in Table 26 there were 7 area assessed as being of very high risk, four areas of high risk and three area of moderate risk. **As such the risk analysis simply confirms that there is an unacceptable level of risk associated with the current water supply** and that something will need to be done to reduce this risk to more manageable proportions given that demand is predicted to increase by 33% over the next 84 years.

The risk profile associated with the do nothing scenario rules out this option. In reality this option will not occur because funding to construct a further storage at Nyngan has already been approved and construction is scheduled for 2017. Hence there will be improvements over the current levels of security and risk assessment case 2 represents the **base case**.

Notes on how the specific rankings were determined for this scenario along with assumptions and considerations are set out below. Reference to Table 26 should be made in reading these notes.

1. *This is a worst case scenario wherein the Macquarie River has no flow in it at the draw off point for a significant period of time (potentially up to six months) and with that there will be significant consequences for the towns such as industry shutting down and some potential evacuation of the townships, to be able to get through this event. In short the impact would be catastrophic for the region. Based upon past history this would seem to have around a 1 in 100 year probability of occurring but potentially climate change modelling would seem to indicate this may actually occur 2 – 3 times over this 100 year period. Hence it is thought that this would be an unlikely event. That it almost occurred in 2007 would seem to confirm this possible event.*
2. *Macquarie River Water may need to be withdrawn for a short period of time due to some event such as a blue green algae event in the river or some pollutant making its way into the river. Such events should be short term ranging from a few days up to say 2 – 3 weeks. Clearly the impacts of this will be magnified by the status of the storages at the time but it is policy not to draw the storages too low. Thus the consequences of these short term unavailabilities should normally be relatively minor and somewhat infrequent. Clearly the consequences may be more significant if it occurred in the week or two before the channel was to be opened to refill the weir pool but a close eye on the storages and what is happening should be sufficient to offset this.*
3. *In the 16 years since 2000 there have been three occasions on which allocations have been reduced but this has happened only on some 9 occasions since 1900. It is likely based on current water security modelling that the number of these occasions will increase in the period 2000 to 2100. The consequences of these reductions will depend greatly on how significant the reduction is and how long the period the reduction needs to be applied for. A repeat of the 1980/81 drought potentially constitutes what would be considered a catastrophic event whereas a repeat of the 2003/2004 even would be described as moderate with more financial*

implications in terms of the money spent in procuring additional water and the reduction in confidence for the towns that any water restrictions bring.

4. *Whilst water restrictions is something of a way of life in these western regions, each introduction of water restrictions makes it harder to retain people in town particularly the families of miners where the miner in the family can move to a fly in fly out operation. It also adds further uncertainty to businesses such as the mines and could at some time be something that tips a number of decisions in favour of closure, with flow on ramifications for the township. The adoption of restrictions as such is considered as something that is likely to occur with moderate to major impacts of the towns. For the sake of this exercise the lower category will be adopted.*
5. *Loss of the channel could be significant but based upon past history such problems can be repaired and have the channel back on line within a week. More substantive repairs can be conducted when the channel is not in use. Historically there has not been a situation where the channel has been out of action for a long period of time and the frequency of failure during the operational periods is relatively low due to the ongoing regular inspections of the channel. However this constant monitoring adds considerably to the overall operational costs. It is also possible to operate the channel in a less satisfactory manner but this can increase the losses occurring in the existing system.*
6. *Ongoing siltation of the weir pool given the 23% decline in capacity between 1983 and 2007. Over time without any further intervention will result in decreased water security and forcing greater purchases of water to compensate for this reduced storage capacity. Impacts will range from major (much more frequent use of channel, increased losses resulting from this greater need to purchase water) to catastrophic (in terms of a worst case scenario for a short term loss of Macquarie River Water – exceeding residents' capacity to pay). This is happening with the reduction in a relatively short period being very significant hence his is likely. With no other secure storages it is hard to remove sediment from the pools at any time.*
7. *Potential loss of the endangered Olive Perchlet fish species that are contained in the weir pools is a possibility with the potentials for both the river to stop flowing for a period of time, the town fighting for every drop of increased allocation and the weir pools silting. Thus when looking to 2000 to 2100 thus event must be considered likely and the loss of any endangered species can only be considered catastrophic.*
8. *Potential damage to the wetland environment in the wetland area. Similar comment apply here as in 7 above accepting that excepting that the impact assessment has been reduced back to major.*
9. *Possibility that system losses may increase with time is difficult to conceive based upon historical records but the long term recording of such losses is not as well documented as it might be and hence there must be some possibility this could occur, particularly under the worst environmental conditions. For now considered unlikely.*
10. *Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down. The modelling associated with the background to this and the fact that the current secure yield is only around 1/3 of what it should be, indicates this must be considered a likely event. Each time 1000 ML are purchased this add a bill of around $75 -$100 to each rate notice and then only half of the water arrives in the town for consumption.*
11. *Lifestyle in the towns will be threatened in that too frequent water restrictions lead to no one being able to sustain a garden or that evaporative air cooling cannot be operated during a period of time. This has flow on ramifications in terms of potential health problems particularly for the elderly or infirmed, but it also has the potential to totally suppress real-estate values.*
12. *Potential political fallout if this region not provided with a more secure water supply over time, as many other regions do have this security. For example the $500 M pipeline from Wentworth to Broken Hill shows the governments investment in that region and the question would be*

asked why a similar investment wouldn't be made in this region. Such fall out is not likely to occur at a local government level as residents will be aware that the problem is too large for these bodies to address.

13. *Community members would understand providing this is beyond the capacity of local Councils. However a worst case scenario of some of the other high risk scenarios could easily lead to fall back on higher levels of government. There would also be a flow on to other dry western regions sharing similar concerns that they may similarly be left with a less than secure water supply.*
14. *Inability for the towns to provide the regional support role that will be needed of them without improvements to their water supply. Access to a secure water supply is arguably the single most important service required for any urban development to occur and be sustained. If such a supply is not adequate, the towns will decline. This will hold the region back from the role needed of it by the nation. Shortages in water security are a primary cause that leads to the closure of some or all of the mines.*
15. *It is doubted that the landholders will agree to an easement being taken over the channel and that may lead to problems in the future but historically there has not been an issue in terms of the ongoing operation of the channel.*

9.5 Risk Assessment Case 2 - Construction of Storage 1a

The addition of Storage 1a will:

- Increase the overall secure yield to around 2000 ML/annum as modelled by NNUWS increasing capacity to around 45% of what is required.
- Provide more storage in the event of the Macquarie River running dry so that the town will be able to survive such an event for some time.
- Free up some of existing allocation in terms of reduced losses in the storages area

These works will introduce a number of project delivery and operational risks that need to be added to the analysis. There will also be increased operational costs associated with the new headworks.

Table 27 identifies 23 areas of risk. This option was assessed as having the following risk profile:

- 5 areas of very high risks
- 5 area of high risks
- 3 Moderate risks and
- 1 area of low risk

In respect to the project implementation this was assessed as having three areas of moderate risk and 6 areas of low risk. As such the construction of a new storage does not bring any area of significant risk.

The reduced risk profile in the water security overview is to be anticipated as this storage does significantly increase the secure yield for the region and goes part of the way to addressing the scenario of the Macquarie River ceasing to flow. Much of these initial gains will however be lost as the demand increases and the water security decreases accordingly. Nevertheless the risk profile even with this increased storage is still considered unacceptable and does not come close to meeting the required secure yield analysis.

This scenario represents a do the minimum type scenario. Whilst it certainly does improve the current water security, and demonstrates the value of the works, there is clearly a need to do more.

Notes on how the specific rankings were determined for this scenario along with assumptions and considerations are set out below. Reference to Table 27 should be made in reading these notes.

1. *The additional storage should represent an ability to keep operating for a longer period should the river stopping running for a period of time. However this is limited and even with the additional storage there will be a need to manage this and hence significant water restrictions will still be needed should this river event occur.*
2. *With the additional storage the impacts of these short term reductions should be reduced as the additional storage will see it easier to traverse the period of water unavailability.*
3. *The consequences may be more significant if it occurred in the week or two before the channel was to be opened to refill the weir pool and additional storage. Close monitoring should avoid this potential problem.*
4. *The additional storage capacity and the freeing up of some of the current allocation should marginally reduce the need to purchase water in most period where Macquarie River allocation reduced but the concern still exists in relation to any repeat of a 1980/81 event.*
5. *The additional storage capacity should make it possible to reduce the extent of restrictions in the short term.*
6. *The additional storage will afford even more time to effect any channel repairs and as such the likely impact should reduce marginally.*
7. *The additional storage does little to reduce siltation in the existing storage pond but should see the impacts less onerous as there is additional storage capacity in place.*
8. *Potential for loss of the endangered Olive Perchlet that are contained in the weir pools remains a possibility with the potentials for both the river to stop flowing for a period of time and with the weir pools continuing to reduce in volume through siltation. Diversion of flows into a new offstream storage may arguable place the fish at slightly more risk.*
9. *Potential damage to the wetland environment in the wetland area.*
10. *The reduction in some of the losses afforded by the new storage will assist with reducing overall system losses. It may also be possible to operate the channel a little less often reducing some of the losses there.*
11. *Purchases of ongoing allocations may be reduced a little by the freeing up of some allocation and the ability to last longer on the storage once the allocations have been used.*
12. *Potential threats to lifestyle may be reduced a little here due to increased security and the increased ability to traverse dry periods.*
13. *Residents will have witnessed some action occurring and there will be increased confidence in the government and in the region's economy.*
14. *The marginal increase to water security will increase the region's economy and will support planning initiatives into the future.*
15. *The issue of no easement over the Albert Priest Channel is not resolved under this option.*

16. *The design and estimates prepared for these works have been well researched by experienced practitioners, minimising the risk of cost bow-outs. An appropriate standard document will be used as the basis of the contract documents.*
17. *If the project was to run over time the only real exposure for the project would be the costs of further project management support until the project was completed and this is considered minor in nature.*
18. *Inadequate design generally only occurs where there has been insufficient site investigation and that is not the case here.*
19. *Flooding such as occurred in 1990 or unexpected rock on site are examples of site specific issues but as there has been considerable investigation and the likelihood of these events is very low.*
20. *The adoption of agreed project payment milestones plus the retention of appropriate security monies should see Council appropriately protected if the Contractor was unable to finish the work.*
21. *Warranties of a minimum of three years will be specified with mechanical and electrical components such as the pumps and the expected lives of other materials will all be part of the selection criteria for this project hence this is considered a low risk.*
22. *Operators mistakes are always a possibility with any system but with appropriate training and good operational procedures should minimise any such errors and this risk at maximum is moderate but more likely low.*
23. *Getting goo d quality operators is always difficult in western towns but Council has a long history of exemplary operators which it has achieved through appropriate succession planning, which will continue.*
24. *Operational costs will be affordable. If power costs continue to rise then the potential to construct a supporting solar power station may become an option.*

9.6 Risk Assessment Case 3 - Construction Storage 1a and a pipeline to replace the Albert Priest Channel

The addition of the pipeline over the existing situation will:

- Increase the overall secure yield to around 2900 ML/annum as modelled by NUWS, which represents 66% of the sought after secure yield based on current demand. This represents 50% of the future demands.
- Provide more storage in the case of the Macquarie River running dry so that the towns will survive such an event for some time.
- Free up some of existing allocation in terms of reduced losses. The existing channel loses will be eliminated.

The pipeline and the storage introduce a number of new risks over and above Case 2. Table 28 assesses the risks as follows:

- 1 area of very high risks
- 5 areas of high risks
- 8 areas of moderate risks and
- 1 area of low risk
- One risk no longer applicable as the channel will no longer be required.

This represents a very considerable reduction in risk over the previous options due to the reduction in losses in the channel as well as some reduction in losses in the use of the new storage. The risk profile is however still high and requires further work to ensure that water security is increased for the region.

In respect to the project implementation this was assess as having four areas of moderate risk and 5 areas of low risk. There is an increase is in the operating costs, which could escalate if were significant increases in power costs. There is nothing in the project risk profile that would preclude proceeding with the pipeline.

The reduced risk profile in the water security is to be anticipated given that there has now been a significant gain in secure yield. That will drop of over time as demand increases but there are other options to offset this as well.

Notes on how the specific rankings were determined for this scenario along with assumptions and considerations are set out below. Reference to Table 28 should be made in reading these notes.

