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economics
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Water for the Environment Special Account—independent review

Advice to the independent WESA review panel

A Marsden Jacob report

Prepared for Water for the Environment Special Account – Independent Review Panel

Marsden Jacob Associates

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1. Overview

1.1 Independent review of the Water for the Environment Special Account

The Minister for Agriculture has appointed an independent panel to review the Water for the Environment Special Account (WESA). The terms of reference require the panel to:

- review whether the money credited to the WESA is sufficient to, by 30 June 2024:
  - – increase the volume of Murray–Darling Basin (MDB) water resources available for environmental use by 450 GL[1]
  - – ease or remove the constraints identified by the Murray–Darling Basin Authority (MDBA) on the capacity to deliver environmental water to the environmental assets of the Basin
- consider the progress that has been made, and is expected to be made, towards achieving the 450 GL volume outcome
- consider whether the design of projects funded by the WESA to date is likely to be effective for achieving that outcome
- provide a written report to the minister.

The terms of reference limit the scope of the review to matters directly related to the WESA. The panel has recognised that a range of broader issues related to the Basin's water resources and the recovery of water for environmental use concern stakeholders. However, those broader issues are not the focus of this review.

1.2 Project scope

Marsden Jacob Associates has been engaged to analyse nine issues to help inform the findings of the WESA review panel. This report presents the results of our analysis of the issues on which the panel is seeking input. Table 1 summarises the issues and the key findings from our analysis.

[1] In long-term annual average yield (LTAAY) terms. LTAAY is a method used to standardise the calculation of expected water recoveries in the MDB from different water access entitlement categories and across catchments in the Basin. In short, each entitlement type across the MDB has a calculated LTAAY factor (between 0 and 1). The registered nominal volume of an entitlement is then multiplied by that factor to calculate the entitlement's LTAAY volume. It's important to make the distinction between the nominal and LTAAY volumes of entitlements as MDB water recovery is measured on LTAAY basis. It is noteworthy that LTAAY factors are focused on historical patterns of water usage and allocation yield for different entitlement classes, they are not a prediction or a guide of future water use.

1.3 Summary findings

Table 1 summarises the key findings from our analysis of each of the key issues.

Table 1: Key findings from the analysis

Issues		Report location	Key findings
Projected water entitlement prices			
1	Projected water entitlement prices and potential ranges and/or scenarios for the relevant regions for the period ending on 30 June 2024.	Section 3	Project funding under the Water Efficiency Program (WEP) is equal to 1.75 times the current market value of the water rights transferred to the Government. Therefore projected water entitlement prices provide insight as to the future costs of the WEP. In this project, we developed entitlement price projections that reflect a continuation of the current dry period or a return to wet conditions. The key points to note are as follows: • Forecasting prices is very difficult because they are a function of commodity market circumstances, market sentiment and climatic conditions. Therefore, all forecasts are inherently uncertain. • Northern MDB markets are relatively stable because the crop mix has remained relatively constant. Southern MDB markets have witnessed significant price changes. Higher reliability entitlements have increased significantly in price over the past few years. Lower reliability entitlements, after initially increasing, have started to decline. Our projections indicate entitlement prices in the northern and southern MDB markets may continue to rise.
Where would it come from, and how much might it cost to recover 450 GL under the WEP?			
2	Identification of the potential and likely sources of water entitlements available to, and accessible by, the	Section 4	This section investigates recovery of 450 GL, assuming that this outcome is achieved. We highlight how sensitive the results are to the assumed locations and types of water entitlements that might be acquired.

Issues		Report location	Key findings
	WESA, to meet the LTAAY target of 450 GL.		
3	Development of potential water recovery scenarios with different mixes of entitlements.	Section 4	We set out three potential water recovery scenarios: • Scenario 1: based on our understanding of the potential opportunities in each catchment • Scenario 2: maintains the historical proportion of infrastructure-related recovery • Scenario 3: we also set out an 'illustrative' scenario looking into whether 450 GL could be recovered with the available budget if lower cost entitlements were the focus.
4	Given the likely scenarios for price (Issue 1) and the mix of entitlements (Issue 3), what is the total cost of projects required to meet 450 GL LTAAY by 30 June 2024, compared to the available budget of $1.575 billion?	Section 4	Our finding is that recovering 450 GL would exceed the available WESA budget of $1.575 billion. • Scenario 1: $4.8 billion • Scenario 2: $4 billion • Scenario 3*:* $1.6 billion (recovering 450 GL within budget)
Factors affecting participation in the WEP			
5	The extent to which water, commodity and other markets' views on climate change and the current drought affect current participation in the WEP, or may affect future participation.	Section 5	The MDB has experienced significant variability in water availability. It is currently going through a period of widespread drought, and there has been significant growth in higher value cropping (particularly cotton and nuts in the southern MDB, but this is also extending into the northern MDB). Our analysis finds that all of these things are likely to adversely affect participation in the WEP. However, drought was also identified as a key motivator for efficiency upgrades, because potential participants are more aware of the need to make the most of every available drop of water.
6	The extent to which changes in the agricultural sector since the introduction of water recovery programs affect the nature of, or the	Section 5	The agriculture sector in the northern MDB has been relatively stable. Cotton continues to be the dominant irrigated crop, because in those catchments there is not much high security entitlement available and it is very risky to grow perennials using general security water.

Issues		Report location	Key findings
	way, participants might engage with the Water Efficiency Program (such as the modernisation of farms and irrigation networks; crop production patterns; understanding of the water market and water recovery; awareness of the value of possessing water entitlements; and changes in commodity and other market factors).		The agriculture sector in the southern MDB has changed significantly since the introduction of water recovery programs. The area under tree nuts and cotton has increased significantly and the area of rice and dairy production has reduced significantly. Stakeholders interviewed by Marsden Jacob consistently commented that the low-hanging fruit (easy and low-cost efficiency opportunities) have already been harvested across both the southern and northern MDB, having been either self-funded (as a result of the transformation of properties) or government funded. That is not to say that there are not still opportunities out there, but interviewees commented that the projects are becoming more expensive, and new participant cohorts (who are not early adopters) need to be accessed.
7	The extent to which the Water Efficiency Program's funding formula (multiplying entitlement prices by the market multiple of 1.75) affect participation in the program.	Section 5	Elevated entitlement prices are being witnessed across general security (NSW), high security (NSW), high reliability (Vic.) and Class 3 (SA) entitlement types. Because of this, the market multiple appears to represent an attractive proposition, once participants realise that they are getting more than they would have previously with higher multiples. However, the problem is that at these elevated prices—if the required participation can be achieved—the program will run out of funding well before the 450 GL target is reached. Furthermore, if lower reliability products are targeted instead because they have lower cost per ML long-term average annual yield (LTAAY), then the 1.75 multiple might become a barrier because the analysis finds that it could fall below the cost threshold.
How much might the WEP recover by 30 June 2024 given key constraints?			
8	Estimate the potential water recovery opportunities available under the Water Efficiency Program given program eligibility criteria, the remaining time for the program, current social/political views, and the	Section 6	After considering the impact of individual factors on potential recovery under the WEP, the Panel asked Marsden Jacob to estimate their combined impact. This exercise involved sequential consideration of four key factors on potential recovery: eligible projects targeted by the WEP, program timing, social/political views, and the attractiveness of the program's funding formula for potential participants.

Issues		Report location	Key findings
	attractiveness of the program's funding formula.		In Marsden Jacob's opinion, the WEP program (based on the current program settings and circumstances) will not recover 450 GL by 2024. After taking into account eligible efficiency projects targeted by the WEP and recovery through previous infrastructure or efficiency programs we estimate an upper bound of 600-650 GL could be recovered through the WEP (in the absence of any time, budget or participation related constraints). We estimate that timing constraints alone reduce the volume of recovery under the WEP by 2024 to around 185 to 195 GL. Once the current social and political context and the program's funding formula are considered, potential recovery under the WEP falls further. We estimate up to 60 GL could be recovered by 30 June 2024, once these key factors are considered.
Comparison with other public reports			
9	Comparison of Marsden Jacob analysis on the above matters with recent relevant public reports and findings.	Section 7	Comparison of our analysis with that of others reveals that there are concerns regarding the sufficiency of the 1.75 market multiple. Few studies have looked into potential recovery scenarios, and with the exception of Ernst & Young, the scenarios have been developed at a very high level.

2. Introduction

Marsden Jacob has been engaged to analyse nine issues to help inform the findings of the WESA review panel.

2.1 What has the independent panel been asked to do?

The Minister for Agriculture has appointed an independent panel to review the WESA. The terms of reference require the panel to:

- review whether the money credited to the WESA is sufficient to, by 30 June 2024:
  - increase the volume of MDB water resources available for environmental use by 450 GL
  - ease or remove the constraints identified by the MDBA on the capacity to deliver environmental water to the environmental assets of the Basin
- consider the progress that has been made, and is expected to be made, towards achieving the 450 GL volume outcome
- consider whether the design of projects funded by the WESA to date is likely to be effective for achieving that outcome
- provide a written report to the minister.

The terms of reference limit the scope of the review to matters directly related to the WESA. The panel has recognised that a range of broader issues related to the MDB's water resources and the recovery of water for environmental use concern stakeholders. However, those broader issues are not the focus of this review.

For example, the panel is not considering:

- whether 450 GL additional environmental water should be acquired
- whether 450 GL is the right volume of additional environmental water
- whether acquiring 450 GL and removing or easing delivery constraints will lead to the desired environmental benefits
- whether a portion of the 450 GL should be allocated to Indigenous communities in the MDB for cultural use
- the socio-economic impacts of acquiring water for environmental use on communities and industries, and whether projects to acquire the 450 GL should be required to have neutral or improved socio-economic outcomes.
- other elements of the Murray–Darling Basin Plan, including the sustainable diversion limits (SDLs) and the measures to achieve the SDLs.

2.2 Project scope

Marsden Jacob has been engaged to analyse the nine issues listed in Table 2 to help inform the findings of the WESA review panel.

Table 2: Project scope

Number	
1	Projected water entitlement prices and potential ranges and/or scenarios for the relevant regions for the period ending on 30 June 2024.
2	Identification of the potential and likely sources of water entitlements available to and accessible by the WESA to meet the long-term average annual yield (LTAAY) target of 450 GL.
3	Development of potential water recovery scenarios with different mixes of entitlements.
4	Given the likely scenarios for price (Issue 1) and the mix of entitlements (Issue 3), what is the total cost of projects required to meet 450 GL LTAAY by 30 June 2024, compared to the available budget of $1.575 billion?
5	The extent to which water, commodity and other markets' views on climate change and the current drought affect current participation in the Water Efficiency Program, or may affect future participation.
6	The extent to which changes in the agricultural sector since the introduction of water recovery programs affect the nature of, or the way, participants might engage with the Water Efficiency Program (such as the modernisation of farms and irrigation networks; crop production patterns; understanding of the water market and water recovery; awareness of the value of possessing water entitlements; and changes in commodity and other market factors).
7	The extent to which the Water Efficiency Program's funding formula (multiplying entitlement prices by the market multiple of 1.75) affects participation in the program.
8	Estimate the potential water recovery opportunities available under the Water Efficiency Program given the program's eligibility criteria, the remaining time for the program, current social/political views, and the attractiveness of the program's funding formula.
9	Comparison of Marsden Jacob analysis on the above matters with recent relevant public reports and findings.

2.3 Background to the Water Efficiency Program

The Water Efficiency Program (WEP) provides funding to eligible water rights holders in the Murray-Darling Basin to help them upgrade their water infrastructure to improve water usage efficiency. This section provides some background on the sources of water losses that projects under the WEP seek to address, and some details about the Program.

2.3.1 Water efficiency opportunities

In all water supply systems, some proportion of the water diverted from rivers or dams is lost in conveyance to the plant (irrigators) or consumer (urban and industrial). This is true for both urban piped water supply systems and irrigation delivery schemes.

Irrigation delivery efficiency

The efficiency of irrigation delivery systems is measured as the difference between the volume of water diverted and the volume of water that is used. For instance, for irrigation supply districts efficiency reflects the intake (from the river or groundwater source) less the volume of water recorded at irrigators' meters. The sources of losses include the following:

- **Leakage.** The loss of water from channels through channel banks and structures increases conveyance losses. Leakage is a 'real' loss of water when it flows to salt sinks. Some leakage is reused; for example, it is relatively common practice to pump ponded water from leakage sites adjacent to channels for irrigation purposes.
- **Seepage.** Seepage is the movement of water through the beds of irrigation channels. Seepage losses are 'real' losses when seepage flows to saline groundwater and becomes unusable. However, in some situations, such as in areas with low groundwater salinity, seepage may beneficially recharge rivers or form a lens of fresher groundwater near the surface that is either pumped from the ground for crop irrigation or intercepted by the roots of crops.
- **Outfalls of water flowing from the downstream end of a delivery system.** Outfalls often flow back into rivers and are available to downstream users, for environmental flows, or both. This means that on the other side of the coin to 'bad' losses there are 'good' return flows.
- **Farm irrigation water meter inaccuracy.** With increased demands for shorter irrigation cycles and the growing practice of operating channels at full volumes and outside meter calibration limits, many irrigation meters systematically under-record the volume of water flowing through the meter. The understatement of water used on farms for irrigation leads to an equivalent overstatement of the conveyance loss.
- **Unrecorded usage.** Not all water usage is metered. Water received through unmetered outlets—and water theft—contribute to conveyance losses.
- **Evaporation.** Evaporation losses occur in channels and storages. Evaporation losses are a 'real' loss of water resource, in the sense that there is no economic value in water vapour. However, in situations where water ponded in storages provides recreational opportunities or amenity values, the loss of water through evaporation could be considered to be a reasonable cost of a beneficial use of the resource.[2]

Urban delivery efficiency

The efficiency of urban water delivery systems is measured as the difference between the volume of water diverted and the volume of water that is used.

A number of water businesses across Australia have implemented smart water meters and data loggers to identify sources of inefficiency and improve water delivery and use efficiency (Table 3).

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[2] Improving water-use efficiency in irrigation conveyance systems: a study of investment strategies, Marsden Jacob Associates, Land & Water Australia, 2003, online.

Table 3: Water loss categories and benefits of metering technology

Loss category	Description	Benefits from metering technology
Baseflow	Baseflow losses are leaks that existed before the smart water meter or data logger was installed. Baseflow leaks are important because in some cases the customer might not have resolved the problem because they were unaware of its existence.	Baseflow leaks can be detected by analysing hourly data during periods when water use should be negligible or zero, such as in the early morning hours for accommodation providers and households.
Early detection of leaks	New leaks might only be identified by the customer at the time of the next bill, or through visual inspection of the property. However, changed consumption patterns are evident in the data logger or smart meter information within a much shorter period.	Time-of-use data can quickly identify new leaks by revealing elevated water use when use should be negligible (e.g. overnight). The use of this data increases the likelihood of new leaks being detected and reduces the period over which a leak persists.
Irrigation efficiency	Irrigation efficiency relates to sites that are irrigating or watering in contravention of local rosters (e.g. every night, not every second night) or have excessive run times.	Irrigation patterns are generally characterised by spikes in water usage during the early hours of the morning (for larger users) or for smaller (e.g. 15-minute) intervals for households. Time-of-use data can help to identify water use that contravenes irrigation rosters.

Source: Marsden Jacob analysis.

2.3.2 Water efficiency opportunities funded through the Water Efficiency Program

The WEP delivers funding to upgrade water infrastructure in the Murray-Darling Basin. Over $1.5 billion is available through the WESA to improve water efficiency and deliver 450 GL of water for the environment by 30 June 2024.

There are five project streams under the Program: urban, industrial, off-farm, metering and on-farm. Examples of eligible projects are listed in Table 4.

Table 4: Eligible projects

Loss category	Description
Urban water efficiency projects	Reduced leakage Sewerage processing practices Stormwater capture and recycling
Industrial water efficiency projects	Plant upgrades Processing or product redesign and implementation Water recycling
Off-farm projects	Dams and water storage Stock and domestic pipelines Upgraded channel systems
Metering projects	Flow regulation infrastructure Installing meters Upgrading meters to comply with the Australian Standard
On-farm projects	Drip systems Replacing open channels with pipes Water-efficient rootstock

Source: *Water Efficiency Program*, Department of Agriculture, 20 January 2020, online.

Water efficiency projects must demonstrate a neutral or positive socio-economic impact for the community. Participants will:

- implement the project as agreed
- return an agreed volume of saved water rights to the Australian Government, and
- keep any extra water savings that the project generates.

Project funding is 1.75 times the current market value of the water rights transferred.

2.4 Analytical framework and terminology

In this project, we assessed a number of the factors that affect the likelihood of achieving the volume target of 450 GL long-term annual average yield (LTAAY) within the available time and budget.

The WEP is demand driven, so participation by eligible water holders—irrigators, urban water utilities, industrial water users and irrigation infrastructure operators (IIOs)—will be critical to the program achieving the 450 GL LTAAY target by 30 June 2024.

To ensure that the analysis is grounded in a proven analytical framework that has been developed to inform the review of government programs, we used the following framework to inform our analysis. It has been adapted from the Australian National Audit Office's *Better practice guides*[3] and the

[3] These guides are no longer maintained by the Australian National Audit Office, but they are still recognised as containing well-developed frameworks for analysing government program initiatives.

International Project Management Association. The overarching framework is summarised in Figure 1:

- The *external* context reflects factors outside the control of either the delivery partners or the program agency, including climate (water availability and temperature), economic factors (commodity and water markets), political factors (local, state and national) and structural factors (numerous stakeholders with differing objectives).
- The *internal* context reflects factors within the control of either the delivery partners or the program agency.

Figure 1: External and internal contexts

Reflecting the nature of the issues that we have been asked to consider, the analysis in this report particularly focuses on external factors, but we are also mindful of a number of internal factors that can affect participation and program outcomes.

2.5 Analytical method

To inform the analysis in this report, we conducted in-depth interviews with various stakeholders, including:

- Australian Government managers responsible for the implementation of current and earlier water efficiency programs.
- current and previous delivery partners
- water market intermediaries from across the MDB.

We have also drawn upon a range of datasets to perform quantitative analysis. The datasets are all specified in the relevant sections in the report. In summary, they include data from:

- the Australian Bureau of Statistics (ABS)
- the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)
- the MDBA
- state government water registers
- Waterflow™.

We have also participated in round table events organised by the review panel.

We have not interviewed any state government representatives in the preparation of this report, as those interviews are being separately undertaken by the review panel.

3. Market prices: historical, current and forecast

The focus of this section is on:

- **Issue 1**: Projected water entitlement prices and potential ranges and/or scenarios for the relevant regions for the period ending on 30 June 2024.

3.1 Key findings

- Projected water entitlement prices provide insight as to the future costs of the WEP and whether the WESA can cover these costs.
- In this project, we developed entitlement price projections that reflect a continuation of the current dry period or a return to wet conditions. The key points to note are as follows:
  - Forecasting prices is very difficult because they are a function of commodity market circumstances, market sentiment and climatic conditions. Therefore, all forecasts are inherently uncertain.
  - Northern MDB markets are relatively stable because the crop mix has remained relatively constant.
- Southern MDB markets have witnessed significant price changes. Higher reliability entitlements have increased significantly in price over the past few years. Lower reliability entitlements, after initially increasing, have started to decline.
- Our projections indicate entitlement prices in the northern and southern MDB markets may continue to rise.

See Table 5 and Table 6 for current prices and outlook prices in the southern and northern MDB, respectively.

Table 5: Current and outlook prices, southern MDB ($/ML) as at November 2019

Region	Entitlement type	Current market price ($/ML) as at November 2019	Price outlook ($/ML)
HIGH RELIABILITY/SECURITY			
SA Murray	Class 3	7,000–8,000	5,000–10,000
Vic. Murray	High reliability	5,000–7,250	4,000–8,000
Goulburn	High reliability	4,300–5,000	3,500–8,000
NSW Murray	High security	6,500–9,900	5,000–10,000
Murrumbidgee	High security	7,800–8,500	6,000–10,000

Region	Entitlement type	Current market price ($/ML) as at November 2019	Price outlook ($/ML)
LOW RELIABILITY / GENERAL SECURITY			
Vic. Murray	Low reliability	450–650	300–800
Goulburn	Low reliability	350–425	250–550
NSW Murray	General security	1,350–1,850	1,000–2,300
Murrumbidgee	General security	1,900–2,000	1,500–2,500

Source: Marsden Jacob analysis.

Table 6. Current and outlook prices, northern MDB ($/ML) as at November 2019

Region	Entitlement type	Current market price ($/ML) as at November 2019	Price outlook ($/ML)
HIGH SECURITY			
Macquarie	High security	6,000	4,500–8,000
Lachlan	High security	4,500	4,000–7,500
Border Rivers	High security	6,500	5,800–7,200
GENERAL SECURITY			
Macquarie	General security	1,700	1,200–1,800
Lachlan	General security	1,200	850–1,400
Border Rivers	General security Class A	3,600	3,200–4,000
Namoi	General security	2,500–3,000	1,750–3,750
Gwydir	General Security	2,700–3,000	2,400–3,000

Source: Marsden Jacob analysis.

3.2 Methodology

Accurately projecting market prices, even one or two years ahead, is very difficult and involves wide confidence bounds. Water markets have undergone a number of structural shifts that cannot be captured in the historical data, and that affects the robustness of price predictions from longer term market prediction models (econometric models). So, instead of relying on econometric modelling to estimate the project water entitlement prices, we used the following method:

- We performed statistical modelling that focused on a number of key market price drivers, including:
  - water availability (e.g. inflows to storages and announced allocations)
  - the size of the consumptive pool
  - market performance during previous drought (millennium and more recent) and wet periods
  - commodity market and production trends.

- We interviewed a number of water brokers from across the MDB to test the current market drivers and price outlooks for different entitlement types.
- We reviewed historical broker interviews—Marsden Jacob has been interviewing brokers since early 2011 and has a running log of the results from those interviews.
- We drew upon and updated our net margin models for key crop types. The models can be used to estimate price ceilings based on capacity to pay for key irrigated crops

The inflow analysis was informed by the MDBA's River Murray inflow data.

3.3 Water market products

Products in the Australian water market can be grouped in to three categories:

1. *Primary products*—basic trade mechanism for allocation and entitlement transfers
2. *Secondary products*—products that have been derived from the characteristics of allocations and entitlements and/or are executed using the basic trade mechanism to achieve a specific outcome
3. *Related products*—products that are not derived or related to the characteristics of allocations and entitlements but can be used in conjunction with them.

The market price analysis in this report focuses on one aspect of the primary products market known as the entitlement (or permanent) market. An entitlement trade involves the transfer of ownership of an entitlement between two parties. The price of water entitlements is essentially equivalent to the discounted returns to water allocated to entitlements (which we estimate using net margins in section 3.5.3).

In the analysis, we also refer to the allocation market, which is also known as the spot allocation trade or temporary trade. The transfer of allocation between one party and another is specifically for the duration of the ongoing irrigation season.

More information on water markets in provided in Appendix 2.

3.4 Historical and current prices

The total volume of water entitlement and resources is capped in the MDB, resulting in changes in supply and demand for water being reflected in the price of water in the water market.

The high degree of hydrological connectivity in the southern MDB allows for relatively unconstrained trade in water entitlements and water allocations between systems, subject the presence of use restrictions. The southern MDB is Australia's most significant water market and is widely regarded as one of the world's most sophisticated water markets.

Conversely, the disconnected nature of most river systems in the northern MDB means that most water market activity there is between farmers within a region, so prices can be quite different in different regions.

All figures in this section use cleaned data (that is, outlier trades have been excluded).

