Independent Panel for Capacity Project Review

Report to Murray Darling Basin Ministerial Council

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Executive Summary

On 4 August, 2019, the MDB Ministerial Council agreed to appoint an independent panel of experts to peer review the River Murray Capacity and Delivery Shortfall Project currently being undertaken by the MDBA in partnership with jurisdictions.

The Capacity and Delivery Shortfall Project was developed in response to a growing concern within governments and communities that, over time, the risk of the River Murray system (RMS) not being able to meet all system and delivery demands was increasing.

The Independent Panel for Capacity Project Review (the Panel) undertook a short term, high level review of the work program, the work done to date and the model that has been developed to underpin it. In undertaking this review, the Panel considered that the work program should be designed to ensure that it could provide governments with adequate information on all key issues relating to the risk and management of system and delivery shortfalls to enable them to make robust, evidence-based decisions on options for the future management of shortfall risk.

The Panel made three findings in relation to the work program and the underpinning model.

> ***Finding 1*** **–** The Capacity and Delivery Shortfall Project work plan is appropriately focused on the identification of factors affecting the risk of system and delivery shortfalls within the River Murray system and the investigation of management options to alleviate that risk. Issues related to water availability are outside the scope of the project.
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> ***Finding 2*** **-** The current risk of a system or delivery shortfall downstream of the Choke will increase as a consequence of reducing channel capacity at the Barmah Choke and in downstream tributaries, increasing horticulture development in the Murray Valley, the increased water requirements of horticulture developments as recent plantings mature, and the requirement to deliver environmental entitlements to achieve outcomes under the Basin Plan. This is likely to be exacerbated under a drying climate.
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> ***Finding 3*** **-** The model is appropriate for comparative analysis of scenarios to determine sensitivity to risk factors. It is not appropriate to determine absolute risk.

The Panel then made a number of detailed recommendations on where additional work was required to improve the current process, enable appropriate evaluation of management options and provide greater confidence in the analyses. These included the following:

Understanding the risk of system and delivery shortfalls in the current system (Section 2.1)

1. Incorporate detailed planting and irrigation-method data from South Australia (which is readily available) into the SunRISE report as soon as practicable to ensure that the MDBA is using the best available reference data in managing the river system.

2. Request Victoria and New South Wales to Investigate the significance of environmental issues in the Lower Goulburn and Murrumbidgee Rivers and their implications for system capacity – this includes identifying potential summer-autumn flow regimes that could minimise environmental damage whilst facilitating inter-valley transfers in the Lower Goulburn River and understanding whether IVTs are causing environmental damage in the Lower Murrumbidgee.

Understanding whether shortfall risk changes under future scenarios (Section 2.2)

3. Undertake as a priority, two additional future modelling scenarios:
    a. Examining the impacts of climate change on both inflows and increased temperature.
    b. Examining the impact of constraint relaxation proposals that are currently under active consideration by governments.

Understanding impacts of system or delivery shortfalls for consumptive and environmental entitlement holders (section 2.3)

4. Undertake detailed work on impacts and duration of a water deficit at different points in the growing season for a variety of crops taking into consideration variations in soil type across the major river reaches.

5. Develop indicators of environmental delivery shortfalls.

6. Undertake detailed work in consultation with environmental water holders to understand the implications of shortfalls for a range of categories of environmental watering events under different climate sequences to understand their impacts on environmental outcomes.

Assessing the impacts of possible management options (Section 2.4)

7. **As an immediate priority**, jurisdictions should develop a contingency framework for making decisions on how they will manage shortfalls when they occur and agree on key steps, roles and responsibilities in implementing and communicating these decisions. This should also include consideration of environmental delivery shortfalls.

8. Revisit previous work on Barmah Choke bypass options and undertake a first-cut feasibility analysis to bring forward revised set of options in mid-2020.

9. Determine the rate of sedimentation of Barmah Choke and feasibility of extraction to increase capacity.

Model Capability (Section 2.5)

10. As a high priority, improve the representation of environmental watering demands across the system, and the ability to indicate when environmental water orders are not able to be met.

11. Undertake a number of general model improvements including a more contemporary representation of: Victorian allocation policies, modelled inflows from the Goulburn and Murrumbidgee valleys, Lake Victoria operating levels, river transmission losses in the Barmah Choke area and the interim operational measures in the Lower Goulburn recently introduced by Victoria.

12. Review potential for operational analysis to inform the interpretation of modelled delivery shortfalls.

Finally, the Panel examined the timelines, resourcing and governance of the project and made the following recommendations.

Timelines, review and resourcing (Section 3)

13. Extend the timeline for the project and plan it over a period till June 2021.

14. Include regular 6-9 monthly reviews of the project outputs and planned activities.

15. Maintain at least current levels of resourcing within MDBA and jurisdictions.

Governance and Communication (Section 4)

16. Ensure that jurisdictional representatives on the CPWG have the skills, authority and time available to properly manage the project.

17. As a high priority, develop a shared proactive communication strategy including key messages, clear roles and responsibilities for communicating with stakeholders and a clear pathway for stakeholders to engage.

1 Introduction

On 4 August, 2019, the MDB Ministerial Council agreed to appoint an independent panel of experts to peer review the River Murray Capacity and Delivery Shortfall Project currently being undertaken by the MDBA in partnership with jurisdictions. Panel members and final Terms of Reference were agreed by the Basin Officials Committee on 10 October 2019 and are provided at Appendix A.

The BOC determined that the Independent Panel for Capacity Project Review (the Panel) would be established to undertake a short term piece of work (reporting back to the Ministerial Council on 17 December, 2019) to:

- Provide advice on the Capacity and Delivery Shortfall Project work plan including
  - Scope, timeframes, resources and risk management.
- Peer review technical and policy work to ensure it is adequate to provide high quality advice to governments on options for the future management of shortfall risk including reviewing the:
  - modelling approach;
  - adequacy of data and analyses; and
  - adequacy of existing and proposed policy development to address issues relating to the deliverability of all water entitlements in the River Murray system.

The Panel Chair provided a detailed presentation of their conclusions and recommendations to BOC 20 November 2019.

1.1 Project Context

The Capacity and Delivery Shortfall Project was developed in response to a growing concern within governments and communities that, over time, the risk of the River Murray system (RMS) not being able to meet all system and delivery demands was increasing.

The concern was generated by observations that, in the 2014-15 and 2015-16 water years, flows in the River Murray were at or close to system capacity for long periods of time. This was due to high overall water availability within the system, combined with dry conditions. Whilst demands were able to be met in those years, the prospect of an increasing risk of a system or delivery shortfall had been raised. From the perspective of the MDB joint venture, the question needed to be answered and, if found to be correct, action taken to mitigate the risk.