1. *The ability to capture and transport small amounts of river flow when coupled with the additional storage capacity should give the towns the ability to survive most if not all of the likely stoppages in flow in the Macquarie River. Water restrictions will still be required but overall the impacts will be reduced slightly and the likelihood of the event will decrease. There still remains a high risk as there is some potential for a worst case scenario to occur.*
2. *The additional allocation freed up by the reduced losses from removing the channel losses should decrease this concern over purchasing additional allocations but given that we have still only an assured yield of 66% this risk must remain high.*
3. *The freed up allocation when coupled with the restrictions should lead to a reduced frequency of severe water restrictions and a reduction in risk.*
4. *The channel is no longer required under this option*
5. *This option does not effectively address the siltation of the weir pool*
6. *The freed up allocation and the ability to transfer small river flows should reduce the possibility of this occurring*
7. *Same comments as above.*
8. *This option achieves very significant reductions in system losses particularly with the removal of the channel freeing up around 25% of all water procured.*
9. *Freed up allocations should reduce the needs to procure significant amounts of water hence reducing the likelihood of this risk occurring.*
10. *Possible the ranking in this area should be reduced to moderate but this option still only meeting 66% of required secure yield.*
11. *The expenditure on the existing storage and the pipeline should be sufficient to reduce this to low overall risk assessment but it may grow again with time as demand increases and the fact that there is still insufficient yield.*
12. *Region still does not have what could be termed a secure water supply so risk here must remain high.*
13. *The advent of a pipeline and pumping station will require a very different operation regime and a series of operational protocols need to be developed.*

14. *Will need operational experience to confirm that there is no significant increase in power but initial studies indicate that there should not be any significant increase in operational costs.*

9.7 Risk Assessment Case 4 - Construction of Storages 1a and 1b and a pipeline to replace the Albert Priest Channel

The addition of the pipeline and storages 1a and 1b over the existing situation will:

- Increase the overall secure yield to around 3,400 ML/annum as modelled by NNUWS, which represents 78% of the sought after secure yield based on current demand and 58% of the anticipated future demand.
- Provide good storage in the case of the Macquarie River running dry so that the town will be able to survive such an event for some time.
- Free up some of existing allocation in terms of reduced losses as most of the current channel loses will be voided.
- Free up sufficient storage that it will allow for some cleaning out of the current weir pools after techniques have been developed to protect the endangered fish species.

Storage 1b will be less costly than building Storage 1a. The two storages at the same size will also lead to greater consistency in the system operation.

Table 10 .7 demonstrates the now identified 25 areas of risk. In relation to the 16 risk areas identified purely in relation to water security basis this option was assessed as having:

- No very high risk areas
- 5 high risks areas
- 8 moderate risks areas
- one low risk area
- One risk no longer applicable as the channel will no longer be required.

This represents a very considerable reduction in risk over the previous options. This is due to the now significant volumes of storage, which are not subjected to the same level of system losses experienced in the weir pool. The risk profile has now moved almost into the acceptable range for the short term as it meats 78% of the current need and essentially eliminates a worst case scenario. However with increased demand this solution becomes less acceptable.

In respect to the project implementation this was assessed as having three areas of moderate risk and seven areas of low risk. As one storage will have been built already, there is less risk of cost overrun.

The reduced risk profile in the water security is to be anticipated given that there has now been a significant gain in secure yield with both reduced system losses and increased storage capacity to guard against the worst case scenario.

Notes on how the specific rankings were determined for this scenario along with assumptions and considerations are set out below. Reference to Table 29 should be made when reading these notes.

1. *The additional 1400 ML of storage plus the weir pools and the pipeline should be sufficient to traverse a likely period when the Macquarie River flow would be unavailable and as such the towns should be able to survive this period with only light restriction. It is extremely unlikely that a worst case scenario could occur.*
2. *Even with the storages drawn down there should easily be sufficient water stored to traverse such a short term interruption without the need for water restrictions.*
3. *The weir pool is becoming less impacted as there is now significant alternative storage. It will be possible to use this additional storage as a buffer whilst cleaning out the existing weir pool. The need to recover this capacity will become more important with time as demand increases at a time when storage is decreasing.*
4. *Whilst water will in these more extreme times be more directed to the new secure storages, some water may be available from retained allocations to convey some environmental flows to the storages without the system losses.*
5. *Similar comments to 4 above apply here.*
6. *The need to procure additional water should be marginally reduced.*
7. *The increased storage capacity should result in considerably reduced needs to adopt severe water restrictions. Hence risk here is reduced.*
8. *In the short term the additional water security will generate economic confidence in the towns. Thus just after the works were constructed it would be said risk here was moderate some time into the shorter future that risk would climb again to high hence this risk ranking has been left unchanged.*
9. *The considerable work done on the existing site is anticipated to provide an excellent guide to the proposed second storage.*
10. *With the money invested by governments in the additional storage capacity at Nyngan it will send a significant message to the landholders of the desire to provide a secure water supply for the region. Potentially this risk should have also been rated low for previous scenario.*
11. *Similar comments apply here as for 10.*
12. *Based on the experience of having built one of the storages then cost control should be quite sharp for this item.*
13. *If there were any minor design difficulties it is expected that these would have been ironed out from the experience of constructing the first storage and cost estimates for the second storage will have a high level of accuracy.*

9.8 Risk Assessment Case 5 - Construction of Storages 1a and 1b, a pipeline and groundwater supply at Warren.

This is the preferred option in the NNUWS report to add a ground water supply to the pipeline and at least 1300 ML of additional storage. If adopted that report indicates that this would meet the secure yield requirements for the Nyngan Cobar water supply, however it is difficult to provide an accurate risk assessment as too little is known at this stage of the capacity of any ground water in the Warren region. Accordingly this business case is simply seeking funding to undertake the investigation work.

Table 30 demonstrates that the water security risk profile essentially falls to low in all categories, with the exception of:

- The possibility of a series of years of reduced allocations greatly exceeding past experience. These are assessed as a moderate risk because of the gains under this project.
- The ongoing siltation that has now effectively become an operations problem more than a risk, also because of the gains on this project.

An additional option to build a 3,000 ML storage along the pipeline route is suggested in the NNUWS report. This would be pursued if the ground water source is not viable or is too expensive.

Assuming that either the groundwater or the additional large storage is viable, then a solution does exist for a secure water supply where risk is more than acceptable.

Risks associated with the investigative work

There is little risk associated with the investigative work excepting that:

- There is a need to ensure that the people of Warren do not become concerned that this project may be stealing their water security. This risk may be addressed by including Warren Council representatives in the discussions. This source when tapped may also provide additional security for Warren itself.
- The thought of a 3,000 ML storage along the pipeline route may be of some concern to landholders not wanting to lose any of their land but this should be able to be managed through the consultative process already established.

Table 26 - Risk Assessment Case 1 - The Existing Nyngan Cobar Water Supply

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
1	Macquarie River ceases to flow at the draw off point for an extended period of time and hence no water available to the towns.	▪ Close liaison with State Water over this event when Lake Burrendong becomes drawn down. ▪ Use of water restrictions prior to the event occurring ▪ Endeavouring to keep the weir pools as full as possible when long range forcasts indicate extended dry periods. ▪ Some evacuation of the townships	C	5	Very High	1
2	Macquarie River to be available at the draw off point for short period of time	▪ Close liaison with State Water and other river Councils ▪ Use of short term water restrictions to preserve what is in weir pools. ▪ Seek to have industry minimise their consumption during this period ▪ Make greater use of the Cobar Storages. ▪ Revised operational protocols.	D	3	Moderate	2
3	Macquarie River allocations reduced due to drier conditions reducing inflows in Lake Burrendong	▪ Use of water restrictions ▪ Procurement of other water through water trading arrangements	C	4	D$	3
4	Over frequent use of water restrictions leading to loss of faith in water supply system by industry	▪ Purchase of additional water to minimise impact of restrictions. ▪ Possibly acquire more allocation as it becomes available. ▪ Reduce system losses	D	3	Moderate	4
5	Loss of the Albert Pries Channel for a period of time making it impossible to fill the weir pool.	▪ Regular inspections of the channel ▪ Inspections of channel when it is empty and any below the water line damage is more evident ▪ Scheduled upgrading works when channel not required	C	1	Moderate	

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
6	Ongoing siltation of the weir pool leading to decrease storage capacity and the chance of a worst case scenario being realised or much more frequent use of the channel.	▪ Dredging of the weir pools but only after careful study and successful plan implements and even then it may not be possible. ▪ Better operating protocols	C	4-5	High to very High	
7	Potential loss of the endangered Olive perchlet	▪ Attain an environmental allocation for the fish. ▪ Bette understanding of what is required to protect the fish.	C	5	Very High	
8	Potential damage to the wetland environment in the wetland area	▪ Attain an environmental allocation for the fish. ▪ Better operating protocols	C	4	Very High	
9	Possibility that system losses may increase with time	▪ Ongoing assessment by experts ▪ Short term reduction in losses due to new storage	D	3	Moderate	
10	Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down.	▪ Reserves established for this type of event. ▪ Possible purchase of additional allocations and sale of water in years when not required may offset some of these costs	C	4	Very High	
11	Lifestyle made unacceptable by an insecure water supply potentially impacting the ability to attract people to the towns.	▪ Obtain a more secure water supply	C	3	High	
12	Potential Political fallout from an inadequate water supply	▪ Meetings with the community ▪ Development and commitment to long term strategy	C	3	High	
13	Towns/Region unable to fulfil the role expected of it	▪ Identify what is required to ensure a secure water supply.	C	4	Very High	
14	Attain easement for Channel	▪ Long informal discussion with farmers	B	3	High	

Table 27 - Risk Assessment Case 2 - Existing Nyngan Cobar Water Supply plus a new 700 ML Storage at Nyngan

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
1	Macquarie River ceases to flow at the draw off point for an extended period of time and hence no water available to the towns.	▪ Close liaison with State Water over this event when Lake Burrendong becomes drawn down. ▪ Use of water restrictions prior to the event occurring ▪ Endeavouring to keep the weir pools as full as possible. ▪ Some evacuation of the townships	D	4	Very High	1
2	Macquarie River to be available at the draw off point for short period of time	▪ Close liaison with State Water and other river Councils ▪ Use of short term water restrictions to preserve what is in weir pools. ▪ Seek to have industry minimise their consumption during this period ▪ Make greater use of the Cobar Storages. ▪ Revised operational protocols.	E	3	Moderate	2
3	Macquarie River allocations reduced due to drier conditions reducing inflows in Lake Burrendong	▪ Use of water restrictions ▪ Procurement of other water through water trading arrangements ▪ Possibly acquire more allocation as it becomes available. ▪ Make use of the extra storage capacity	C	4	Very High	3
4	Over frequent use of water restrictions leading to loss of faith in water supply system by industry	▪ Purchase of additional water to minimise impact of restrictions. ▪ Possibly acquire more allocation as it becomes available. ▪ Reduce system losses ▪ Extra storage may allow these to be a little more reduced for a short period of time.	C	3	High	4

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
5	Loss of the Albert Pries Channel for a period of time making it impossible to fill the weir pool.	▪ Regular inspections of the channel ▪ Inspections of channel when it is empty and any below the water line damage is more evident ▪ Scheduled upgrading works when channel not required	C	1	Low	
6	Ongoing siltation of the weir pool leading to decrease storage capacity and the chance of a worst case scenario being realised or much more frequent use of the channel.	▪ Dredging of the weir pools but only after careful study and successful plan implements and even then it may not be possible. ▪ Better operating protocols	C	4	Very High	
7	Potential loss of the endangered Olive perchlet	▪ Attain an environmental allocation for the fish. ▪ Bette understanding of what is required to protect the fish.	D	5	Very High	
8	Potential damage to the wetland environment in the wetland area	▪ Attain an environmental allocation for the fish. ▪ Better operating protocols	D	5	Very High	
9	Possibility that system losses may increase with time	▪ Ongoing assessment by experts ▪ Reduced losses afforded by new storage	D	2	Low	
10	Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down.	▪ Reserves established for this type of event. ▪ Some reduced pressure on purchases ▪ Possible purchase of additional allocations and sale of water in years when not required may offset some of these costs	C	3	High	
11	Lifestyle made unacceptable by an insecure water supply potentially impacting the ability to attract people to the towns.	▪ Obtain a more secure water supply	C	3	High	
12	Potential Political fallout from an inadequate water supply	▪ Very visible works will have been carried taking the short term pressure off in this area but it will return demand increases and gains reduced.	C	3	High	
13	Towns/Region unable to fulfil the role expected	▪ Development of long term strategy	D	4	Very High	

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
	of it					
14	Attain easement for Channel	▪ Long informal discussion with farmers	B	3	High	
15	Project Costs may exceed estimate	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices. ▪ Effective project management plan ▪ Good contract documents	D	3	Moderate	
16	Project may run overtime	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices.	D	2	Low	
17	Design may be inadequate or some item of cultural significance may be uncovered whilst undertaking the works.	▪ Geo-technical investigation has been completely carried out. ▪ Site has been surveyed ▪ Competent choice of designers ▪ Appropriate environmental studies have been done	D	3	Moderate	
18	Site Specific Construction Problems	▪ Geotechnical information and site surveys. ▪ Competent designer ▪ Generally dry conditions will assist ▪ Effective works program with appropriate contingencies ▪ Good choice of project managers on behalf of Council. ▪ Environmental Studies carried out.	D	2	Low	
19	Ensuring project expenditure matches work done on site.	▪ Adoption of payment by milestones with designated milestones to reflect	D	2	Low	
20	Ensuring reliable mechanical equipment	▪ 3 year minimum warranty to apply ▪ Material lives as demonstrated key selection criteria.	D	2	Low	
21	Operators Make mistakes in operating the new storage that may impact the existing weir pool or the endangered fish	▪ Training for operators ▪ Development of new operating protocols to incorporate new assets.	D	3	Moderate	