3.4.1 Southern MDB

From Figure 2 through Figure 5 it can be seen that entitlement prices for:

- both high reliability/security and general security entitlements fell after the millennium drought (Figure 2)
- high reliability (Vic.), high security (NSW) and Class 3 (SA) entitlements have increased significantly since 2014, and the overall southern MDB volume weighted average price (VWAP) increased by over 400% over that period (Figure 3)
- general security (NSW) and low reliability (Vic.) entitlements have increased since 2014, but not as significantly (100%), and now appear to be declining marginally (Figure 3 and Figure 4)

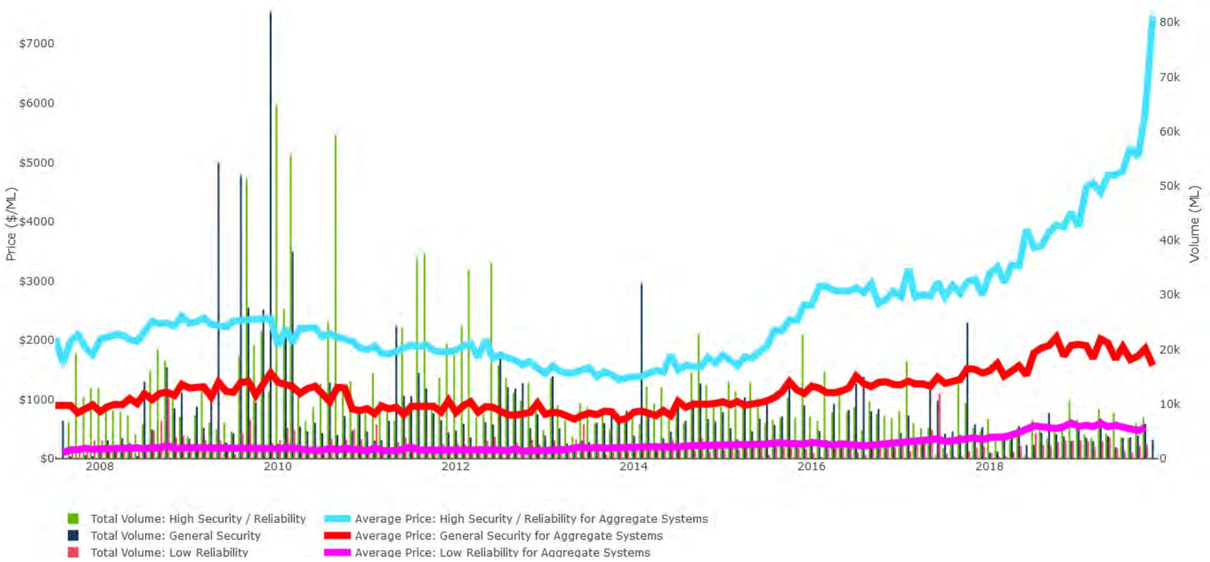
Based on our research and interviews with brokers and other water market participants, the key factors that explain the price increases include:

- increased demand for water from horticulture (nuts and citrus) and viticulture for higher reliability entitlements`
- increased demand for water from cotton producers for general security entitlements
- reduction in supply in the entitlement market because there are fewer sellers and the Commonwealth Environmental Water Holder (CEWH) holds more water.

Where previously the lower and higher security entitlement types tended to follow a similar price trend, over the past 12 months a significant divergence has occurred. Higher security entitlement prices are continuing to increase significantly, compared with prices for lower security entitlements. Key factors driving this include:

- *water availability*—as shown in Figure 6, the availability of water (announced allocations) from general security entitlements has been poor because dam storage levels are falling, so irrigators who need water in the short run are looking towards higher security entitlements.
- *thin markets*—a number of brokers have commented that where previously there were many sellers, for instance because of a generational change occurring, there are now fewer.

Figure 2: Southern MDB entitlement market summary, 2007 to 2019



Source: Marsden Jacob Waterflow™.

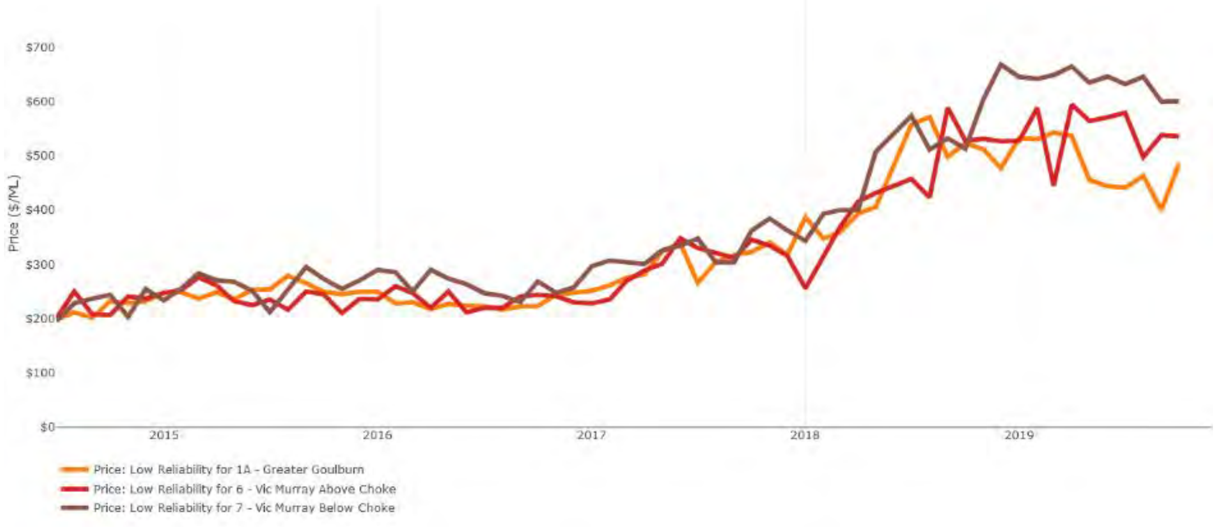
Figure 3: Murray below Choke high security/reliability entitlement market summary, 2007 to 2019

Source: Marsden Jacob Waterflow™.

Figure 4: NSW general security entitlement market summary, 2007 to 2019

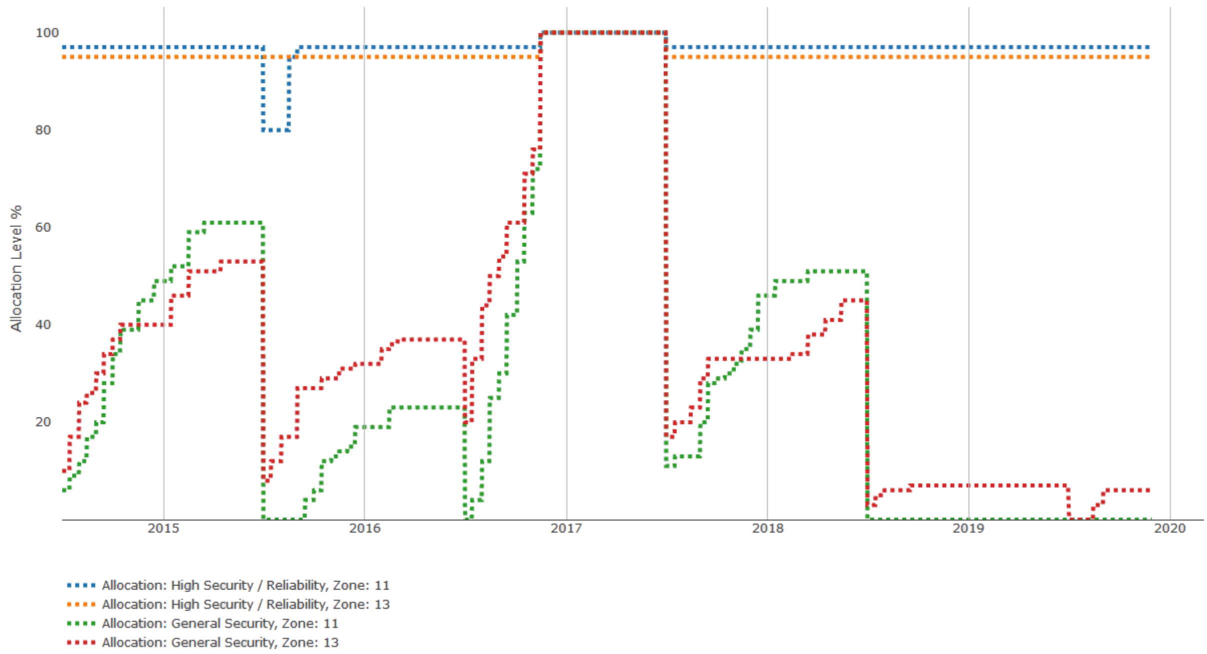
Source: Marsden Jacob Waterflow™.

Figure 5: Vic. low reliability entitlement market summary, 2007 to 2019



Source: Marsden Jacob Waterflow™.

Figure 6: NSW Murray and Murrumbidgee, announced allocations, 2014 to 2019



Source: Marsden Jacob Waterflow™.

Table 7 illustrates the continued price increases for high security/reliability entitlements. Compared to market prices in July 2018, current prices are 40–100% higher (depending on the entitlement type). In contrast, general security entitlement prices (NSW) have fallen by 10–20%, while low reliability prices (Victoria) have fallen by 23% in Goulburn and remained relatively stable in the Victorian Murray.

Table 7. Market price comparison of selected southern connected MDB entitlements ($/ML)

Region	Entitlement type	Market price July 2018	Current market price November 2019
SA Murray	Class 3	4,050–3,400	7,000–8,000
Vic. Murray above Barmah Choke	High reliability	3,400–3,550	5,000–5,500
Vic. Murray above Barmah Choke	Low reliability	400–500	450–550
Vic. Murray below Barmah Choke	High reliability	4,000–4,200	6,500–7,250
Vic. Murray below Barmah Choke	Low reliability	500–600	550–650
Goulburn	High reliability	3,350–3,550	4,300–5,000
Goulburn	Low reliability	450–550	350–425
NSW Murray above Barmah Choke	High security	3,500–4,000	6,500–8,000
NSW Murray above Barmah Choke	General security	1,900–2,000	1,350–1,575
NSW Murray below Barmah Choke	High security	4,900–5,050	7,900–9,900
NSW Murray below Barmah Choke	General security	2,000–2,100	1,650–1,850
Murrumbidgee	High security	5,000–5,200	7,800–8,500
Murrumbidgee	General security	2,000–2,200	1,900–2,000

Source: Marsden Jacob analysis.

3.4.2 Northern MDB

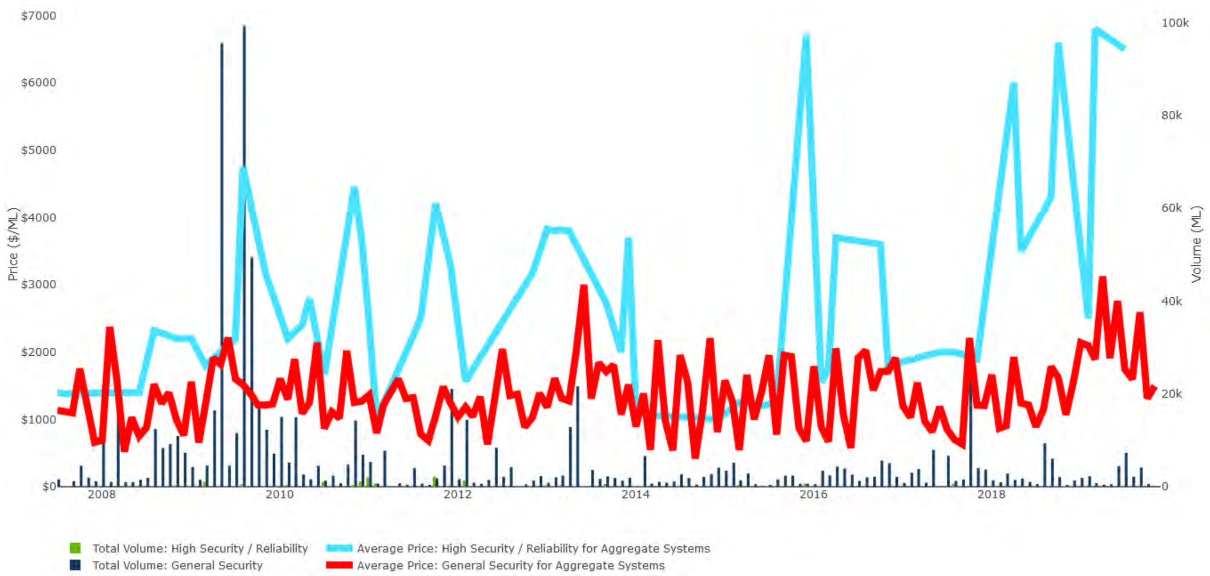
From Figure 7 through Figure 9 it can be seen that:

- Trading activity for both general and high security entitlements is much thinner in the northern MDB, and there are frequently extended gaps between trades. This is particularly true for high security entitlements in northern NSW, because most of the water there has been allocated as general security entitlements.
- Prices in most zones have been relatively stable, with the key exceptions being the Lachlan and Macquarie catchments (Figure 8). Brokers have commented that:
  - prices in the Lachlan are increasing because this catchment was very badly affected during the millennium drought and a significant proportion irrigators left the region, so storage levels have held up better than in other regions and the irrigation sector is now rebuilding (also underpinned by new investment in agriculture and shift in crop types in the Lower Lachlan area)

– in the Macquarie, there have been a number of significant investments into irrigation efficiency infrastructure, and the region is witnessing significant generational change and farm consolidation, which means demand is high.

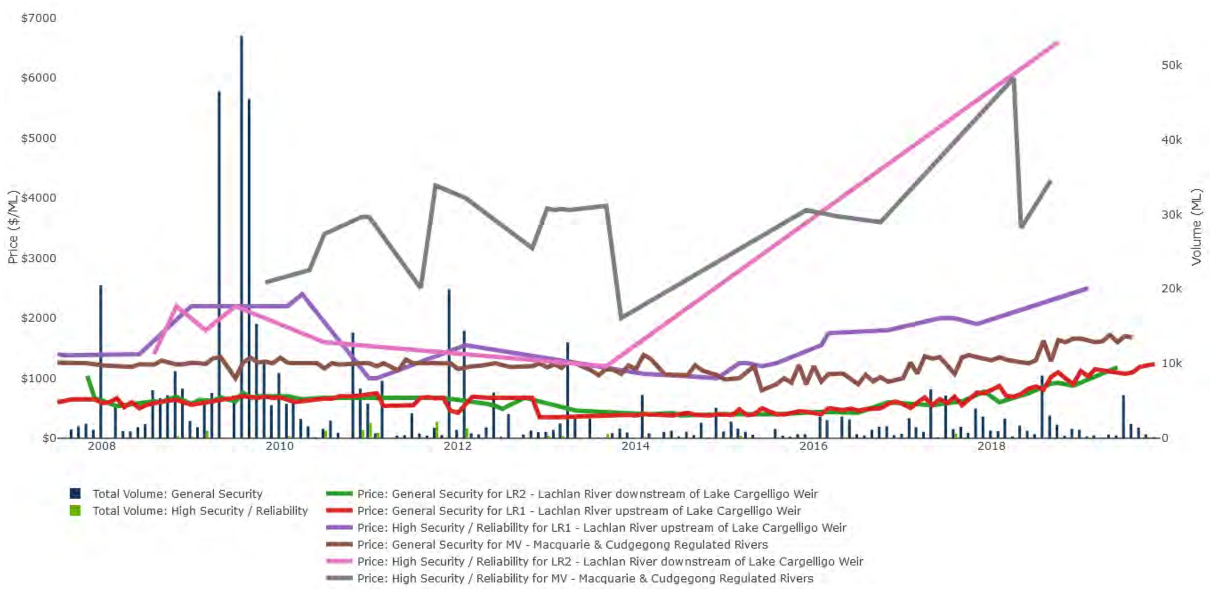
- Prices in other zones have been generally stable because the northern MDB markets are quite mature markets in which established crop types (particularly cotton) drive market performance.

Figure 7: Northern MDB entitlement market summary, 2007 to 2019



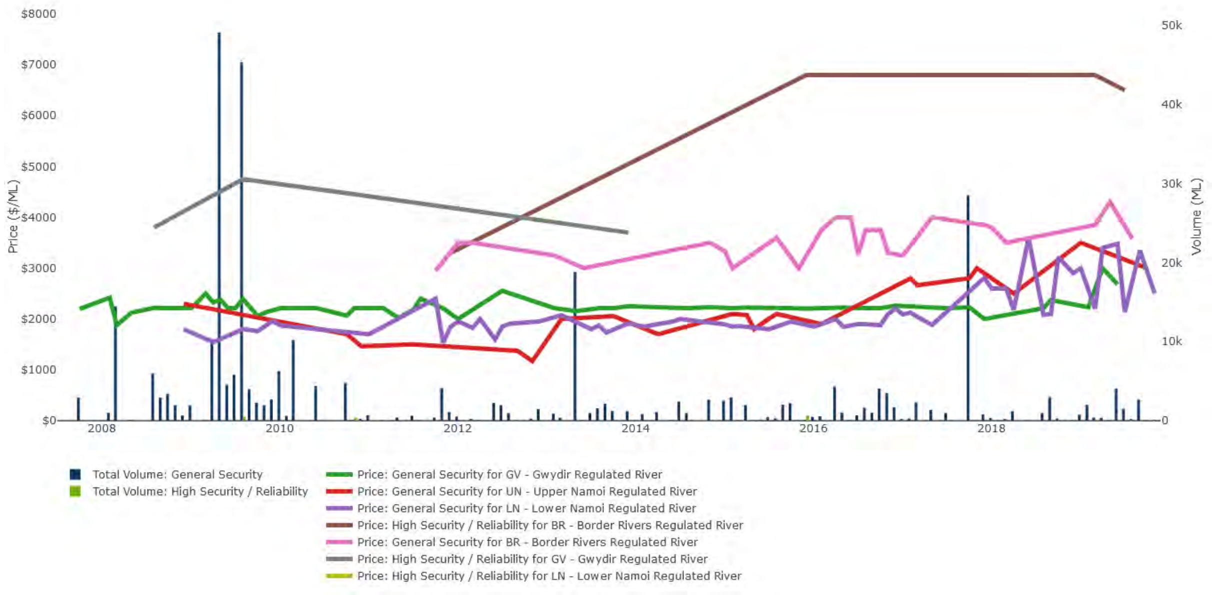
Source: Marsden Jacob Waterflow™.

Figure 8: Lachlan and Macquarie entitlement market summary, 2007 to 2019



Source: Marsden Jacob Waterflow™.

Figure 9: Gwydir, Namoi and NSW Border Rivers entitlement market summary, 2007 to 2019



Source: Marsden Jacob Waterflow™.

Table 8 illustrates that compared to July 2018, entitlement market prices in most northern MDB catchments have been relatively stable, with the key exceptions being the Lachlan and Macquarie. In the Lachlan and Macquarie both general and high security entitlement prices have increased significantly. It is important to note that high security entitlements are rarely traded in all northern MDB catchments and therefore price movements for high security entitlements have a less of a material impact to the market compared to general security trends.

Table 8: Market price comparison of selected northern MDB entitlements ($/ML)

Region	Entitlement type	Market price July 2018	Current market price November 2019
Macquarie	High security	4,300	6,000
Macquarie	General security	1,400	1,700
Lachlan	High security	2,500	4,500
Lachlan	General security	800	1,200
Border Rivers	High security	6,800	6,500
Border Rivers	General security Class A	3,500	3,600
Namoi	General security	2,000–3,000	2,500–3,000
Gwydir	General security	2,200–2,300	2,700–3,000

Source: Marsden Jacob analysis.

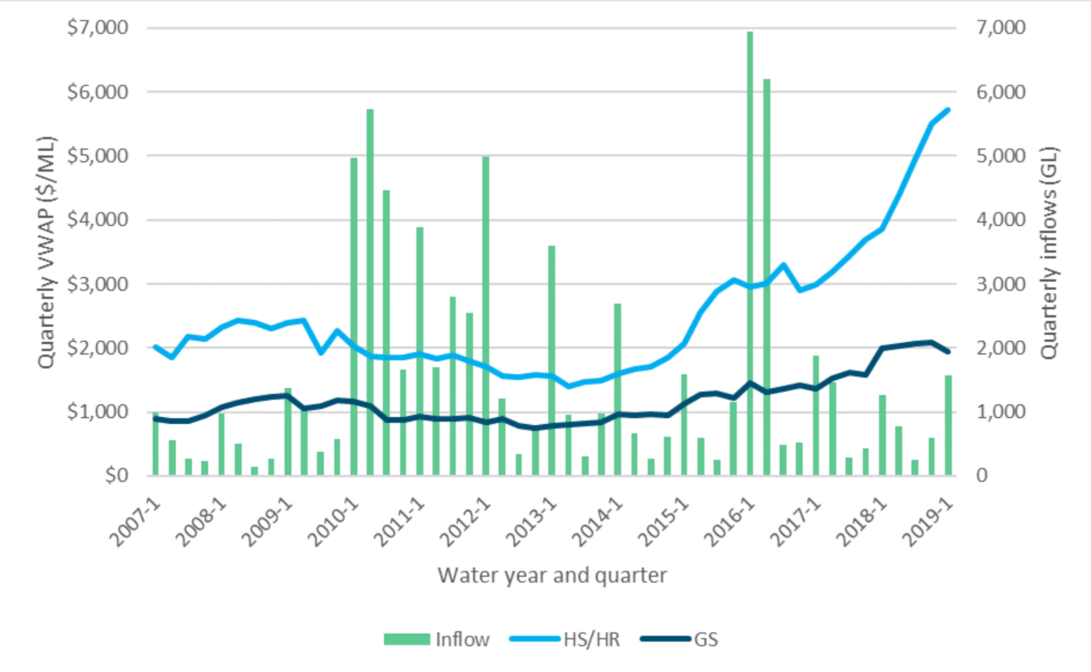
3.5 Price outlooks

As previously noted, the price outlooks are based on historical and current prices; expert knowledge; and likely upper bounds imposed by the realities of farm business profitability (see section 3.5.3). The outlooks are reported for aggregated zones, meaning that some of the idiosyncrasies of individual trading zones (and the crops grown there) have been averaged out.

Box 1: Historical price changes during wet and dry periods

Climate and weather (wet or dry periods) have significant impacts on water availability and market prices (see Figure 10). For instance, as a result of three consecutive years of above-average inflows (water years 2010 to 2012), both high security/reliability and general security prices decreased by 30–40%.

Figure 10: Market prices and MDB storage inflows, water years 2007 to 2019



VWAP = volume weighted average price.

Source: MDBA, Waterflow™.

The only significant wet period since 2012 occurred in 2016 (and lasted only one water year). Prices remained around $3,000/ML and $1,400/ML for high security/reliability and general security entitlements, respectively, through the 2016 water year.

Since then, below-average inflows have caused entitlement prices to reach unprecedented levels: high security/reliability prices have close to doubled, while general security prices have increased by 30–40%. The disparity in price increases is likely to reflect the fact that high security/reliability entitlements realise high allocations even during dry periods, whereas general security entitlements have reduced allocations during dry periods.

In contrast, high security/reliability and general security prices converged slightly over the water years from 2010 to 2012, as allocation levels were typically more similar across the different entitlement types, and high security/reliability entitlements attracted a lower price premium.

3.5.1 Capacity to pay: high security/reliability entitlements

Figure 11 shows the likely ranges of capacity-to-pay values for different crop types, based on margin analysis. The ranges include allowances for farm size, management practices, and whether the purchase is for a newly established farm or for the expansion of existing operations. Also, to a lesser degree than temporary prices, entitlement prices are affected by short-term fluctuations in output (crop) prices. The combination of all of those factors results in an estimated range of capacity-to-pay values, rather than a point estimate.

The current market price in selected zones in the southern MDB has been included to provide some insight into the crop types that are likely to be ‘making the market’, those that might soon be or are already priced out of the market, and those that still have room to move and have the capacity to pay higher than the current market price.

There are a number of higher security entitlement types across the MDB, including high security (NSW), high reliability (Vic.), and Class 3 (SA) entitlements.

For those entitlement types, the current market prices and outlook ranges are shown in Table 9.

Table 9: Outlook market prices for high security/reliability entitlements ($/ML)

Entitlement type	Current market price (November 2019)	Outlook range
Murrumbidgee high security	7,800–8,500	6,000–10,000
Vic. Murray high reliability	5,000–7,250	4,000–8,000
Goulburn high reliability	4,300–5,000	3,500–8,000
NSW Murray high security	6,500–9,900	5,000–10,000
SA Murray Class 3	7,000–8,000	5,000–10,000
Border Rivers high security	6,500	5,800–7,200

Source: Waterflow™, Marsden Jacob analysis.

From the net margin analysis (Figure 11), the current market price for higher security entitlements (Table 9) reflects returns from almonds (and nut crops more generally), and there may even be some upside potential, whereas it appears that the current market price exceeds citrus producers’ capacity to pay unless they already have sizeable holdings and are using the extra entitlements for expansion or water-security purposes.

