Government of South Australia
Department for Environment and Water

81-95 Waymouth Street
Adelaide SA 5000
GPO Box 1047
Adelaide SA 5001
Australia
Ph: +61 8463 6945

www.environment.sa.gov.au

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26 OCT 2018

Ms Joanne Masters
Senior Instructing Solicitor
Murray-Darling Basin Royal Commission
GPO Box 1445
ADELAIDE SA 5001

Dear Ms Masters

I refer to your letter dated 27 September 2018 regarding the Royal Commissioner's request for further information and matters taken on notice during the South Australian Government's evidence on 26 September 2018. Please find below responses to the individual requests.

Whether Minister Speirs responded to a submission made by the Commonwealth that modelling showed that a Basin-wide SDL of 10,873 GL reflected an ESLT?

> Minister Speirs is in regular contact with Minister Littleproud to discuss Basin related matters. There was no written response to this letter from Minister Littleproud.

In the context of section 23B of the Water Act 2007, could adaptive management include an algorithm to produce an SDL within which all the WRPs have to fit by what may be considered 'a moving average approach'? And if so, the merits of this?

> We understand the intent of the moving average approach is to mitigate the possibility that a regular Water Resource Plan (WRP) review process will not be able to detect, or find basis to act on, a long term trend in water resource availability in the context of a highly variable climate. Technically a moving average approach could be implemented along with regular ongoing water recovery for the environment. However, the information required to implement a moving average approach in a rigorous manner in practice is not currently available.
>
> Using a shorter period of historical data than the 114 + year record is unlikely to be suitable, given the highly variable nature of the climate, potentially with long term cycles (up to decades) of wetter and drier periods. On an annual and decadal basis, natural variability in the climate system can act to mask or enhance any long-term human induced trend, particularly in the next 20 years for rainfall. For example, the average annual flow to South Australia in the Baseline Diversion Limit model (pre Basin Plan) is 5,697 gigalitres per year over the first 57 years of the model run, and substantially higher at 7,830 gigalitres per year

over the second 57 years. This is not consistent with the projected drying trend[1] and illustrates the extreme variability of climate in south-eastern Australia which makes it difficult to demonstrate that rainfall has changed in a statistical sense. Shorter time windows produce similar variability. A trend has not yet been determined for rainfall in south-eastern Australia. Hence a change to SDLs based on a moving time interval may lead to either decreases or increases at successive review intervals. This would either lead to very reactive WRP rules and significant, frequent, disruption to the irrigation and water user community, or produce the same difficulties of identifying when to act on an observed change over a given period.

Rather than using the historical hydrological data, climate change projections could be a possible source of information for a moving average approach for the future. Nevertheless, as outlined by a number of witnesses, current climate change projections are highly uncertain in the magnitude and timing of an overall drying trend, even for a given assumption about future greenhouse gas emissions. To change the SDL based on climate projections alone would require a (at least partly) subjective judgement on the likelihood of a projected future being realised. Such an approach is likely to be subject to high degrees of criticism and would be very difficult to reach agreement on.

What is the best way to account for climate change projections and data in the determination of the SDL, including by way of calculating the SDL and/or determining the appropriate intervals at which the SDL should be reviewed?

Rather than building a highly uncertain moving average into the SDL upfront, a better approach could be to take a multiple lines of evidence approach to determine appropriate, or necessary, changes when reviewing the Basin Plan and therefore the SDL. This would provide a greater understanding of the risks involved and the vulnerability of the system to variations in temperature and water availability. There are a number of options to provide this evidence, including a combination of "top-down", "bottom-up" and attribution approaches that build on the climate change projection and climate driver causality research that has been undertaken over the past decade. These approaches have been developed relatively recently and represent a largely new phase of climate change research that has developed risk–based assessment frameworks to incorporate uncertain climate information into water planning and review processes.