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
		▪ Formal review with appropriate staff and expert ▪ Auditing of works internally and externally				
22	Ensuring good quality system managers for the new arrangements.	▪ Auditing of works internally and externally	D	2	Low	
23	Operational Costs becoming too expensive	▪ Business case identifies these are affordable. ▪ Review closely after 12 months and optimise. ▪ Potential solar array ▪ Correct choice of materials to minimise depreciation costs	E	3	Low	

Table 28 - Risk Assessment Case 3 - Existing Nyngan Cobar Water Supply plus a new 700 ML Storage at Nyngan and Pipeline to Nyngan

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
1	Macquarie River ceases to flow at the draw off point for an extended period of time and hence no water available to the towns.	▪ Close liaison with State Water over this event when Lake Burrendong becomes drawn down. ▪ Use of water restrictions prior to the event occurring ▪ Endeavouring to keep the weir pools as full as possible. ▪ Some evacuation of the townships	D	4	High	1
2	Macquarie River to be available at the draw off point for short period of time	▪ Close liaison with State Water and other river Councils ▪ Use of short term water restrictions to preserve what is in weir pools. ▪ Seek to have industry minimise their consumption during this period ▪ Make greater use of the Cobar Storages. ▪ Revised operational protocols.	E	3	Moderate	
3	Macquarie River allocations reduced due to drier conditions reducing inflows in Lake Burrendong	▪ Use of water restrictions ▪ Procurement of other water through water trading arrangements ▪ Possibly acquire more allocation as it becomes available. ▪ Make use of the extra storage capacity	C	3	High	2
4	Over frequent use of water restrictions leading to loss of faith in water supply system by industry	▪ Purchase of additional water to minimise impact of restrictions. ▪ Possibly acquire more allocation as it becomes available. ▪ Reduce system losses ▪ Extra storage may allow these to be a little more reduced for a short period of time.	D	3	Moderate	3
5	Loss of the Albert Pries Channel for a period of time making it impossible to fill the weir pool.	No longer applicable				4

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
6	Ongoing siltation of the weir pool leading to decrease storage capacity and the chance of a worst case scenario being realised or much more frequent use of the channel.	▪ Dredging of the weir pools but only after careful study and successful plan implements and even then it may not be possible. ▪ Better operating protocols	C	4	High to very High	5
7	Potential loss of the endangered Olive perchlet	▪ Attain an environmental allocation for the fish. ▪ Bette understanding of what is required to protect the fish.	E	5	High	6
8	Potential damage to the wetland environment in the wetland area	▪ Attain an environmental allocation for the fish. ▪ Better operating protocols	D	4	High	7
9	Possibility that system losses may increase with time	▪ Ongoing assessment by experts ▪ Reduced losses afforded by new storage	D	2	Low	8
10	Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down.	▪ Reserves established for this type of event. ▪ Some reduced pressure on purchases ▪ Possible purchase of additional allocations and sale of water in years when not required may offset some of these costs	D	3	Moderate	9
11	Lifestyle made unacceptable by an insecure water supply potentially impacting the ability to attract people to the towns.	▪ Obtain a more secure water supply	D	3	Moderate	10
12	Potential Political fallout from an inadequate water supply	▪ Very visible works will have been carried taking the short term pressure off in this area.	D	2	Low	11
13	Towns/Region unable to fulfil the role expected of it	▪ Development of long term strategy	D	4	High	12
14	Inability to get the landholders to agree to a pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the landholders	D	3	Moderate	
15	Attain easement for Pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the landholders	D	3	Moderate	
16	Environmental studies may preclude proposed	▪ Modern under boring construction if	E	3	Moderate	

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
	pipeline route leading to problems of supplying all of the existing landholders	required ▪ Land already significantly disturbed				
17	Project Costs may exceed estimate	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices. ▪ Effective project management plan ▪ Good contract document	D	3	Moderate	
18	Project may run overtime	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices.	D	2	Low	
19	Design may be inadequate or some item of cultural significance may be uncovered whilst undertaking the works.	▪ Geo-technical investigation has been completely carried out.\ ▪ Site has been surveyed ▪ Competent choice of designers ▪ Appropriate environmental studies have been done	D	3	Moderate	
20	Site Specific Construction Problems	▪ Geotechnical information and site surveys. ▪ Competent designer ▪ Generally dry conditions will assist ▪ Effective works program with appropriate contingencies ▪ Good choice of project managers on behalf of Council. ▪ Environmental Studies carried out.	D	2	Low	
21	Ensuring project expenditure matches work done on site.	▪ Adoption of payment by milestones with designated milestones to reflect	D	2	Low	
22	Ensuring reliable mechanical equipment	▪ 3 year minimum warranty to apply ▪ Material lives as demonstrated key selection criteria.	D	2	Low	
23	Operators Make mistakes in operating the new storage that may impact the existing weir pool or the endangered fish	▪ Training for operators ▪ Development of new operating protocols to incorporate new assets.	D	3	Moderate	13

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
		▪ Formal review with appropriate staff and expert ▪ Auditing of works internally and externally				
24	Ensuring good quality system managers for the new arrangements.	▪ Auditing of works internally and externally	D	2	Low	
25	Operational Costs becoming too expensive	▪ Business case identifies these are affordable. ▪ Review closely after 12 months and optimise. ▪ Potential solar array ▪ Correct choice of materials to minimise depreciation costs	D	3	Moderate	14

Table 29 - Risk Assessment Case 4 - Existing Nyngan Cobar Water Supply plus two 700 ML Storages at Nyngan and Pipeline to Nyngan

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
1	Macquarie River ceases to flow at the draw off point for an extended period of time and hence no water available to the towns.	▪ Close liaison with State Water over this event when Lake Burrendong becomes drawn down. ▪ Use of water restrictions prior to the event occurring ▪ Endeavouring to keep the weir pools as full as possible. ▪ Some evacuation of the townships	D	3	Moderate	1
2	Macquarie River to be available at the draw off point for short period of time	▪ Close liaison with State Water and other river Councils ▪ Use of short term water restrictions to preserve what is in weir pools. ▪ Seek to have industry minimise their consumption during this period ▪ Make greater use of the Cobar Storages. ▪ Revised operational protocols.	E	2	Low	2
3	Macquarie River allocations reduced due to drier conditions reducing inflows in Lake Burrendong	▪ Use of water restrictions ▪ Procurement of other water through water trading arrangements ▪ Possibly acquire more allocation as it becomes available. ▪ Make use of the extra storage capacity	C	3	High	
4	Over frequent use of water restrictions leading to loss of faith in water supply system by industry	▪ Purchase of additional water to minimise impact of restrictions. ▪ Possibly acquire more allocation as it becomes available. ▪ Reduce system losses ▪ Extra storage may allow these to be a little more reduced for a short period of time.	D	3	Moderate	
5	Loss of the Albert Pries Channel for a period of time making it impossible to fill the weir pool.	No longer applicable				

6	Ongoing siltation of the weir pool leading to decrease storage capacity and the chance of a worst case scenario being realised or much more frequent use of the channel.	Dredging of the weir pools but only after careful study and successful plan implements and even then it may not be possible. Better operating protocols	C	3	High	3
7	Potential loss of the endangered Olive perchlet	Attain an environmental allocation for the fish. Bette understanding of what is required to protect the fish.	E	3	Moderate	4
8	Potential damage to the wetland environment in the wetland area	Attain an environmental allocation for the fish. Better operating protocols	D	3	Moderate	5
9	Possibility that system losses may increase with time	Ongoing assessment by experts Reduced losses afforded by new storage	D	2	Low	
10	Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down.	Reserves established for this type of event. Some reduced pressure on purchases Possible purchase of additional allocations and sale of water in years when not required may offset some of these costs	D	3	Moderate	6
11	Lifestyle made unacceptable by an insecure water supply potentially impacting the ability to attract people to the towns.	Obtain a more secure water supply	D	3	Moderate	7
12	Potential Political fallout from an inadequate water supply	Very visible works will have been carried taking the short term pressure off in this area.	D	2	Low	
13	Towns/Region unable to fulfil the role expected of it	▪ Development of long term strategy	D	4	High	8
14	studies indicate that the proposed second storage is not suited to the proposed area and need to be relocated at increased cost to the project	▪ Work done on the adjacent storage to date. ▪ Consistency of site profile with that of the proposed storage	E	e	Moderate	9
15	Inability to get the landholders to agree to a pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the landholders	D	2	Low	10
16	Attain easement for Pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the	D	2	Low	11

		landholders				
17	Environmental studies may preclude proposed pipeline route leading to problems of supplying all of the existing landholders	▪ Modern under boring construction if required ▪ Land already significantly disturbed	E	3	Moderate	
18	Project Costs may exceed estimate	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices. ▪ Effective project management plan ▪ Good contract document	E	3	Low	12
19	Project may run overtime	▪ Minimise the number of variations ▪ Estimate prepared by Public Works after significant scrutiny. ▪ Good project management practices.	D	2	Low	
20	Design may be inadequate or some item of cultural significance may be uncovered whilst undertaking the works.	▪ Geo-technical investigation has been completely carried out.\ ▪ Site has been surveyed ▪ Competent choice of designers ▪ Appropriate environmental studies done	E	3	Low	13
21	Site Specific Construction Problems	▪ Geotechnical information and site surveys. ▪ Competent designer ▪ Generally dry conditions will assist ▪ Effective works program with appropriate contingencies ▪ Good choice of project managers on behalf of Council. ▪ Environmental Studies carried out.	D	2	Low	
22	Ensuring project expenditure matches work done on site.	▪ Adoption of payment by milestones with designated milestones to reflect	D	2	Low	
23	Ensuring reliable mechanical equipment	▪ 3 year minimum warranty to apply ▪ Material lives as demonstrated key selection criteria.	D	2	Low	
24	Operators Make mistakes in operating the new storage that may impact the existing weir pool or the endangered fish	▪ Training for operators ▪ Development of new operating protocols to incorporate new assets. ▪ Formal review with appropriate staff and	D	3	Moderate	

		expert ▪ Auditing of works internally and externally				
25	Ensuring good quality system managers for the new arrangements.	▪ Auditing of works internally and externally	D	2	Low	
26	Operational Costs becoming too expensive	▪ Business case identifies these are affordable. ▪ Review closely after 12 months and optimise. ▪ Potential solar array ▪ Correct choice of materials to minimise depreciation costs	D	3	Moderate	

Table 30 - Risk Assessment Case 5 - Adoption of Preferred Method of Attaining a Secured Yield analysis

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
1	Macquarie River ceases to flow at the draw off point for an extended period of time and hence no water available to the towns.	▪ Close liaison with State Water over this event when Lake Burrendong becomes drawn down. ▪ Use of water restrictions prior to the event occurring ▪ Endeavouring to keep the weir pools as full as possible. ▪ Some evacuation of the townships	D	2	Low	1
2	Macquarie River to be available at the draw off point for short period of time	▪ Close liaison with State Water and other river Councils ▪ Use of short term water restrictions to preserve what is in weir pools. ▪ Seek to have industry minimise their consumption during this period ▪ Make greater use of the Cobar Storages. ▪ Revised operational protocols.	E	2	Low	2
3	Macquarie River allocations reduced due to drier conditions reducing inflows in Lake Burrendong	▪ Use of water restrictions ▪ Procurement of other water through water trading arrangements ▪ Possibly acquire more allocation as it becomes available. ▪ Make use of the extra storage capacity	D	3	Medium	
4	Over frequent use of water restrictions leading to loss of faith in water supply system by industry	▪ Purchase of additional water to minimise impact of restrictions. ▪ Possibly acquire more allocation as it becomes available. ▪ Reduce system losses ▪ Extra storage may allow these to be a little more reduced for a short period of time.	D	2	Low	
5	Loss of the Albert Pries Channel for a period of time making it impossible to fill the weir pool.	No longer applicable				