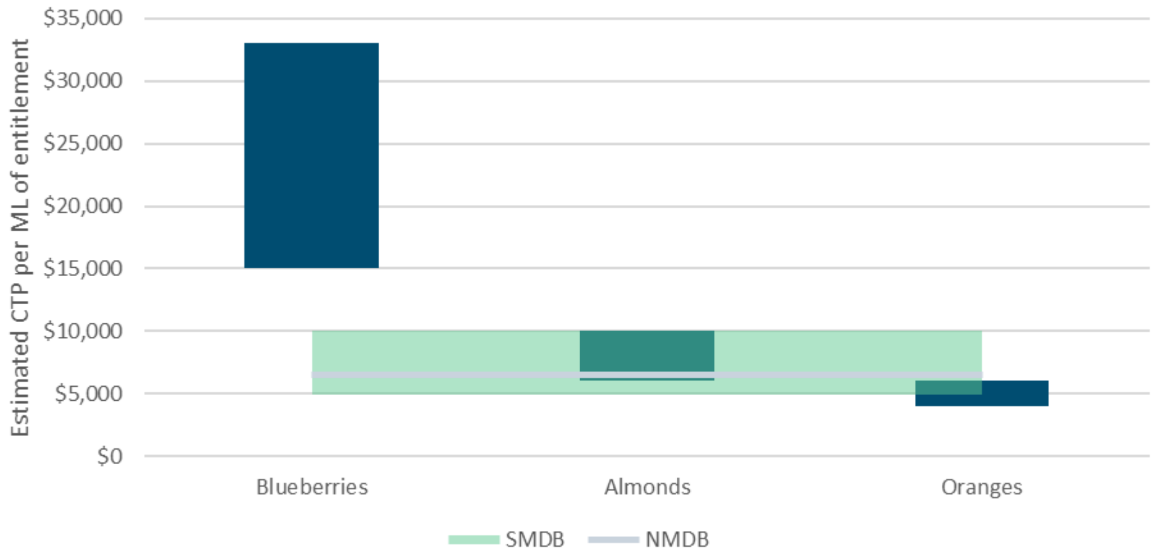
It is noteworthy that the production of some niche crops, such as blueberries, remains highly profitable at current entitlement prices, which means that prices could move higher in a relatively more supply-constrained water market or if production of those crops increases.

3.5.2 Capacity to pay: general security entitlements

Figure 11 shows the likely ranges of capacity-to-pay values for different crop types that are typically grown using general security water, based on margin analysis.

Across these entitlement types, the current market prices and outlook ranges are shown in Table 10.

Figure 11: Estimated capacity to pay for 1 ML of high security/reliability entitlement, selected crops



CTP = capacity to pay.

Source: Marsden Jacob analysis.

Table 10: Outlook market prices for general security entitlements ($/ML)

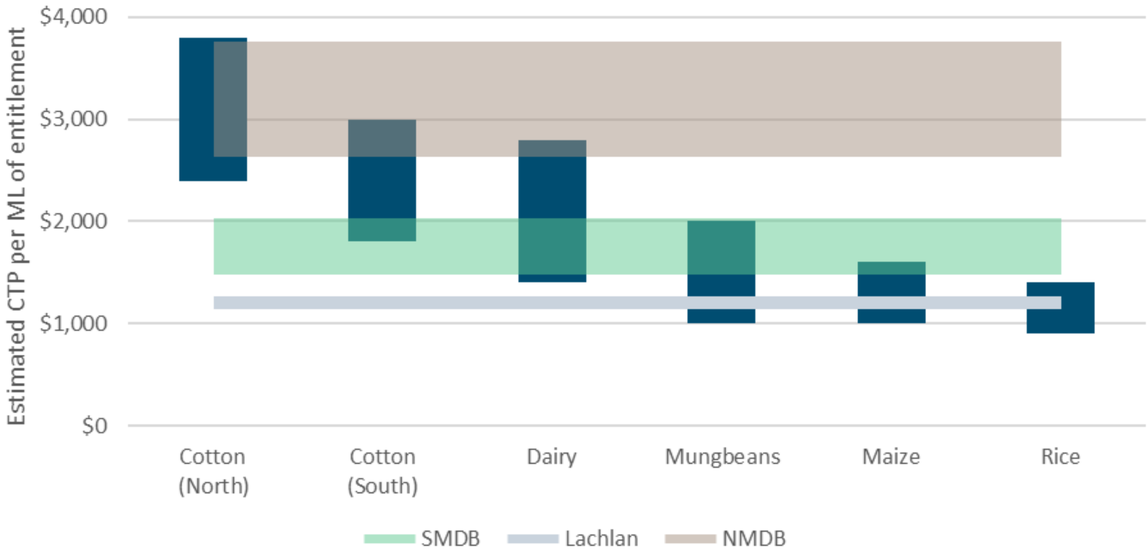
Entitlement type	Current market price (November 2019)	Outlook range
Murrumbidgee general security	1,900-2,000	1,300–2,200
NSW Murray general security	1,350-1,850	1,250–2,000
Macquarie general security	1,700	1,200–1,800
Lachlan general security	1,200	850–1,400
Border Rivers general security Class A	3,600	3,200–4,000
Namoi general security	2,500-3,000	1,750–3,750
Gwydir general security	2,700-3,000	2,400–3,400

Source: Waterflow™, Marsden Jacob analysis.

In the south, general security entitlement prices reflect returns from dairy and mungbean production (Figure 12). However, as cotton production is rapidly expanding southward, we understand that cotton is now ‘making the market’ in some of the southern catchments.

In the north, in contrast, cotton has long been the dominant crop. Trades in northern catchments are infrequent, meaning that price signals can be quite noisy; however, in May 2019, 39 ML of general security entitlement was traded in NSW Border Rivers for $4,300/ML. That trade is likely to have been right at the upper bound, or even exceeded the upper bound, of reasonable entitlement market prices. Current market prices range from $2,500/ML for Namoi general security entitlement to $3,600/ML for Border Rivers general security Class A.

Figure 12: Estimated capacity to pay for 1 ML of general security entitlement, selected crops



CTP = capacity to pay.

Source: Marsden Jacob analysis.

3.5.3 Margin analysis summary

Because the price of water entitlements is essentially equivalent to the discounted returns to water allocated to entitlements, we performed net margin modelling to inform our assessment of capacity to pay.

Table 11 and Table 12 summarise margin estimates for selected crops, grouped by the type of entitlement typically used to irrigate the crop. These are point estimates only, so they do not capture the full range of margins across all farms. In both tables, the estimates have been rounded to the nearest $100.

Table 11: Margin estimates for selected crops that are typically grown using high security/reliability water

		Blueberries	Almonds	Oranges
New establishment	NPV net margin/ha (over 20 years)	$150,000	$60,000	$53,000
	NPV net margin/ML (over 20 years)	$20,000	$8,500	$5,300
	Levelised net margin/ML	$2,400	$1,000	$620
Expanding production	NPV net margin/ha (over 20 years)	$215,000	$62,000	$53,000
	NPV net margin/ML (over 20 years)	$29,000	$9,000	$5,300
	Levelised net margin/ML	$3,400	$1,000	$625

NPV = net present value.

Source: Marsden Jacob analysis of NSW DPI and AgMargins gross margin budgets.

Table 12: Margin estimates for selected crops that are typically grown using general security water

		Cotton (north)	Cotton (south)	Dairy	Mungbeans	Maize	Rice
New establishment	NPV net margin/ha (over 20 years)	$31,000	$28,000	$4,650	$2,300	$8,700	$17,500
	NPV net margin/ML (over 20 years)	$3,100	$2,800	$2,200	$1,500	$1,500	$1,350
	Levelised net margin/ML	$360	$325	$260	$180	$170	$160
Expanding production	NPV net margin/ha (over 20 years)	$31,000	$29,000	$5,850	$2,800	$9,000	$18,000
	NPV net margin/ML (over 20 years)	$3,100	$2,900	$2,750	$1,900	$1,500	$1,400
	Levelised net margin/ML	$365	$340	$320	$220	$180	$160

NPV = net present value.

Source: Marsden Jacob analysis of NSW Department of Primary Industries and AgMargins gross margin budgets.

4. Water recovery scenarios to meet the 450 GL target

The focus of this section is on:

- **Issue 2**: Identification of the potential and likely sources of water entitlements available to and accessible by the WESA to meet the LTAAY target of 450 GL.
- **Issue 3**: Development of potential water recovery scenarios with different mixes of entitlements.
- **Issue 4**: Given the likely scenarios for price (Issue 1) and the mix of entitlements (Issue 3), what is the total cost of projects required to achieve 450 GL LTAAY by 30 June 2024, compared to the available budget of $1.575 billion?

4.1 Key findings

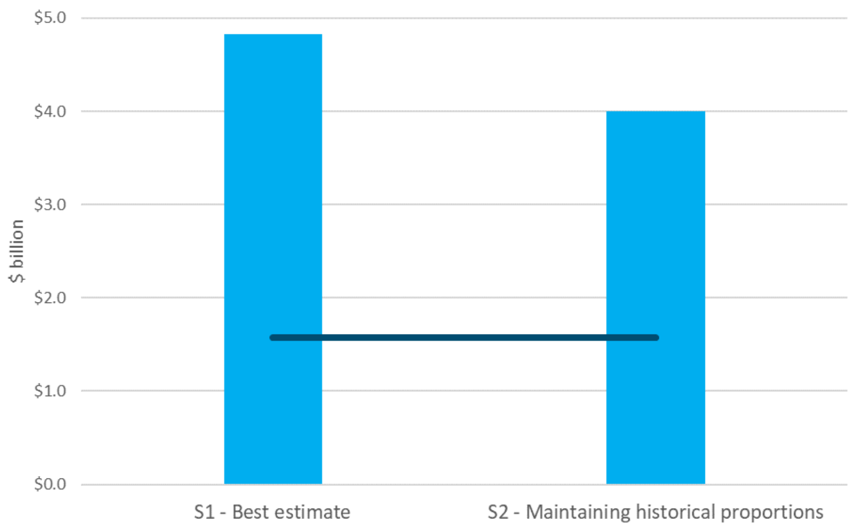
We defined two potential recovery scenarios with specified recovery locations and entitlement types:

- Scenario 1: Best estimate
- Scenario 2: Recovering 450 GL while maintaining historical proportions of infrastructure recovery.

Effectively this analysis explores that if 450 GL can be recovered under the WEP, where would the water come from, and how much might it cost.

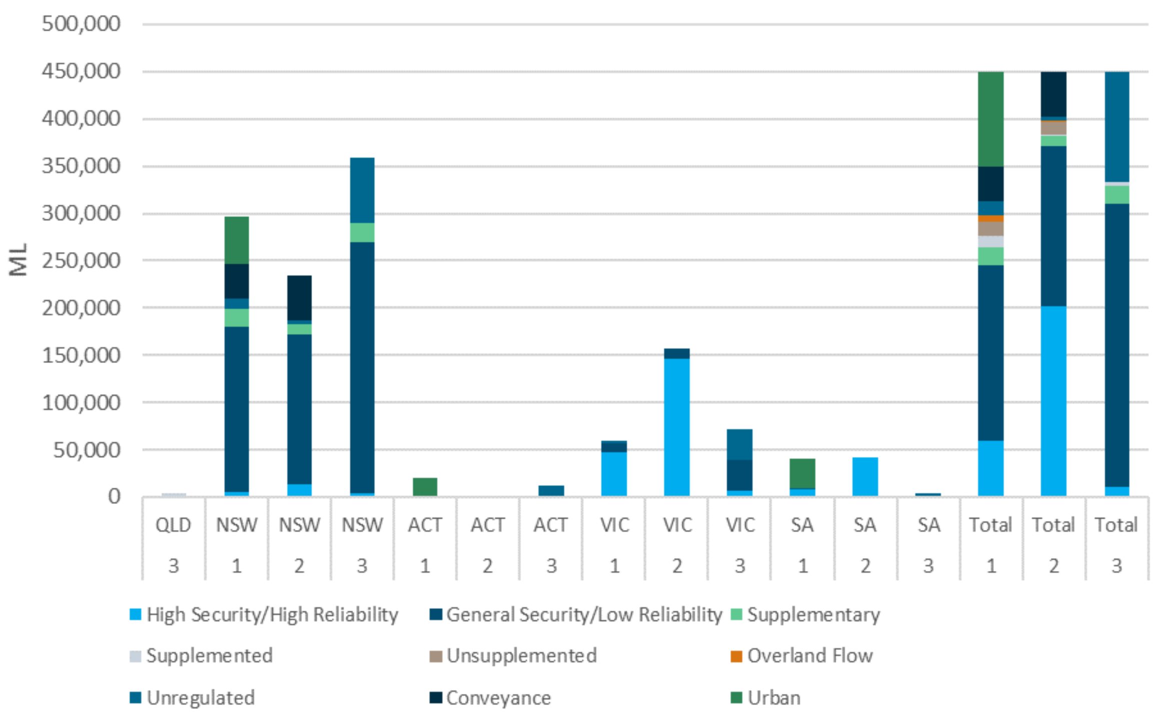
Figure 13 shows the estimated costs for the two main scenarios at current market prices, indicating that both scenarios would exceed the budget to recover 450 GL.

Figure 13: Cost to recover 450 GL LTAAY under Scenarios 1 and 2 ($ billion)



In addition to the two main scenarios, we included a third scenario to investigate whether it would be theoretically possible to recover 450 GL within the budget (Scenario 3). Whilst such calculated outcome does exist, we do not consider it realistic in practice (hence Scenario 3 is not included in Figure 13). As can be seen from Figure 14, this requires that a large proportion of the recovery volume comes from lower cost entitlements with a high LTAAY value (such as unregulated water), which is not a realistic or currently desired outcome.

Figure 14: LTAAY recovered under different scenarios, by basin state and entitlement type (ML)



Scenario 1 gives our best estimate of recoverable volumes per entitlement and project type between SDL units. The estimates are based on stakeholder feedback from interviews, insights from previous research projects, and expert knowledge. At current market prices, the cost estimate for Scenario 1 is $4.8 billion, which far exceeds the budget.

Figure 15 and Figure 16 show the recovery volumes and cost breakdowns for the northern and southern MDB, by project type. Most of the water would be recovered from the southern MDB and through on-farm projects, whereas the cost breakdown between the three major project types is roughly equal. This implies that the project cost for off-farm and urban/industrial projects is higher than for on-farm projects.

Figure 15: LTAAY recovered and cost incurred under Scenario 1, by MDB location

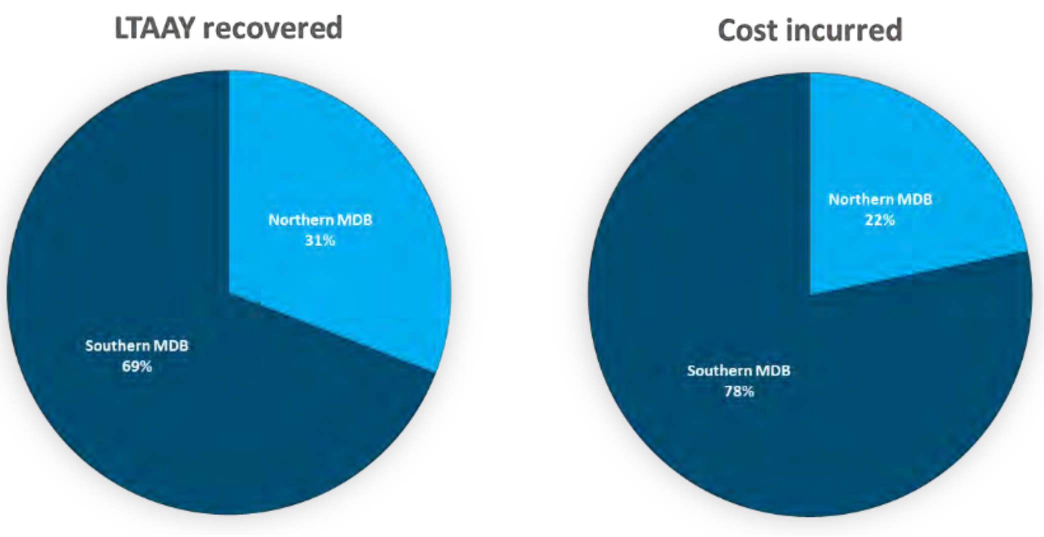
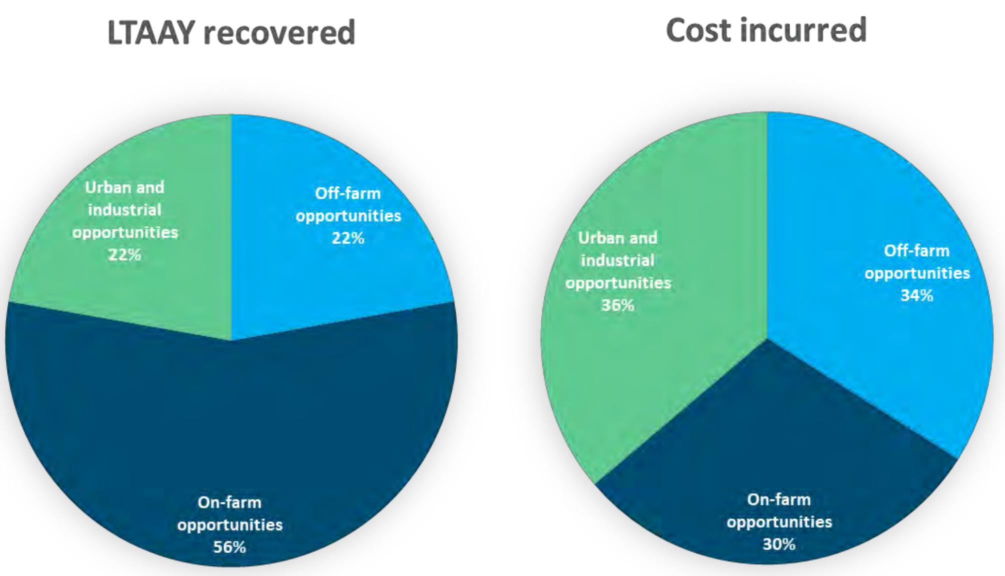


Figure 16: LTAAY recovered and cost incurred under Scenario 1, by project type



4.2 Introduction

Developing water recovery scenarios requires the identification of the potential and likely sources of water entitlements available to and accessible by the WESA to meet the LTAAY target of 450 GL. We investigated those issues and developed potential water recovery scenarios with different mixes of entitlements. We followed a staged process to determine an accurate baseline for this analysis:

1. We determined the size of the consumptive pool of water that is potentially available for participation in the Water Efficiency Program. We did this across the MDB for each entitlement class by subtracting the current environmental holdings held by the federal and state environmental water holders from the total entitlements on issue.[4]

   Ideally, we would have excluded from the consumptive pool individual licence holders who have already participated in the On-Farm Irrigation Efficiency Program or similar programs and are unlikely to do so again, and licences that have not been held for three years (a program requirement). However, data limitations and time and budget constraints made this level of detailed analysis infeasible. However, we have factored in previous participation in the On-Farm Irrigation Efficiency Program and similar programs more broadly at SDL unit level.

2. We established current market values for each of the entitlement types in each SDL unit.

3. We looked at the LTAAY factors of each entitlement type, by location. This determines what types of scenarios are hypothetically or mathematically achievable to meet the 450 GL target. For example, hypothetically, a low reliability entitlement in Victoria has an LTAAY factor of 0.4, and there are 821 GL of low reliability entitlements on issue. Therefore, it is impossible to achieve 450 GL of LTAAY with those entitlements alone, since $821 \times 0.4 = 328.4$ GL.

As a result of the analysis, we defined two main recovery scenarios, with specified recovery locations and entitlement types:

- Scenario 1: Best estimate
- Scenario 2: Recovering 450 GL while maintaining historical proportions of infrastructure recovery.

In addition to the above scenarios, we also set out an illustrative Scenario 3, looking into if 450 GL could be recovered with the available budget if lower value entitlements were the focus of the water efficiency program.

Each of the scenarios is discussed in detail in the following sections.

4.3 Scenario 1: Best estimate

Scenario 1 presents our best estimate of recoverable volumes by entitlement and project type among the SDL units to recover 450GL. The estimates are based on stakeholder feedback from interviews, insights from previous research projects, and expert knowledge.

Key assumptions were as follows:

[4] This is based on public information on the Commonwealth Environmental Water Holder and Victorian Environmental Water Holder websites and state water registers.

- We determined the consumptive pool across the MDB for each entitlement class as total entitlements on issue minus current environmental holdings held by the federal and state environmental water holders.
- Market prices for the recovered entitlements are as estimated at the time of writing (November 2019).
- While identified barriers to recovery have been accounted for on a high level, the premise of Scenario 1 is that 450 GL can be recovered. Hence, the analysis focuses on the most likely locations and entitlement and project types that this water will come from (in line with questions 5 and 6).
- We assumed that urban and industrial projects will cost around $10,000/ML (see section 5.5.3).

The results of the Scenario 1 analysis are shown in Table 13. According to our best estimate, the recovery would cost much more than the $1.575 billion budget, and most of the water would be recovered from the southern MDB.

Table 13: Scenario 1—recovery volume and cost, by SDL unit

State	SDL unit	LTAAY (ML)	Cost ($m)
Qld	Condamine–Balonne	20,000	$77.0
Qld	Moonie	1,000	$3.5
Qld	Nebine	1,000	$3.5
Qld	Paroo	0	$0.0
Qld	Qld Border Rivers	10,000	$53.3
Qld	Warrego	2,000	$7.0
NSW	Barwon–Darling	8,000	$16.8
NSW	Gwydir	10,000	$105.9
NSW	Intersecting streams	2,000	$4.2
NSW	Macquarie–Castlereagh	20,000	$146.9
NSW	Namoi	10,000	$81.3
NSW	NSW Border Rivers	10,000	$72.2
NSW	Lower Darling	2,000	$1.5
NSW	NSW Murrumbidgee	70,000	$544.0
NSW	NSW Murray	90,000	$270.5
NSW	Lachlan	25,000	$134.0
ACT	ACT Murrumbidgee	20,000	$350.0
Vic.	Broken	1,000	$3.7
Vic.	Campaspe	2,000	$14.0
Vic.	Goulburn	25,000	$217.1

State	SDL unit	LTAAY (ML)	Cost ($m)
Vic.	Kiewa	0	$0.0
Vic.	Loddon	2,000	$14.0
Vic.	Ovens	2,000	$3.7
Vic.	Vic. Murray	25,000	$217.1
Vic.	Wimmera–Mallee	2,000	$3.5
SA	Eastern Mount Lofty Ranges	2,000	$1.8
SA	Marne Saunders	0	$0.0
SA	SA Murray	38,000	$641.7
SA	SA non-prescribed	0	0
MDB	Urban areas across the MDB	50,000	$875.0
Northern MDB total		**139,000**	**$1,055.7**
Southern MDB total		**311,000**	**$3,782.0**
TOTAL		**450,000**	**$4,837.8**

Figure 17 presents a breakdown of recovered volumes by entitlement type and SDL unit under Scenario 1. The largest individual entitlement group contributing to the 450 GL recovery target would be general security water from NSW, but the entitlement spectrum across the MDB will be broader compared to the other scenarios.

Table 14 breaks down Scenario 1 projects by type.