The situation has arisen because of changes in the typical historic demand pattern that have occurred gradually over the past 25 years as a result of water reform, coupled with a climatic sequence where the system has been in drought for much of that period.

In the past (i.e. pre 1994), the RMS and its major tributaries were operated to supply a number of generally predictable consumptive demands. These included:

- South Australia's entitlement flow;
- town water supplies and domestic and stock along the system; and
- consistent irrigation demands in known irrigation districts and private diverters in known locations.

Meeting these demands throughout the season has always been a challenge for river operators because of the naturally-occurring Barmah Choke in the mid-River Murray which is a major constraint on the transfer of water between the upper storages (i.e. Hume and Dartmouth Dams) and demands in the lower river reaches. However, the predictability of these demands enabled river operators to optimise their management of the system by transferring water into Lake Victoria in the far south-west of NSW earlier in the season (i.e. over late spring) so that South Australia's entitlement flow could be stored and supplied from Lake Victoria in summer and autumn rather than from Hume and Dartmouth dams. This enabled water to be available from these storages to meet irrigation demands in NSW and Victoria between the Barmah Choke and the South Australian border. In past decades, Lake Victoria has also been filled from shared resources in the Menindee Lakes on the Darling River. Even under these arrangements, there has always been an inherent risk of a delivery shortfall.

However, in the past 25 years, a number of changes has occurred. Governments have introduced some significant policy changes, including:

- the introduction of water trading and the establishment of an interstate water market for both permanent entitlements and water allocations. As a result of water trading, there are now significant new areas of permanent plantings in the Sunraysia and Riverland areas which did not exist 25 years ago; and
- the development of the Basin Plan which required recovery and transfer of a significant volume of consumptive entitlements to the environment with environmental water holders now holding ~1970 GL across the southern connected system to be managed to meet a new and very different suite of demands which will evolve in response to new knowledge. Some of these demands require the provision of high flows i.e. up to 50 000ML/day downstream of Yarrawonga (although this is currently limited to 15,000ML/d).

In addition, the past 25 years has included some of the driest periods on record and as a consequence, businesses have changed the way they used water and governments have made a number of changes to rules including carryover of unused allocation and changes to system reserve to assist entitlement holders to manage through drought.

All of these changes combined have led to substantial changes in demand patterns. They have shifted largely downstream and are now far more dynamic in nature that ever before. This has occurred against a background of changing inflows (e.g. through much of the past 20 years the Darling River has been in drought and the contribution of water from the Menindee Lakes to the RMS for this purpose has been limited). River operators have had to adapt their system management and become more flexible and adept. They are now running sections of the River Murray at capacity for much of the time, and increasingly relying on Inter-valley Transfers (IVT) from mainly the Goulburn River and sometimes the Murrumbidgee River.

In the Panel's view, given the major changes that have occurred over the last 25 years and the changing climate, this issue was always going to be having to be dealt with – it was more a question of when.

1.2 Panel Approach

Given the short timeframe, the Panel undertook a high-level review of the Capacity and Delivery Shortfall Project work plan (Appendix B) which had been developed by the MDBA and endorsed by the Capacity Policy Working Group (CPWG). This included:

- Meetings between the full Panel and MDBA project staff on the overall work program.
- Meetings by Panel experts on specific technical issues including
    - modelling – with MDBA modellers and relevant jurisdictional staff

    - environmental water demands and methods of assessing implications of policy options on environmental outcomes
    - methods of assessing implications of policy options on agricultural production and industries.
- Peer review of two reports and project scope documents.
- A Panel representative attending two meetings of the Capacity Policy Working Group.
- A final teleconference with jurisdictional members of CPWG to discuss the broad outcomes and conclusions.

No stakeholder consultation was undertaken.

1.3 Project Scope

The Panel considers that the focus of the project should be on the identification of factors which could increase the risk of system and delivery shortfalls within the River Murray system and the investigation of management options to alleviate that risk.

A water supply shortfall is defined as an inability to provide entitlement holders with their water allocations when and where they want it. This includes all entitlement holders – both consumptive and environment.[1]

The Panel notes that a shortfall in water supply can occur in two ways.

- **System shortfall** – where the system management is unable to deliver system requirements over the full season. Under this scenario, Lake Victoria drops too low and it is potentially necessary to restrict consumptive/environmental diversions into NSW and Victoria downstream of the Barmah Choke in order to supply more of SA entitlement flow from the upper Murray. This generally occurs as a result of channel capacity constraints.

- **Short-term delivery shortfall** - where a spike in demand exceeds water available in river for diversions. These shortfalls can result from extended/intense heat waves. The long travel times from the upper storages (3-4 weeks) and capacity constraints at the Barmah Choke mean that it is not possible to respond to release water in time to meet demands and other potential mitigation measures (e.g. temporary draw down of weir pools) may be inadequate to avoid a short term shortfall.

The Panel recognises that the risk of a system or delivery shortfall within the River Murray system is often confused in the public domain with the risk posed to entitlement holders by reduced water availability due to drought. In the Panel's view these are two very different things and the role for governments in each is quite different.

- In the case of a system or delivery shortfall, the risk is that actual water allocated to entitlement holders in a season cannot be supplied to them when they need it because of issues in system management. The management of the River Murray system is the joint business of jurisdictions and is undertaken by the MDBA on their behalf under the MDB Agreement. Given that any system or delivery shortfall is the responsibility of the MDB Joint

[1] The Panel notes, that strictly under the MDB Agreement, it is actually the states that suffer the shortfall but they can only manage it by restricting access to their entitlement holders so the effect is felt by entitlement holders.

Venture, there is a role for governments to review system management and, where practicable, alleviate this risk.

- In the case of reduced water availability because of low inflows to the system, this is a private risk borne by the entitlement holder who makes a business decision on the volume and type of entitlements required to support their business enterprise and in doing so, chooses their level of risk based on their commercial decision-making. The role for governments in this case is about providing adequate information to the market and community to inform these decisions.

Given this, the Panel reviewed the Capacity and Delivery Shortfall Project work plan and considers that it is appropriately focused on the necessary issues.

> ***Finding 1 –*** *the Panel considers that the Capacity and Delivery Shortfall Project work plan is appropriately focused on the identification of factors affecting the risk of system and delivery shortfalls within the River Murray system and the investigation of management options to alleviate that risk. Issues related to water availability are outside the scope of the project.*

1.4 Conceptual Model for Review

In reviewing the Capacity and Delivery Shortfall Project work plan, the Panel considered that it should be designed to ensure that it could provide Ministers with adequate information on all key issues relating to the risk and management of system and delivery shortfalls so governments could make robust, evidence-based decisions on options for the future management of shortfall risk.