No	Potential Hazardous Event	Examples of Other Control Measures that can be used.	Controlled Risk Score			Notes
			L	C	Rating	
6	Ongoing siltation of the weir pool leading to decrease storage capacity and the chance of a worst case scenario being realised or much more frequent use of the channel.	▪ Dredging of the weir pools but only after careful study and successful plan implements and even then it may not be possible. ▪ Better operating protocols	D	3	Moderate	3
7	Potential loss of the endangered Olive perchlet	▪ Attain an environmental allocation for the fish. ▪ Bette understanding of what is required to protect the fish.	E	2	Low	4
8	Potential damage to the wetland environment in the wetland area	▪ Attain an environmental allocation for the fish. ▪ Better operating protocols	D	2	Low	5
9	Possibility that system losses may increase with time	▪ Ongoing assessment by experts ▪ Reduced losses afforded by new storage	D	2	Low	
10	Purchases of ongoing allocations may become too prevalent and prove to be just too expensive and further generate significant water restrictions including some business shut down.	▪ Reserves established for this type of event. ▪ Some reduced pressure on purchases ▪ Possible purchase of additional allocations and sale of water in years when not required may offset some of these costs	E	2	Low	6
11	Lifestyle made unacceptable by an insecure water supply potentially impacting the ability to attract people to the towns.	▪ Obtain a more secure water supply	E	2	Low	7
12	Potential Political fallout from an inadequate water supply	▪ Very visible works will have been carried taking the short term pressure off in this area.	D	2	Low	
13	Towns/Region unable to fulfil the role expected of it	▪ Development of long term strategy	E	2	Low	8
14	Environmental geotechnical and other studies indicate that the proposed second storage is not suited to the proposed area and need to be relocated at increased cost to the project	▪ Work done on the adjacent storage to date. ▪ Consistency of site profile with that of the proposed storage	E	3	Moderate	9
15	Inability to get the landholders to agree to a pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the landholders	D	2	Low	10
16	Attain easement for Pipeline	▪ Long informal discussion with farmers ▪ Pipeline offers additional advantages to the landholders	D	2	Low	11

10 References

CPE Associates, "Nyngan and Cobar Raw Water Security Business Case" Version 1.3, February 2013

Table 31 – Source information for 2013 CPE Associates Report

Year	Author and Report
2003	Bill West's report
2004	NSW Public Works Background Paper
2005	SKM's Nyngan-Cobar Water Supply – Investigation Study plus Appendices
2007	Paul Geurtsens (WaterBiz) reports plus appendices Bogan River Weirpool Assessment (April 2007) Implementation Review - of APC metering and Bogan weirpool operational upgrade (November 2006) (REF) Review of Aquatic Factors – Bogan River Wierpools (October 2007) Progress Report – Temporary Dam ; and APC meter replacement (November 2007) Cobar Raw Water Supply – Transfer System Feasibility (April 2007) Cobar Raw Water Supply - Transfer System Feasibilty – Option D detail and costings (September 2007)
2009	Mapping Groundwater and Salinity using Airborne Electromagnetics in the Lower Macquarie River Valley
2011	Irritek proposal
2012	Matt Parmeter Rough Notes on the Albert Priest Pipeline Project

NSW Urban Water Services Pty Ltd "Nyngan and Cobar Water Security Project – Water Supply System Modelling" Report No 14009, May 2016

NSW Public Works "Albert Priest Channel Replacement Pipeline: Options Report" Report No 16015, May 2016.

ARUP – "RDA Orana Infrastructure Plan – Qualitative Infrastructure Assessment and Prioitorisation" - June 2016

Hydroscience Consulting (2010) *Joint Integrated Water Cycle Management Evaluation Study*, revision 2, Hydroscience job number A169.

Hydroscience Consulting (2010) *Lower Macquarie Water Utilities Alliance Best-Practice Management, Joint IWCM Evaluation Study*

Hydroscience Consulting (2010) *Regional Drought Management Plan*, revision 2, Hydroscience job number A169.

Hydroscience Consulting and Hydrosphere Consulting (2010) *Bogan Demand Management Plan*, revision 2, Hydroscience job number 09-007.

Western Research Institute Ltd (2013) *Regional Development Australia Orana Profile and Opportunities*

Collaborative Planning and Engineering Associates Pty Ltd (2013):

- Discussion Paper 1 – Water Losses
- Discussion Paper 2A – Water Costs and Availability
- Discussion Paper 2B – Water Security for Nyngan and Cobar
- Discussion Paper 3 – Likely Capital Options
- Discussion Document for Workshop on 19 August 2013
- Workshop Outcomes
- Briefing Paper 22 August 2013

Regional Development Australia Orana NSW and Western Research Institute Ltd – "Profile and Opportunities." September 2013

LMWUA (2015) Water and Drought Security Report – Bogan and Cobar Shire Councils

Mike Brearley & Associates Pty Ltd (2017) – Bogan Shire Council Water Supply and Sewerage Business: Financial Plan Version 1.0.

Appendix A Economic Analysis – Technical Note

Independent insight.

Technical Note

Nyngan Cobar Water Security Project cost benefit analysis

The Nyngan Cobar Water Security Project aims to replace the Albert Priest channel, which transfers water from the Macquarie River to the Upper Nyngan Pool on the Bogan River, with a pumping station and pipeline, discharging to the Upper Nyngan Pool. Additionally two 700ML storages are proposed to provide drought security, which will transfer water to and from the weir pool as necessary. This pipeline aims to reduce water losses from seepage and evaporation. This technical note considers the likely costs and benefits of this project, and conducts a cost-benefit analysis.

Economies of Bogan and Cobar

The major industries of Bogan and Cobar LGAs are mining and agriculture. In 2012-13, these two LGAs produced a total of $879 million of output in Non-Ferrous Metal Ore mining, $96 million in output in Sheep, Grains, Beef and Dairy Cattle and $32 million in output in Exploration and Mining Support Services. Support industries such as Retail Trade and Construction are dependent on the income generated by these major industries.

Data sources

SGS has been provided with data on the following:

- Simulations of additional water available as a result of the pipeline
- Capital Costs
- Operating costs
- Current water pricing
- Estimates of water cartage costs

Other data sources used include:

- Water Accounts 2013-14, Category number 4610.0
- Australian Bureau of Statistics National Accounts, 2012-13

Assumptions

SGS has been provided with information on the expected distribution of water flows under base infrastructure levels (700ML storage) and levels expected if the Project is completed (with pipeline and 1400ML storage).

The base case for this analysis is the existing Albert Priest Channel and a new 700ML storage, and the option tested is the replacement of the Albert Priest channel with a pipeline and increasing the storage to 1400ML (referred to as the Project).

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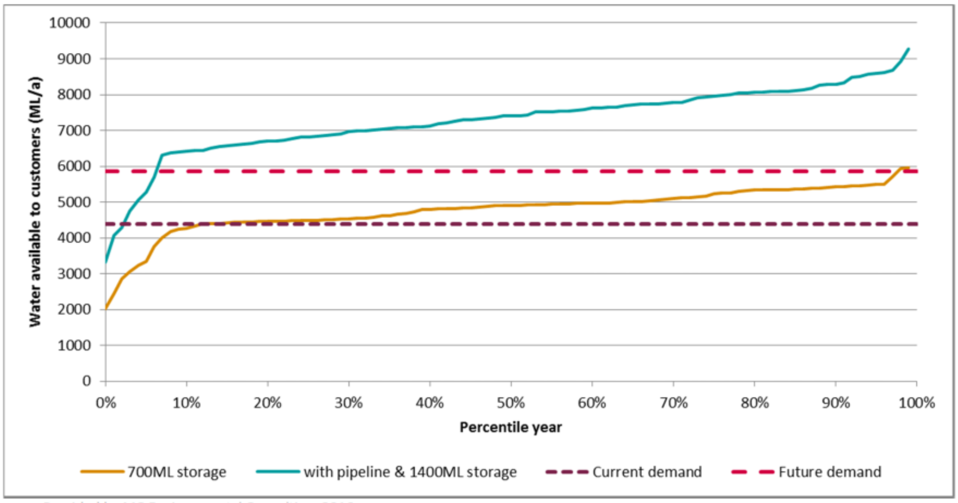
FIGURE 1. WATER AVAILABLE TO CUSTOMERS, WITH AND WITHOUT PIPELINE



Source: Provided by MC Environmental Consulting, 2016

MC Environmental Consulting has indicated that the capital costs of the project consist of:

– Upfront capital expenditure of $80,976,198 on the pipeline and storage construction between 2018 and 2025, followed by an additional $1.65m every ten years from 2043 onwards.
– Operating and maintenance expenses of $130,341 per year under a current demand scenario, or $133,908 under the future demand scenario. Operating costs under the base case are $200,000 per year, so this represents a reduction in operating costs.

SGS have been advised that the cost of temporary water licences typically ranges from $200-$400 per ML, although trades in the Lower Macquarie system are rare. In the event that there is insufficient water available to buy enough temporary licences for a certain activity, the next cheapest alternative water supply involves carting water. Cartage of water typically costs $600/ML/km. The journey from Bogan storages to Cobar terminal storages is 145km, this would result in a cost of $87,000/ML. Of course is prohibitive for any mining, agricultural, recreational or environmental purpose.

Financial analysis

An initial assessment of the viability of the pipeline was undertaken in which the additional water generated was priced at its indicated market value. SGS was advised that the water would cost between $200-$400 per ML for a temporary licence. Based on a market price of $300/ML, the project provides a net present value (NPV) of the investment of -$54.9 million at the 50th percentile of water availability, and a benefit cost ratio (BCR) of 0.28 as shown in Table 1.

TABLE 1. FINANCIAL ANALYSIS

Percentile of water availability	NPV	BCR
1%	-$60,974,725	0.20
10%	-$57,357,395	0.25
25%	-$56,157,443	0.27
50%	-$54,912,199	0.28
75%	-$53,206,883	0.31
90%	-$52,455,527	0.32
99%	-$49,388,637	0.36

Source: SGS calculations, 2016

SGS then estimated the values of water that would be necessary to justify the investment in the pipeline, under three discount rates and three different assumptions. The results are shown in Table 2.

TABLE 2. WATER VALUES REQURIED FOR INVESTMENT TO BREAK EVEN ($/ML)

	25th percentile water flows	50th percentile water flows	75th percentile water flows
Discount rate			
2.5%	1356	1258	1145
5%	2109	1956	1780
7.5	3027	2807	2554

Source: SGS calculations, 2016

The investment in the project cannot be justified by the market values of water alone. The water price required to justify the investment in the pipeline, purely on financial terms, is between $1000-$3000/ML, much higher than the market price of temporary water permits. However the pipeline is expected to provide other economic, social and environmental benefits that exceed the market price of the water.

Benefits of the pipeline

There are a number of benefits that are likely to arise as a result of the Project. Many of these are due to a more secure water supply.

These include:

- Greater stability of water supply leading to higher levels of output in the agricultural and mining sectors
- Greater availability of water for environmental flows
- Reduced likelihood of water needing to be restricted for recreational activities, for example reduced need to ban garden watering, filling swimming pools or watering sporting fields
- Psychological and quality of life benefits from greater stability and planning security in agricultural and mining industries

Higher output in agriculture and mining

Information provided by MC Environmental Consulting indicates that some miners have reduced operations due to a lack of a reliable water supply. It is also quite possible that farmers in the area would like to increase their production, but are not able to do so without an increase in the supply of secure water.

Figure 1 shows the future demand expected for water given the increased availability is likely to be 5850 ML, up 1460 ML compared to the existing 4390 ML. Historical water patterns suggest that this increased amount of water would be available 93% of the time, while the current supply is only available 87% of the time. It is likely that a significant proportion, if not all of this additional water, will be directed towards increasing production in agriculture and mining.

The potential benefit to Bogan and Cobar of the mine will not only be the price that the water will sell for at current temporary licence prices, but the gross value added that would not otherwise occur if a reliable water supply was not available. Table 3 shows the gross value added (GVA) per unit of water consumed in the Agriculture, Fishing and Forestry and Mining industries in Australia. The average industry GVA/ML in agriculture (excluding aquaculture, forestry and fishing) is $2641, and in Other Mining (which includes gold, copper and other minerals mined in Bogan and Cobar Shires) is $177,730.

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These figures are not indicators of the likely increase in GVA in Bogan and Cobar if the pipeline is built. First, these are average returns, while the marginal production generated from additional megalitres of water is likely to be lower. Secondly, returns are highly variable year on year due to fluctuating commodity prices.

TABLE 3. GROSS VALUE ADDED PER UNIT OF WATER CONSUMED, AUSTRALIA,

	Industry gross value added	Water consumption	Industry gross value added per GL of water consumed	Industry GVA $/ML
Agriculture, Forestry & Fishing				
Agriculture	30,605	11,588	3	$2,641
Aquaculture, Forestry, Fishing	5,038	226	22	$22,292
Total Agriculture, Forestry & Fishing	35,643	11,814	3	$3,017
Mining				
Coal mining	17,661	141	125	$125,255
Oil & gas extraction	29,815	73	407	$408,425
Other mining	72,514	408	178	$177,730
Exploration & mining support services	10,430	29	355	$359,655
Total mining	130,420	652	200	$200,031

Source: (Australian Bureau of Statistics, 2015), Table 4.6

For the purpose of this cost benefit analysis, we have assumed that additional industry demand will be the difference between current and future demand, or 1460 ML. This will be available in 93% of years – the years in which water availability is expected to meet or exceed future demand

We have assumed that 10% of the demand increase in water will be used by the mining industry, with a GVA/ML of $75,000, the other 90% of the demand will be used by agriculture, with GVA/ML of $2000.