Figure 17: Scenario 1—LTAAY recovered, by SDL unit and entitlement type (ML)

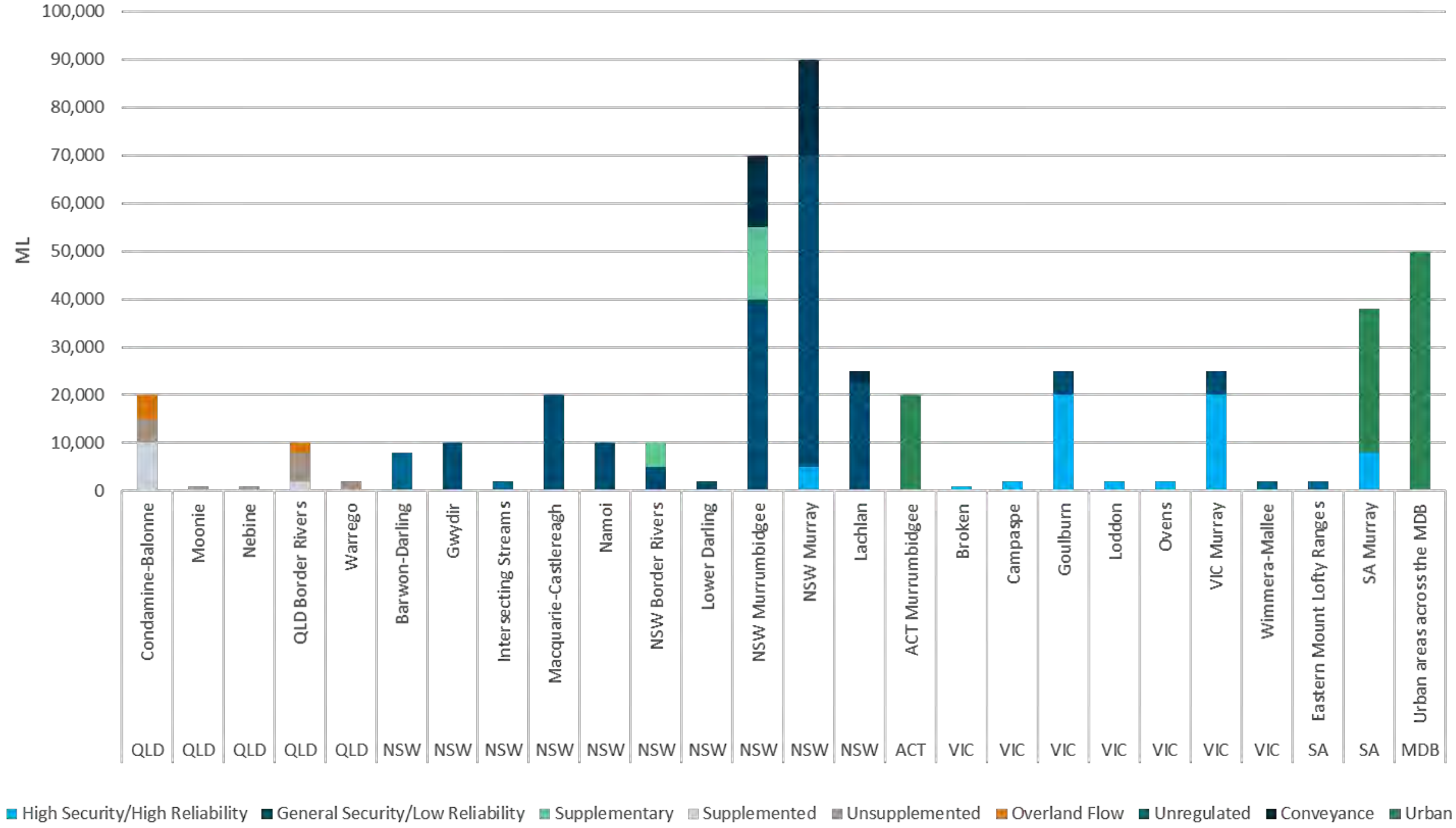


Table 14: Scenario 1—breakdown of project types

Project type	Project opportunities	Bases of estimate	Comments
Off-farm	Large-scale southern MDB IIOs (60 GL) Small-scale southern MDB IIOs (20 GL) Northern MDB IIOs (20 GL)	Ernst & Young report, stakeholder estimates, internal analysis on remaining consumptive pool and past participation in infrastructure programs	Recovering 100 GL from off-farm projects would require that some of the identified barriers be overcome (see section 5). For instance, many IIOs are interested in undertaking further efficiency projects but it is questionable whether their projects will pass the market multiplier test. Some IIOs have completed their efficiency upgrades, so there are no material opportunities, and other IIOs are not interested in participating due to political reasons.
On-farm	Southern MDB (151 GL) • NSW – 102 GL • SA – 10 GL • Vic. – 39 GL Northern MDB (99 GL) • NSW – 75 GL • Qld – 24 GL	Ernst & Young report, stakeholder estimates, internal analysis on remaining consumptive pool and past participation in infrastructure programs	Opportunities for improvements to farm business practices still exist across the MDB. However, high water prices and the current drought mean that, in order to be successful in recovering 450 GL, it is unlikely that high reliability entitlements can be recovered at scale. As most of SA and Vic. water entitlements are higher reliability by design, a large proportion of the water will have to come from NSW, where more general security entitlements exist. There are numerous opportunities across all sized catchments in NSW, but barriers to the socio-economic criteria need to be overcome (see section 5).
Urban and Industrial	ACT (20 GL) • ICON Water has unused water kept aside to support sustainable growth SA (30 GL) • Further utilisation of the SA desalination plant, stormwater substitution projects Across the MDB (50 GL) • For example, urban water efficiency projects in NSW MDB towns—70	Ernst & Young report, stakeholder estimates and internal analysis	There is great uncertainty associated with urban and industrial projects (e.g. regarding project cost and life cycle), but stakeholders acknowledged that, in order to be able to recover 450 GL, a significant proportion has to come from this stream. Thus, it is essential that the identified large individual projects in ACT and SA eventuate.

Project type	Project opportunities	Bases of estimate	Comments
	local utilities across the state are interested in efficiencies • Various industrial projects (e.g. abattoirs, feedlots, refineries)		

4.4 Scenario 2: Recovering 450 GL while maintaining historical proportions of infrastructure recovery

For the second scenario, we looked into the historical proportions of infrastructure recovery and applied those proportions for the SDL units to recover 450 GL LTAAY, using today's market prices (as at November 2019). Key assumptions were as follows:

- The historical recovery pattern of SDL units[5] and entitlement types and volumes recovered within the SDL unit is applied to recover 450 GL.
- The only exception is the exclusion of historical recovery in the Lowbidgee system in the Murrumbidgee: one-off land and water purchases through the Nimmie–Caira Project[6] resulted in 176 GL[7] LTAAY of Lowbidgee supplementary water access licences being recovered. In our opinion, including it in the historical pattern would create a significant bias and would result in more water being recovered from the Lowbidgee system than there are remaining entitlements in the consumptive pool.
- Market prices for the recovered entitlements are as estimated at the time of writing.

The results of the Scenario 2 analysis are shown in Table 15. Recovery at the historical proportions would cost much more than the $1.575 billion budget, and most of the water would be recovered from the southern MDB.

Table 15: Scenario 2—recovery volume and cost, by SDL unit

State	SDL unit	LTAAY (ML)	Cost ($m)
Qld	Condamine–Balonne	7,309	$25.1
Qld	Moonie	1,233	$4.0
Qld	Nebine	0	$0.0
Qld	Paroo	0	$0.0
Qld	Qld Border Rivers	7,838	$48.2

—

[5] As at 31 March 2019, incorporating draft NSW LTAAY factors and v2.05 LTAAY factors in all other SDL resource units. Total volumes recovered per SDL unit via infrastructure are sourced from *Surface water recovery under the Basin Plan as at 31 March 2019*, Department of Agriculture, online. Entitlement type breakdown within the SDL units is based on public information on the Commonwealth Environmental Water Holder website, state water registers and in instances, where public data was not available, Marsden Jacob's assessment.

[6] *The Nimmie–Caira Project*, NSW Department of Planning, Industry and Environment, no date, online.

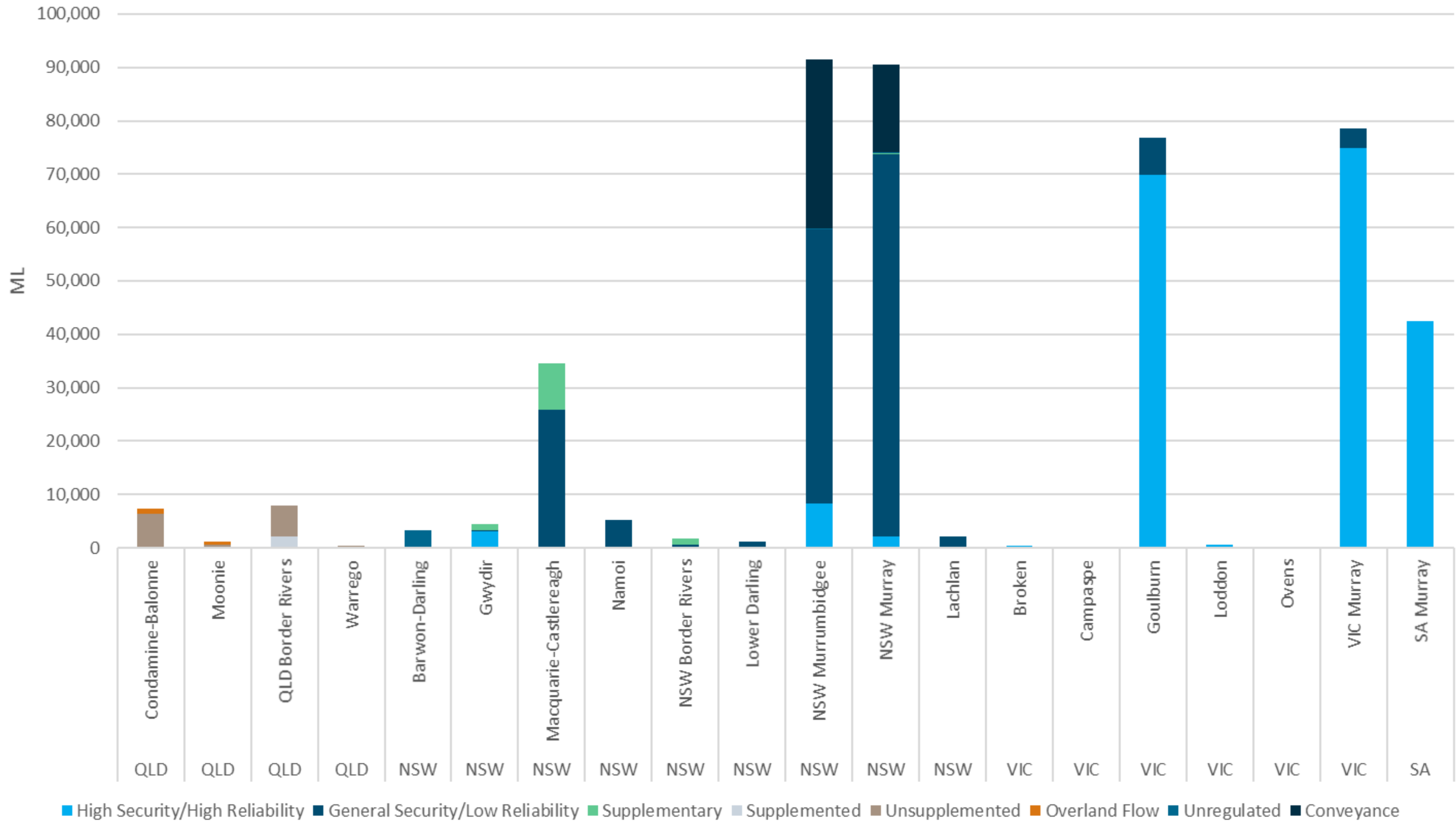
[7] *Derivation of LTDLE factors in NSW*, water reform technical report, NSW Government, May 2018, online.

State	SDL unit	LTAAY (ML)	Cost ($m)
Qld	Warrego	352	$1.2
NSW	Barwon–Darling	3,258	$8.6
NSW	Gwydir	4,403	$68.9
NSW	Intersecting streams	0	$0.0
NSW	Macquarie–Castlereagh	34,521	$140.6
NSW	Namoi	5,196	$47.2
NSW	NSW Border Rivers	1,673	$10.6
NSW	Lower Darling	1,233	$0.9
NSW	NSW Murrumbidgee	91,409	$916.8
NSW	NSW Murray	90,440	$590.5
NSW	Lachlan	2,025	$10.7
ACT	ACT Murrumbidgee	0	$0.0
Vic.	Broken	440	$1.6
Vic.	Campaspe	176	$1.2
Vic.	Goulburn	76,791	$604.9
Vic.	Kiewa	0	$0.0
Vic.	Loddon	528	$3.7
Vic.	Ovens	88	$0.2
Vic.	Vic. Murray	78,552	$897.0
Vic.	Wimmera–Mallee	0	$0.0
SA	Eastern Mount Lofty Ranges	0	$0.0
SA	Marne Saunders	0	$0.0
SA	SA Murray	42,534	$620.2
SA	SA non-prescribed	0	$0.0
Northern MDB total		**67,808**	**$365.2**
Southern MDB total		**382,192**	**$3,637.1**
TOTAL		**450,000**	**$4,002.3**

Figure 18 presents a breakdown of recovered volumes within SDL units under Scenario 2, by entitlement type. It shows that in the southern MDB most of the recovered volume would be high reliability/security water in Vic. and SA, whereas in NSW the largest recovery volumes would come from general security entitlements. In the northern MDB, the entitlement spectrum is broader.

While Scenario 2 analysis provides useful insights, the main limitation associated with it is that it does not take a stand on which project streams the recovery volume of 450 GL will come from (whereas Scenario 1 addresses this, hence being our ‘best estimate’ scenario).

Figure 18: Scenario 2—LTAAY recovered, by SDL unit and entitlement type (ML)



4.5 Scenario 3: Recovering 450 GL within the available budget

In addition the two main scenarios, we included a third, academic scenario to investigate whether it would be theoretically possible to recover 450 GL within the budget. The key assumptions of Scenario 3 were as follows:

- We determined the consumptive pool across the MDB for each entitlement class as the total entitlements on issue minus current environmental holdings held by the federal and state environmental water holders.
- Market prices for the recovered entitlements are as estimated at the time of writing (November 2019).
- Using mathematical optimisation, we developed the recovery portfolio based on the consumptive pool and current market prices, with the following restrictions on how much water can come from non-regulated entitlements and/or from specific SDL units:
  - 15% of the consumptive pool (by water source and entitlement type) is offered for recovery, with a restriction that no more than 136 GL[8] LTAAY can be through non-regulated entitlements (that is, unregulated entitlements in NSW, the ACT, Vic. and SA, supplementary water in NSW, unsupplemented and overland flow water in Qld)
  - Without any constraints, the analysis results would be highly unrealistic since most of the 450 GL would be recovered from unregulated river water sources. Also, without restrictions, the mathematical optimisation method would in some instances take 100% of the remaining consumptive pool, which is also deemed undesirable and unrealistic.

The results of the Scenario 3 analysis are shown in Table 16. Under the assumed restrictions, 450 GL can be recovered within the budget.

Table 16: Scenario 3—recovery volume and cost, by SDL unit

State	SDL unit	LTAAY (ML)	Cost ($m)
Qld	Condamine–Balonne	3,707	$18.3
Qld	Moonie	0	$0.0
Qld	Nebine	0	$0.0
Qld	Paroo	0	$0.0
Qld	Qld Border Rivers	0	$0.0
Qld	Warrego	392	$1.4
NSW	Barwon–Darling	0	$0.0
NSW	Gwydir	4,943	$4.3
NSW	Intersecting streams	1,848	$1.6
NSW	Macquarie–Castlereagh	63,861	$217.2

[8] This limit was determined through the optimisation process with the objective of minimising the proportion of non-regulated entitlements whilst recovering 450 GL within the available budget.

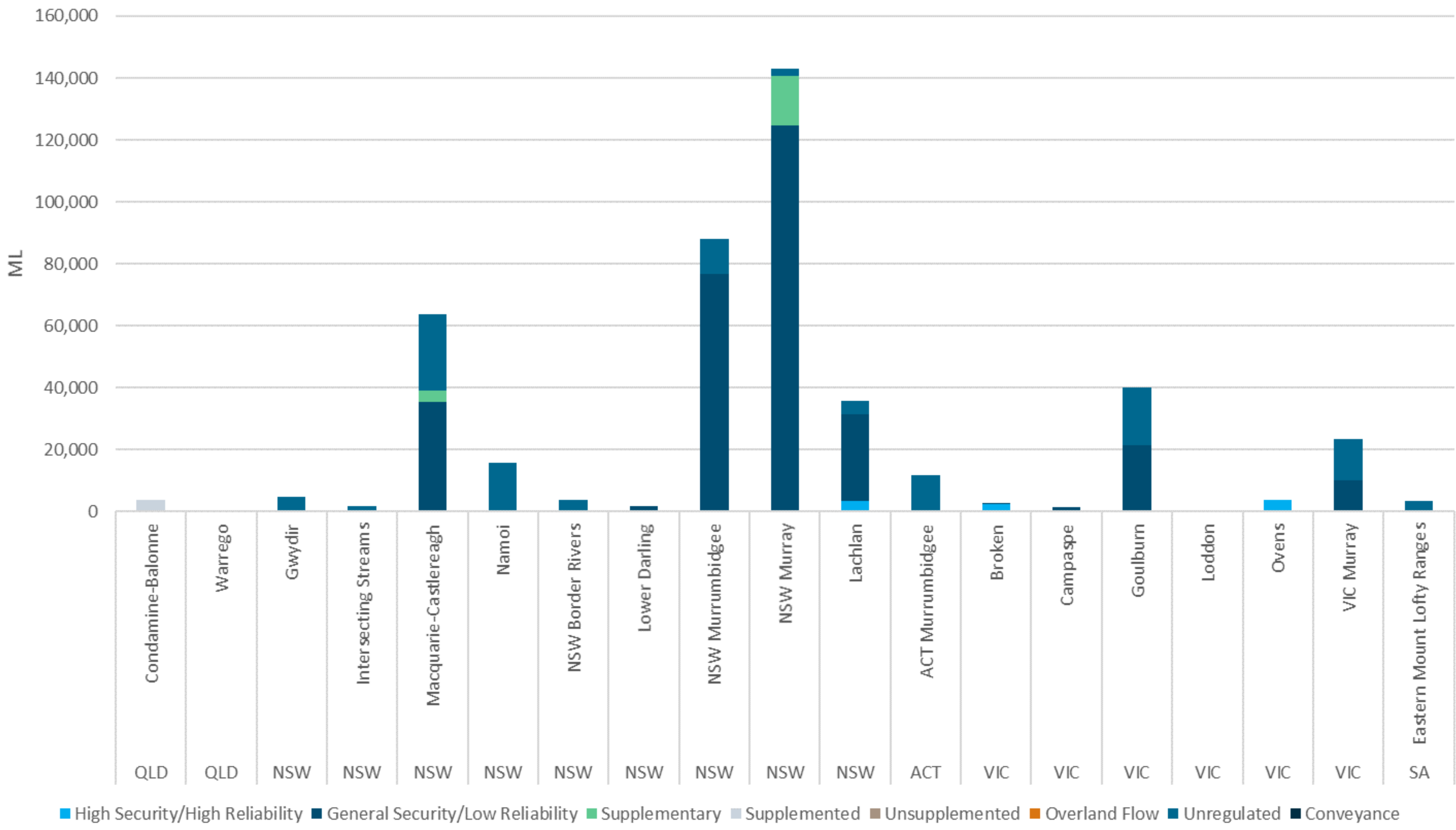
NSW	Namoi	15,861	$13.9
NSW	NSW Border Rivers	3,671	$3.2
NSW	Lower Darling	1,878	$3.0
NSW	NSW Murrumbidgee	88,164	$433.9
NSW	NSW Murray	142,895	$528.2
NSW	Lachlan	35,847	$169.9
ACT	ACT Murrumbidgee	11,628	$10.2
Vic.	Broken	2,820	$9.1
Vic.	Campaspe	1,380	$2.0
Vic.	Goulburn	40,129	$86.3
Vic.	Kiewa	0	$0.0
Vic.	Loddon	306	$0.7
Vic.	Ovens	3,711	$6.8
Vic.	Vic. Murray	23,588	$60.4
Vic.	Wimmera–Mallee	0	$0.0
SA	Eastern Mount Lofty Ranges	3,370	$2.9
SA	Marne Saunders	0	$0.0
SA	SA Murray	0	$0.0
SA	SA non-prescribed	0	$0.0
Northern MDB total		**130,130**	**$429.9**
Southern MDB total		**319,870**	**$1,143.6**
TOTAL		**450,000**	**$1,573.4**

Figure 19 presents a breakdown of recovered volumes by entitlement type within SDL units under Scenario 3. While a big proportion of the 450 GL target will be recovered from unregulated water sources, almost 60% will come from NSW general security entitlements. Also, a small volume of high security/reliability entitlements is included in this scenario.

It is worth noting that a mathematical solution to recover 450 GL within budget (with current market prices as at November 2019) only exists if at least 136 GL of the total recovery comes from non-regulated entitlements. This indicates that, to be successful in recovering 450 GL with the available funds, a significant proportion of it must come from lower cost entitlements with a high LTAAY value (such as unregulated entitlements).

We understand that, while unregulated water can be highly useful to the CEWH under certain conditions, it would not be preferred if this much of the 450 GL LTAAY were unregulated water. Hence, we do not consider Scenario 3 being realistic in practice.

Figure 19: Scenario 3—LTAAY recovered, by SDL unit and entitlement type (ML)



5. Factors affecting participation in the WEP

The focus of this section is on:

- **Issue 5**: The extent to which water, commodity and other markets' views on climate change and the current drought affect current participation in the Water Efficiency Program, or may affect future participation.
- **Issue 6**: The extent to which changes in the agricultural sector since the introduction of water recovery programs affect the nature of, or the way, participants might engage with the Water Efficiency Program (such as the modernisation of farms and irrigation networks; crop production patterns; understanding of the water market and water recovery; awareness of the value of possessing water entitlements; and changes in commodity and other market factors).
- **Issue 7**: The extent to which the Water Efficiency Program's funding formula (multiplying entitlement prices by the market multiple of 1.75) affects participation in the program.

5.1 Key findings

- There has been a shift to higher value commodities such as cotton, fruit and nuts in the southern MDB. This is having an impact on market prices (see section 3).
- The agricultural sector is achieving a higher gross value of agricultural production while using a lower volume of water.
- The number of farm businesses irrigating dropped from 18,000 in 2005–06 to just over 9,500 in 2017–18, highlighting a shift in farm ownership.
- Commodity prices have a significant economic impact on agriculture across the MDB and can vary widely from year to year. Prices for cotton have continued to increase over the long term, while almond prices have increased in the short term.
- Farm modernisation and improved water efficiency have played a significant role in facilitating the change in crop diversity across the southern MDB. Opportunities for further infrastructure projects, both on-farm and off-farm, will remain primarily in the southern MDB, although a small percentage will occur in the northern catchments.
- Water availability across the MDB is influenced by complex weather systems that can combine to produce severe weather conditions.
- The MDB is currently experiencing a severe drought. Water storage levels in both the northern and southern MDB are continuing to fall, and no significant rainfall is forecast for the short term.

- Market prices have increased significantly for high security (NSW), high reliability (Vic.), Class 3 (SA) and general security entitlements across many parts of the southern and northern MDB, so program participants are getting a better deal (more dollars per ML) than was previously the case when prices were lower but the multiple was higher. However, as per section 4, this means the available funding will not be adequate.
- There are some notable exceptions where prices have not increased as significantly, such as some of the northern NSW regions (Gwydir, Namoi and Border Rivers) and Qld regions (Condamine–Balonne and Border Rivers). In those regions, the lower market multiple could be a material barrier to participation if participants are habituated to higher multiples.
- Market prices for lower reliability, supplementary and unregulated entitlement types tend to be significantly lower than for other entitlement types. When those values are compared to the cost of water efficiency upgrades, they often fall below the cost of implementation, so this could emerge as a barrier for those entitlement types.
- Several interviewees commented that participants (irrigators, industrial and urban users) are confronted with a decision-making process that is much more complex than a simple water trade because they need to consider such issues as the tax implications of the funding, maintenance and replacement costs, water efficiency outcomes and future water availability (because the gains are only realised when water is available).
- Many urban and industrial project opportunities appear to be too expensive. Also, as discussed in section 5.5, a number of interviews have identified that some urban centres in the MDB are facing material supply constraints, so, while water efficiency is important, identifying new water sources is even more important.

5.2 Approach

The success of the water efficiency programs funded through the WESA depends on participation. A range of different factors, including water availability, commodity and other markets, and the current drought will affect participation in the Water Efficiency Program.

In this section, we outline how key economic and climate-driven factors have led to changes in the production mix and participation opportunities across the MDB. We also assess how participation is affected by the 1.75 market multiple. To inform our analysis of these issues, we have held targeted consultations and interviews with a range of stakeholders, including Australian Government program leaders, delivery partners in current and past efficiency programs, and water market intermediaries.

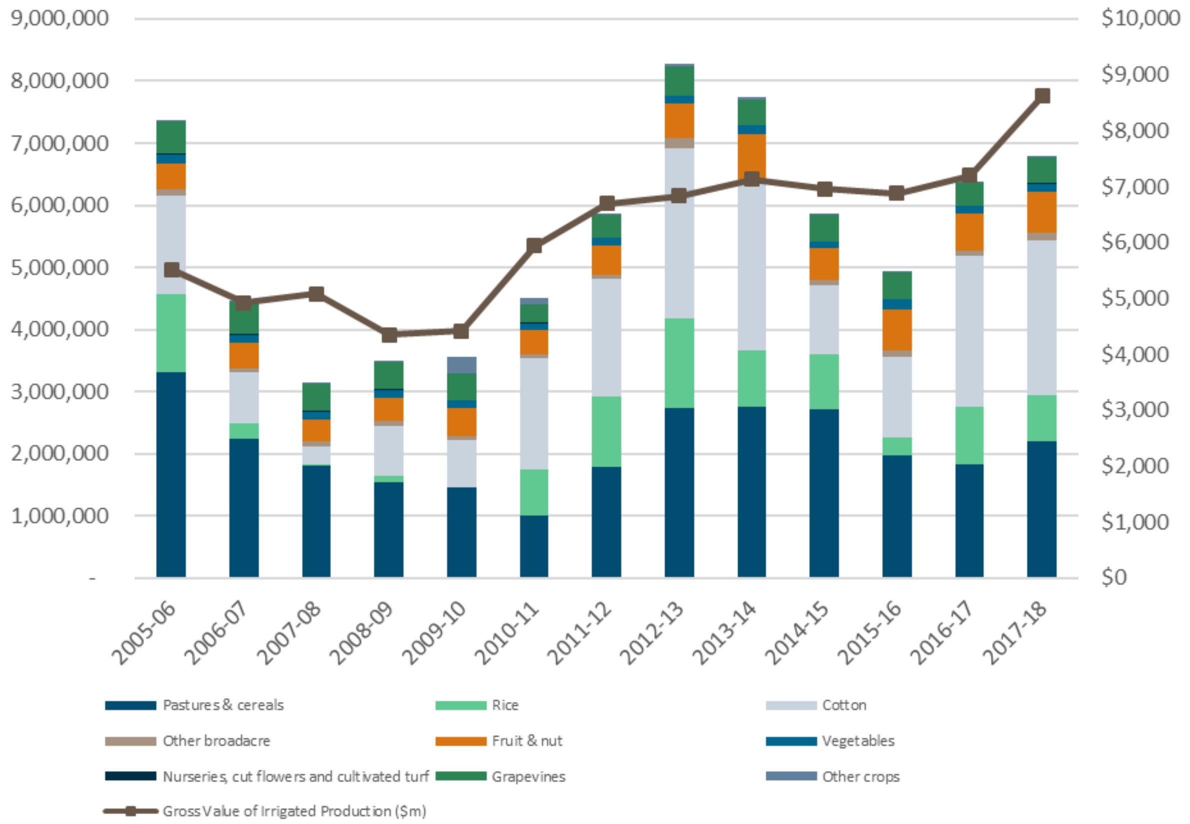
5.3 Economic factors

5.3.1 Commodity types

In any given region, commodity types are driven by the highest value crop that can be grown, given water availability. As climatic conditions have changed and new crop opportunities have emerged, the mix of commodities grown in the MDB has changed.