The top down approach generates an assumption about future greenhouse gas emissions trajectories (Representative Concentration Pathways) and then runs this through a range of Global Circulation Models (GCMs). The outputs from the GCMs are then downscaled to the local scale and the resulting climate projections are then run through hydrological models to assess the achievement of environmental water requirements. This series of steps, with uncertainty introduced by each process, produces a 'cascade of uncertainty', resulting in a very wide range of projected future outcomes. However, the results of such a process could

[1] In the near future (2030) natural variability is projected to predominate over trends due to greenhouse gas emissions. Late in the century (2090) cool season (April to October) rainfall is projected to decline under both an intermediate (RCP4.5) and high (RCP8.5) emission scenario. In the warm season (November to March), little change in rainfall is projected by different models. The magnitude of projected changes for late in the century (2090) span approximately -40 to +5 percent in winter and -15 to +25 percent in summer for a high emissions case (RCP8.5). By late in the century, less rainfall is projected during the cool season, with high confidence. There is medium confidence that rainfall will remain unchanged in the warm season. Accessed on 15 October 2018 from https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/clusters/?current=MBC&popup=true&tooltip=true.

be used to inform the possible range of outcomes to consider in a risk assessment combining likelihood and consequences of potential impacts. This would enable an informed assessment of risk and the need and timing of anticipatory risk management measures, including changing the SDL.

Bottom up approaches avoid the 'cascade of uncertainty' by stress testing a system to understand its vulnerabilities and failure states. The success criteria and failure modes of the system are defined initially, followed by a simulation of the system's performance under a wide range of possible climate conditions. Scenarios where 'failure' occurs are used to identify the climate conditions that would require change to the system (such as change to SDL) to avoid this happening in reality. This approach helps to strengthen the understanding of the system and the 'failure' criteria. It can be useful to inform the degrees to which the system is resilient to climate variation (and change) and the development of robust actions that achieve the success criteria across the broadest range of future scenarios.

The science of event attribution is rapidly advancing through improved understanding of the mechanisms that produce extreme events and the marked progress in development of methods that are used for event attribution. Attribution approaches have recently been used to explain how the likelihood of individual events (such as hurricanes or large storms) may have changed as a result of increased greenhouse gas concentrations in the atmosphere. A similar approach could possibly be used to understand the likelihood that environmental water requirements will be achieved, for a given climate and SDL. This would require coupled climate and hydrological models to be run a large number of times, based on the level of greenhouse gas emissions in the atmosphere when a review is undertaken and then determining the likelihood that environmental water requirements will be met for a given SDL. If the level of risk exceeds that which is deemed tolerable, the SDL could be adjusted accordingly.

All approaches will require scientific consensus about the assumptions, failures and assessable outcomes. However, combining multiple lines of evidence will take into account the challenges of climate non-stationarity and will help to account for our incomplete knowledge about probabilities of future outcomes.

Is there any more recent information on the operation of the Chowilla Regulator and in particular, your experience with respect to the risk of increased numbers of carp?

There will be a carp breeding response in association with any inundation of the Chowilla floodplain, unregulated or managed[2]. Consequently, key aspects of the fish risk assessment work and Carp Management Strategy for the Chowilla Floodplain have been incorporated into the Chowilla Regulator Operations Plan and event plans. In particular, the plan focuses on implementing the recommendation to adopt a managed filling and inundation regime that maximises flowing water habitats.

All operations are undertaken to ensure flow velocities of >0.18 m/sec are maintained through at least 75 percent of the identified critical fish habitat. This is achieved through the alignment of Chowilla regulator operational levels with identified River Murray flow

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[2] As evidenced by Appendix A, table 5, (noting that 2011 and 2017 data was collected following natural flooding in 2010/11 and late 2016 respectively) of Fredberg, J., Zampatti, B.P., and Bice, C.M. (2018) *Chowilla Icon Site Fish Assemblage Condition Monitoring 2017* South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

thresholds, along with the concurrent raising of Lock 6 and opening of the inlet weirs on influent creeks. Other strategies to improve conditions for native species such as the construction of fishways and improved water delivery into the anabranch have also been adopted.

Recognising that it is not considered possible to avoid a carp response to floodplain inundation, the focus of regulator inundations is to target operation of the regulator for broad scale floodplain inundation under River Murray flows to SA in the order of 15,000 ML/d or more. This will not necessarily reduce the carp response to the floodplain inundation but will increase the likelihood of favourable conditions for several native fish species. The managed inundation in 2016 was undertaken in line with these conditions.