Environmental flows

The Macquarie River discharges into the Macquarie Marshes, a Ramsar listed wetland. Water that is not used for industry can have environmental benefits if it is returned for environmental flows or not diverted from the river system at all. The CSIRO undertook an assessment (CSIRO, 2012) of the ecological benefits of buying back water for the Murray Darling Basin in 2012. Some of these benefits included carbon sequestration from floodplain vegetation remaining in a healthy condition from increased water flows, improvements in native animal life, improved water quality and so forth. This assessment found that purchasing 2800 GL/year for environmental flows in the Murray Darling basin system meant a reduction in agriculture of $542 million, for environmental benefits worth $3-8 billion. This translates to a benefit of $1071 - $2857/ML.

Naturally, this amount is specific to the conditions considered in the CSIRO report and actual environmental benefits experienced in this project can be expected to be less than this. First, the marginal benefits likely to arise from additional environmental flows in the Macquarie River will be different from the conditions faced in Coorong, the Lower Lakes and the Murray Darling mouth, considered in the CSIRO report. Second, environmental water flows are most valuable in years where there is low rainfall, when water allocations are likely to take most of the additional water.

It should be noted that there will be some environmental costs as a result of replacing the channel with a pipeline. An open channel can provide water for animal life and habitat for fish and birds, which a pipeline cannot. This may result in some reduction in biodiversity along the channel, while improving biodiversity and providing other environmental benefits elsewhere downstream.

Due to the uncertainties around the correct pricing of environmental flows in the area, the analysis uses the current price for a temporary water licence, $200/ML, as a proxy for environmental benefits.

Recreational benefits

Increased water flows from the pipeline will result in more water being made for recreational uses. These uses include water for parks, ornamental water fountains, sporting fields and swimming pools, as well as open bodies of water on public land that are have more recreational value for fishing, swimming and so forth when water supply is well available. They can also represent the benefits of lower risk of water restrictions, which result in restricted abilities to water gardens and so forth. One of the shortcomings of converting channels to pipelines is some reduced recreational benefits, such as loss of swimming and yabbying in channels.

There are no estimates of the benefits of recreational uses of water in the region, so the lower estimate of $200/ML, the current temporary water licence price, will be used.

Any water that is available above future demand estimates will be assumed to be used for recreational or environmental benefits, and thus valued at $200/ML.

Quality of life benefits

Improving water security can have significant psychological benefits for people whose livelihood depends on a regular supply of water. Social benefits found from water pipeline analyses include better quality domestic water supply, reduced mental stress and ability to leave the farm. This technical note will not attempt to value quality of life benefits, but acknowledges they exist.

Cost-benefit analysis

This analysis assumes that of the increase in future demand over current demand, ten percent of this will be used by the mining industry to increase production and the other 90 percent used by the agricultural industry to increase production. Any additional flows over this amount are assumed to be used for environmental and recreational purposes.

It is not possible to predict the amount of rainfall that will occur each year, so SGS calculated the expected value of additional water generated at 1%-99% rainfall levels. Then net present values and benefit cost ratios were calculated using a Monte Carlo process to randomise the expected rainfall in the years over which the project is assessed, from 2017-2070. Fifty iterations were used.

The mean net present value calculated in this process was $29.3 million with a benefit cost ratio of 1.52. The lowest NPV recorded using this process was $19.7 million and the lowest BCR was 1.35. Figure 2 shows the distribution of results.

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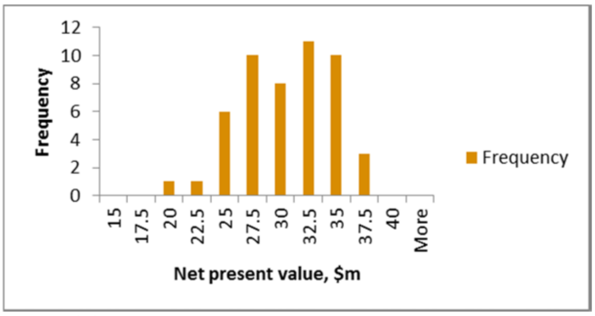
FIGURE 2. DISTRIBUTION OF POTENTIAL NET PRESENT VALUES



Source: SGS calculations, 2016

Most of these benefits are expected to come from increased activity in the agricultural and mining industries.

Conclusion

This technical note conducts a brief, high level cost benefit analysis of the proposed Albert Priest pipeline project. It finds that the market price of temporary water licences alone is insufficient to justify the capital and ongoing expenditure of the Project. However, the lack of water presently available for purchase and the high level of water losses through evaporation is a barrier to operation and expansion of local businesses. The additional output that could be generated with a greater water supply far exceeds the market value of temporary water licences.

This analysis considers the likely benefits of the pipeline, including additional gross value added in agriculture and mining industries from the additional secure supply of water available, and the benefits of additional water for environmental or recreational purposes

The cost-benefit analysis finds the Project has an expected net present value $29.3 million and a benefit cost ratio of 1.52, with most of the benefits arising from increased business activity. A Monte Carlo assessment of the results under random rainfall levels finds that at the assumed benefit levels, a positive return to the Project is likely.

Appendix B Affordability comparison of pipeline options 2 and 6

***The following are extracts from a discussion paper titled* Albert Priest Pipeline Business Case: Affordability Discussion Paper*, prepared by CPE Associates for Bogan Shire Council in June 2016.* The extracts document the anaylsis behind the section of pipeline option 2.**

Capital works

The affordability assessment is based on the capital works proposed under **Option 2** and **Option 6** of the May 2016 Public Works report. **Note that the affordability assessment does not include an off-stream storage.** The yield study generally assumes the provision of at least 700ML of off-stream storage. The tables also provide proposed asset lives for the purposes of depreciation and renewals scheduling. Note that for pumps two possible determinants of life were allowed for. Under lower demand scenarios pumps are only operated for the purposes of scouring the pipeline- however as demand increases, pumping operations become more significant. Therefore **the frequency of pump renewal (and hence the rate of depreciation) varies by scenario.**

Pipeline Option 2

This option consists of:

1. A 63.1km length, 1000mm diameter pipeline, capable of delivering 33 megalitres of water per day under gravity, and 55 megalitres of water per day with pumping.
2. A pumping station at Gunningbar Creek capable of pumping 55 megalitres of water per day, including the associated upgraded to electrical supply, control and monitoring equipment.

The Public Works report costs these assets at $75.2m. For depreciation and renewals costing purposes, the replacement value of the assets have been slightly reduced to reflect the non-depreciable nature of certain tasks such as survey, investigations and design, directional drilling and thrust boring. The aggregated costs and reduced replacement costs are provided in Table 9.

Table 32: New asset and renewed asset costings, asset life determinants – Pipeline Option 2

Asset Group	Capital cost	Renewal cost	Max Life (GL)	Max Life (years)	Note
Pipeline	$67,563,600	$62,366,400		100	End of life independent of usage
Thrust boring Directional drilling Access roads	$2,366,000	$0			Non-depreciable components

Asset Group	Capital cost	Renewal cost	Max Life (GL)	Max Life (years)	Note
Air Valves	$728,000	$672,000		30	End of life independent of usage
Scour Valves	$520,000	$480,000		30	End of life independent of usage
Pumping Station - Civil works	$1,560,000	$1,440,000		50	End of life independent of usage
Pumping Station - Pumps	$676,000	$624,000	240	50	Assume a 80% utilisation pumpset achieves 15 years
Pumping Station - Mech/Elec General	$1,794,000	$1,656,000		20	Parts don't wear, more corrode
TOTAL	**$75,207,600**	**$69,422,400**			

Pipeline Option 6

This option consists of:

1. A 63.1km length, 900mm diameter pipeline, capable of delivering 25 megalitres of water per day under gravity, and 44 megalitres of water per day with pumping.
2. A pumping station at Gunningbar Creek capable of pumping 44 megalitres of water per day, including the associated upgraded to electrical supply, control and monitoring equipment.

The Public Works report costs these assets at $68.3m. For depreciation and renewals costing purposes, the replacement value of the assets have been slightly reduced to reflect the non-depreciable nature of certain tasks such as survey, investigations and design, directional drilling and thrust boring. The aggregated costs and reduced replacement costs are provided in Table 33.

Table 33: New asset and renewed asset costings, asset life determinants – Pipeline Option 6

Asset Group	Capital cost	Renewal cost	Max Life (GL)	Max Life (years)	Note
Pipeline	$60,180,900	$55,551,600		100	End of life independent of usage
Thrust boring Directional drilling Access roads	$2,366,000	$0			Non-depreciable components
Air Valves	$728,000	$672,000		30	End of life independent of usage
Scour Valves	$520,000	$480,000		30	End of life independent of usage
Pumping Station - Civil works	$1,430,000	$1,320,000		50	End of life independent of usage

Asset Group	Capital cost	Renewal cost	Max Life (GL)	Max Life (years)	Note
Pumping Station - Pumps	$1,040,000	$960,000	192.7	50	Assume a 80% utilisation pumpset achieves 15 years
Pumping Station - Mech/Elec General	$2,041,000	$1,884,000		20	Parts don't wear, more corrode
TOTAL	**$68,305,900**	**$63,051,600**			

Maintenance costs

The models will be based on the Public Works approach of a percentages based maintenance regime. The resulting maintenance cost used in the model is summarised in Table 10 and Table 35.

Table 34: Maintenance costs – Pipeline Option 2

Item	CRC ($'000)	Rate (%pa)	Maintenance ($'000 pa)
Air Valves	672	3%	20.2
Pipeline	62,366	0%	0.0
Pumping Station - Civil works	1,440	0.2%	2.9
Pumping Station - Mech/Elec General	1,656	3%	49.7
Pumping Station - Pumps	624	3%	18.7
Scour Valves	480	3%	14.4
TOTAL	**67,238**		**105.8**

Table 35: Maintenance costs – Pipeline Option 6

Item	CRC ($'000)	Rate (%pa)	Maintenance ($'000 pa)
Air Valves	672	3%	20.2
Pipeline	55,552	0%	0.0
Pumping Station - Civil works	1,320	0.2%	2.6
Pumping Station - Mech/Elec General	1,884	3%	56.5
Pumping Station - Pumps	960	3%	28.8
Scour Valves	480	3%	14.4
TOTAL	**60,867**		**122.5**

Operations costs

The Public Works assessment only considers the cost of electricity for operations, which appears reasonable given that other costs such as overheads will be comparable to the current Albert Priest Channel operation.

Option 2 assumes that 3GL per annum of water needs to be pumped at a cost of $0.18/kWh. No pump efficiency calculation is documented. As the affordability scenarios vary significantly from this assumption, electricity costs have been re-estimated based on the Nyngan raw water offtake pump station. The tariffs applying at this station result in an annual cost of $8,940 per annum plus $0.115 per kWh. The electrical power required for a 55ML/d (637L/s) station at 15m head is about 130kW, allowing 80% motor efficiency and a pipe tolerance of 1.1. **This results in an electricity cost of about $8,940/annum plus $6.59/ML.**

For **Option 6**, the electrical power required for a 44ML/d (509L/s) station at 20m head is about 130kW, allowing 80% motor efficiency and a pipe tolerance of 1.1. **This results in an electricity cost of about $8,940/annum plus $8.78/ML.**

Modelling objective

The financial models sought to minimise long-run price of the pipeline, subject to the following constraints[9]:

- Cash and investments in any year were not less than one year of operating payments (ie the business was solvent);
- The return on assets was greater than zero for at least 50% of modelled years (indicator of financial sustainability);
- The return on assets was zero or greater in model year 125 (indicator that the business is financially viable at the end of the model run).