Figure 20 shows that there has been a steady increase in higher value crops, such as cotton, fruit and nuts. The change to higher value commodities is reflected in the increase in the gross value of irrigated production (GVIP) since 2009–10.

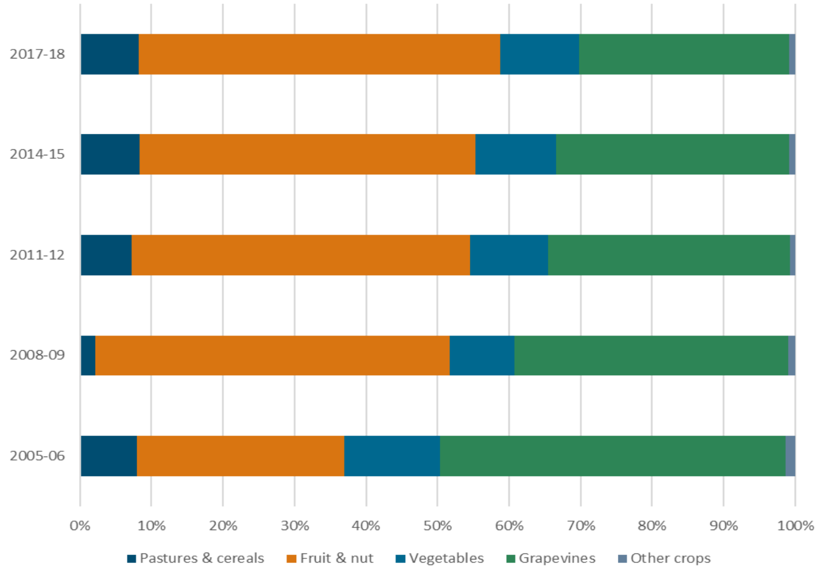
Figure 20: MDB water use (ML, LH side) and gross value of irrigated production ($m, RH side), by crop type, 2005–06 to 2017–18



Sources: ABS, *Gross value of irrigated agricultural production* and *Water use on Australian farms* statistics 2005–2018.

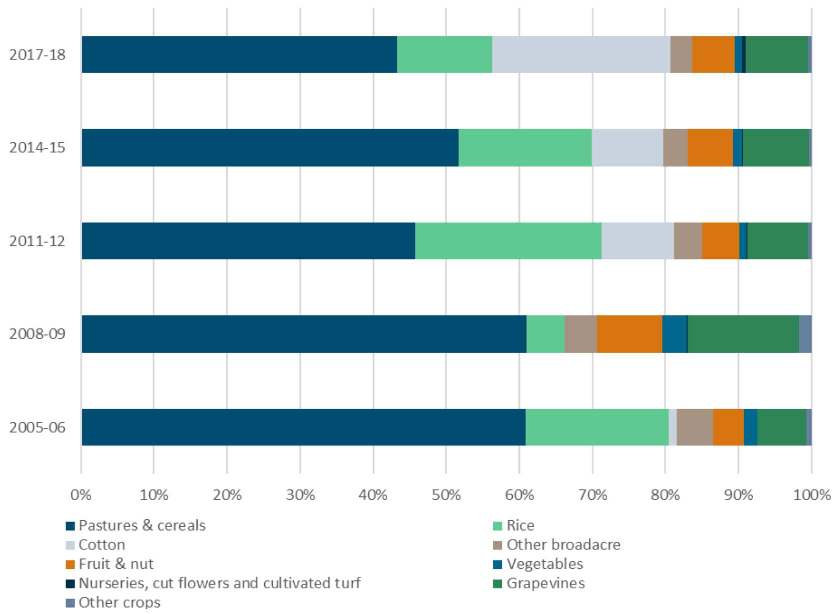
Changes to the mix of crops have mostly taken place in the southern MDB, where water sources are more reliable and can support the growth of permanent crops such as fruit and nuts (Figure 21 and Figure 22). It is also important to note that a higher GVIP is being supported by lower applications of water per crop type. This shows an increasing trend towards higher water efficiency in irrigated farming production systems, especially for higher value crops.

Figure 21: Victorian Mallee irrigated area, by crop type, selected years from 2005–06 to 2017–18 (% of total area)



Source: *2018 Mallee horticulture crop report*, Mallee Catchment Management Authority, November 2018, online.

Figure 22: Murrumbidgee area irrigated, by crop type, selected years from 2005–06 to 2017–18 (% of total area)



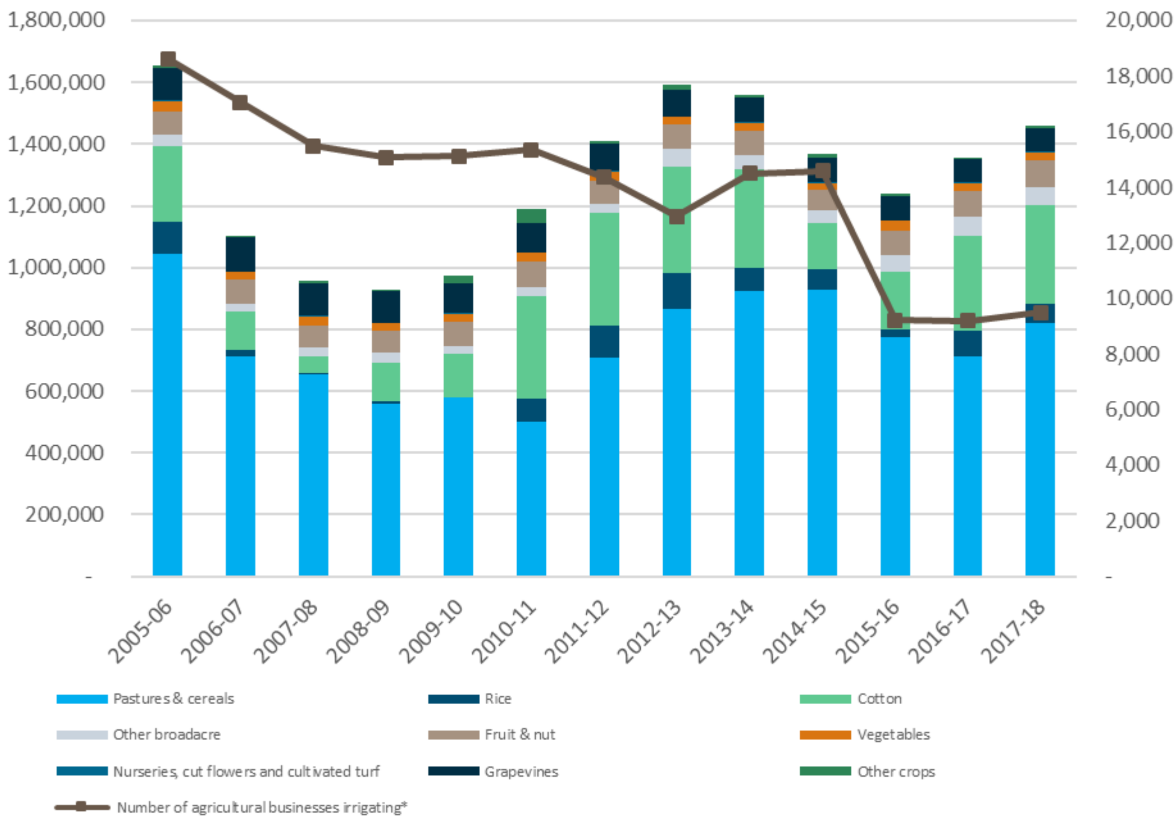
Source: ABS, *Water Use on Australian Farms* statistics 2005–2018.

5.3.2 Agricultural irrigation businesses

Alongside changes in water use and the diversity of commodities, evidence suggests that changes to farming businesses are occurring across the MDB. Figure 23 highlights the ongoing reduction in the number of irrigation businesses in the basin. This drop could be explained by a range of factors, including water availability, property amalgamations, corporate acquisitions and commodity prices.

For example, smaller farms may be merging together to improve their scale of production, or corporate agribusinesses may be acquiring more properties to convert to higher value commodities, such as almonds. Overall, since 2005–06 the number of irrigated businesses has dropped from 18,000 to just over 9,500.

Figure 23: MDB irrigated area, by crop type (ha, LH side) and number of agricultural businesses irrigating ($m, RH side), by crop type, 2005–06 to 2017–18



Note: The ABS method for counting the number of businesses changed in 2016–17, so these figures are not fully comparable.

Source: ABS, *Water Use on Australian Farms* statistics 2005–2018.

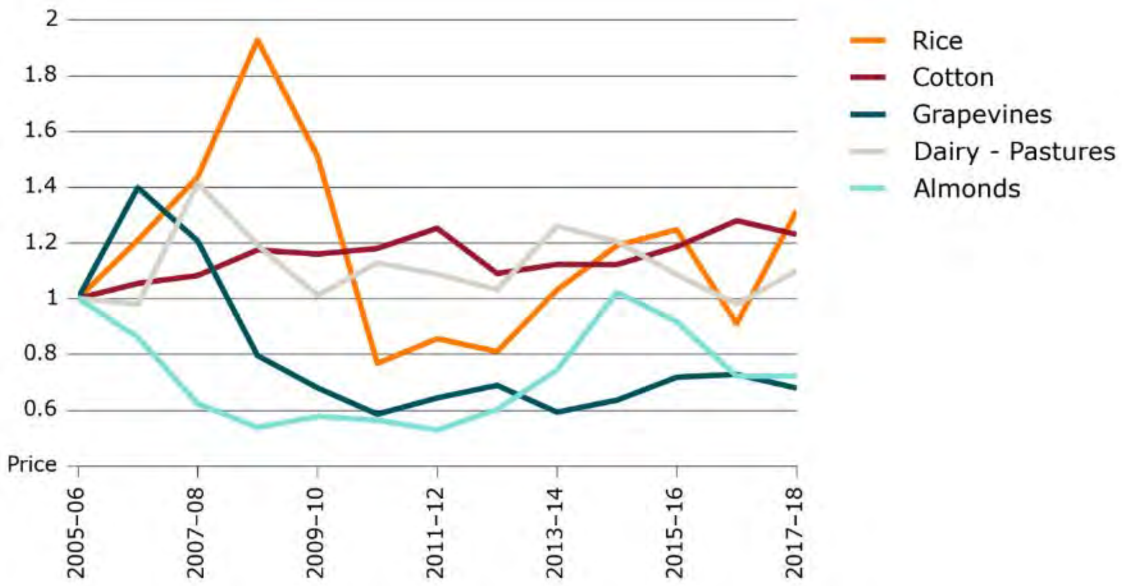
5.3.3 Commodity prices

Commodity prices have a significant economic impact on agriculture across the MDB and can vary widely from year to year (Figure 24). Some industries that have relatively low return margins, such as rice growing and dairying, are very sensitive to both commodity and water market prices, while higher value crop producers (such as nut growers) are able to pay higher water market prices because their margins are underpinned by strong commodity prices and global demand.

Figure 24 shows that the price of cotton has risen since 2005–06. The price rise, coupled with new cool climate varieties, growing market confidence, several years of relatively high water availability and gin expansions (in the southern MDB), has led to a significant expansion in cotton production.

Similarly, almond prices have resurged in recent years after a period of decline between 2005 and 2012, highlighting the change to higher value crops in the MDB. Rice prices are highly variable and closely follow water availability.

Figure 24: Selected commodity price indexes, 2005–06 to 2017–18



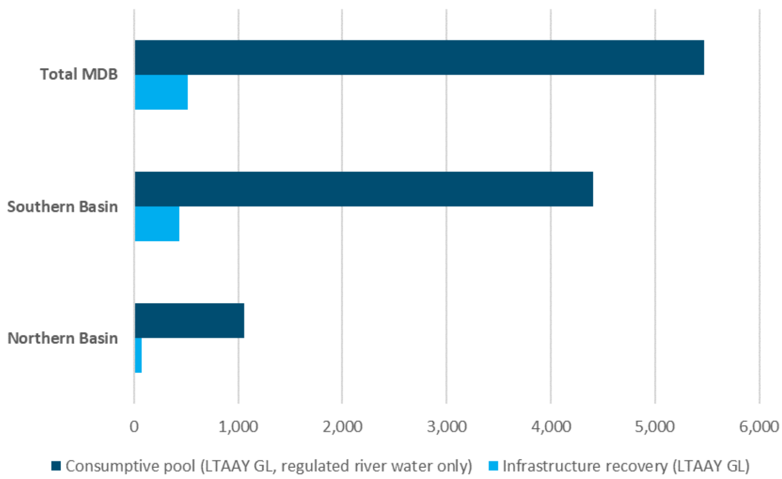
Note: The prices have been indexed to 2005–06 and adjusted for inflation by using the ABS Consumer Price Index.

Source: ABARES agricultural commodities publications.

5.3.4 Modernisation programs

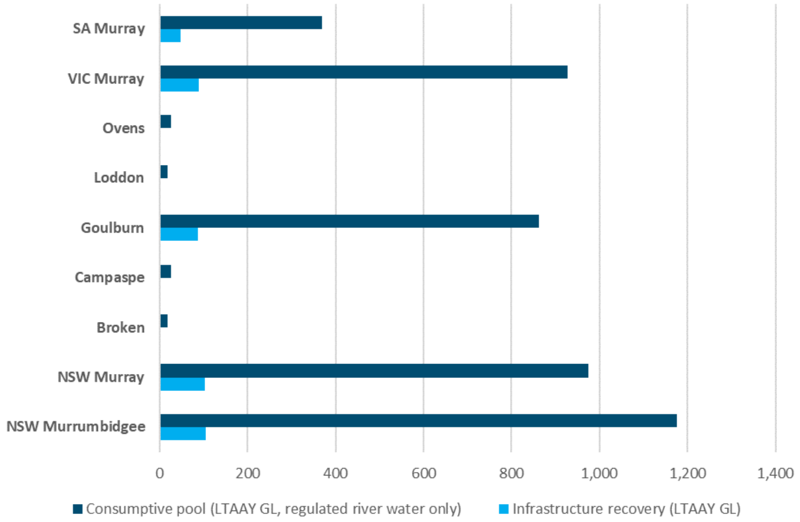
Farm modernisation has primarily involved the upgrading of on-farm and off-farm irrigation networks used to deliver water. The take-up of these projects has mostly centred on the southern MDB (Figure 25 and Figure 26), where increased water efficiency is also understood to be supporting the expansion of higher value crops such as cotton, fruit and nuts.

Figure 25: MDB surface water recovered via infrastructure versus water left in the consumptive pool (LTAAY GL)



Source: Department of Agriculture, Marsden Jacob analysis.

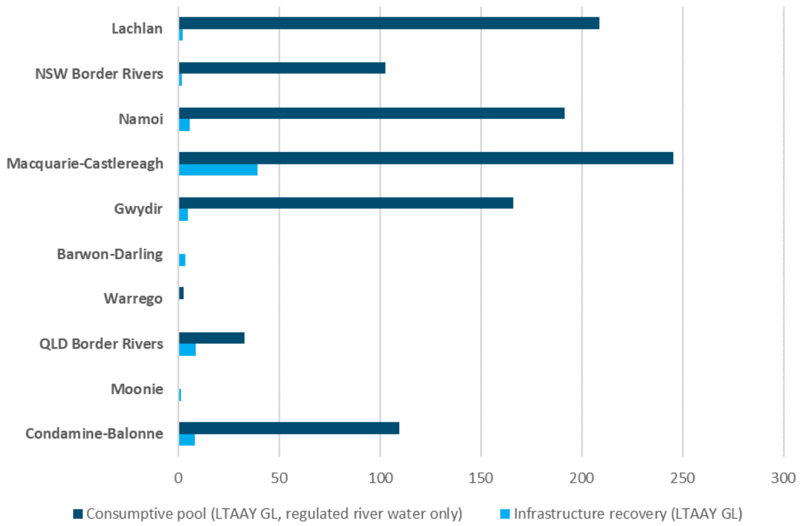
Figure 26: Southern MDB total surface water recovered via infrastructure versus water left in the consumptive pool (LTAAY GL)



Source: Department of Agriculture, Marsden Jacob analysis.

In the northern MDB, there has been less take-up of off-farm modernisation as there are only a small number of large-scale irrigation infrastructure networks compared to the southern MDB (Figure 27). Similarly, on-farm modernisation has also been lower due both to the northern MDB being already relatively efficient in its water use and its more sporadic climatic conditions leading to highly variable water availability.

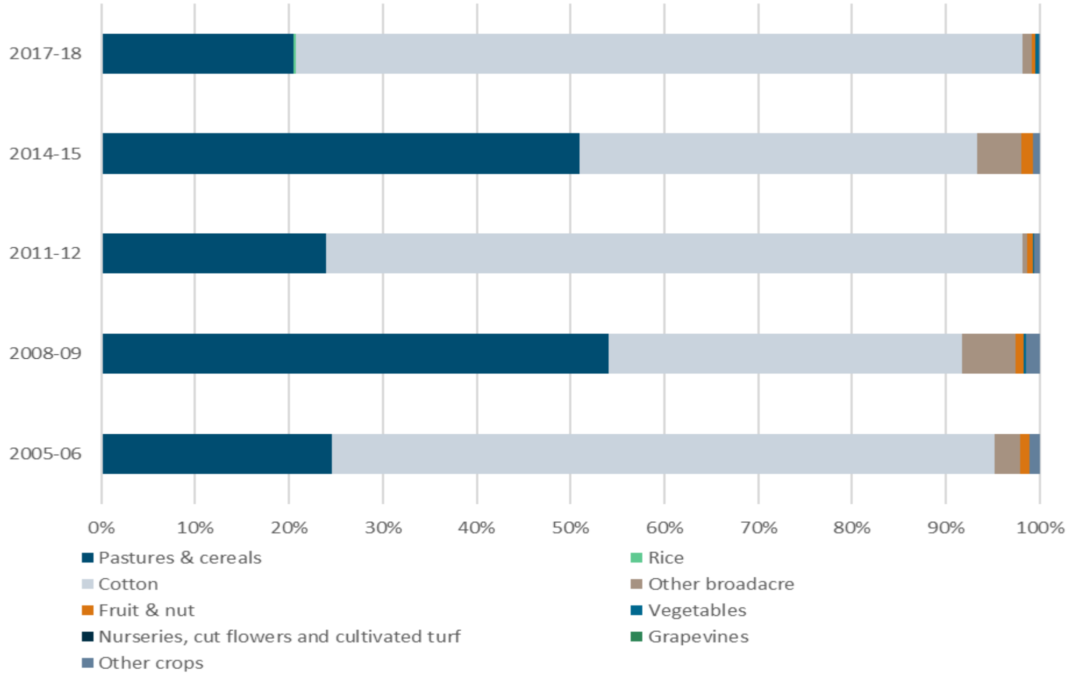
Figure 27: Northern MDB total surface water recovered via infrastructure versus water left in the consumptive pool (LTAAY GL)



Source: Department of Agriculture, Marsden Jacob analysis.

In the northern MDB, farms are also set up to make the most of high water availability. Cotton is the dominant crop (Figure 28), as it can be opportunistically grown when water is available and has a relatively high return value and a strong international market.

Figure 28: NSW Gwydir and Border Rivers area irrigated, by crop type, selected years from 2005–06 to 2017–18 (% of total area)



Source: ABS, *Water Use on Australian Farms* statistics 2005–2018.

Overall, our analysis indicates that opportunities for further infrastructure projects, both on-farm and off-farm, will remain primarily in the southern MDB, but a small percentage will occur in the northern catchments.

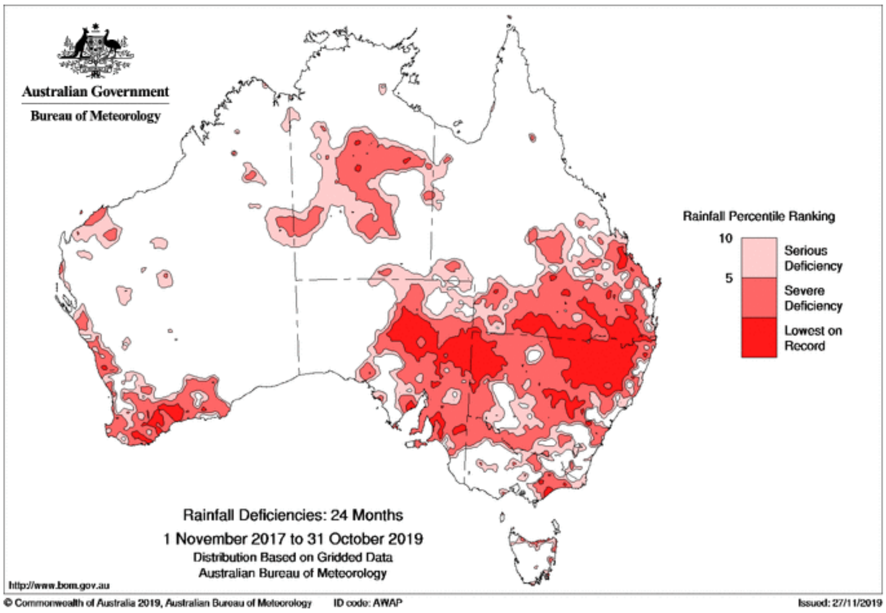
5.4 Climate factors

5.4.1 Climate influences

Two major weather systems influence the climate across the MDB: the Indian Ocean Dipole (IOD) and the El Niño – Southern Oscillation (ENSO). The IOD refers to the difference between sea surface temperatures in the tropical western and eastern Indian Ocean. It has three phases: neutral, positive (lower rainfall) and negative (higher rainfall). El Niño refers to the situation when sea surface temperatures in the central to eastern Pacific Ocean are significantly warmer than normal and is generally associated with reduced rainfall in Australia. Its opposing phase is called La Niña and is associated with increased rainfall in Australia. ENSO is the term used to describe the oscillation between the two phases.

Usually, these systems operate independently, but when they coincide they can reinforce the climatic effects, leading to severe drought and or to floods, depending on which phases are involved. This phenomenon has occurred across the MDB many times and most recently during the millennium drought, when an El Niño and a positive IOD combined. Over the past 24 months, much of the MDB has been in severe drought as a weak El Niño and a positive IOD dominate the climate systems (Figure 29).