We considered there were five key areas that the work plan needed to cover (Fig 1). These include

1. Understanding the risk of system and delivery shortfalls in the current system.
2. Understanding whether that risk changes under likely future scenarios.
3. Understanding the impacts of either system or delivery shortfalls for both consumptive and environmental entitlement holders.
4. Assessing the impacts on entitlement holders of a range of possible management options (including policy, structural and operational options) to support decision-making.
5. The development of a model and a program of modelling work that could support these analyses.

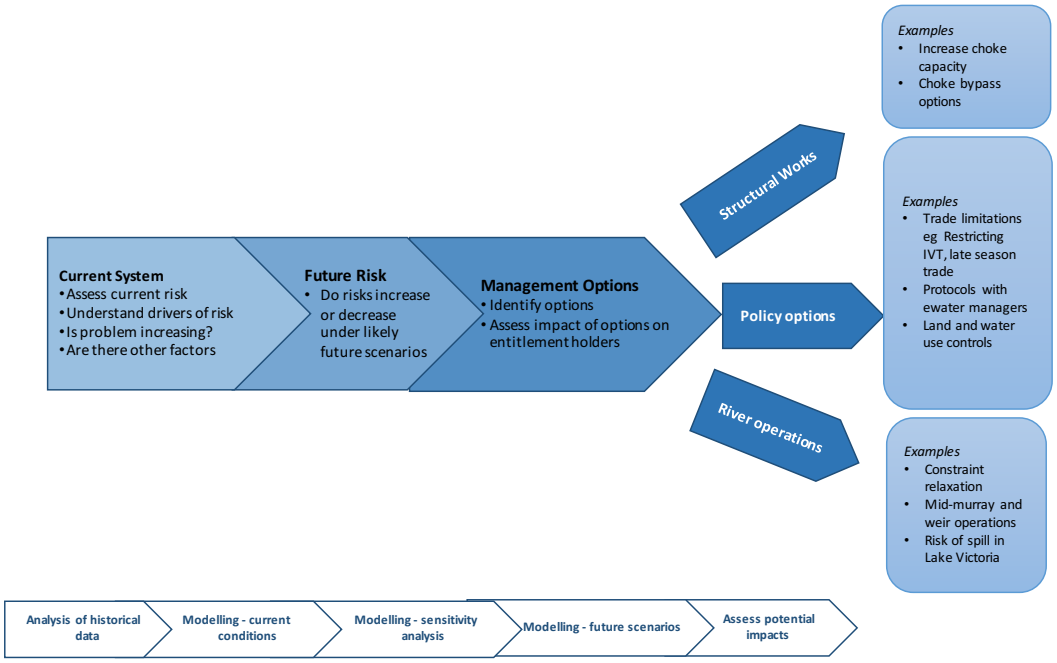

Fig 1. Conceptual model of a Work Plan to support evidence-based decision-making on delivery shortfall risk

For each of these key elements, we reviewed relevant areas of the work program to determine:

- Whether the current work (undertaken to date and planned) was appropriate
- Whether there were any gaps
- If there were possible improvements that could be made
- Whether some areas required a higher priority
- If the modelling capability was adequate for the task.

We then finally examined the project governance arrangements and the communication plan.

Our comments, findings and recommendations for each of these elements are outlined in the Sections below.

2 Review of Key Elements of Capacity and Delivery Shortfall Work Program

In reviewing the work program, the Panel noted that it effectively has 18 months still to run and that the work to date had been focused on building the model which will provide the basis for much of the analysis and populating it with data. Therefore, some elements are further advanced than others and a number are scheduled for completion in 2020 and some have yet to commence.

2.1 Risk in Capacity and Delivery Shortfalls in the Current System

In establishing the water supply shortfall risk in the current system, a number of tasks have been completed. These include:

- ***Understanding current water use and its drivers***. This involved:
    - Updating figures for irrigated crop areas in the Lower Murray-Darling (undertaken by SunRISE 21) as input to the model; and
    - An analysis of water use in the reach Barmah-SA border over the past 25 years to fully understand the extent of change in water demands (the HARC report).

- ***Understanding the reduction in Barmah Choke capacity***
  The channel capacity at the Barmah Choke to pass regulated flows has been reducing over the past three decades from 11,500ML/d in the 1980's, to 10,500ML/d in the mid-1990's to 9,200ML/d in 2019. Work undertaken by the MDBA, supported by SA Water has identified that sections of river bank on outside bends are experiencing increasing rates of erosion, but that the channel is reducing because of sediment transport from upstream of the Barmah Choke. A geomorphological study suggests that it is due to a sand slug moving slowly from Victorian tributaries down the river. However, the increasing erosion of outside bends of the river and undermining of riparian vegetation is damaging the natural values of the forest and gives the broader community the potentially erroneous impression that the increasingly constant delivery of high flows through the Barmah Choke is responsible for decreasing channel capacity.

The Panel reviewed both the HARC and the SunRISE21 reports and made the following comments.

SunRISE21 report

This report, commissioned by the MDBA for use in configuring the SOURCE model, provides irrigated crop area data for the Lower Murray Darling 2003-2018. The report covers the River Murray reaches 10-22, approximately from Lake Boga to the Barrages. The data is taken from aerial imagery of January 2018, and 'for Victoria and NSW data was sourced from over 80% of irrigators. The data is considered to be the most up to date available as of the 2017/2018 season with the report mapping changes in the irrigated crop areas over the 15 years and reporting the methods of irrigation.

The Panel noted that the data, as presented, appears acceptable for NSW and Victoria, but the South Australian data is incomplete and entirely inadequate. In Reach 22, some 6000 ha of permanent plantings (grape vines) in the Langhorne Creek and Currency Creek area are not recorded, even though they lie within the MDB. In addition, water drawn from Reaches 19/20 is used to irrigate approximately 5000-6000 ha of high value plantings in the Barossa and Clare Valleys. Whilst South Australia's use of River Murray water is capped, the model's focus on ensuring the delivery of 1850 GL each year does not allow for any consideration of the water requirements of these crops, nor the timing thereof, nor the economic impact of a serious shortfall. The Panel considers that detailed planting and irrigation-method data from South Australia (which is readily available) should be incorporated into the SunRISE report as soon as practicable to ensure that the MDBA is using the best available reference data in managing the river system.