In 2018, water levels within the Chowilla anabranch are currently being raised by approximately 2.1 metres (up to 18.5 mAHD). Flows will remain within-channel throughout the event but water levels will rise to near the top of the creek banks, resulting in some water flowing into low-level wetlands. To further reduce carp numbers, screens are being used on control structures where possible to prevent fish entering or exiting the wetlands during the inundation event.

To support the effective and adaptive management of the Chowilla regulator, approximately 40% of the monitoring budget has been allocated to monitoring fish condition and the impacts of management interventions on fish. Quantitative fish surveys have been undertaken to track the achievement of objectives relating to the diversity, distribution and recruitment of native fish and abundance of non-native fish for the last 14 years. Table 5 of *The Chowilla Icon Site Fish Assemblage Condition Monitoring 2017* indicates significant increases in carp abundance associated with high overbank flows that occurred over an extended period in late 2010 and 2011 and in late 2016 but not necessarily associated with the operations of the Chowilla regulator in 2014 and 2015.[3]

In addition to this, recommendations from fish experts regarding potential water quality impacts on native fish have driven a very strong focus on the establishment and maintenance of the surface water monitoring network, including the real-time monitoring of dissolved oxygen. The surface water network provides real-time information on changes in water quality which informs the management of regulator operations.

In the context of sections 7.03 and 7.15 of the Basin Plan, please clarify the South Australian Government's interpretation of why the hydro-cues supply measure is not an unimplemented policy measure, as defined in the Water Act 2007?

Historically, in standard regulated river operations, water orders are not filled from a particular storage but are met from the most efficient supply source. This may include unregulated flow from an upstream tributary. Water that returns to the river following an environmental watering event is currently re-regulated or can also be used to meet other water orders downstream. The approach used is consistent with requirements to maximise the water available for consumptive use.

[3] Refer to Appendix A, Table 5, Fredberg, J., Zampatti, B.P. and Bice, C.M. (2018). *The Chowilla Icon Site Fish Assemblage Condition Monitoring 2017.* South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

In developing the Basin Plan, the MDBA assumed that environmental releases could be called from storage during un-regulated flow events and that environmental water return flows would be re-credited for downstream environmental use. The Benchmark model was set up to include these actions whereas previous modelling of river operations specifically excluded these actions from occurring.

These actions, outlined in section 7.15 (2) as unimplemented policy measures and assumptions in the Benchmark model, were first implemented in reality in a trial multi-site environmental watering event in 2010-11. In this instance, a parcel of The Living Murray water was called from Hume Dam and used first in the Barmah-Millewa Forest with the return flows being allowed to travel to the Coorong and Lower Lakes without extraction or re-regulation. To enable this environmental watering to occur, the Basin Officials Committee (BOC) and individual States approved a number of departures from prior practice and the relevant instruments relating to operational and water accounting issues for that specific water year.

To protect environmental water from re-regulation or extraction by consumptive users, or allow the re-use of environmental water through re-crediting of return flows, requires a number of distinct actions and changes to the currently codified rules at both the bulk water level (MDB Agreement and operational frameworks) and the retail water level (Basin State regulatory operations and framework). The rule changes allow river operators to undertake the actions requested of them by environmental water holders and the MDBA to deliver environmental water up to the existing constraints to river operations assumed in the Basin Plan.

For river operators to action and account for requests from environmental water holders (unimplemented policy measures) based on the original trial does not make current environmental water delivery more efficient and effective or countenance new ways to deliver environmental water. In contrast, the Enhanced Environmental Water Delivery (EEWD) SDL proposal is a step change in river management over and above the scale envisaged by implementation of the unimplemented policy measures in section 7.15 and has been driven by the resultant complexity established by the Basin Plan. Put simply, the unimplemented policy measures allow river operators to undertake specific actions while the EEWD will help define when and where those actions should occur.