Figure 29: Australian rainfall deficiencies over the past 24 months



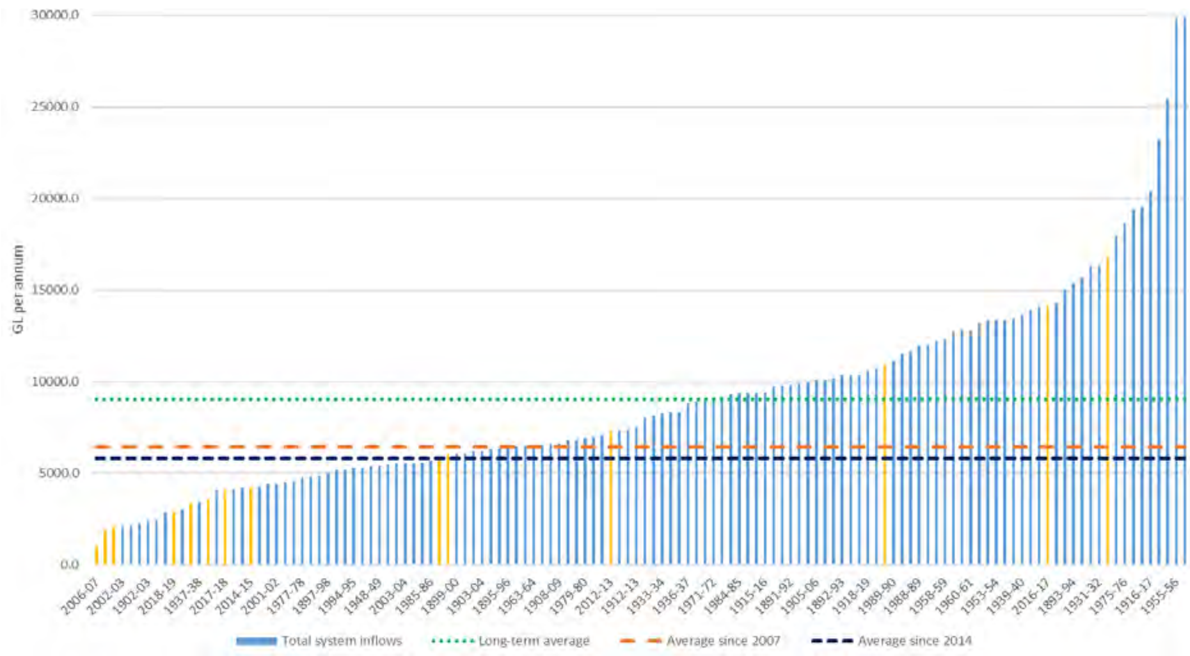
Source: *Twenty-four-monthly rainfall deficiency for Australia*, Bureau of Meteorology, February 2020, online.

5.4.2 Historical inflows

Water supply in the MDB is primarily dependent on the climate, and especially on rainfall within the watersheds that feed storages. The variation in climate across the MDB is particularly noticeable when comparing the northern and southern MDB.

The main factors influencing water supply in the southern regulated systems are the volume of water held in storages and inflows into those storages. Figure 30 shows a historical series of annual system inflows in the River Murray between 1891 and 2019. The chart is ranked from lowest to highest inflows, which shows that the occurrence of lower inflows over the past 15 years has been increasing; the average inflow since 2014 has been considerably lower than the longer-term average.

Figure 30: River Murray total annual system inflows, 1891 to 2019, ranked from lowest to highest (GL/year)



Note: The past 15 years are highlighted in yellow.
Source: MDBA, Marsden Jacob analysis.

5.4.3 Basin storage levels

The southern MDB experienced a drying phase during the millennium drought, which ended in 2010, and storage increased from 30% to 70% in 2011 (Figure 31). That was followed by another short drying phase, after which storages resurged back to around 80% in 2017. At present, dam storage levels have fallen significantly and are now below 50% and continuing to fall.

Figure 31: Southern MDB aggregate storage volume, 2004 to 2019 (% of capacity)

Source: Marsden Jacob Waterflow™,

The northern MDB experienced a similar drying phase until late 2010, when storages increased significantly and remained relatively high until late 2014 (Figure 32). A brief wet period in 2017–18 has subsided, and the northern MDB is facing even more extreme water conditions than the south, as storages have fallen below 10%.

It will take significant rainfall to improve storage levels right across the northern and southern MDB. However, the forecast for summer 2019–20 indicates drier than average conditions in the MDB and the rest of eastern Australia.[9] This is due to a strong positive IOD that is bringing below-average rainfall to southern and central Australia and higher temperatures in the southern two-thirds of the continent.

Figure 32: Northern MDB aggregate storage volume, 2004 to 2019 (% of capacity)

Source: Marsden Jacob Waterflow™.

5.5 The market multiple

Market multiples are premiums above market prices (that is, > 1.0) that the government 'pays' for water entitlements in order to fund water saving infrastructure. The premiums seek to offset structural adjustment pressures in relevant communities by ensuring that a property can continue to produce the same amount of food or fibre after giving up saved water.

In this section we assess the impact that the 1.75 market multiple has on participation in the WEP by comparing the cost of implementing water efficiency opportunities with funding provided by the Program.

5.5.1 How much do improvements to water efficiency cost?

The cost of implementing water efficiency opportunities is highly project and site specific, but based on an analysis of previous projects we can identify the potential cost ranges.

5.5.2 Irrigation

Table 17 is based on our analysis of more than 2,690 projects that have been funded under the following programs:

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[9] BOM Weather Outlooks

- Australian Government On-Farm Further Irrigation Efficiency Program
- Goulburn Murray Water Connections
- Healthy Headwaters Water Use Efficiency Project
- Irrigated Farm Modernisation
- Northern Victoria Irrigation Renewal Project Two (On-Farm)
- NSW Basin Pipe
- NSW Metering Pilot
- NSW Southern Valleys Metering Project
- On-Farm Irrigation Efficiency Program
- Private Irrigation Infrastructure Operators Program in NSW
- Private Irrigation Infrastructure Program for South Australia
- South Australia River Murray Sustainability Program
- Sunraysia Modernisation Program
- Victorian Farm Modernisation Program.

Table 17: Cost range for irrigation efficiency projects, including market multiple ($/ML)

Project type	Project	Minimum	Median project price	Maximum
Metering	Metering/telemetry	2,958	3,290	3,621
Off-farm	Channels/drains/pipes/pumps	1,650	3,642	13,979
	Dam/storage	502	2,933	3,344
	Drip/spray irrigation	1,650	3,500	4,587
	In-field	1,650	2,300	4,400
	Metering/telemetry	7,040	7,040	7,040
	Overhead sprinkler	2,500	2,500	2,500
	Retirement from irrigation	36	300	730
	Unspecified/off-farm	1,359	5,361	10,687
On-farm	Automation	1,292	3,500	5,500
	Channels/drains/pipes/pumps	780	3,491	7,350
	Dam/storage	664	3,932	6,177
	Drip/spray irrigation	653	3,494	7,202
	In-field	750	2,875	6,289
	Metering/telemetry	5,400	5,400	5,400
	Overhead sprinkler	1,443	3,100	6,177
	Unspecified/off-farm	3,220	3,281	4,259

Source: Marsden Jacob analysis of efficiency program data.

5.5.3 Urban and Industrial

Similarly to the margin budget in Table 11 and Table 12, which provides capacity-to-pay estimates for different crops, it is possible to develop cost estimates for a range of urban and industrial infrastructure opportunities.

Various economic regulators have determined the long-run marginal cost (LRMC) of developing new water sources. Those estimates represent the change in cost if new water sources are brought forward or delayed (including new dams, desalination and water recycling schemes). The variables included in the estimates are capital costs, operating costs or savings, and anticipated water yield or savings.

For instance, in Table 18 the estimated LRMC is compared against the levelised cost (the total capital and operating costs of the project over its life divided by the volume of water saved) of installing a rainwater tank. It is important to note that the reliability of rainwater tanks is different from the reliability of other water sources, so direct comparisons should be treated with some caution.

Table 18: Cost of rainwater tanks to the community ($/kL)

City	Cost of tanks – outdoor use only	Estimated LRMC
Brisbane	1.41–3.29	2.00+
Sydney	2.31–3.63	1.20–1.50
Melbourne—Yarra Valley	2.00–5.51	0.50–0.54
Melbourne—City West	n.a.	0.74
Adelaide	2.48–6.39	~1.09
Perth	2.87–5.74	0.82–1.09

Source: *The cost-effectiveness of rainwater tanks in urban Australia*, National Water Commission, 2007.

While levelised costs can vary significantly in different locations, particularly for climate-dependent sources, they can nevertheless be used as a guide to help with the assessment of potential opportunities for the WEP.

To inform the assessment of how much it costs to implement water efficiency opportunities, we have updated previous analysis by Marsden Jacob for the National Water Commission in 2007 that estimated the levelised cost ($/ML) for a variety of source and efficiency options (Table 19).

Table 19: Range of levelised costs across all water supply categories, 2019/20 ($/ML)

	Lower bound cost	Upper bound cost
Water Efficiency measures (efficient appliances, leak repair, water restrictions)	$2	$5,170
Surface water and dams	$240	$2,850
Groundwater	$60	$3,320
Pipeline	$610	$8,510
Recycled Water for Drinking	$940	$6,900
Seawater Desalination	$690	$33,240
Precinct-scale Stormwater	$640	$16,410
Recycled Water for Non-Drinking	$370	$15,270
Small-scale Stormwater	$1,380	$27,120
Household Raintanks	$2,060	$19,140
Water Cartage	$12,100	$46,670

Source: Marsden Jacob Analysis.

Note that the levelised cost estimates more closely resemble annual values because they reflect the cost per megalitre yielded from the source, so when comparing them to entitlement (permanent) market prices they need to be multiplied by 10 (at least). Based on this analysis, we conclude that urban and industrial water efficiency measures can be implemented for as little as $1,000/ML (for some loss-reduction initiatives), but typically they are going to cost over $10,000/ML.

This is confirmed by a 2016 cost–benefit analysis by Marsden Jacob on the potential to use the Adelaide Desalination Plant to offset reductions in irrigation allocations under dry conditions in the River Murray. That analysis found that the incremental cost of using desalinated water from the plant is between $510/ML and $950/ML, based on the annual operating cost and excluding the fixed costs that SA Water customers are already bearing (for example, costs associated with the construction of the plant and its ongoing maintenance).[10]

5.5.4 How do those costs compare with the market multiples for different entitlements?

We analysed the project costs of all 2,690 efficiency projects to determine whether current water market prices can fund historical water saving infrastructure (Figure 33).

For our analysis, we used the current average price for general security and high security entitlements in the southern MDB because the potential for future projects is primarily going to be in that part of the basin. For general security water the price was $1,703/ML and for high security water $7,618/ML, all multiplied by the 1.75 market multiple.

The results show that the current high security entitlement price would be sufficient to fund all previous efficiency projects. General security entitlements, on the other hand, would only be able to

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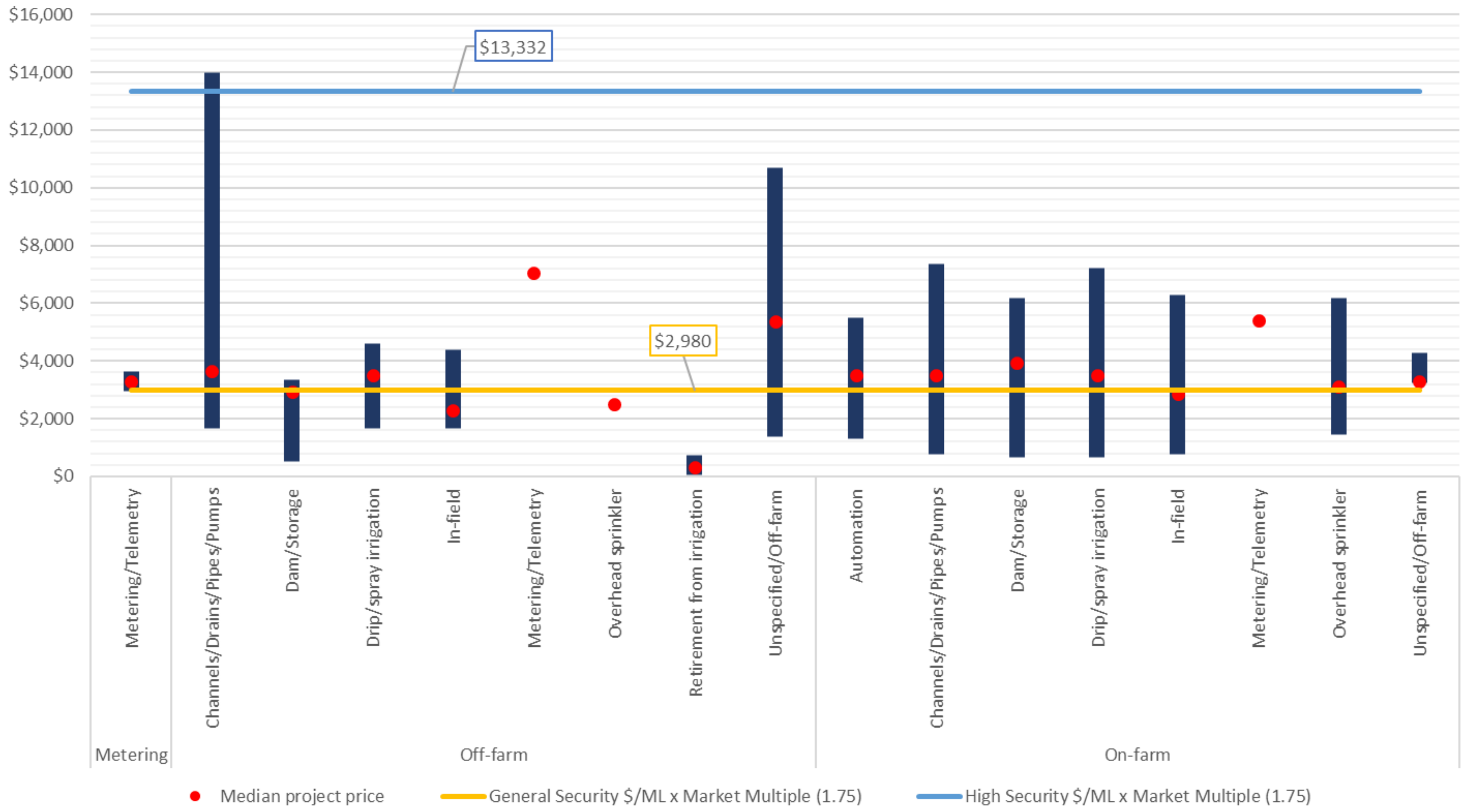
[10] *Benefit–cost analysis—potential use of the Adelaide Desalination Plant to offset reductions in irrigators' allocations in dry periods*, Marsden Jacob Associates, report prepared for the South Australian Department of Environment, Water and Natural Resources, June 2016, online.

fund less than 50% of the efficiency projects. In Figure 33, the red marker indicates the median cost of each project type.

Further, when we factor in the estimated costs for urban and industrial projects discussed above, the current market multiple, combined with market prices for entitlement types other than high security, is insufficient to fund the cost of implementation for most infrastructure projects.

The recovery scenarios discussed in section 4 include options for recovering 450 GL LTAAY through lower reliability entitlements, such as supplementary and unregulated entitlements. Those entitlements invariably have lower values relative to high security entitlements and therefore are prone to fall below the cost of implementation. This could emerge as a barrier to participation for those entitlement types.

Figure 33: Historical efficiency project costs ($/ML) against current water prices multiplied by the market multiple (1.75)



MM = market multiple.

Source: Marsden Jacob analysis of efficiency program data.

5.5.5 Irrigators are confronted with a complex decision

Decision-making about water efficiency funding and grant processes involves a complex analysis of a number of factors by irrigators, towns and industrial water users. Marsden Jacob's previous analysis and interviews that we have undertaken to inform the development of this report have confirmed that many potential participants struggle with the analysis needed to confirm that the funding process will be beneficial.

Sources of complication that are not present in simple water trades include:

- *Balance sheet impact:* They are replacing an appreciating asset (water entitlements) with depreciating assets (water infrastructure). This means that the asset base on their balance sheet will reduce over time, and that can affect their ability to secure loans from financial service providers. A stakeholder noted that farmers weigh up the incentives to participate in efficiency programs against the costs to their business now and in the future of the forgone water entitlements transferred to the Commonwealth. It highlighted that this process led to participation in earlier efficiency programs such as OFIEP and PIIOP dropping off over time, as many farmers decided water entitlements were too valuable to give up, even in return for government funding for works.
- *Tax implications:* Under certain conditions farmers may be entitled to claim a deduction for capital expenditure incurred on a water facility. Water facilities include a range of water infrastructure such as dams, tanks, bores, irrigation channels, pipes and pumps[11]. Equally the grant funding under the program may be treated as income with associated tax implications.
- *Maintenance and replacement of assets:* Many improvements (such as laser levelling) will be long-lived, whereas others (drip tape, lateral or centre pivot systems) will have shorter lives and require ongoing maintenance.
- *Yield estimates per ML of water applied (with and without the efficiency upgrades):* From our analysis and interviews water users are seeking to maximise benefit from the water holdings they have. That is, they are growing a crop that can achieve the highest yield estimate per ML of water. Efficiency projects generally lead to water users having more water available and to ensure the asset is not underutilise, changes to crop type or farm expansion may be required in order to achieve the highest yield per ML. These undertakings can range from purchasing more farmland or completely changing to a different crop that would require considerable investment.

Much of this is already factored into water market pricing, but, given that this transaction doesn't provide the water user with cash (like a water purchase), there a range of other factors irrigators are confronted with that need to be considered before participating in an efficiency program.

[11] https://www.ato.gov.au/Business/Primary-producers/In-detail/Capital-expenditure/Water-facilities/

5.6 What do interviewees think?

To inform the analysis of external factors, the project team interviewed 11 stakeholders, who were previously or are currently:

- delivery partners
- government officials
- water market brokers.

We note that the WESA panel also undertook a stakeholder engagement exercise using the 'Have your say' platform. We have specifically excluded these comments from our analysis to separate the sentiments captured by the panel.

5.6.1 Stakeholder sentiment

The stakeholders that we interviewed were generally pessimistic (ranging from highly pessimistic to neutral) about the potential for the WEP to recover the 450 GL by 2024 (Figure 34). In particular they noted that:

- there was an inability to identify projects that will contribute towards the 450 GL target
- even if there were sufficient money, it may not be possible to reach the target in the available time
- there is uncertainty that the level of participation will not be strong enough to enable the 450 GL to be acquired, despite optimism that there are a number of projects out there which would contribute towards the target
- the limited awareness of the Water Efficiency Program which is impacting on the number of projects coming forward for funding.

The consensus finding from the interviewees is that a number of external factors are likely to adversely affect participation in the WEP. These broadly include:

- climate
- economic
- political
- other.

Figure 34: Overall stakeholder sentiment

Table 20 summarises the interviewee perspectives.

Table 20: Summary of interviewee perspectives on external factors

Key factors		Interviewee comments
Climate	Price risk	The current drought is a key factor that is constraining participation, because it is contributing to price increases for many entitlement types (particularly higher reliability entitlements). However, some perceived high prices also as an opportunity, since participants can receive the same amount of funding and keep a larger proportion of the water savings. Many stakeholders do not want water to leave the region, because they believe that will dampen economic activity. The longer this drought lasts and pushes up prices, the more reluctant are stakeholders to participate, because (i) some believe that early participation will mean that they will miss out on high prices and (ii) while others do not want more water to leave the consumptive pool.
	Allocation risk	Many irrigators are concerned that the available allocation is low this year and will be again next year, so they are not willing to give up water and reduce their access to water.
	Water availability	When water availability increases, it will be much easier to identify participants because the allocation risk will be lower, the financial strength of the business will improve (allocation water will be cheaper) and general optimism will improve.
	Making the most of water	Some identified the drought as being a constraint that would ease when it rains again, whereas others thought that it can provide an opportunity because it makes it easier to upgrade on-farm assets.
Economic	Demand for entitlements is high	Demand is exceeding supply in many water markets because a number of crop types (such as nuts and cotton) are expanding their footprint, particularly in the southern MDB. Some of that expansion is resulting from irrigators switching crop types, but there is also demand from new and expanding irrigation businesses. Circumstances have changed since the last drought, because much generational change has now occurred (in many regions in the southern and northern basin) and the returns from crops are higher because commodity prices are higher and the Australian dollar is lower. High prices and entitlement demand also makes it harder for participants in the program to source water from the permanent market if they decide after the program is completed that they want more entitlement.
	Asset risk	Water in recent years has been an appreciating asset (see section 3), whereas water efficiency infrastructure is a depreciating asset with a finite life and will need to be replaced.
	Market risk	In previous programs, a significant proportion of participants stepped back into the market when they had finished their project to buy more

Key factors		Interviewee comments
		water. However, participants are now concerned that it will be hard to find a seller and that the price will have increased. The cost of water has driven irrigators to self-fund water efficiency measures because those measures are more cost-effective than outright purchases of entitlement. The opportunities that were present a decade ago have been reduced significantly.
	Market opportunity	The program is moving into industrial and urban areas, and this could be important in the future. So far, engagement with those sectors has not been significant, so there is a lot of work to do to progress such projects. Interviewees also commented that water authorities are interested but are not confident in their ability to get stakeholder agreement to participate in the program. They were concerned that if future growth, drought or climate change impact their future water reliability, and thus ability to meet their water demand, that participation in the program could bring forward an expensive source augmentation.
	Financing implications	Farm debt levels can be high, particularly for new entrants or younger farmers, and water is being used as a security over the debt, so any change in ownership of water has implications for farmers' lending position. Current low interest rates will also be an impediment because they make it easier to self-fund efficiency measures. Self-funding is a normal part of running an irrigation business, along with constantly improving operations. Self-funding is the default position, so a program such as the Water Efficiency Program is just a bonus.
Political	Neutral or positive socio-economic outcome	There is considerable uncertainty about whether projects are going to be approved under the socio-economic outcome test, so some participants have decided not to waste their time putting in an application. It is noteworthy that this is a participation barrier especially in Vic. and NSW, but not so much in SA. Many interviewees are concerned that towns have been adversely affected, and that view is being fuelled by politicians and some consultants despite considerable evidence that the programs have maintained or increased employment and supported improved economic outcomes (the quality of produce, as much as higher quantities). All the evidence is that participation equals positive socio-economic outcomes.
	Stigma	Water efficiency programs are not favourably viewed in many regions because people are concerned that the programs are contributing to the depth of the current drought, or that enough water has already been recovered for the environment. Interviewees were also concerned that stigma is steering potential participants away from the programs.

Key factors		Interviewee comments
	Opposition from some regional leaders	Many of the IIOs are understood to be interested in further efficiency projects, but many of the projects that they want to undertake are very expensive and fail the market multiplier test. There is also a lot of anxiety about water acquisition programs that is linked to local politics and a general desire to not give any more water to the government.
Other	Early adopters have completed their projects	Many early adopters of programs and self-funded infrastructure have already completed upgrades. Many farmers are slower adopters, but they can be much harder to bring into water efficiency programs. However, there are areas where further room for efficiencies exists. Some IIOs have completed their efficiency upgrades as well so there are no more material opportunities (many IIOs in the Macquarie and Coleambally Irrigation fall into this category).
	Awareness is low	Many interviewees commented that the awareness of the Water Efficiency Program is very low, and will need to be significantly increased if participation is to increase.
	Timing	On- and off-farm water efficiency infrastructure will only be installed in the off-season, so there is a constrained window in which they can undertake their projects.
	Lots of small projects	Interviewees are confident that there will be a number of on-farm efficiency projects but note that metering will be difficult. However, they find it hard to believe that there will be enough on-farm participants to get to the 450 GL target. If on-farm efficiency is the main solution, then projects are going to need a lot of water and a lot of participants.
	Timing	Surveys have indicated that many current participants would consider applying again, but interviewees realised that there is a clear need for diversity, as is seen among the larger corporates. There is considerable frustration about the time between lodging an application and learning the outcome.
	Urban and industrial	Most interviewees were not sure whether there are great opportunities in the urban and industrial sectors, particularly as potential urban participants need to be mindful of both future growth and climate-related hydrological risk. The only two opportunities that deem to be emerging are in the ACT (four projects are currently being discussed) and SA, where the desalination plant is being assessed. Interviewees noted that the major industrial users in the northern MDB are mines and are willing to pay a lot for water security because of the financial implications of having to slow production because of inadequate water. Other industrial users, such as golf courses, abattoirs and manufacturers, are using only relatively small volumes of water, and don’t envisage that they will be big participants.

6. How much might be recovered under the WEP by 30 June 2024?

The focus in this section is on:

- **Issue 8**: Estimate the potential water recovery opportunities available under the Water Efficiency Program given the program's eligibility criteria, the remaining time for the program, current social/political views, and the attractiveness of the program's funding formula.

6.1 Key findings

- There is around 8,200 GL of eligible surface water entitlements available in the MDB, excluding environmental holdings
- After taking into account eligible efficiency projects targeted by the WEP and recovery through previous infrastructure or efficiency programs we estimate an upper bound of 600-650 GL could be recovered through the WEP (in the absence of any time, budget or participation related constraints)
- We estimate that timing constraints reduce the volume of recovery under the WEP by 2024 to around 185 to 195 GL.
- Once the current social and political context and the program's funding formula are considered, potential recovery under the WEP falls further.
- We estimate potential recovery of up to 60 GL once these key factors are considered.

6.2 Introduction

After considering the impact of individual factors on potential recovery under the WEP, the Panel asked Marsden Jacob to estimate their combined impact.