HARC report

This report, undertaken as an independent review by Hydrology and Risk Consulting (HARC), examined the historical use of water, using SunRISE crop data for NSW, Victoria and South Australia. It has shown:

- A significant increase in crop area, particularly permanent plantings, downstream of the Barmah Choke;
- Recovery of water entitlements for the environment;
- Expansion of permanent horticulture in the Sunraysia region;

- Increased inter-valley trade of water from the Goulburn and Murrumbidgee Rivers into the Murray, and
- Increased flows to South Australia due to trade and environmental flows.

The analysis undertaken by HARC, concluded that there has been little change to the annual pattern of consumptive (irrigation) use downstream of the Barmah Choke although demand has moved from closer to the Barmah Choke (Torrumbarry) downstream to Sunraysia. The analysis also indicates that environmental water use and consumptive water use (including trade to South Australia) are combining to generate higher peak monthly demands.

The primary conclusion by HARC is that the combined consumptive use, inter-valley trade and the generally separate timing of consumptive and environmental flows shows there has been no increase in total or peak season consumptive demand in the Murray system over time. This, in-turn, would indicate that there has been no increase in the potential for supply or delivery shortfalls over time.

While the HARC analysis considers the historical use of water and concludes there is no increase in potential for supply or delivery shortfalls, it only considers the impact on consumptive entitlements, and assumes there is no conflict with the delivery of environmental entitlements, which may not be valid in all years.

The Panel considers that the HARC report is a useful input. Taken on its own, it suggests that there is no change in shortfall risk solely as a result of growth in irrigated horticulture plantings. However, the Panel considers that this is no reason for complacency as there are a number of other factors that need to be acknowledged in relation to the current system.

These include

1. **Implications of current permanent planting for future water demands**
   Plantings in Sunraysia and Riverland are not yet at full maturity and development is continuing to occur. The SunRISE report does not record the new nut plantings in Sunraysia in 2019 and the Almond Board expects there to be an increase of almost another 10% of plantings in the current wave of development to reach 50,000ha across all states. The Almond Board indicates that 38% of the total plantings are in Victoria, 20% in South Australia and 8% in NSW. The Board further estimates that about 30% of current plantings are young or not at full maturity, so with these orchards and others yet to be planted there is clearly going to be a higher demand from the river system in Sunraysia and South Australia.

2. **Potential future reductions in System Capacity**
   a. *Barmah Choke* - The analysis undertaken by HARC concludes that the directed release of environmental water from Hume Dam are timed to ensure no increased pressure on the Barmah Choke. However, the Panel believes that the cumulative increase in diversions through the Choke, for transfer to Lake Victoria, for delivery of water for consumptive use and for delivery of environmental entitlements is resulting in high flows passing through the Choke for much longer periods than would have occurred naturally and is contributing to the increased erosion of the river banks. The trajectory and rate of sedimentation of the Barmah Choke due to the sand slug also needs to be determined to understand whether it will continue to reduce and by how much.

b. *The Lower Goulburn* - Anecdotal evidence provided to the Expert Panel suggests that the channel and riparian environment of the Lower Goulburn River is being severely degraded as a consequence of the inter valley transfer of large volumes of water from the Goulburn Valley in summer and autumn in the past few years. The Victorian Government recently introduced interim arrangements for IVTs from the Goulburn River to reduce the detrimental impact of these transfers on the environment of the Lower Goulburn River. The impact of these interim measures on system capacity will need to be understood and their effectiveness in reducing environmental impacts will need to be monitored. The Panel notes that, depending on the success of these interim measures, further restrictions may be necessary in the future - which could in turn impact system capacity.

c. *The Murrumbidgee River* – The Panel also heard that there may be potential for environmental degradation occurring as a result of IVTs in the Murrumbidgee River. There seemed to be less evidence to support this. Given this, the Panel considers that it is important to establish whether this is an actual issue which will require action or not.

3. **Actual Environmental Shortfall in 2018** - In 2018, the MDBA was unable to deliver environmental entitlements in spring and summer as the channel capacity of the Barmah Choke was already exceeded in the delivery of water to meet downstream consumptive demand and the transfer of water to Lake Victoria (IRORG 2019). This is the first actual shortfall since 2002.

4. **RMS driven much harder over the last 20 years –** as reported previously to Ministerial Council (August 2019), the last 20 years have been drier than previous and RM operations has had to drive the system much harder to meet higher peak demands in summer when trade and environmental water deliveries to South Australia are taken into account. They have reported that using a number of contingency actions within their control to avoid delivery shortfalls has virtually become normal practice and there is no further operational buffer that can be employed.

5. **Consequences of delivery shortfalls are significantly higher –** because of the level of investment in Sunraysia and the Riverland, the economic consequences of an actual delivery shortfall (depending on timing and duration) on irrigators is likely to be much higher than in the past whilst the impact of a shortfall on the environment is yet to be assessed.

As a consequence, the Panel considers that a risk of system and delivery shortfalls in the River Murray downstream of the Barmah Choke to the South Australian border remains, particularly in dry seasons with high water allocations that restricts the use of Murray Irrigation Limited channel infrastructure (the Mulwala canal) to pass additional volumes around the Barmah Choke. Moreover, the current risk is complicated by the lack of secure arrangements for access to additional capacity through the use of the Mulwala Canal. Currently, the Joint Venture only has temporary arrangements with Murray Irrigation Limited, and there has been no agreement in place in some years.

Moreover, the Panel also believes the risk of system or delivery shortfalls will potentially increase as the capacity of the Barmah Choke and downstream tributaries reduces, as horticulture development continues, and if the pattern of the delivery of environmental entitlements should extend further into periods of peak consumptive demand. This is likely to be exacerbated under climate change.

Finding 2 - *the Panel considers that the current risk of a system or delivery shortfall downstream of the Choke will increase as a consequence of reducing channel capacity at the Barmah Choke and in downstream tributaries, increasing horticulture development in the Murray Valley, the increased water requirements of horticulture developments as recent plantings mature, and the requirement to deliver environmental entitlements to achieve outcomes under the Basin Plan. This is likely to be exacerbated under a drying climate.*

2.2 Risk in Capacity and Delivery Shortfalls under Likely Future Scenarios

The next logical step is to understand how the current risk of system and delivery shortfalls could change under likely future scenarios.

The work program included several scenarios to be tested and completed by May-June 2020. These included changes to inflow sequences, reductions in Barmah Choke capacity and increasing consumptive demand in the lower reach to simulate current plantations reaching full maturity and further development.