Results

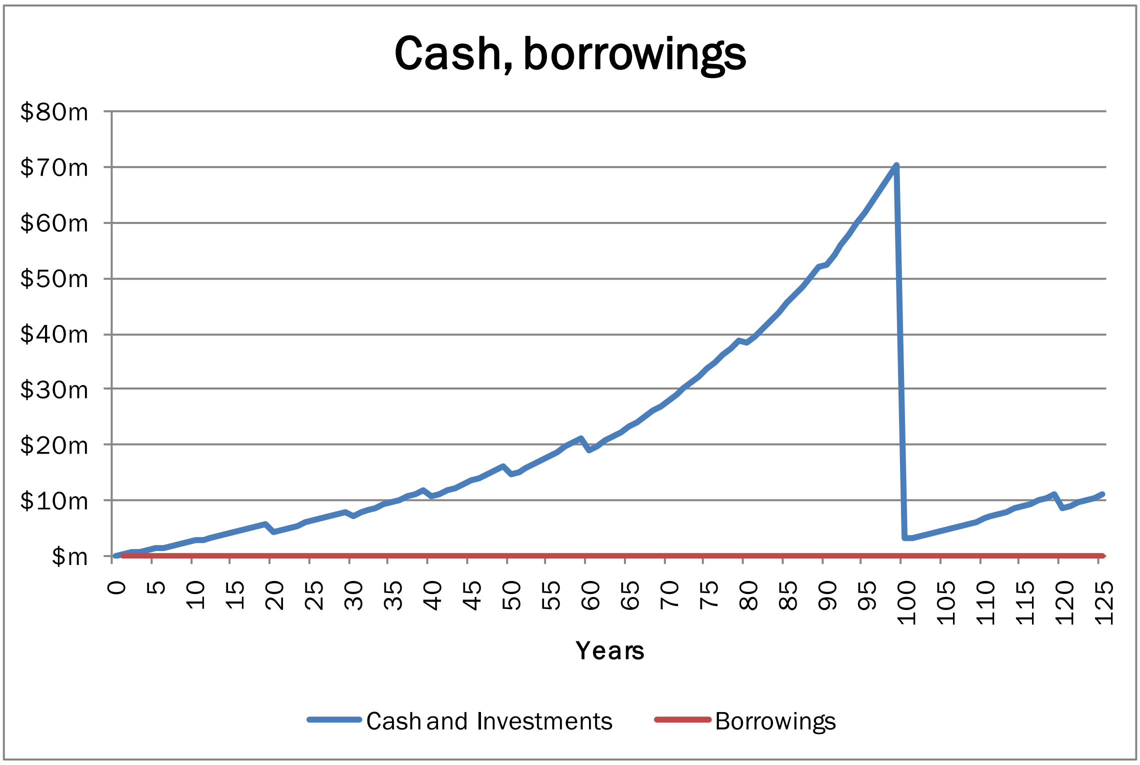
Summary financial results for each scenario are provided as **Appendix C.**

Financial profile

Figure 15 and Figure 16 provide an illustration of the financial performance of pipeline option 2. These parameters do not significantly vary between scenarios, with slightly more noticeable variations between pipeline option 2 and option 6.

[9] These constraints are described in terms of year zero dollars.

Figure 29: Typical cash and borrowings - pipeline option 2

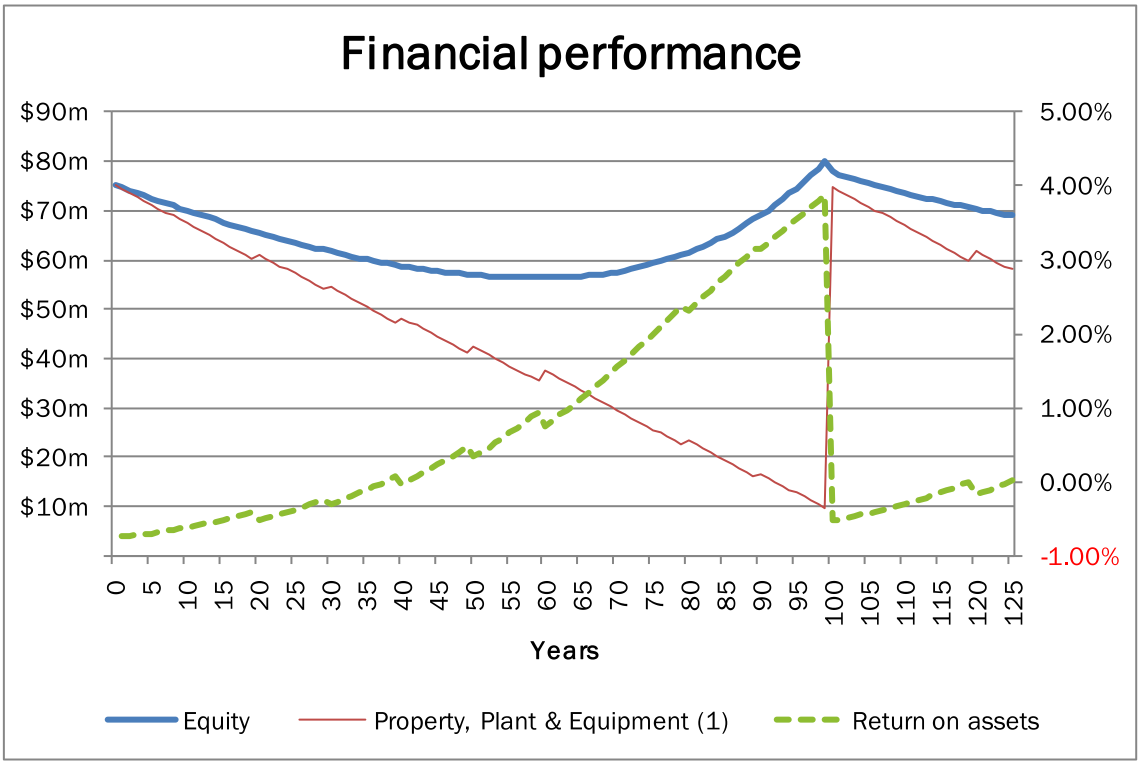


As the original pipeline is assumed to be 100% grant funded, the theoretical business does not need to service debt. Instead the business accumulates reserves, earning interest in a similar manner to a superannuation scheme, until pipeline renewal occurs at year 100, when the funds are almost completely depleted.

Slight variations in reserves over the rest of the years are the result of valve and pump renewals.

The price point for customers is controlled by the objective to achieve a positive return on assets by year 125. Figure 16 does show that a positive rate of return over most years, although returns are generally negative for the first 30 years due to the concentration of the asset base on one very long life asset.

Figure 30: Typical financial performance - pipeline option 2



Unit cost of pipeline services

The unit cost of pipeline services for the various options are shown in Table 11 for the NSWPW 'current demand' and Table 12 for the NSWPW 'future demand'. Costs have been broken up into an operations and maintenance (O&M) cost, borne every year, and a capital component, that needs to be saved and invested for future renewals.

Table 36: Long-run cost of pipeline to customers, NSWPW 'current demand'

Scenario	O&M component	+	Capital component	=	Long run cost
Option 2 pumping	$22/ML		$30/ML		$52/ML
Option 2 gravity with scour	**$16/ML**		**$29/ML**		**$46/ML**
Option 6 pumping	$29/ML		$33/ML		$61/ML
Option 6 gravity with scour	$19/ML		$29/ML		$48/ML

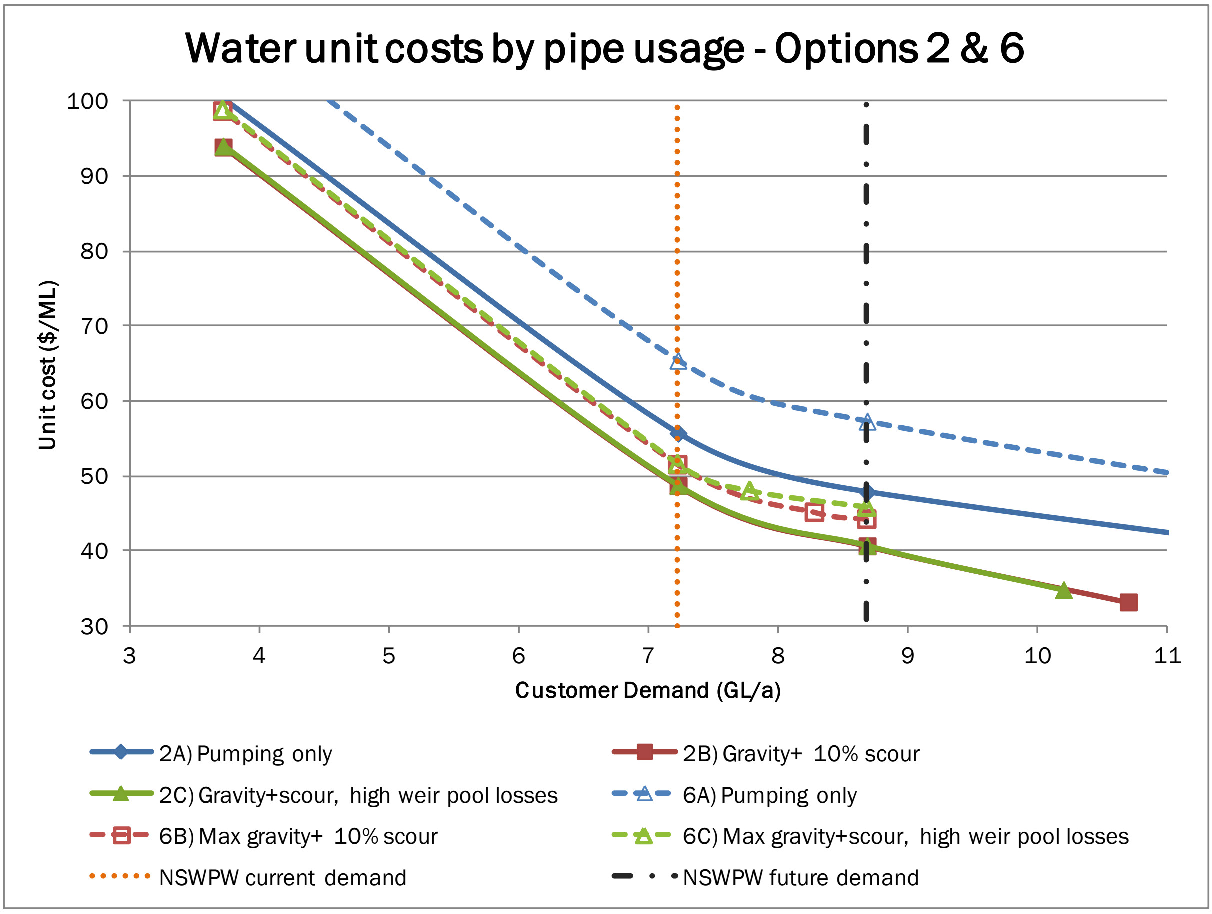
Table 37: Long-run cost of pipeline to customers, NSWPW 'future demand'

Scenario	O&M component	+	Capital component	=	Long run cost
Option 2 pumping	$20/ML		$26/ML		$45/ML
Option 2 gravity with scour	**$14/ML**		**$25/ML**		**$38/ML**
Option 6 pumping	$26/ML		$28/ML		$54/ML
Option 6 gravity with scour	$17/ML		$24/ML		$42/ML

These results are also plotted as Figure 17. The unit cost of the pipeline varies strongly depending on how much the pipeline is used. **The results confirm, however, that pipeline option 6 is more costly than pipeline option 2 under all scenarios.** The full pumping scenarios, are about

15% more costly than the gravity dominated equivalent, which means it should be reasonable to rely on pumping for peak demand periods.

Figure 31: Pipeline costs for various pipeline and usage options



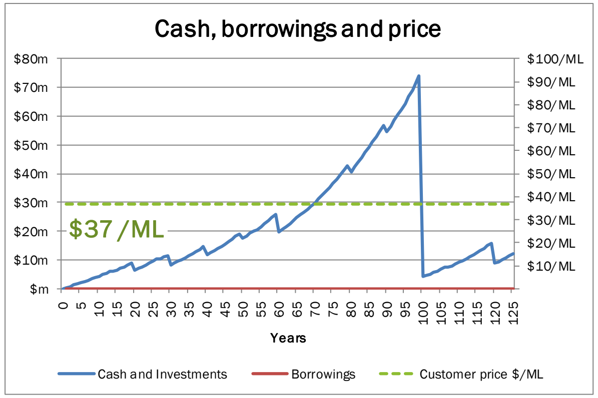
Appendix C Financial model outputs

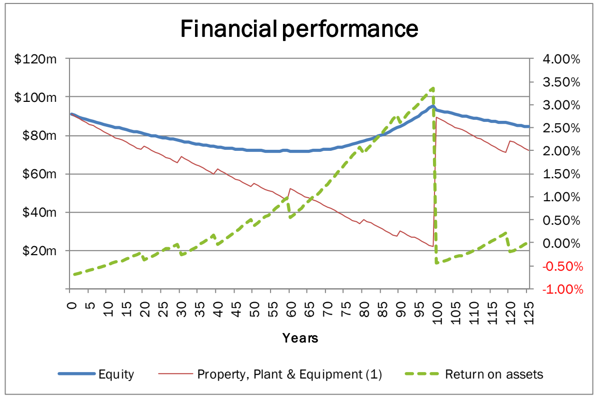
Pipeline Option 2, Storage Option 2

Scenario A

Input scenario	A0	**Year 100 loan**	0.0% % cap works
Input price	$36.82 /ML		

Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	125 year 1%	20%	50%	80%	100%	30 year 0%	20%	50%	80%	100%
Customer price $/ML	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82	$ 36.82
Cash and investments	$384,256	$7,003,424	$5,119,021	$12,205,830	$877,457	$7,339,195	$13,345,908	$35,488,909	$73,862,114	$384,256	$2,846,458	$6,454,534	$8,833,958	$11,593,250
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,226	-$271,151	-$369,390	$65	-$590,514	-$253,646	$59,500	$1,213,874	$3,214,373	-$616,226	-$487,865	-$299,766	-$175,720	-$31,871
Return on assets	-0.68%	-0.33%	-0.40%	0.00%	-0.66%	-0.29%	0.07%	1.64%	3.36%	-0.68%	-0.56%	-0.37%	-0.22%	-0.04%
Property, plant and equipment	$89,887,516	$75,504,288	$87,268,497	$72,257,012	$22,968,172	$38,539,927	$62,324,309	$77,882,922	$89,887,516	$65,954,011	$70,132,324	$76,004,529	$84,084,721	$89,887,516
Total equity	$90,271,772	$82,507,712	$92,387,518	$84,462,842	$71,767,480	$72,800,201	$79,976,022	$87,810,213	$95,589,688	$77,054,771	$79,137,451	$82,721,713	$86,931,179	$90,271,772