This involved sequential consideration of four key factors on potential recovery: eligible projects targeted by the WEP, program timing, social/political views, and the attractiveness of the program's funding formula for potential participants. To estimate the potential water recovery opportunities available under the WEP we took the following steps:

- We determined the size of the consumptive pool in the MDB which involved excluding environmental water holdings and converting into LTAAY values
- We then undertook a region by region assessment of the total recovery opportunities available through the WEP – this was based on stakeholder interviews, previous reports in relation to recovery potential, and our understanding of the water market, having regard to the types of eligible projects under the WEP as well as previous participation in Commonwealth infrastructure efficiency programs within each region

- The next step involved estimating how much of the total recovery opportunities through the WEP could be recovered by 30 June 2024 – this involved estimating the average time to undertake efficiency projects and the capacity to process applications before the deadline
- We then estimated what recovery might be possible given the current political and social environment – this drew on our analysis in section 5 and statements made by Basin states about their participation in the Program
- Finally, we estimated the impact that current entitlement prices and the 1.75 market multiple might have on participation in the program, by considering what sorts of the remaining recovery opportunities that would be financially viable.

The sections below outline in more detail how we derived our estimates. This analysis is closely related to our approach to developing water recovery scenarios in section 4 and is elaborated upon further in this section. Unless otherwise stated, all figures are LTAAY.

Because our approach is based on high-level analysis, it accounts for the main (but not all) factors affecting water recovery, and is based on limited consultation, the results should be considered indicative.

6.3 Determining the size of the consumptive pool in the MDB

The first step in our analysis was to determine the total eligible surface water entitlements that comprise the consumptive pool in the Basin. Eligible surface water entitlements exclude:

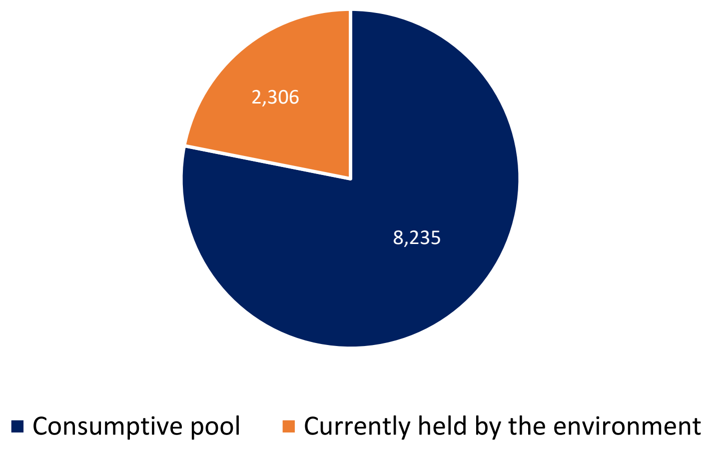
- entitlements held for environmental purposes by the Commonwealth Environment Water Holder and its state counterparts
- groundwater entitlements, and
- non-tradable entitlements (such as NSW stock and domestic water and other specific purpose entitlements).

We determined the size of the consumptive pool across the MDB for each entitlement class by subtracting the current environmental holdings held by the federal and state environmental water holders from the total entitlements on issue.[12] We established current market values for each of the entitlement types in each SDL unit and looked at the LTAAY factors of each entitlement type, by location. This converts holdings into LTAAY values.

Based on this process we determined there is around 8,200 GL available for consumptive purposes and around 2,300 GL currently held for environmental purposes (Figure 35).

[12] This is based on public information on the Commonwealth Environmental Water Holder and Victorian Environmental Water Holder websites and state water registers.

Figure 35: Consumptive pool in the Murray-Darling Basin (GL, LTAAY)



Source: Marsden Jacob analysis.

6.4 Total potential recovery under the WEP

Marsden Jacob estimates that up to 600-650 GL (LTAAY) of water could be recovered through the WEP across off-farm, on-farm, urban and industrial projects, in the absence of any time, budget or participation related constraints.

To estimate the quantum of entitlement that might potentially be recoverable through water efficiency projects we used a range of analytical approaches and information sources. A survey of potential participants was outside the scope of our review. While undertaking a survey may help to 'ground truth' our analysis, it may also introduce bias.

Instead, we undertook a catchment by catchment analysis having regard to the following:

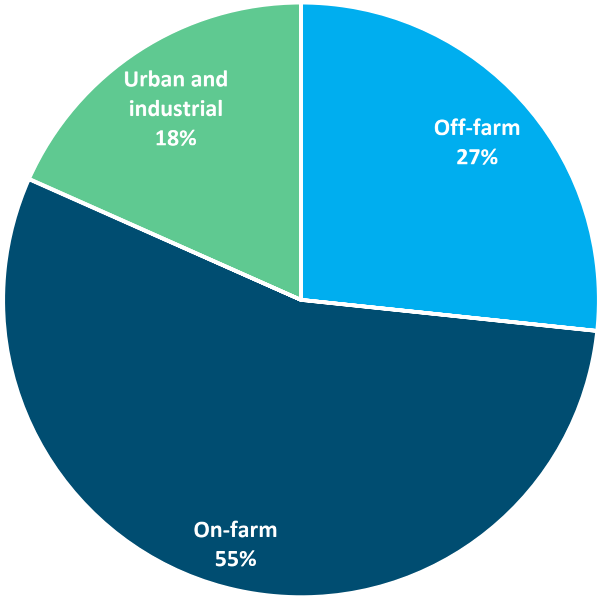
- The amount of water in the consumptive pool, net of environmental water holdings.
- The water efficiency projects that have already been undertaken in the catchment and whether further efficiency projects might be possible.
- The project eligibility criteria under the WEP.
- Constraining the recovery to a small proportion of the consumptive pool in the region.

The sources that informed this analysis, included:

- Data on previous projects provided by the Department of Agriculture, Water and the Environment
- Interviews with Departmental officials, delivery partners (both past and current) and water brokers.

Based on this analysis it was concluded that on-farm and off-farm projects would comprise the majority of the water recovery, see Figure 36.

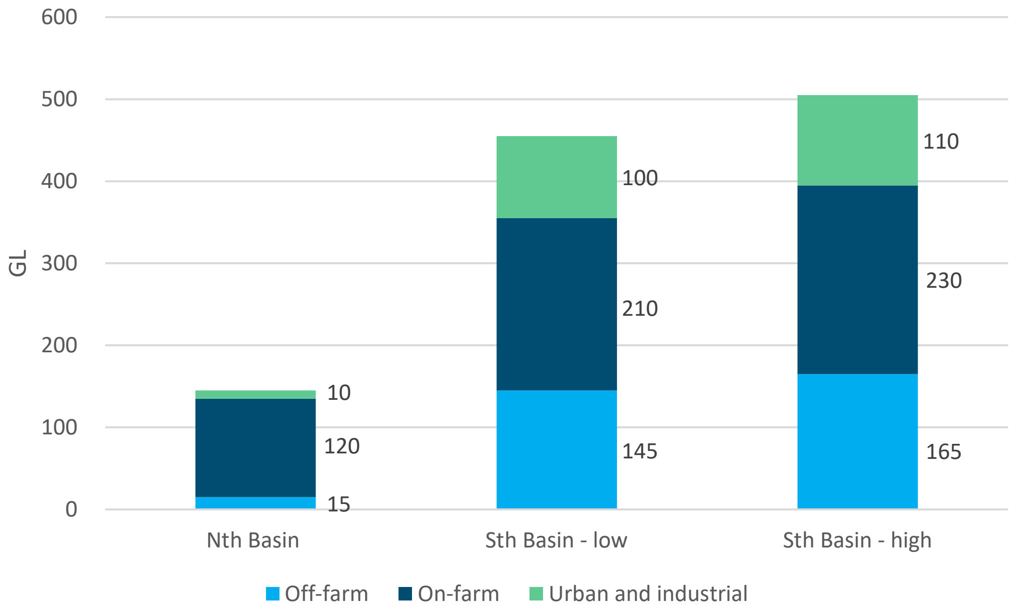
Figure 36: Estimated water recovery by project type



Source: Marsden Jacob analysis.

The analysis further concluded that the majority of the water would result from projects undertaken across the southern basin. Note that there is a range for potential water recovery in the southern basin (Figure 37).

Figure 37: Estimated location of water recovery (GL LTAAY)



Source: Marsden Jacob analysis.

To 'sense-check' our catchment by catchment analysis, we also undertook a top-down analysis. We reviewed previous on and off-farm water efficiency project information and identified that the average water efficiency gain was approximately 10 to 20%.[13] From this, we note that recovery of 650 GL is confirmed as an upper bound estimate as it relies upon irrigators, IIOs, and urban and industrial water users in the basin that hold 50% of the eligible consumptive pool (8,200 GL LTAAY, see above) achieving an average efficiency gain of 15%.

6.5 Potential recovery through the WEP given timing constraints

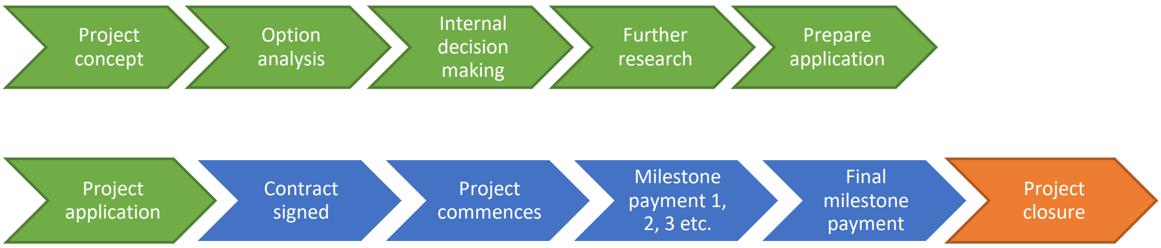
A timing constraint arises for the WEP because payments for efficiency projects funded from the WESA cannot be made after 30 June 2024. Given that efficiency projects can take several years to complete and final funding payments are often not made until a project is complete, the remaining 4.25 years of the WEP will constrain the volume that can practically be recovered.

To estimate the impact of this timing constraint on potential recovery under the WEP we drew on historical program data provided by the department[14], publicly available data and Marsden Jacob's past experience with urban and industrial water projects. In summary, we estimated the amount of recovery that is practical over the remaining 4.25 years of the program given typical project timeframes and the capacity of the department to process applications.

6.5.1 Project timeframes

To estimate the range and average time to complete each project we have taken into account both pre and post application activities. These activities are outlined in Figure 38 below.

Figure 38: Typical pre- and post-application phases for efficiency projects



Source: Marsden Jacob analysis.

Figure 39 shows that the average project lifecycle including pre- and post-application phases ranges from around 4.5 to 5.5 years for the types of projects eligible under the WEP (see red diamonds in Figure 39). Given these are largely based on actual data, the averages include the effect of weather and other disruptions on project timeframes. Figure 39 also shows the range of time to undertake pre- and post-application phases for each type of project. For example, pre-application phases for off-farm projects take between 0.5 years and 3 years. These ranges are shown for information, but our analysis focusses on the average project timeframes.

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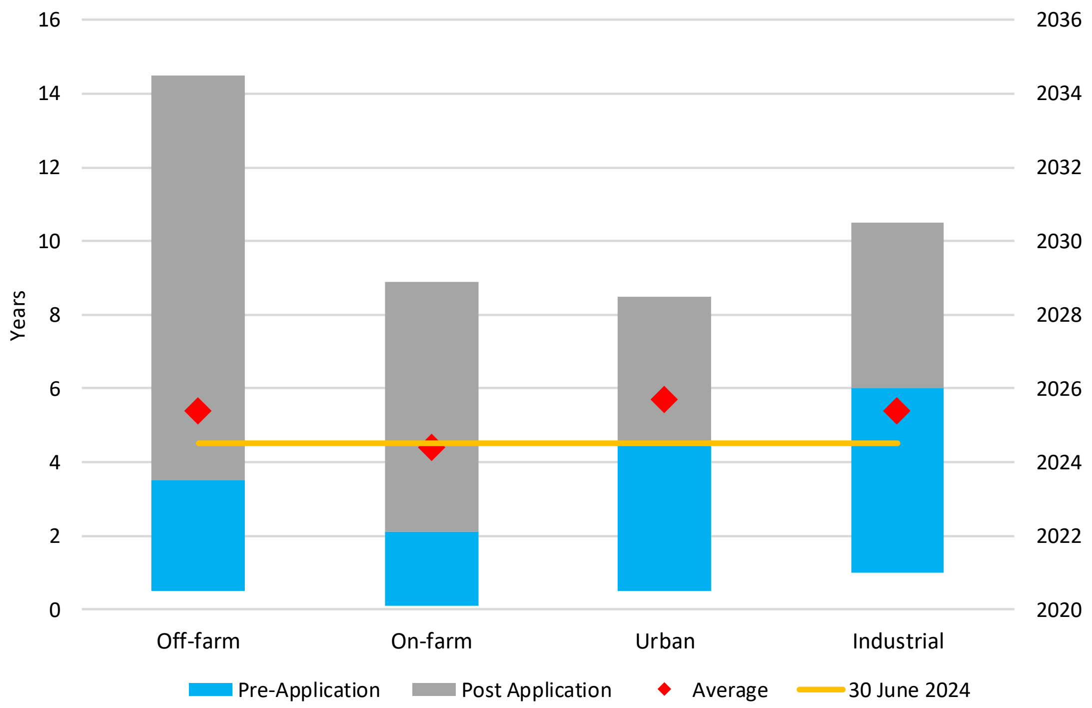
[13] Review of previous projects identified that water efficiency gains of 10-20% are typical for common infrastructure upgrades, such as conversion from furrow to overhead irrigation, or improvements to storages combined with laser levelling. Water efficiency improvements of 20-40% have been reported for conversion from furrow to drip irrigation in cotton farming, however, these efficiency improvements are also associated with a higher probability of lower yields in some growing seasons, such as resulting from disease outbreaks caused by overly wet soils.

[14] The historical infrastructure program data provided by the department contains both start and completion dates for each project. Based on discussions with the department, we note that the data does not contain all infrastructure projects and project timeframes reflect either project or round level information.

Figure 39: Average project lifecycles compared to the WEP timeframe



Source: Marsden Jacob analysis.

These average project lifecycles mean that for projects commencing immediately, around half on-farm and more than half of off-farm, urban and industrial projects would conclude after 30 June 2024. We understand the department already has around 90 GL in its pipeline, which are all in the pre-application phase and based on history, some of which will not proceed.

It is important to note that water savings for each project type is transferred at different times throughout the project lifecycle and generally corresponds to when the water savings are realised. This affects the recovery that can be obtained from each project type before the WESA deadline of 30 June 2024. For example, it could mean that some projects don't need to reach closure before 30 June 2024 in order for the efficiency savings to be realised and funded from the WEP.

Based on previous infrastructure projects undertaken by the department:

- On-farm projects typically deliver the water savings at the first milestone payment. This means that on-farm projects could be offered and accepted up until 31 December 2023 with the first milestone occurring before 30 June 2024.
- Off-farm projects tend to transfer water savings throughout the project implementation phase as the water efficiency gains are realised.
- For urban and industrial projects, this will depend on the type and scale of the project. For example, projects that are upgrading existing infrastructure will realise water savings earlier than projects seeking to build new infrastructure. Similarly decommissioning of industrial infrastructure will see immediate water savings, as opposed to water treatment plants in mining sites where the infrastructure must be completed before being incorporated into the plant's operations.

From the above, we could expect that on-farm and some urban and industrial projects may proceed even if they don't fully conclude by 30 June 2024, on the basis that the water savings can be achieved, entitlement transferred to the Government and projects paid from the WESA before the program deadline.

On the other hand, the WESA program criteria itself will have a considerable impact on project timeframes. In addition to the average project lifecycles above (based on historical data), for projects to be considered and submitted under the WEP they must address agreed criteria which vary across each Basin State and territory. Under the revised program design, for a proposal by project partner to become a project it must pass the socio-economic neutrality test, which involves state government and public consultation, and can take between three and six months. Similarly, for delivery partner led projects, the socio-economic assessment for the delivery partner stream takes place before the project can be accepted and funding provided. This process however is administered by the department and not the States.

Future project timeframes might also be affected by increasingly complex projects. As previous efficiency programs are likely to have attracted many of the more readily implementable efficiency opportunities, the remaining opportunities could be more complex and time consuming.

On balance, we have assumed that of the total water recovery opportunities under the WEP, the following proportion of projects would have time to receive funding by 30 June 2024:

- On-farm projects, 60% (or around 200 – 210 GL)
- Off-farm projects, 40% (or around 64 – 72 GL)
- Urban and industrial, 40% (or around 44 – 48 GL)

6.5.2 Capacity to process and complete applications

Because there has been very little recovery under the WEP since the establishment of the WESA in 2014, in the event that many applications started commencing immediately there would be a potential 'bottle neck' to assess, process and complete these applications.

From the analysis above, should a large number of projects commence immediately or continue in pre-application stage, the department would face a large number of applications coming in over the remainder of the program. Given typical pre-application timeframes (which average around 2 years for off-farm, 1 year for on-farm and 2.5 years for urban and industrial), these applications would mostly need to be processed and completed in the final 2-3 years of the program.

In Table 21 below we summarise the estimated recovery after accounting for processing constraints. The first component just shows the potential recovery given average processing times discussed above. We then present an estimate of the average project size (ML) based on historical efficiency programs or Marsden Jacob experience with urban and industrial projects. The 'projects needed each year' is a calculation of the average number of projects that would need to be processed and completed in the remaining 2-3 years of the WEP. Note that this is not the average number of projects over the remaining 4.25 years of the WEP given the projects have a pre-application phase. The 'annual processing capacity' is our estimate of how many applications could be processed and completed each year by the department based on past performance. We have been conservative with this estimate (i.e. higher than past performance). Where the number of projects needed each year exceeds the capacity, this results a further reduction in recoverable water under the WEP due to timing.

Table 21. Potential recovery after processing timing constraint (ML LTAAY)

Project type	Potential recovery given average project timeframes	Average project size	Projects needed each year	Annual processing capacity	Potential recovery after timing/processing constraint
Off-farm	64,000-72,000	398	58-66	60	64,000-66,000
On-farm	200,000-210,000	93	615-655	240-250	77,000-80,000
Urban & Industrial	44,000-48,000	1389	16-17	18	44,000-48,000
Total					**185,000-195,000**

Source: Marsden Jacob analysis.

The above table shows that given there is a large number of on-farm projects that need to be processed and completed each year and this exceeds estimated capacity. This would further reduce potential recovery. Overall we estimate that time constraints would limit potential recovery under the WEP to between roughly 185 to 195 GL.

6.6 Potential recovery through the WEP given social and political factors

In December 2019, the NSW Minister for water announced that the state "will not contribute to the additional 450 GL".[15] The Victorian Government has similarly announced that further recovery towards the 450 GL will only be supported if there are positive socio-economic impacts, meaning it is no longer sufficient for projects to have a neutral socio-economic impact.[16]

Given these governments are responsible for assessing socio-economic impacts for each project it is unlikely that many projects from these states will contribute to the Program. The submission from Murray Irrigation Limited to the panel's review noted that it strongly opposes recovery of an additional 450 GL for the environment, implying that off-farm recovery opportunities in the NSW Murray will be very limited.[17]

To estimate the impact of social and political factors on potential water recovery under the WEP, we have that assumed that there will be:

- No on-farm water recovery in regions in NSW and Victoria, and
- No off-farm water recovery in the NSW Murray.

The above have been removed from the recovery estimate based on available time under the WEP. This leaves a total of around 110 to 120 GL potentially available for water recovery.

[15] http://melindapavey.com.au/nsw-changes-course-of-basin-plan-and-puts-regional-communities-first/
[16] https://www.premier.vic.gov.au/standing-up-for-victorian-irrigators/
[17] https://www.murrayirrigation.com.au/wp-content/uploads/resource/2020/01/450GL_MIL-Final-Submission_FORMATTED.061219.pdf

6.7 Potential recovery through the WEP given financial factors

Based on our stakeholder interviews and considering historical costs for off-farm and urban and industrial efficiency projects, we estimate that many projects would be not be financially viable at current entitlement prices and based on the WEP market multiple of 1.75.

To estimate the impact of financial constraints on financial outcomes we assumed:

- Almost half the off-farm opportunities would not be financially viable, noting that the Department has advised that off-farm proposals provided under the WEP (to date) have not been able to be funded because they exceeded the market multiple.
- No urban and industrial water recovery, apart from in the ACT which is understood to be potentially financially viable.

We estimate the remaining water saving under the WEP is limited to around 60 GL LTAAY (Table 22). What is left is on-farm projects in South Australia and Queensland, some off-farm projects in the Murrumbidgee, Victorian Murray/Goulburn and Queensland and urban & industrial opportunities in the ACT. Following our approach to estimating the cost of water recovery scenarios in Chapter 4, we estimate the cost of recovering 60 GL as outlined in Table 22 is around $630 million.

Table 22: Potential water recovery under the WEP after key constraints (GL LTAAY)

Project type	Total WEP water recovery opportunities	Available within WEP timeframe	And after social and political factors	And after financial constraints
Off-farm	160-180	64-66	48-50	28-30
On-farm	330-350	77-80	19	19
Urban & Industrial	110-120	44-48	44-48	12
Total	**600-650**	**185-195**	**110-120**	**~60**

Note: some figures/ranges have been rounded.

7. Comparison with other reports

The focus in this section is on:

- **Issue 9**: Comparison of Marsden Jacob analysis on the above matters with recent relevant public reports and findings.

7.1 Key findings

In this section, we briefly compare the results our analysis with those of previous similar analyses. The key previous reports considered in this section are

- Ernst & Young, *Analysis of efficiency measures in the Murray–Darling Basin*, January 2018[18]
- Productivity Commission, *Murray–Darling Basin Plan: five-year assessment*, December 2018[19]
- *Murray–Darling Basin Royal Commission report*, January 2019[20]
- Seftons, *Murray–Darling Basin Water Infrastructure program—consultation for additional criteria*, December 2018[21]

Table 23 compares the key findings from our analysis of each of the key issues.

Sections 7.2 and 7.3 provide further details on the Ernst & Young and Productivity Commission recovery scenarios. Those were the only two previous reports that looked into those matters in greater detail.

[18] Available online.
[19] Available online.
[20] Available online.
[21] Available online.

Table 23: Comparison of key findings

	Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
1	Projected water entitlement prices and potential ranges and/or scenarios, for the relevant regions for the period ending on 30 June 2024.	In this project, we developed entitlement price projections that reflect a continuation of the current dry period or a return to wet conditions. The key points to note are as follows: • Northern MDB markets are relatively stable because the crop mix has remained relatively constant. • Southern MDB markets have witnessed significant price changes. Higher reliability entitlement prices have increased significantly over the past few years. Lower reliability entitlements, after initially increasing, have started to decline.	n.a.	n.a.	n.a.	n.a.
2	Identification of the potential and likely sources of water entitlements available to and accessible by the WESA to meet the LTAAY target of 450 GL.	In section 4, we set out three potential water recovery scenarios. The scenarios highlight how sensitive the result is to the assumed locations and types of water entitlements that are acquired.	In its cost analysis, the Productivity Commission assumed that the extra 450 GL will be recovered from the southern MDB only. The only entitlement types included in the commission's scenarios were high reliability/security, general security and	Not addressed explicitly. The report concludes that the socio-economic criteria will make the recovery of the 450 GL 'not just impractical but so unlikely it has a negligible chance of being recovered'.	Not addressed explicitly; stakeholder feedback suggested that projects should be undertaken strategically by looking at what parts of the network might be best managed differently. Specifically, it was considered important	Ernst & Young estimated that the indicative size of the future water recovery opportunity is between 209 GL and 690 GL across the MDB—see Table 25 for details.

	Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
			low reliability entitlements due to those being the only classes for which reliable price data was available. On the other hand, the commission stated that 'the volume and entitlement types of water recovered should be prioritised on the basis of how effectively that water can contribute to the enhanced environmental outcomes.'		for Basin governments to look at off-farm efficiencies. This would involve urban and industrial projects such as opportunities to recycle and capture stormwater.	
3	Development of potential water recovery scenarios with different mixes of entitlements.	In section 4, we set out three potential water recovery scenarios. The scenarios detail the WESA outcome implications if acquisition • maintains historical proportions of infrastructure-related recovery • is largely unconstrained by entitlement type and thus least cost is the focus is constrained based on our understanding of the potential opportunities in each catchment.	Four scenarios were presented: 1. *Balanced recovery:* 450 GL is recovered proportional to the remaining entitlements in the market.	n.a.	n.a.	Three scenarios were presented: 1. *High reliability:* 450 GL is recovered with a suite of entitlements based on an estimated 94% LTAAY factor.

	Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
			2. *Aligned recovery:* 450 GL is recovered proportional to the current portfolio of the Commonwealth Environmental Water Holder (CEWH). 3. *Rebalanced recovery:* 450 GL is recovered so that after the water is recovered, the CEWH's portfolio is proportional to all entitlements on offer. 4. *415 GL balanced recovery:* 450 GL is recovered using the same method as Scenario 3.			2. *Low reliability:* 450 GL is recovered with a suite of entitlements based on an estimated 73% LTAAY factor. 3. *Unregulated or Supplementary:*450 GL is recovered with a suite of entitlements based on an estimated 49% LTAAY factor.
4	Given the likely scenarios for price (Issue 1) and the mix of entitlements	Based on current market prices: Scenario 1: *$4.8 billion* Scenario 2: *$4 billion*	The cost of the four recovery scenarios was between $2.0 billion and $2.3 billion, using	n.a.	n.a.	Assumed that 450 GL can be recovered under the $1.575 billion budget, setting

	Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
	(Issue 3), what is the total cost of projects required to meet 450 GL LTAAY by 30 June 2024, compared to the available budget of $1.575 billion?	Scenario 3: *$1.6 billion*	market prices at the time the report was written.			the maximum average prices for the three scenarios at: 1. *High reliability:* $1,880/ML 2. *Low reliability:* $1,460/ML *Unregulated or supplementary:* $980/ML.
5	The extent to which water, commodity and other markets' views on climate change and the current drought affect current participation in the Water Efficiency Program, or may affect future participation.	The MDB has experienced significant variability in water availability. It is currently going through a period of widespread drought and there has been significant growth in higher value cropping. Our analysis finds that all of these things are likely to adversely affect participation in the Water Efficiency Program.	n.a.	n.a.	Stated that many potential participants are very uncertain of the success of the 450GL recovery, and that they don't want to give up any more water for the environment. This was underpinned by the uncertainty about future water availability or security.	Reported stakeholder concerns included that the expanding footprint of horticulture means that there will be a significant impact on the industry in the next drought if an extra 450 GL is taken out of the consumptive pool.
6	The extent to which changes in the agricultural sector since the	The agriculture sector in the northern MDB has been relatively stable, and cotton continues to be the dominant irrigated crop.	Not addressed explicitly. Stated that recovering 450 GL is 'highly contentious,	n.a.	Noted that (according to stakeholders) there has been close to three decades of	On-farm efficiency measures have allowed farmers to increase production,

	Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
	introduction of water recovery programs affect the nature of, or the way, participants might engage with the Water Efficiency Program.	The agriculture sector in the southern MDB has changed significantly since the introduction of water recovery programs. The area under tree nuts and cotton has increased significantly, and there has been a significant reduction in the area of rice and dairy production. Interviewees consistently commented that the low-hanging fruit (easy and low-cost efficiency opportunities) have already been picked in both the southern and northern MDB.	largely because of concerns about the potential social and economic impacts of additional water recovery on Basin communities'.		endeavour to improve water efficiency (in addition to general water reform), implying that the most cost-effective and low-impact water recovery projects have already been implemented.	but the consumptive pool has decreased.
7	The extent to which the Water Efficiency Program's funding formula (multiplying entitlement prices by the market multiple of 1.75) affects participation in the program.	Elevated entitlement prices are being witnessed for general security (NSW), high security (NSW), high reliability (Vic.) and Class 3 (SA) entitlement types. Because of that, the market multiple appears to represent an attractive proposition, once participants realise that they are getting more than they would have previously. However, the problem is that at the current elevated prices—if the required participation can be achieved—the program will run out funding well before the 450 GL target is reached.	Stated that the 1.75 'multiple is below those of previous infrastructure projects and there is a risk that it may be too low to encourage sufficient participation'.	Not addressed explicitly, the report concludes that efficiency measures are 'a very expensive means of recovering water for the environment' compared to the cost of purchasing water through buybacks.	Concluded that according to stakeholders the 1.75 multiplier is 'insufficient to encourage wide participation in the Program and many irrigators believe that funding their own project is more practical in economic terms'.	Stated that stakeholders have indicated that a market multiple of 1.75 is unlikely to attract enough participation to allow 450 GL to be recovered by 2024.
8	Estimate the potential water recovery opportunities	After taking into account the eligible efficiency projects targeted by the WEP and recovery through previous infrastructure or efficiency programs we estimate around 600 GL to 650	Not addressed explicitly, found that 'there is a high risk that the efficiency	Not addressed explicitly, found that it 'is doubtful that much of the 450 GL of	n.a.	Ernst & Young estimated that the indicative size of the future water recovery

Issues	Marsden Jacob	PC	MDBRC	Seftons	Ernst & Young
available under the Water Efficiency Program by 2024.	GL could technically be recovered through the WEP (ignoring other constraints). Practical timing constraints alone reduce the volume of entitlement that could be recovered under the WEP by 2024 to around 185 to 195 GL; less than half the 450 GL target. Consideration of the current social and political context and the funding formula further reduce potential recovery under the WEP up to around 60 GL.	measures program will not achieve the enhanced environmental outcomes of the Basin Plan by 2024'.	upwater will ever be actually recovered for the environment through efficiency measures', especially under the socio-economic criteria.		opportunity is between 209 GL and 690 GL across the MDB. It wasn't explicitly stated whether this is recoverable by 2024, but it was implied.

7.2 Productivity Commission report recovery scenarios and cost estimates

In its analysis, the Productivity Commission considered four different scenarios, 'reflecting differences in the suite of entitlements used to recover water'. The four scenarios were as follow:

1. *Balanced recovery:* 450 GL of water is recovered proportional (based on the LTAAY of entitlements) to the remaining entitlements on offer in the market; that is, all entitlements minus the current holdings of the Commonwealth Environmental Water Holder (CEWH).
2. *Aligned recovery:* 450 GL of water is recovered proportional (based on LTAAY) to the CEWH's current portfolio.
3. *Rebalanced recovery:* 450 GL of water is recovered so that after the water is recovered the CEWH's portfolio is proportional to all entitlements on offer.
4. *415 GL balanced recovery***:** 415 GL of water is recovered using the same method as the balanced recovery scenario.[22]

In these scenarios, the Productivity Commission assumed that the extra 450 GL will be recovered from the southern MDB only (due to enhanced environmental outcomes set in Schedule 5 of the Basin Plan). Further, the only entitlement types included in the commission's scenarios were high reliability/security, general security and low reliability entitlements due to those being the only classes for which reliable price data was available. Other than that, the commission's report did not take a stand on which kinds of projects it is recovered from.

Table 24: Productivity Commission recovery scenarios by total cost and volume recovered per location and entitlement type (GL LTAAY)

		Scenarios			
Region	**Entitlement type**	***Rebalanced***	***Balanced***	***Aligned***	***415 GL balanced***
NSW Murray	High security	33.8	15.3	6.1	14.1
NSW Murray	General security	78.4	97.7	107.3	90.1
Murrumbidgee	High security	91.2	32.6	3.5	30.1
Murrumbidgee	General security	157.7	95.8	65.0	88.3
Goulburn	High reliability	6.3	66.8	96.9	61.6
Goulburn	Low reliability	38.4	17.4	6.9	16.0
Vic. Murray	High reliability	22.0	81.1	110.5	74.8
Vic. Murray	Low reliability	24.4	10.5	3.6	9.7
SA Murray	High security	–2.3	32.7	50.2	30.2

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[22] The 415 GL scenario was used to consider whether recovery can occur within budget if 35 GL of overrecovered water in the southern MDB is reclassified as efficiency measures. This option was raised in the Ernst & Young report.

Region	Entitlement type	*Rebalanced*	*Balanced*	*Aligned*	*415 GL balanced*
		Scenarios			
Total		**450**	**450**	**450**	**415**
Per cent high reliability		34%	51%	59%	51%
Cost ($ billion)[a]		**2.163**	**2.235**	**2.271**	**2.061**

a As per 1.75 market multiple and water prices calculated based on volume weighted average price over the previous 12 months from September 2018.

Source: *Murray–Darling Basin Plan: five-year assessment*, Productivity Commission, December 2018.

7.3 Ernst & Young report recovery scenarios

In its analysis, Ernst & Young developed three different scenarios 'with a different reliability class applied to each to demonstrate the impact of different entitlement classes, LTAAY factors and prices on the multiple and VWAP that can be applied to recover the 450 GL within the statutory budget'. The scenarios were as follows:

1. *High reliability:* 450 GL of water is recovered with a suite of entitlements based on an estimated 94% LTAAY factor.
2. *Low reliability:* 450 GL of water is recovered with a suite of entitlements based on an estimated 73% LTAAY factor.
3. *Unregulated or supplementary:* 450 GL of water is recovered with a suite of entitlements based on an estimated 49% LTAAY factor.

The Ernst & Young report did not detail how the estimated LTAAY factors were formulated for each scenario. We note that, while the high reliability scenario's LTAAY factor broadly corresponds with the LTAAY factors of different high reliability/security entitlements across the MDB, that is not necessarily the case with the other two scenarios.

Ernst & Young concluded that, under a 1.75 market multiple, the full utilisation of the $1.575 billion budget to recover 450 GL would set the maximum average prices for the three scenarios as follows:

- *High reliability:* $1,880/ML
- *Low reliability:* $1,460/ML
- *Unregulated or supplementary:* $980/ML.

Based on an analysis of available information on water recovery achieved through different types of programs to date in the MDB, Ernst & Young estimated that the indicative size of the future water recovery opportunity is between 209 GL and 690 GL. This was estimated through stakeholder input and by applying assumptions of further water efficiencies to catchments or types of projects based on available data on efficiencies achieved historically.

Table 25: Ernst & Young report estimates of potential water savings, by location and project type (GL)

Potential water savings Location	Type / Basis of estimation	Potential savings
Off-farm opportunities nominated by stakeholders		
Vic. Murray/Goulburn	Stakeholder estimates	0–239
NSW Murray	Stakeholder estimates	10–25
Murrumbidgee	Stakeholder estimates	<10
Qld	Stakeholder estimates	6
Subtotal		**26–280**
On-farm opportunities (Ernst & Young estimates)		
Vic. Murray/Goulburn	On-farm (increase of 200–400 irrigator participants)	26–52
Murrumbidgee	On-farm (sensitivities to OFIEP participation figures)	26–35
NSW Murray	On-farm (sensitivities to OFIEP participation figures)	29–44
SA Murray	Reaching 10–20% of interested irrigators in SARMS	6–12
Lachlan	On-farm (increase to 2–4% of SDL)	10–21
Macquarie–Castlereagh	On-farm (increase to 6% of SDL)	n.a.–2
Namoi	On-farm (increase to 2–4% of SDL)	3–12
Gwydir	On-farm (increase to 2–4% of SDL)	3–11
Condamine–Balonne	On-farm (increase to 2–4% of SDL)	7–24
Border Rivers (Qld)	On-farm (increase to 4.5% of SDL)	n.a.–2
Warrego	On-farm (increase to 2–4% of SDL)	2–4
Moonie	On-farm (increase to 2–4% of SDL)	0–2
Nebine	On-farm (increase to 2–4% of SDL)	1–1
Border Rivers (NSW)	On-farm (increase to 2–4% of SDL)	2–8
Barwon–Darling	On-farm (increase to 2–4% of SDL)	n.a.–1
Intersecting streams	On-farm (increase to 2–4% of SDL)	2–5
Lower Darling	On-farm (increase to 2–4% of SDL)	n.a.–1
Wimmera	Stakeholder estimates	-
Loddon	On-farm (increase to 2–4% of SDL)	3–6
Campaspe	On-farm (increase to 2–4% of SDL)	2–5
Ovens	On-farm (increase to 2–4% of SDL)	2–3
Broken	On-farm (increase to 2–4% of SDL)	1–2
Subtotal		**125–253**
Integration of on- and off-farm opportunities (Ernst & Young estimates)		
Northern MDB	On- and off-farm (65–93% network efficiency)	5–9
Southern MDB	On- and off-farm (65–93% network efficiency)	29–61
Sub-total		**34–70**
Urban and industrial opportunities (Ernst & Young estimates)		
SA	Urban and industrial	<= 50
ACT	Urban and industrial	20–30
Urban areas within the MDB	Urban and industrial (80–85% or 90% efficiency)	4–9
Subtotal		**24–89**
Total		**209–450+**

OFIEP = On-Farm Irrigation Efficiency Program.

Source: *Analysis of efficiency measures in the Murray–Darling Basin*, Ernst & Young, January 2018.

Appendix 1 Margin analysis

A1.1 Methodology for margin analysis

Because the price of water entitlements is essentially equivalent to the discounted returns to water allocated to entitlements, we performed net margin modelling to inform our assessment of capacity to pay.

Net margin analysis involves the estimation of revenues, variable costs and fixed costs. It also requires assumptions about how costs vary with farm size, and what constitute realistic long-run prices for outputs and inputs. For the net margin analysis, the following modifications were applied to gross margin budgets used as the basis for the analysis:

- *Input prices:* adjusted using ABARES' subcomponent indexes of prices paid by farmers
- *Output prices:* adjusted to reflect a representative or long-run average price, not the current spot price
- *Water requirements:* adjusted to reflect local temperature, rainfall and soil conditions based on either anecdotal evidence provided by local producers or publicly available weather and climatic data
- *Discount rate:* 10% for the base case
- *Length of time considered:* 20 years for the base case
- *Fixed and variable water delivery fees and charges:* adjusted to reflect current service prices
- *Temporary water price:* $50/ML.

Capacity-to-pay estimates were calculated based on the long-run prices and maximum annual irrigation requirements shown in Table 26.

Table 26: Assumed long-run output prices and irrigation requirements, selected crops

	Blueberries	Almonds	Oranges	Cotton	Dairy	Mungbeans	Maize
Long-run price	$17,500/t	$7,000/t	$625/t	$450/bale	$6,000/t MS	$1,150/t	$300/t
Maximum annual irrigation requirement (ML/ha)	7.5	14	10	10–11	2.1	1.5	6

Source: Marsden Jacob analysis of NSW DPI and AgMargins gross margin budgets.

A1.2 Limitations

This analysis relied on gross margin budgets from a range of sources. Some of the budgets are older than ideal, which has been addressed by updating input prices in the original budgets to reflect current prices. However, best management practice guidelines and farming practices might also have changed since the original budgets were published.

Additionally, irrigation requirements have been adjusted to reflect differences between local growing conditions and those used in the original budgets. For example, the analysis on maize production is based on a gross margin budget for the Goondiwindi region, which is typically both drier and warmer than the northern NSW region. It has been assumed that lower rates of evapotranspiration associated with a cooler climate, combined with higher average rainfall in northern NSW, result in lower water requirements there than in Goondiwindi. However, the lower water requirement is largely offset by lower yields in northern NSW. Similar adjustment processes have been undertaken for the other crops analysed.

There is also uncertainty about both input and output prices. Long-run output prices have been estimated as average or indicative prices over the past 5–7 years, while input prices have been updated from the original budgets based on ABARES' subcomponent indexes of prices paid by farmers.

Finally, published gross margin budgets (for example, NSW Department of Primary Industries, AgMargins) are based on average or representative farms. In practice, some farms will outperform, and others will underperform, relative to average farms. Therefore, when using margin analyses as the basis for price outlooks, it is prudent to report a range of feasible values rather than a point estimate.

Appendix 2 Water markets overview

A2.1 Water markets overview

Water trading in Australia goes back decades. The greatest changes to market arrangements occurred in the 1990s, and the market has continued to evolve ever since.

The 1980s and 1990s saw the first tentative but far-reaching steps towards capping diversions and permitting the more flexible reallocation of water between irrigators, rather than continuing to issue more licences (upon request). The introduction of water trading was certainly not a speedy process, as governments closely controlled the development of water as an economic good. Nevertheless, the first steps by state governments to enable water to be held separately from land can now be seen as seminal moments in the development of water markets in Australia.

The initial steps towards water trading in the southern MDB states included[23]:

- *South Australia:* The embargo on new licences in 1969 was followed by the commencement of entitlement and allocation trading between private diverters in 1983. Trading within irrigation districts began in 1989, but it was not until 1995 that trading between private diverters and those in irrigation districts was allowed.
- *New South Wales:* The embargo on new licences from 1977 was followed by trading in water allocations in 1983 and entitlement trading among private diverters in 1989. Intervalley allocation trading was enabled in 1991.
- *Victoria:* State government reports recommended no new entitlements for irrigation from the late 1970s and early 1980s. Trading in allocations was possible from 1987 but gained more momentum following the introduction of new legislation in 1989. Intra-district entitlement trading was allowed in 1991, and inter-district entitlement trading commenced in 1994.

A major impetus for the development of cohesive water markets in Australia, particularly in the MDB, was the 1994 national reform agenda agreed by the Council of Australian Governments (COAG) as part of the broader National Competition Policy. In relation to water allocations and entitlements, the COAG water reform framework included agreement that comprehensive systems of water allocations or entitlements be established, backed by the separation of water property rights from land titles and the clear specification of ownership, volume, reliability, transferability and, if appropriate, quality. It also provided that cross-border trading be facilitated, and that arrangements be consistent, where that is socially, physically and ecologically sustainable. Those reforms, along with other conditions, provided for the establishment of the cohesive water market we have today.

In 2004, a review of the 1994 agreement extended the national water reform agenda and led to the development of the National Water Initiative, which is a national blueprint aimed at increasing the productivity and efficiency of water use in Australia while ensuring the health of rivers, groundwater systems and other water assets.

[23] Source: *Water Markets in Australia - A Short History*, National Water Commission, 2011.

Major changes to water management in the MDB were given effect in interstate agreements and the introduction of the *Water Act 2007* (Cwlth). The Act built on the earlier reforms and incorporated the overarching objectives of the National Water Initiative. The Water Act provides the legislative framework for ensuring that Australia's largest water resource—the MDB—is managed in the national interest. In doing so, the Act recognises that Australian states in the MDB continue to manage basin water resources within their jurisdictions. The Act gave the BoM water information functions that are in addition to its existing functions under the *Meteorology Act 1955*, including the collection, holding, managing, interpreting and disseminating of Australia's water information.

The Water Act also required the MDBA to prepare the Murray–Darling Basin Plan 2012 (Basin Plan)—a strategic plan for the integrated and sustainable management of water resources in the MDB. The Basin Plan provides a coordinated approach to water use across the MDB's four states and the ACT. The plan centres on providing a share of the total available water to the environment while ensuring that communities have sufficient water of a suitable quality for drinking and domestic uses and agricultural industries remain productive. It is a major step forward in Australian water reform, balancing environmental, social and economic considerations by setting water use to an environmentally sustainable level following decades of overallocation and environmental degradation.

A2.2 Basin State water market regulation

Figure 40 shows the relationships between legislation and water rules, plans and protocols.

The Murray–Darling Basin Authority

The Basin Plan water trading rules operate as an overarching framework to existing MDB state rules and IIO rules. The rules aim to improve transparency and access to information, reduce restrictions on trade and improve market confidence through a more effective water market. The rules apply to the Australian Government, the Basin states, IIOs and individual market participants. The rules only apply to water access rights that can be traded under state water management law.

New South Wales

In NSW, the *Water Management Act 2000* provides the legislative frameworks and supporting requirements for water trading. Responsibilities for granting and managing water licences and approvals are shared between the Department of Planning, Industry and Environment and WaterNSW. WaterNSW is responsible for managing trades of water access licences, licence entitlements, water allocations and licences for rural users, while the department is responsible for water licences and approvals for urban, industrial and government water users.

South Australia

Water resources in South Australia are managed under the *Natural Resource Management Act 2004*. The Act provides the statutory framework for the development of water management controls. The controls manage activities that can affect water, such as dams and infrastructure, water licensing, water resource plans, and authorisations of or restrictions on water use. The trading rules for the

South Australian River Murray are contained in Chapter 7 (Transfers of water access entitlements and water allocations) of the Water Allocation Plan for the River Murray Prescribed Watercourse.

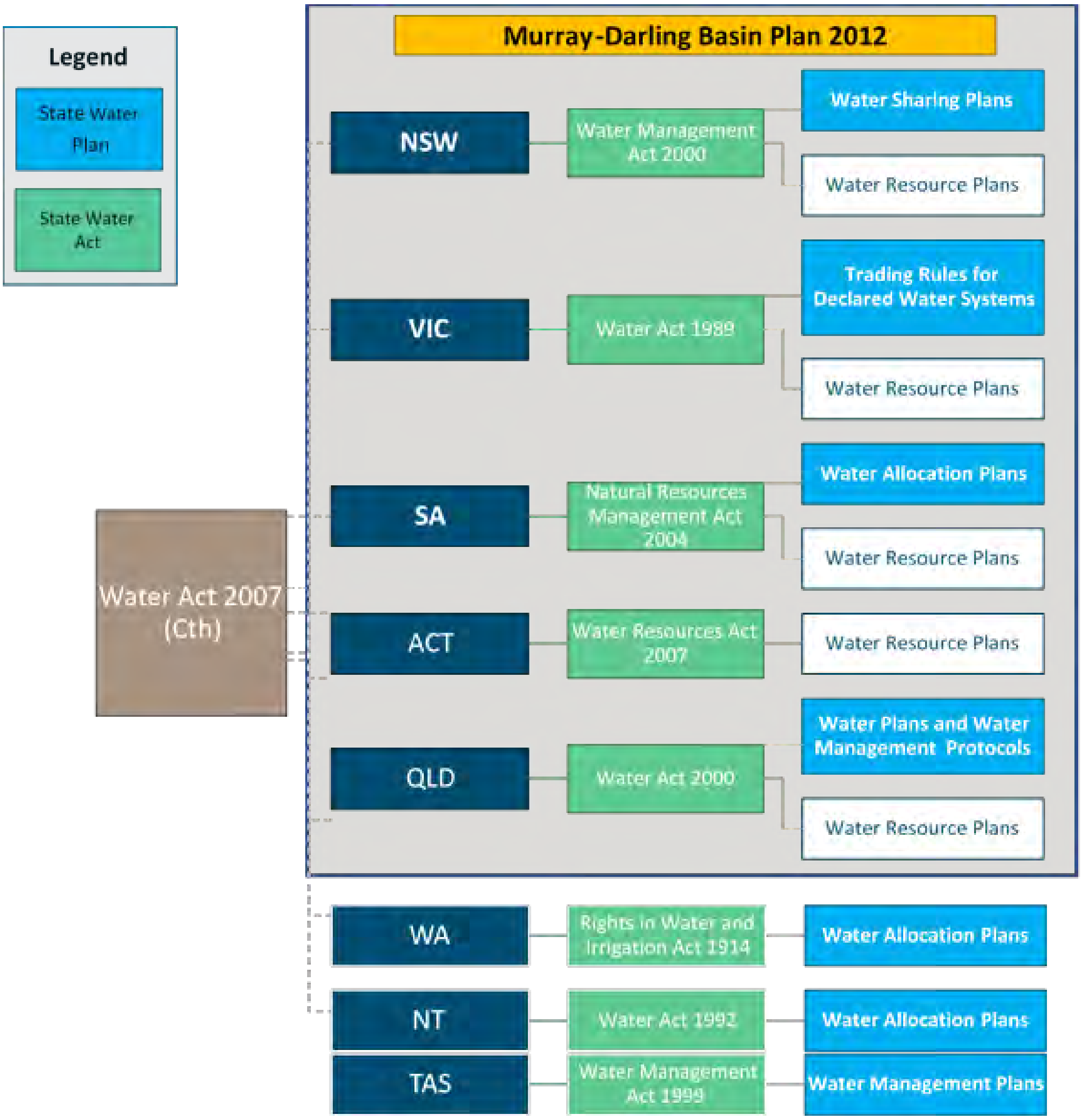
Victoria

The Victorian *Water Act 1989* governs the issuing of water entitlements and the management of Victoria's water resources and supply. The Act provides rights to water for domestic and stock use and traditional owner (Indigenous) use and water entitlements for both consumptive and environmental purposes.

Queensland

In Queensland, the *Water Act 2000* provides the legislative framework for managing water resources in the state. It requires that water planning and allocations of the state's water resources must 'advance sustainable management and efficient use of water'. The Water Regulation 2016 prescribes administrative and operational matters for the Act, such as statutory authorisations to take or interfere with water without a water entitlement, metering water entitlements, authorised interstate water trades and reporting on water plans.

Figure 40: State and territory water governance



Source: Marsden Jacob.

Acronyms and abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
BoM	Bureau of Meteorology
CEWH	Commonwealth Environmental Water Holder
COAG	Council of Australian Governments
ENSO	El Niño – Southern Oscillation
GL	gigalitre
GVIP	gross value of irrigated production
IIO	irrigation infrastructure operator
IOD	Indian Ocean Dipole
LRMC	long-run marginal cost
LTAAY	long-term average annual yield
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
ML	megalitre
SDL	sustainable diversion limit
VWAP	volume weighted average price
WEP	Water Efficiency Program
WESA	Water Efficiency Special Account