The Panel considers that there are two additional scenarios that need to be undertaken as a priority. These are

1. ***Climate change scenario*** – incorporating as far as possible
    a. potential changes in inflows
    b. likely irrigator response to both increased temperatures and reduced water availability

2. ***Constraint Relaxation*** scenario – The Panel considers that ideally there should be a scenario which looks at the impact of full Basin Plan implementation incorporating all SDLAM projects and unconstrained environmental delivery sequences. However, the Panel understands that many of the SDLAM projects are still under active discussion. Consequently, it will take a number of years to fully develop the environmental delivery pattern and it is not possible to undertake this in the next few months. However, the Panel considers there is real merit in modelling the impact of the constraint proposals that are currently under active consideration by governments and which directly affect the capacity of the River Murray system. It is important for governments to understand whether these proposals are likely to affect the risk of a water supply shortfall and therefore whether they would have any additional benefits for the RMS over and above the environmental outcomes of the Basin Plan.

These additional two pieces of work will assist governments in understanding whether the current risk is likely to be increased or decreased under these future scenarios.

2.3 Understanding Impacts of Capacity and Delivery Shortfalls on Entitlement Holders

In addition to understanding the current and future risk of system and delivery shortfalls in the RMS, it is important to understand the consequences of a shortfall on entitlement holders should it actually occur.

There are likely to be significant differences between consumptive users (i.e. irrigators) and the environment in a range of parameters to be considered. These include;

- the identification of a shortfall i.e. how it is defined in the model for irrigation and environment
- the types of shortfalls that will impact e.g. a short-term delivery shortfall (duration of days) in summer is unlikely to have environmental effects but could have severe impacts on growers. Whereas a long-term capacity constraint in spring could cut short a long term planned environmental delivery resulting in an unsuccessful bird breeding event with the deaths of large numbers of chicks.

Work to date has focused on developing the capability to quantify economic impacts on consumptive users (i.e. irrigators) with work being undertaken by Agriculture Victoria. This work is currently in progress and needs careful scoping to ensure that it will be credible to irrigators. Such work will need to be quite detailed with attention given to the within season water requirements of different permanent plantings and to the impacts and duration of a water deficit at different points in the growing season such as flowering, fruit set or fruit maturity. To add to the complexity, the main crops of grapevines, nuts and citrus do not have synchronised growing seasons. The work should also attempt to consider major variations in soil type (soil water holding capacity) in different reaches, as some districts may well cope better with a shortfall than others.

Less attention has been paid to date to the environmental impacts of a system or delivery shortfall although it is scheduled on the work program for the next few months. This is because environmental watering is a new management discipline and our understanding of the factors influencing its success is continuing to evolve as environmental water holders undertake more complex watering events. In trying to determine the risk profile of delivering environmental water or the impact of suffering a shortfall in that delivery, the following should be noted:

- The relationship between the volume of deficit and ecological response is often non-linear. Failure to activate an environmental trigger expected from an environmental watering event may result in wasting the total environmental allocation. It follows that *pro rata* reduction in volume amongst environmental flows facing a shortfall is an inappropriate response. A review of priorities to fewer sites may be better use of the available environmental water.
- Timing of the beginning of an environmental flow event may be negotiable (weeks) but, once it's commenced, the shape of the hydrograph is critical and needs to be maintained over the full duration to achieve the environmental outcomes.

The Panel recognises that the work required to enable some prediction of the environmental impacts of a shortfall will be not be easy and will be a best attempt to consolidate existing knowledge. It will need to be undertaken in consultation with environmental water holders and should include:

- The development of an indicator(s) of an environmental shortfall within the model.
- The undertaking of detailed work to understand the implications of a shortfall for the full range of categories of environmental watering events. This would include understanding, under different climate sequences, their impacts on the planned outcome for that environmental event and the longer-term environmental outcomes for the site.

The Panel recognises that this will be able to be continuously improved over the next few years as real-time watering events are undertaken and adaptively monitored.

In the view of the Panel, both these areas of work are important and of high priority because until they are completed, it is not possible to consistently evaluate the impacts of any management options that governments may wish to consider.

2.4 Assessing Management Options

Following analysis of the current and potential future risks, government will have to make decisions on whether it's worthwhile to take action to reduce risk and if so, how.

There are three types of possible management options that could be undertaken to alleviate the risk over the longer term (Figure 1). These include:

- ***Structural*** options to increase the capacity of the system e.g. increasing the capacity of Barmah Choke or by-passing the Barmah Choke. These options are likely to be costly, have a number of environmental issues associated with them and would require decisions on how much additional capacity would be desirable to meet current and future demand.
- ***Policy*** options which could include:
    - Reviewing trade limits to influence levels of irrigation development and water use in the River Murray below the Barmah Choke e.g. restricting IVT, late season trade or all trade from upstream to downstream of the Barmah Choke. Depending on how they were implemented, these could have significant impacts on existing entitlement holders, the value of water on the market and future development.
    - Development of protocols with environmental water holders, including where agreements are undertaken between environmental water holders and river operators which reflect the level of risk to the environment and enable improved environmental outcomes. This could be a sensible approach but starts to depart from the principle that all entitlement holders have the same conditions and obligations.
    - Land and water use controls in areas where future development is likely to occur. Currently there are salinity controls in place in Victoria and SA but given the pace and prospect for future development in the Lower Murray area, governments may have to consider a range of potentially stronger and different controls.
- ***Operational*** options e.g.
    - Relaxing key constraints along the River Murray through implementing some of the proposed constraint projects.
    - Review mid-Murray weir and storage operations.
    - Review protocols for transferring water from Lake Hume to Lake Victoria – this could result in earlier transfers from Lake Hume. This would reduce volumes in Lake Hume and have some impact on resource availability in some years and increase the risk of spills from Lake Victoria from tributary inflow.

The list above gives an idea of some of the options available. The Panel considers that with the consideration of any option there will be perceived winners and losers, including jurisdictions and entitlement holders.

There will be many variations on these options and multiple combinations. A key message is none of them are without some impact and therefore they will have to be consistently assessed and evaluated and their comparative impacts well understood. The model and its related predictions of impacts will be an important component in assisting to identify a preferred subset of management options. However, any final decision by governments on a management solution would not only take into account model outcomes but would have to also assess a broader range of potential impacts e.g. potential impact on price of water - temporary and permanent, potential flow-on community impacts, effects on Basin Plan environmental outcomes.

Because the effort to date has gone into developing the model and the capacity to evaluate impacts (still requiring further work as detailed above), the section of the work program dealing with the

assessment of management options is less well-advanced. Once the model is fully configured and the work to predict impacts is completed, it will be possible to start assessing a range of management options. At this point, it will be important for jurisdictions to agree on a priority list of options for assessment. This should not be left to the MDBA alone. The Panel considers that jurisdictions will have to manage any impacts on their entitlement holders and that they will need to agree on what options they want to jointly consider. In the Panel's view, jurisdictions should undertake to do this by March 2020.