The potential for delivery of environmental water has changed significantly following the 2010-11 trial. The amount of environmental water available for environmental purposes and the timing and locations for its use have increased significantly with the Basin Plan (over 2,000 gigalitres per annum from multiple water holders across 100 nationally important wetlands, compared to the original trial conditions in 2010-11 of less than 300 gigalitres from one water holder for two sites). Environmental water is now released as much as possible in conjunction with natural events and the intent is to synchronise operations of all of the southern connected basin sites to hydrological cues.

Current river operating frameworks are not designed for this complexity and it has become apparent that even with implementation of the unimplemented policy measures, the current operating and management arrangements under the MDB Agreement do not always provide for the delivery of these new demands in the most effective and efficient way. Examples include:

- the fifteen decision and approval steps needed to deliver just one integrated water order from multiple water holders restricts the ability to respond to hydrological cues with timely releases;
- channel capacity limitations are a major influence on the system's operating approach and there is limited information available to anticipate downstream demands ahead of time, leading to restrictions to the delivery of environmental water; and
- an improved understanding of the incremental losses and travel times associated with incremental river flows could reduce estimated environmental losses and allow improved coordination between river systems to meet hydrological cues and flow rates.

Moreover, current coordination of environmental water delivery is very reliant on the goodwill and knowledge of environmental water holders and river operators and therefore, is not transparent to stakeholders and the general public.

Supply measures, as outlined in section 7.03 of the Basin Plan, can improve ways to manage the Basin's rivers to more efficiently deliver water for the environment. These measures include changes to river operations and rules, which achieve environmental outcomes with less water, or additional environmental outcomes with the same quantity of water.

The EEWD proposal seeks to improve the efficiency of environmental water delivery across the southern connected Basin by establishing and streamlining a decision making delivery framework more closely linked to environmental outcomes. Much of the EEWD project relates to the development of decision support tools to enable decisions about environmental water delivery to be made in a more timely and accurate fashion. Building on existing knowledge it will improve information gaps and allow environmental water managers to be able to respond to natural variability by adding held environmental water in step with natural hydrological cues, including rainfall and river flow events, more effectively than is currently possible. This means releasing held environmental water from storage at the right time, in the right amount, across multiple river systems, across multiple environmental water holders, taking into account variable travel times, under different resource conditions. This is necessary to build a flow of the right size that lasts for the right length of time to get water to where it is needed in the landscape.

The model run to determine the benefit of the supply measures includes the supply measures and all of the assumptions from the Benchmark model. It is then directly compared to the Benchmark model run. The EEWD and other projects generate a benefit in the supply measure model run and the actions they are implementing were not included in the Benchmark model run, therefore they are not unimplemented policy measures. In fact, implementation of the unimplemented policy measures was identified as critical for the supply value of EEWD and the constraints projects.

In the context of section 7.17 to 7.21 of the Basin Plan, please clarify the South Australian Government's approach to the reconciliation in 2024 and the possibility of continuous review up until that time?

If the package of supply measure projects is implemented in accordance with its approved notifications, then the reconciliation provisions in the Basin Plan do not arise. That said, and as was presented to the Commission by the Department for Environment and Water at the public hearing, this is not a case of set-and-forget. The jurisdictions will be applying extensive project management skills, monitoring and issue resolution to the progress of supply measure project implementation to ensure that reconciliation provisions are not required to be enacted, or are done so to achieve minor adjustment only.

The Murray-Darling Basin Authority has proposed that it will engage an adaptive management approach through to 2024. The Basin Officials Committee (BOC) has established an Adjustment Implementation Committee (AIC). The AIC will be responsible to BOC for managing risks to the delivery of the 605 gigalitre offset and escalating issues it is unable to address to BOC. Working groups for joint projects and state level governance committees are responsible for the delivery of individual projects and will report to the AIC and the relevant individual jurisdictions. All states are involved in the working groups for the constraints measures, EEWD, Menindee Lakes and the rules based projects.

The AIC will monitor the overall implementation of the entire package of supply and constraints measures, resolve policy issues, provide advice to proponents and conduct formal stocktakes and reviews of the progress of supply measure project implementation towards expected outcomes at several defined points until 2024.