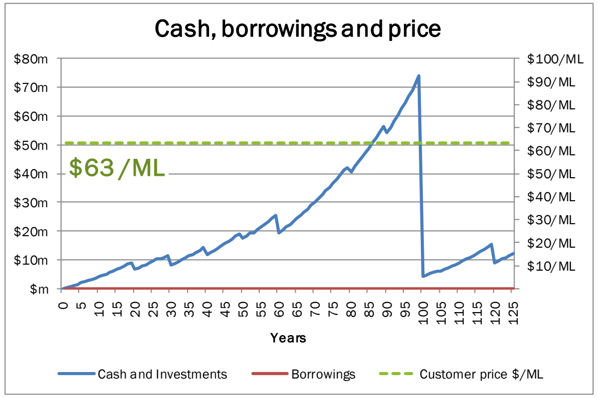


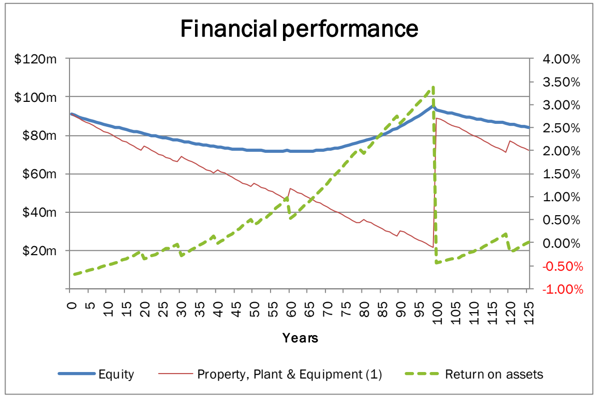
Input scenario A1 **Year 100 loan** 0.0% % cap works

Input price $63.45 /ML

Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125
Customer price $/ML	$ 63.45	$ 63.45	$ 63.45	$ 63.45
Cash and investments	$360,209	$7,218,929	$5,156,607	$12,199,953
Borrowings	$0	$0	$0	$0
Operating result	-$617,257	-$259,693	-$367,207	-$19
Return on assets	-0.68%	-0.31%	-0.40%	-0.00%
Property, plant and equipment	$89,910,532	$75,248,543	$87,120,128	$72,014,011
Total equity	$90,270,741	$82,467,472	$92,276,735	$84,213,964

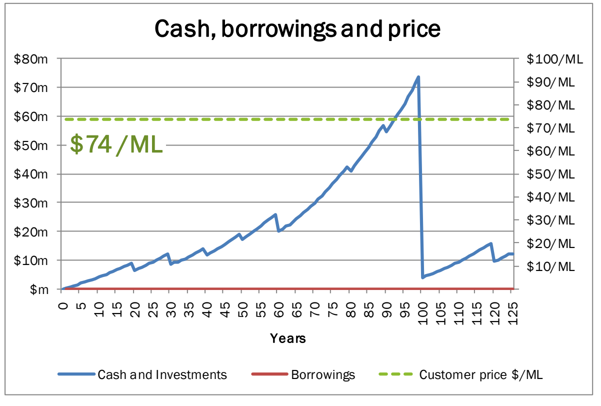
	125 year					30 year				
Metrics (Year 0$)	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45	$ 63.45
Cash and investments	$822,546	$7,209,832	$13,369,996	$35,603,319	$73,964,698	$360,209	$2,668,328	$6,641,590	$8,944,407	$11,532,969
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$593,154	-$260,167	$60,979	$1,220,062	$3,219,944	-$617,257	-$496,928	-$289,791	-$169,739	-$34,790
Return on assets	-0.66%	-0.30%	0.08%	1.65%	3.37%	-0.68%	-0.57%	-0.35%	-0.21%	-0.04%
Property, plant and equipment	$22,722,215	$38,375,713	$62,097,358	$78,011,764	$89,910,532	$65,997,475	$70,065,311	$75,737,276	$84,241,230	$89,910,532
Total equity	$71,698,894	$72,769,224	$79,959,345	$87,670,543	$95,474,855	$77,035,159	$79,124,141	$82,678,583	$86,909,558	$90,270,741

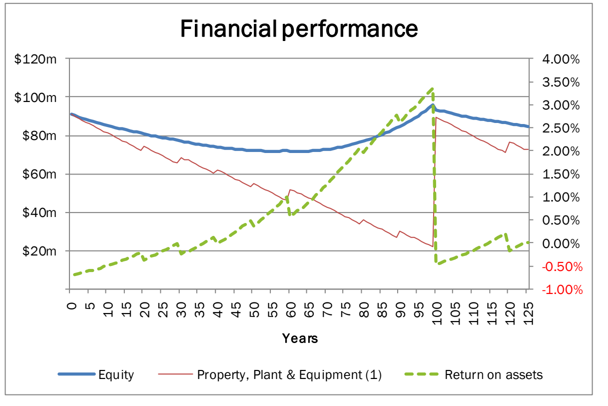




Input scenario	A2	**Year 100 loan**	0.0%	% cap works
Input price	$73.75 /ML			

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75	$ 73.75
Cash and investments	$356,771	$7,150,029	$4,943,208	$12,188,917	$814,696	$7,511,275	$13,279,209	$35,371,048	$73,778,729	$356,771	$2,642,861	$6,563,942	$8,833,436	$12,076,688
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,915	-$262,764	-$377,812	-$73	-$593,042	-$243,931	$56,767	$1,208,474	$3,210,770	-$616,915	-$497,735	-$293,318	-$175,004	-$5,924
Return on assets	-0.68%	-0.32%	-0.41%	-0.00%	-0.66%	-0.30%	0.08%	1.63%	3.36%	-0.68%	-0.57%	-0.36%	-0.22%	-0.01%
Property, plant and equipment	$89,914,311	$75,309,016	$87,505,638	$72,486,449	$23,091,700	$38,656,153	$62,237,200	$77,861,034	$89,914,311	$65,483,080	$70,156,775	$75,795,859	$84,266,930	$89,914,311
Total equity	$90,271,083	$82,459,045	$92,448,846	$84,675,366	$71,807,050	$72,782,762	$79,938,377	$87,867,947	$95,663,057	$77,080,739	$79,096,953	$82,670,916	$86,909,791	$90,271,083

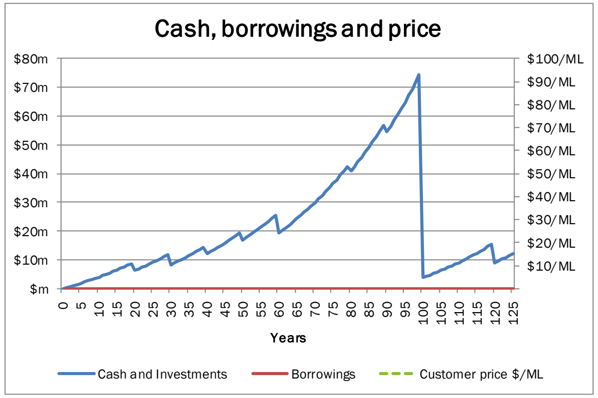


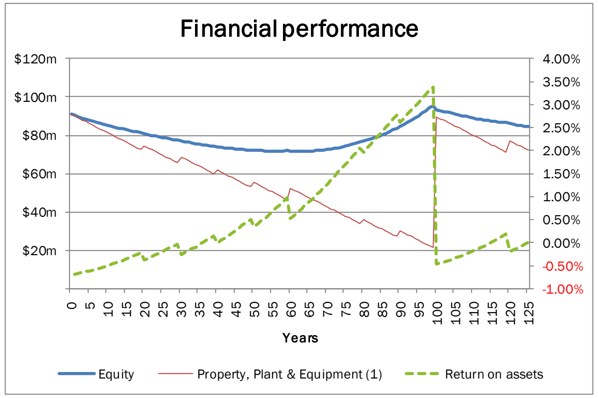


Input scenario A3 **Year 100 loan** 0.0% % cap works

Input price $128.06 /ML

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06	$ 128.06
Cash and investments	$349,609	$7,006,496	$4,716,062	$12,175,804	$798,341	$7,242,281	$13,530,440	$35,345,035	$74,230,302	$349,609	$2,589,807	$6,402,186	$8,602,259	$11,756,497
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,552	-$269,511	-$388,918	-$21	-$593,159	-$257,219	$70,600	$1,207,854	$3,235,048	-$616,552	-$499,765	-$301,015	-$186,320	-$21,881
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,904	$92,365,199	$84,354,816	$71,700,714	$72,797,087	$79,887,018	$87,751,776	$95,611,556	$76,969,749	$79,031,869	$82,649,532	$86,907,904	$90,271,445

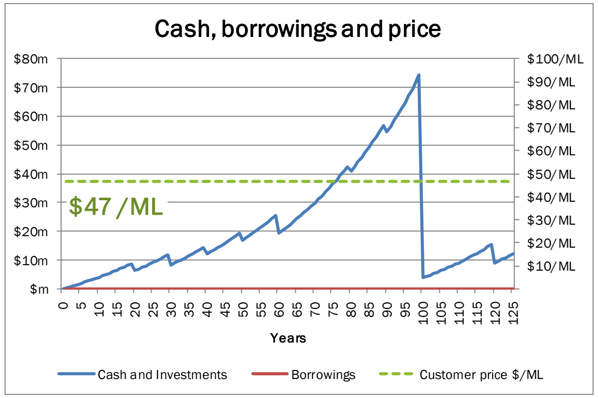


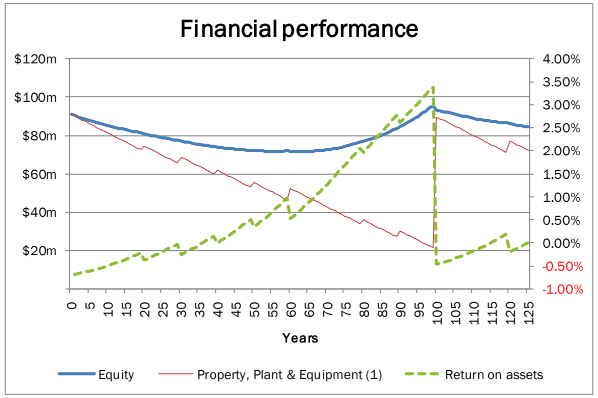


Scenario B

Input scenario	B0	**Year 100 loan**	0.0%	% cap works
Input price	$46.65 /ML			

Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	125 year 1%	20%	50%	80%	100%	30 year 0%	20%	50%	80%	100%
Customer price $/ML	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65
Cash and investments	$349,609	$7,006,486	$4,715,741	$12,175,165	$798,340	$7,241,980	$13,530,398	$35,344,901	$74,230,009	$349,609	$2,589,803	$6,402,174	$8,602,242	$11,756,473
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,935	-$55	-$593,159	-$257,235	$70,597	$1,207,846	$3,235,032	-$616,553	-$499,766	-$301,016	-$186,321	-$21,882
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,893	$92,364,879	$84,354,177	$71,700,624	$72,797,039	$79,887,002	$87,751,580	$95,611,263	$76,969,725	$79,031,851	$82,649,522	$86,907,900	$90,271,445