However, the Panel considers that there is an immediate and urgent priority. Currently, MDBA advise that there is a low likelihood of a delivery shortfall over the remainder of the 2019-20 water year. However, they also advise that there is always an inherent risk arising from factors like a run of extremely hot weather. Currently, jurisdictions do not have contingency arrangements in place to manage such an incident should it occur. Whilst it may not be possible to agree on exact sharing arrangements, given that the impacts of every shortfall will be different depending on timing and duration, it should be possible to develop a framework for making these decisions when they occur and agreeing on key steps, roles and responsibilities in implementing and communicating them. This should also include consideration of environmental delivery shortfalls. Whilst it is on the work program, this task has been delayed and is not yet complete. The Panel consider this to be an urgent priority.

The Panel also consider that there are two tasks that could be undertaken in the short term that would assist in the assessment of management options when the model is ready and the work on predicting impacts is complete. These are:

- Revisit previous work on Barmah Choke bypass options and undertake a first-cut feasibility analysis to bring forward revised set of options in mid-2020.
- Determine rate of sedimentation of Barmah Choke and feasibility of extraction to increase capacity.

2.5 Model Capability

The MDBA has developed a long-term daily simulation model of the River Murray system using the National Hydrologic Modelling Platform (Source), known as the Source Murray Model (SMM).

To support the River Murray Capacity and Delivery Shortfall Project, the MDBA has configured SMM to reflect as closely as possible the irrigation development levels, water user behaviour and management rules in place in 2018/19, known as the Reference Scenario. The Reference Scenario is described in more detail in the following sections. Uniquely among basin models, the Source Murray Model (SMM) has recently been enhanced to include key processes such as allocation (temporary) trade and a more contemporary representation of environmental water use, although these remain difficult processes to reproduce closely.

2.5.1 Initial outcomes

Short-term delivery shortfalls

Modelling suggests that very minor delivery shortfalls are occurring, but it has not been possible at this early stage to form a conclusion of any change to the frequency of short-term delivery shortfalls.

Historically the possibility of short-term delivery shortfalls in high demand periods has been an on-going concern although the occurrence of actual shortfalls has not been frequent. This has largely been due to active management of orders, the drawdown of weir pools as a temporary measure or the timely occurrence of rainfall events.

Within season system shortfalls

The requirement to have minimum operating level in Lake Victoria at the end of the following May to secure South Australia's entitlement flow for the following season is a key driver of River Murray operations. The modelling is showing that meeting these requirements occurs slightly less often in the Reference Scenario than the BDL scenario, although there is no significant increase in transfers from Hume – Lake Victoria. This issue is likely to be increasingly important under dry conditions, particularly when additional supplies cannot be called upon from the Menindee Lakes storages.

2.5.2 Limitations

Notwithstanding the significant advances that have been made in the development of the SMM, it is important to keep in mind that this is a long-term planning model that runs over a 125 year period, and cannot be expected to capture the full range of variability in the behaviour of water users (consumptive and environmental) and the river system, particularly during the extremes in wet and dry conditions. This means that these long-term planning models are not well suited to identifying transient delivery shortfalls during the summer months.

Whilst it is noted that the model simulates a similar lack of delivery shortfalls to that observed in the recent past, it is hard to judge whether the model's response to changes in conditions under some of the intended future scenarios will be robust.

A key process within SMM is the representation of environmental watering, with the environment being one of the largest entitlement holders in the Southern Connected System. However, environmental demands are still evolving, and the model has a relatively simple representation of how water recovered under the Basin Plan is used.

The behaviour of the allocation (temporary) trade market is dynamic, still evolving, and influenced by economic drivers that are not simulated in hydrologic models. The market is also increasingly active across the Southern Connected System, including the Goulburn and Murrumbidgee valleys that are modelled separately to SMM. Accordingly, the initial representation of trade behaviour in SMM has required some simplifications to be made, and it is understandably difficult for the model to closely reproduce observed trade behaviour across the broader southern connected system.

Inter-valley trade and the operation of end of valley accounts is an important influence on the risk of delivery and system shortfalls, and further work is recommended by both the MDBA and the relevant basin states to improve representation of this in the model.

2.5.3 Areas for improvement

A high priority improvement in SMM for this project is the representation of environmental watering demands across the system, and the ability to indicate when environmental water orders are not able to be met. Environmental demands for water recovered under the Basin Plan are currently represented at a few key locations such as downstream of Yarrawonga Weir. However, for a year such as 2018/19, environmental water orders were unable to be met as system requirements to refill Lake Victoria used the available channel capacity through the Barmah Choke. In this circumstance, a simple flow metric at Yarrawonga Weir would be met, even though the intended environmental delivery targets further downstream were not met in practice.

The event of 2018/19 also suggests that a shortfall in meeting environmental demands in the winter/spring could have the effect of increasing environmental demands during the summer months, which would increase the risk of delivery shortfalls. This means that representing the effects of an environmental demand shortfall in the model is also considered a priority model improvement.

With the increasing reliance on temporary trade, including inter-valley trade, to support the expanding horticultural developments in the mid Murray, the model's ability to simulate such trade is becoming increasingly important. Model improvements could include representation of the trade limitations across the Barmah Choke, and a review of assumed inter-valley trade volumes under a range of circumstances that extend beyond those observed in 2017/18 and 2018/19.

As is the case for long-term planning models across the basin, there is always a range of improvements that can, and should, be pursued. Many of these improvements are not likely to be individually significant to the model's ability to simulate delivery and system shortfalls, but there are some that could be pursued in the short term to improve confidence in the model. These include a more contemporary representation of: Victorian allocation policies, modelled inflows from the Goulburn and Murrumbidgee valleys, Lake Victoria operating levels, and river transmission losses in the Barmah Choke area and the interim operational measures in the Lower Goulburn recently introduced by Victoria.

2.5.4 Modelling - Conclusions

The difficulties in closely representing key current processes, such as trade and environmental water use, in long-term modelling means it remains difficult for long-term modelling to be able to closely simulate short-term operational circumstances such as delivery shortfalls that might last only a few weeks. As such, it is difficult to quantify the absolute risk of shortfalls occurring based on the model results.

The larger scale drivers for system shortfalls at Lake Victoria tend to operate at the seasonal scale, such as inflows, water available from Menindee Lakes, river transmission losses, and irrigation demands. There is greater confidence that these are being simulated robustly and that SMM is more capable of identifying the nature and extent of system shortfalls in the River Murray.