Regular reports will be provided to the Basin Officials Committee and Ministerial Council based on the adaptive management framework, considering multiple lines of evidence, including assessment of the potential impact of the original sustainable diversion limit adjustment outcome.

Further, as the Commission has already noted, a number of projects passed Phase 2 and 3 notification processes subject to a number of risk and issue treatments. These treatments all have one or two year time-frames attached and will need to be addressed before any implementation funding is made available from the Commonwealth Government for the individual projects. Commonwealth funding for individual projects will be provided in instalments based on satisfactory achievement of milestones, which will address progress with implementation of the supply measure and other specified obligations.

In addition, the following significant review dates are built into the *Water Act 2007* (Cth):

- The Water for the Environment Special Account first report of independent review is due by 30 September 2019. As the question of funds available to efficiency and constraints measures will impact on the expected outcomes of particular supply projects, the preparation and investigation into the report will be linked to supply project review and introspection on progress against outcomes.
- Annual reporting requirements in line with Schedule 12 of the Basin Plan commence from 31 October 2020. This includes risk analysis, transition to long-term SDLs, reviews of the Environmental Watering Plan, water quality and salinity, trading and water resource planning.
- Other annual reporting requirements already underway or due to commence before 2024 include[4] annual reports of the Commonwealth Environmental Water Holder, Water for the Environment Special Account, annual diversion target, states' annual reports, Cap

[4] See *Water Act 2007* (Cth): Schedule F, s114, s86AI, s71, s 52A, *Murray-Darling Basin Agreement* Schedule E

on Diversions reporting, audit monitoring and the Annual Analysis of the Basin Plan's Effectiveness.

This approach provides multiple opportunities to determine progress with implementation and amend the package of measures, such as amend a notification to accommodate or overcome issues with particular projects. A notification cannot be amended after 31 December 2023. The aim of all managers is to avoid the need to rely on reconciliation provisions and ensure the success of projects and, if needed, make minor adjustments well in advance of 2024.

I trust that this letter addresses your questions, please contact me should you require any further detail.

Yours sincerely

Dan Jordan
A/GROUP EXECUTIVE DIRECTOR WATER

Table 5. Total and standardised (fish.site^{-1}) abundances of fish captured from condition monitoring sites sampled in the Chowilla Anabranch system and adjacent River Murray 2005–2017.