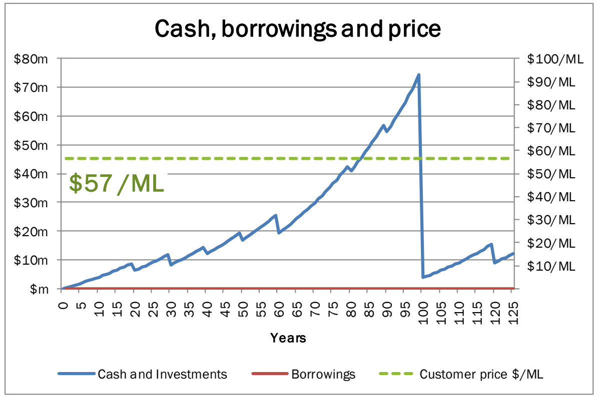


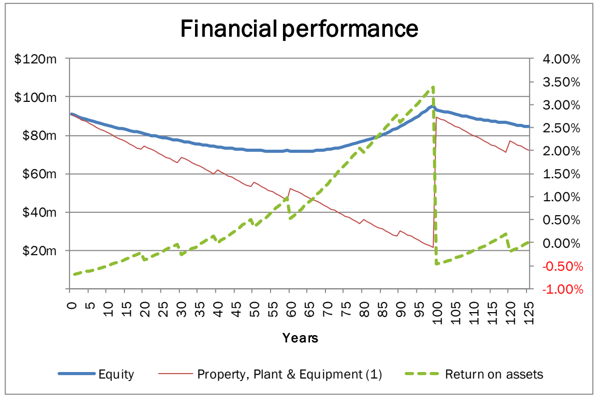


Input scenario B1 **Year 100 loan** 0.0% % cap works

Input price $56.68 /ML

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68	$ 56.68
Cash and investments	$349,609	$7,006,484	$4,715,696	$12,175,075	$798,340	$7,241,938	$13,530,392	$35,344,882	$74,229,968	$349,609	$2,589,802	$6,402,172	$8,602,239	$11,756,470
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,937	-$60	-$593,160	-$257,237	$70,597	$1,207,845	$3,235,030	-$616,553	-$499,766	-$301,017	-$186,321	-$21,883
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,892	$92,364,834	$84,354,087	$71,700,611	$72,797,032	$79,887,000	$87,751,553	$95,611,222	$76,969,721	$79,031,849	$82,649,521	$86,907,899	$90,271,445

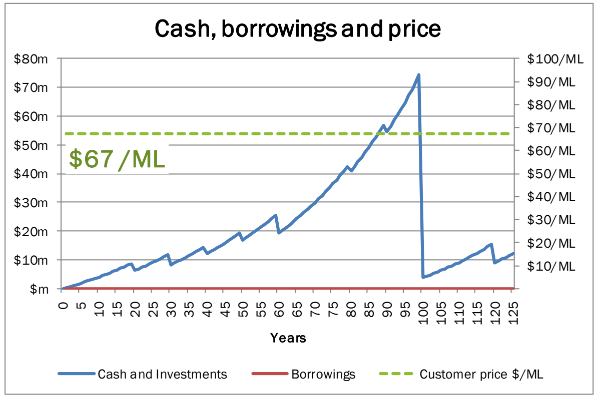


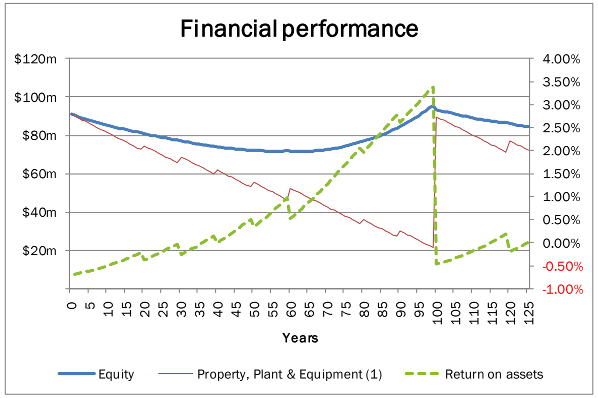


Input scenario B2 **Year 100 loan** 0.0% % cap works

Input price $67.20 /ML

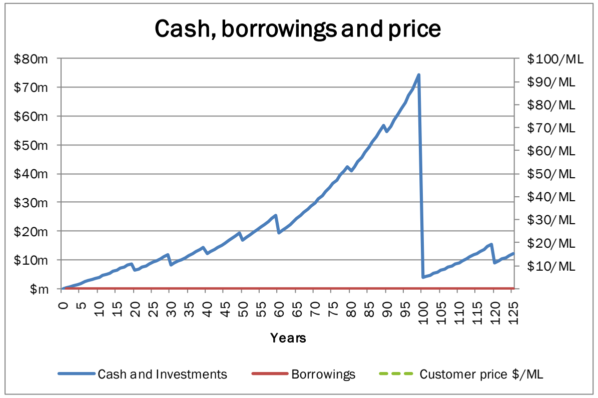
					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20	$ 67.20
Cash and investments	$349,609	$7,006,483	$4,715,663	$12,175,009	$798,340	$7,241,907	$13,530,388	$35,344,868	$74,229,938	$349,609	$2,589,802	$6,402,171	$8,602,238	$11,756,468
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,939	-$63	-$593,160	-$257,239	$70,596	$1,207,844	$3,235,028	-$616,553	-$499,766	-$301,017	-$186,321	-$21,883
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,891	$92,364,801	$84,354,021	$71,700,602	$72,797,027	$79,886,998	$87,751,533	$95,611,192	$76,969,719	$79,031,847	$82,649,520	$86,907,899	$90,271,445

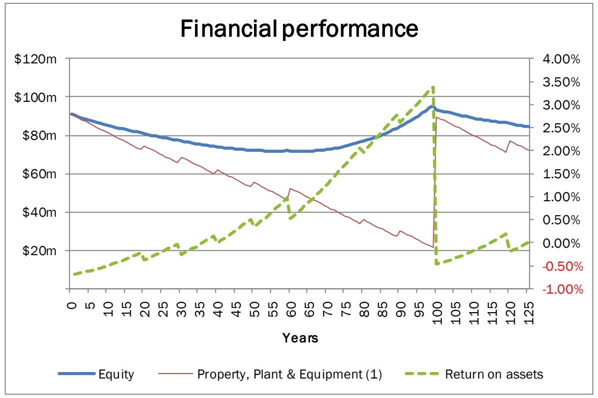




Input scenario	B3	**Year 100 loan**	0.0%	% cap works
Input price	$122.44 /ML			

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44	$ 122.44
Cash and investments	$349,609	$7,006,481	$4,715,586	$12,174,854	$798,339	$7,241,834	$13,530,377	$35,344,836	$74,229,867	$349,609	$2,589,801	$6,402,168	$8,602,234	$11,756,462
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,513	-$388,943	-$71	-$593,160	-$257,243	$70,596	$1,207,842	$3,235,024	-$616,553	-$499,766	-$301,017	-$186,322	-$21,883
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,888	$92,364,723	$84,353,866	$71,700,580	$72,797,016	$79,886,994	$87,751,486	$95,611,121	$76,969,713	$79,031,842	$82,649,517	$86,907,898	$90,271,445

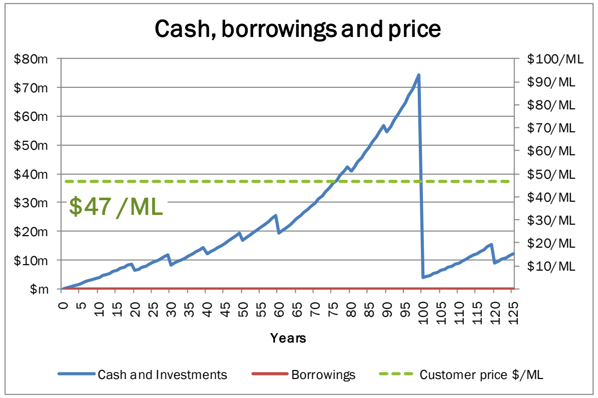


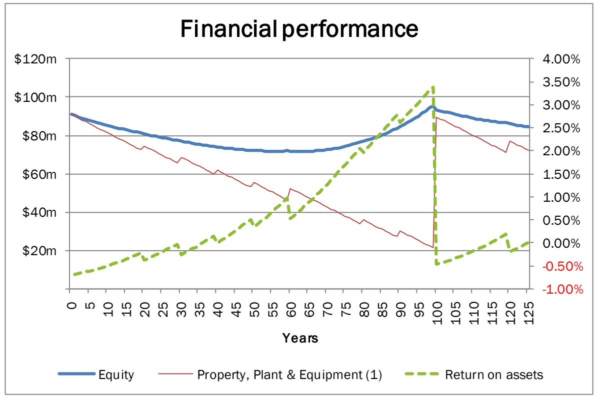


Scenario C

Input scenario	C0	**Year 100 loan**	0.0%	% cap works
Input price	$46.65 /ML			

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65	$ 46.65
Cash and investments	$349,609	$7,006,486	$4,715,741	$12,175,165	$798,340	$7,241,980	$13,530,398	$35,344,901	$74,230,009	$349,609	$2,589,803	$6,402,174	$8,602,242	$11,756,473
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,935	-$55	-$593,159	-$257,235	$70,597	$1,207,846	$3,235,032	-$616,553	-$499,766	-$301,016	-$186,321	-$21,882
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,893	$92,364,879	$84,354,177	$71,700,624	$72,797,039	$79,887,002	$87,751,580	$95,611,263	$76,969,725	$79,031,851	$82,649,522	$86,907,900	$90,271,445

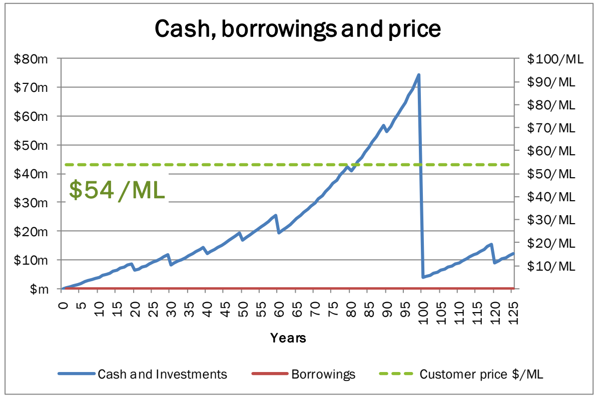


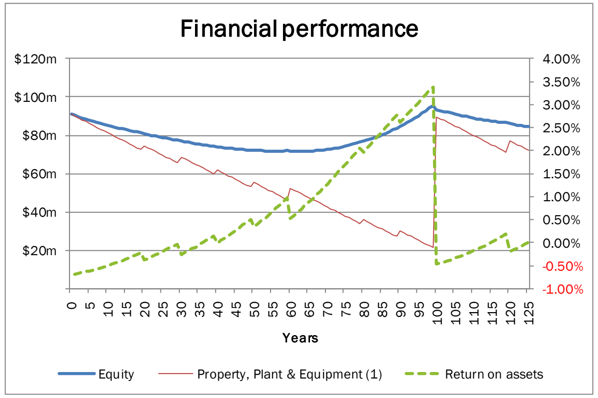


Input scenario C1 **Year 100 loan** 0.0% % cap works

Input price $53.80 /ML

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80	$ 53.80
Cash and investments	$349,609	$7,006,485	$4,715,708	$12,175,097	$798,340	$7,241,949	$13,530,393	$35,344,887	$74,229,978	$349,609	$2,589,803	$6,402,173	$8,602,240	$11,756,471
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,937	-$58	-$593,160	-$257,237	$70,597	$1,207,845	$3,235,030	-$616,553	-$499,766	-$301,017	-$186,321	-$21,883
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,892	$92,364,845	$84,354,109	$71,700,614	$72,797,034	$79,887,000	$87,751,560	$95,611,233	$76,969,722	$79,031,849	$82,649,521	$86,907,900	$90,271,445





Input scenario C2 **Year 100 loan** 0.0% % cap works

Input price $63.18 /ML

					125 year					30 year				
Metrics (Year 0$)	Year 1	Year 15	Year 100	Year 125	1%	20%	50%	80%	100%	0%	20%	50%	80%	100%
Customer price $/ML	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18	$ 63.18
Cash and investments	$349,609	$7,006,483	$4,715,675	$12,175,031	$798,340	$7,241,918	$13,530,389	$35,344,873	$74,229,948	$349,609	$2,589,802	$6,402,172	$8,602,238	$11,756,468
Borrowings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating result	-$616,553	-$269,512	-$388,938	-$62	-$593,160	-$257,238	$70,597	$1,207,845	$3,235,029	-$616,553	-$499,766	-$301,017	-$186,321	-$21,883
Return on assets	-0.68%	-0.33%	-0.42%	-0.00%	-0.66%	-0.31%	0.09%	1.63%	3.38%	-0.68%	-0.58%	-0.37%	-0.23%	-0.03%
Property, plant and equipment	$89,921,836	$75,429,408	$87,649,137	$72,179,012	$22,579,295	$38,590,471	$61,891,606	$78,055,593	$89,921,836	$65,701,291	$70,338,868	$75,912,489	$84,318,097	$89,921,836
Total equity	$90,271,445	$82,435,891	$92,364,812	$84,354,043	$71,700,605	$72,797,029	$79,886,999	$87,751,540	$95,611,202	$76,969,720	$79,031,847	$82,649,520	$86,907,899	$90,271,445