The value of models such as SMM is that they can be used to undertake a comparative analysis between different model scenarios to test the sensitivity of simulated shortfalls to various risk factors, such as plausible alternate climate sequences or different operating rules, and to test potential mitigation measures such as policy changes or infrastructure options. The MDBA have already compared the results of the Reference Scenario to the BDL Scenario that represents 2009 conditions, which suggests that the potential for delivery and system shortfalls has not worsened significantly.

The use of operational case studies may assist in further understanding the potential for delivery shortfalls. Case studies are more applicable to examining individual years than long-term risk.

> ***Finding 3 -*** *the Panel considers that the model is appropriate for comparative analysis of scenarios to determine sensitivity to risk factors. It is not appropriate to determine absolute risk.*

3 Timelines, Review and Resourcing

The Capacity and Delivery Shortfall Project is currently only an 18 month program of work. The Panel considers that, given its current status and the remaining work to be undertaken, it is highly unlikely it could be completed within that time period and that attempting to do so will compromise the quality of the work.

We believe the project needs to be undertaken over a 2-3 year period to enable governments to make considered decisions with high quality information that is credible to key stakeholders. We also consider that the work done to date shows that, whilst this is a serious long-term issue for governments, there is no need for urgent action within the next 18 months other than the development of an agreed contingency framework.

The Panel considers that extending the timeframe of the project will enable:

- Continuous updating of critical data used in the model, including -
    - further ground truthing of data so as to incorporate refinements overtime, such as variations in irrigator behaviour and major differences in soil type. This is a resource intensive exercise but essential to give confidence and transparency to the modelled management of the system and a more definite framework on which to build future advances.
    - improvements in environmental demand planning and knowledge of environmental outcomes of watering events.
    - decisions on SDLAM projects as they are made by governments.
- Improved integration with other work currently in progress within the MDBA such as the PPM (Prerequisite Policy Measures) implementation and the socio-economic study being carried out at the present time.
- Incorporating relevant outcomes of the current ACC water market review due to be handed down at the end of 2020 which is likely to make suggestions or recommendations which could influence the timing and volumes of traded water.

The project work plan will need to accommodate all this new information and be adapted as it generates results from the modelled scenarios and planned studies. Given this, the Panel considers that it should be reviewed every 6 months to ensure that new information has been included, that planned activities remain relevant, and to review priorities and identify any emerging gaps.

In relation to resourcing, the Panel considers that the current level of modelling capability both within the MDBA and jurisdictions is a high risk for the project. There is a shortage of skilled and experienced modellers - experience tells us that such people need time to gain a real understanding of their subject and they need secure and stable employment to achieve this. There is also a key risk that with the worsening of the current drought, jurisdictional staff will be redeployed to deal with this immediate priority issue. Whilst this is understandable, it will delay key elements of this project. As discussed in the section below, this project cannot be undertaken by the MDBA alone – it also requires significant resources from jurisdictions.

4 Governance and Communication

As outlined in the sections above, the Panel considers the Capacity and Delivery Shortfall Project to an important project that should be a high priority for the MDB joint government venture.

We believe that the project governance should reflect both its significance and the fact that it is a shared problem for jurisdictions which will require trust and goodwill to resolve. The project needs to be owned and managed by the jurisdictions with the MDBA acting as a coordinator/facilitator and undertaking agreed activities on the jurisdictions' behalf. Currently, the project is managed by the Capacity Policy Working Group (CPWG). The Panel has reviewed their ToR and found them to be appropriate. However, jurisdictions need to ensure that their representatives:

- have the right mix of skills

- have the authority to make appropriate decisions on behalf of the jurisdiction
- have the time available to properly devote to the project
- are able to act in accordance with the ToR.

The CPWG should report to BOC regularly on the project and be held accountable by BOC for its progress.

In relation to communication, the work program requires the development of a communication strategy in 2020 but the only work to date has been the preparation of a very preliminary draft engagement plan. The Panel notes that there are a range of stakeholders highly concerned about this issue. Therefore, communication needs to be planned carefully with a view to providing stakeholders and communities with the best available information on the current understanding of system and delivery shortfall risk and a clear pathway for input into decisions on management options.

The Panel considers that the development of a proactive communication strategy should be a priority for the CPWG. The strategy should include:

- Key messages and communication outputs.
- Clear understanding of roles and responsibilities between the jurisdictions and the MDBA outlining clearly who talks on what to whom and when.
- Agreed process and pathway for stakeholder engagement either collectively or within individual jurisdictions but coordinated between them.

The Panel considers that ensuring that the jurisdictions and the MDBA speak with one voice and common messages on this issue is critical. It is important to recognise that many irrigators now hold a portfolio of water entitlements to meet their business needs with water products from all the jurisdictions. They are now more interested in collective approaches and the combined impacts of jurisdictional policies and less in the single actions of jurisdictions. A proactive strategy is required because in recent times, in the absence of a shared strategy, the default has been to provide the minimum level of information required to deal with an issue after it has become a significant community problem. This simply increases mistrust within the community and provides the opportunity for misinformation to take hold.

The Panel suggests that the Ministerial Council could give consideration to a slightly more formalised process than originally planned. A short paper outlining findings to date and the range of management options under consideration could be released in March 2020 with stakeholders able to make submissions if they wished. This would provide the opportunity to put factual information on the current risk and the drivers of shortfall risk into the public domain (i.e. to dispel any myths) and enable stakeholders to record their views on possible management options which could assist in prioritising those for further analysis.

5 Findings and Recommendations

The Panel made three findings in relation to the work program and the underpinning model which are outlined in the sections above. In addition, we make the following recommendations relating to the work program

Understanding the current system (Section 2.1)

1. Incorporate detailed planting and irrigation- method data from South Australia (which is readily available) into the SunRISE report as soon as practicable to ensure that the MDBA is using the best available reference data in managing the river system.

2. Request Victoria and New South Wales to investigate the significance of environmental issues in the Lower Goulburn and Murrumbidgee Rivers and their implications for system capacity – this includes identifying potential summer-autumn flow regimes that could minimise environmental damage whilst facilitating inter-valley transfers in the Lower Goulburn River and understanding whether IVTs are causing environmental damage in the Lower Murrumbidgee.

Understanding risk under future scenarios (Section 2.2)

3. Undertake as a priority, two additional future modelling scenarios:
    a. Examining the impacts of climate change including both inflows and increased temperature.
    b. Examining the impact of constraint relaxation proposals that are currently under active consideration by governments

Understanding implications for entitlement holders (Section 2.3)

4. Undertake detailed work on impacts and duration of a water deficit at different points in the growing season for a variety of crops taking into consideration variations in soil type across the major river reaches.