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Grand Total
Golden perch	69	75	112	94	174	114	802	286	230	148	143	99	139	**2485**
(*Macquaria ambigua ambigua*)	(3.8)	(4.7)	(7.5)	(6.7)	(8.3)	(5.2)	(38.2)	(13.0)	(10.5)	(7.0)	(6.5)	(4.7)	(6.3)	
Murray cod	13	11	14	15	21	15	7	9	7	7	14	13	5	**151**
(*Macculochella peelii*)	(0.7)	(0.7)	(0.97)	(1.1)	(1.0)	(0.7)	(0.3)	(0.4)	(0.3)	(0.3)	(0.6)	(0.6)	(0.2)	
Silver perch	5	5	1	14	8	20	30	6	7	5	14	7	4	**126**
(*Bidyanus bidyanus*)	(0.3)	(0.3)	(0.1)	(1.0)	(0.4)	(0.9)	(1.4)	(0.3)	(0.3)	(0.2)	(0.6)	(0.3)	(0.2)	
Freshwater catfish	-	-	1	-	3	2	8	20	15	6	4	1	2	**62**
(*Tandanus tandanus*)			(0.1)		(0.1)	(0.1)	(0.4)	(0.9)	(0.7)	(0.3)	(0.2)	(0.1)	(0.1)	
Bony herring	3849	6229	6251	7782	10629	17948	2521	4433	5508	5225	10314	19,221	11,045	**110,955**
(*Nematalosa erebi*)	(213.8)	(389.3)	(416.7)	(555.9)	(506.1)	(815.8)	(114.6)	(201.5)	(250.4)	(248.8)	(468.8)	(915.3)	(502)	
Australian smelt	526	189	740	803	1067	589	484	132	215	151	1029	916	2169	**9010**
(*Retropinna semoni*)	(29.2)	(11.8)	(49.3)	(57.4)	(50.8)	(26.8)	(22.0)	(6.0)	(9.8)	(7.2)	(46.8)	(43.6)	(98.6)	
Murray rainbowfish	458	378	123	213	231	240	686	50	200	235	652	490	195	**4151**
(*Melantaenia fluviatilis*)	(25.4)	(23.6)	(8.2)	(15.2)	(11.0)	(10.9)	(31.2)	(2.3)	(9.1)	(11.2)	(29.6)	(23.3)	(8.9)	
Flat-headed gudgeon	93	6	20	18	70	21	11	20	69	35	65	14	4	**446**
(*Philypnodon grandicepts*)	(5.2)	(0.4)	(1.3)	(1.3)	(3.3)	(1.0)	(0.5)	(0.9)	(3.1)	(1.7)	(3.0)	(0.7)	(0.2)	
Dwarf flat-headed gudgeon	2	-	-	11	2	6	-	-	-	-	3	4	-	**28**
(*Philynodon macrostomus*)	(0.1)			(0.8)	(0.1)	(0.3)					(0.1)	(0.2)		
Unspecked hardyhead	2659	1602	1574	1786	2145	1687	455	26	84	89	656	2441	1687	**16,891**
(*Craterocephalus stercusmuscarum fulvus*)	(147.7)	(100.1)	(104.9)	(127.6)	(102.1)	(76.7)	(20.7)	(1.2)	(3.8)	(4.2)	(29.8)	(116.2)	(76.7)	
Carp gudgeon spp.	398	113	104	73	84	153	92	2	28	222	137	251	181	**1838**
(*Hypseleotris* spp.)	(22.1)	(7.1)	(6.9)	(5.2)	(4.0)	(7)	(4.2)	(0.1)	(1.3)	(10.6)	(6.2)	(12.0)	(8.2)	
Common carp*	234	466	277	185	400	357	11602	2023	1218	590	730	339	5164	**23,585**
(*Cyprinus carpio*)	(13.0)	(29.1)	(18.5)	(13.2)	(19.1)	(16.2)	(527.4)	(92.0)	(55.4)	(28.1)	(33.2)	(16.1)	(234.7)	
Gambusia*	200	61	125	60	107	490	647	12	40	65	126	300	398	**2631**
(*Gambusia holbrooki*)	(11.1)	(3.8)	(8.3)	(4.3)	(5.1)	(22.3)	(29.4)	(0.5)	(1.8)	(3.1)	(5.7)	(14.3)	(18.1)	
Goldfish*	202	296	177	156	551	217	3945	385	55	171	299	331	2517	**9302**
(*Carassius auratus*)	(11.2)	(18.5)	(11.8)	(11.1)	(26.2)	(9.9)	(179.3)	(17.5)	(2.5)	(8.1)	(13.6)	(15.8)	(114.4)	
Redfin perch*	-	-	9	3	7	8	5	3	-	-	3	1	27	**66**
(*Perca fluviatilis*)			(0.6)	(0.2)	(0.3)	(0.4)	(0.2)	(0.1)			(0.1)	(0.1)	(1.2)	
Spangled perch^	-	-	-	-	-	-	1	-	-	1	1	-	-	**3**
(*Leipotherapon unicolour*)							(0.05)			(0.05)	(0.05)			
Total species	**13**	**12**	**14**	**14**	**15**	**15**	**15**	**14**	**13**	**14**	**16**	**15**	**14**	**16**
Total number of sites	**18**	**16**	**15**	**14**	**21**	**22**	**21**	**22**	**22**	**21**	**22**	**21**	**22**	
Total number of fish	**8,708**	**9,431**	**9,528**	**11,213**	**15,499**	**21,867**	**21,296**	**7,407**	**7,676**	**6,950**	**14,190**	**24,428**	**23,537**	**181,730**
Standardised total abundance (fish.site^{-1})	**483.7**	**589.4**	**635.2**	**800.9**	**738.0**	**934.0**	**969.7**	**336.7**	**348.9**	**330.9**	**644.9**	**1163.2**	**1069.9**	

*Denotes non-native species, ^ denotes native species captured outside its 'normal' distribution range