5. Develop indicators of environmental delivery shortfalls.

6. Undertake detailed work in consultation with environmental water holders to understand the implications of shortfalls for a range of categories of environmental watering events under different climate sequences to understand their impacts on environmental outcomes.

Assessing management options (Section 2.4)

7. **As an immediate priority**, jurisdictions should develop a contingency framework for making decisions on how they will manage shortfalls when they occur and agree on key steps, roles and responsibilities in implementing and communicating these decisions. This should also include consideration of environmental delivery shortfalls.

8. Revisit previous work on Barmah Choke bypass options and undertake a first-cut feasibility analysis to bring forward revised set of options in mid-2020.

9. Determine the rate of sedimentation of Barmah Choke and feasibility of extraction to increase capacity.

Model Capability (Section 2.5)

10. As a high priority, improve the representation of environmental watering demands across the system, and the ability to indicate when environmental water orders are not able to be met.

11. Undertake a number of general model improvements including a more contemporary representation of: Victorian allocation policies, modelled inflows from the Goulburn and Murrumbidgee valleys, Lake Victoria operating levels, river transmission losses in the Barmah Choke area and the interim operational measures in the Lower Goulburn recently introduced by Victoria.

12. Review potential for operational analysis to inform the potential interpretation of modelled delivery shortfalls.

Timelines, review and resourcing (Section 3)

13. Extend the timeline for the project and plan it over a period till June 2021.

14. Include regular 6-9 monthly reviews of the project outputs and planned activities.

15. Maintain at least current levels of resourcing within MDBA and jurisdictions.

Governance and Communication (Section 4)

16. Ensure that jurisdictional representatives on the CPWG have the skills, authority and time available to properly manage the project.

17. As a high priority, develop a shared proactive communication strategy including key messages, clear roles and responsibilities for communicating with stakeholders and a clear pathway for stakeholders to engage.

Appendix A

Terms of Reference: Independent Panel for Capacity Project Review

Independent Panel for Capacity Project Review
TERMS OF REFERENCE

Establishment

1. At the Ministerial Council meeting held on 4 August 2019, it was agreed to appoint an independent panel of experts to peer review the River Murray Capacity and Delivery Shortfall Project.

2. The panel members and terms of reference are to be agreed by BOC members for the Commonwealth, NSW, ACT, Victoria and South Australia.

Primary Objectives

3. Provide independent advice and peer review to the joint governments regarding the Capacity and Delivery Shortfall Project (the Project) and whether it is addressing the right tasks/work to the appropriate standard and timeframes.

Role of the Panel

4. To achieve its primary objective the Panel will be responsible for:

    a. Providing independent advice on the Capacity and Delivery Shortfall Project work plan regarding scope, timeframes, resources and risk management.

    b. Peer review of technical work and policy development to make sure it is on track and fit for purpose and to provide advice to governments and MDBA on options for the future management of shortfall risk. This includes providing advice on:

        - the modelling approach, considering if the modelling is addressing the right questions/scenarios and whether the proposed approach is sound
        - adequacy of data collected and analysed for this project
        - adequacy of analyses and interpretation of collected data and modelling results
        - adequacy of existing and proposed policy development to address the issues around deliverability of all water entitlements

5. In undertaking the assessment the Panel may engage and seek advice from other technical experts in relevant fields.

Office locations
Adelaide, Albury-Wodonga, Canberra, Goondiwindi, Toowoomba

mdba.gov.au 1800 230 067 engagement@mdba.gov.au

6. The operational issues for the 2019/20 water year will be managed through existing mechanisms specifically through WLWG and operational practice at MDBA and do not need to be reported on by the Panel.

Tenure

7. The Panel will report to the next Ministerial Council meeting, nominally December 2019.

8. The Ministerial Council may seek further advice from the panel. In this case, the tenure, scope and deliverables of the Panel will be reviewed by BOC following the Ministerial Council meeting.

Deliverables/Milestones

9. Expected project deliverables and timeframes are provided in
10. Table 1.

Table 1: Panel Deliverables and Timeframes

Deliverable[2]	Timeframe[1]
1. Initial report providing advice to CPWG on the scope of the Capacity and Delivery Shortfall Project including work plan and timeframes for project delivery.	Mid Oct 2019
2. Draft Ministerial Council report to BOC on the review of technical work and policy development of the project including advice on: • the modelling approach, considering if the modelling is addressing the right questions/scenarios and whether the proposed approach is sound • adequacy of data collected and analysed for this project • adequacy of analyses and interpretation of collected data and modelling results • adequacy of existing and proposed policy development to address the issues around deliverability of all water entitlements • any other matters requested by the BOC and/or CPWG that fall within the terms of reference	For Nov. BOC meeting
3. Report to Ministerial Council providing advice on the review of technical work and policy development of the project.	For Dec. MinCo meeting

[1] Timeframes are subject to review, pending timing of budget approval and procurement process

[2] If the Panel is extended, additional deliverables will be developed at that time.

Office locations
Adelaide, Albury-Wodonga, Canberra, Goondiwindi, Toowoomba

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Governance structure

11. The Panel shall report directly to the Ministerial Council through a written report and presentation by the chair of the Panel.

12. The Panel will liaise with the CPWG and BOC regarding the draft report to the Ministerial Council.

Membership

13. The Panel will consist of a chair and up to three additional independent experts appointed by BOC, who will collectively bring the following skills:

    a. Extensive knowledge and administrative experience in water resource management and policy development in the River Murray System.

    b. Extensive knowledge of River Murray operations and hydrological processes, and their representation within river system planning models.

    c. Experience in providing strategic direction to water resource management to address policy issues

    d. Extensive knowledge of socio-economic and/or environmental issues associated with water management in the Southern Connected system

14. As approved by BOC the members of the panel from each group are as follows:

    - Dr Jane Doolan (Chair)
    - Dianne Davidson
    - David Harriss
    - Dr Terry Hillman
    - Paul Simpson
    - Graeme Turner

Budget and Support

15. The Panel has no independent budget.

16. The Panel may make requests through MDBA for funding additional expert advice, which would have to go through the existing budgetary processes of the Joint Governments.

17. In undertaking the assessment, the Panel shall liaise with the CPWG and may seek additional information from any relevant working groups established by the MDBA and jurisdictional governments.

18. MDBA will provide contractual and secretarial support.

Office locations
Adelaide, Albury-Wodonga, Canberra, Goondiwindi, Toowoomba

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Appendix B

Capacity and Delivery Shortfall Project Work Plan