



Office  
of Water

# Response to the Snowy Scientific Committee report on 'The adequacy of environmental releases to the upper Murrumbidgee River'



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The NSW Office of Water manages the policy and regulatory frameworks for the State's surface water and groundwater resources to provide a secure and sustainable water supply for all users. The NSW Office of Water also supports water utilities in the provision of water and sewerage services throughout New South Wales.

***Response to the Snowy Scientific Committee report on 'The adequacy of environmental releases to the upper Murrumbidgee River'***

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## Summary

The Snowy Scientific Committee undertook a review of the adequacy of environmental flows to the upper Murrumbidgee River in 2010. Many of the issues raised by the Snowy Scientific Committee have been previously identified by the New South Wales Office of Water and presented to the committee. The review proposed seven recommendations relating to the management of environmental flows from Tantangara Dam to the upper Murrumbidgee River. The Office of Water response to these recommendations is outlined in Table 1 and further explained in the main text of this report.

**Table 1. Summary response to Snowy Scientific Committee recommendations.**

No.	Recommendation	Response
1	'Re-instate the gauge at Yaouk'	This would improve the ability to develop environmental flow rules for the Upper Murrumbidgee. The Office of Water had previously identified the need to re-establish a gauge in this reach, and acquired funding. A gauge will be installed before July 2011.
2	'Accelerate the development of a hydraulic model for the upper Murrumbidgee River, and in particular from Tantangara Dam to Mittagang Crossing'	The Office of Water has previously identified the need for hydraulic modelling with the SSC. The Office of Water is well placed to provide advice to the SSC regarding how this will be undertaken.  Topographic field survey for the model development for the reach most affected is currently has commenced. Inundation patterns for the Spring 2009 release have been measured.
3	'Explore possibilities for sharing SMRIF amongst the four montane rivers with the view to substantially increasing the proportion and hence also the volumetric allocation to the upper Murrumbidgee River'	Changes to allocations as listed in Table 1 of the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) will require a formal review of allocations to all montane rivers. It is expected that this will be undertaken as part of the development of the Montane Rivers Strategy.
4	'Protect environmental releases first, by accelerating the development of water sharing plans: and second, by developing means for protecting environmental releases from consumptive use.'	The Office of Water has previously raised this issue with the SSC. Two approaches were implemented by The Office of Water: (i) short-term response by sending the water down the Goodradigbee River and (ii) long term response by developing water sharing plan rules that protect the environmental releases in the upper Murrumbidgee.  The Water Sharing Plan for the Murrumbidgee Unregulated Water Source, which covers the Murrumbidgee River above Burrinjuck Dam, is at an advanced stage of development, and a draft plan will soon be released for public comment.  Discussions have occurred between NSW and the ACT to develop and implement appropriate protection for flows released from Tantangara Dam.
5	'Fund, commit to and implement a flow response monitoring program. A two tier approach to flow-response monitoring is suggested as a cost-effective model that separates long-term trend and contextual information from short-term flow related responses and tracking the status of listed aquatic species'	Funds are not currently available for the Office of Water to implement a comprehensive monitoring program.  Funds targeted for the upper Murrumbidgee are being used to address issues raised by the SSC on the Mowamba River.  The Office of Water has sought additional funding to progress the Montane Rivers Program.
6	'Schedule a review process for flow objectives and ecological priorities within the next five years, for 2015.'	The Office of Water acknowledges that the environmental objectives in the SWIOID need to be revised to include new information. This has been previously identified by the Office of Water. The Office will propose new environmental objectives to be considered by the major stakeholders.
7	'Develop a means for integrating the various demands on Tantangara releases whilst optimising flow release for environmental benefit'	The Office of Water is aware of this issue and has been actively discussing release strategies with the ACT and Commonwealth governments.

The Office of Water acknowledges that the condition of the Murrumbidgee River below Tantangara is poor and is subject to a highly disturbed hydrological regime. Regulated flows no longer represent the characteristics of a montane river, i.e. pronounced spring snow melt signals, and stable winter base flows (unpublished data from Kennard *et al.* 2010). Re-instatement of these montane river flow characteristics are part of the desired outcome of the Snowy Montane River Increased Flows. However, changing the allocations as listed in Table 1 of the SWIOID needs to be undertaken as part of a whole of system assessment to ensure that the water is used in the most effective manner. Allocating water planned to be released to other montane rivers to the Murrumbidgee River may limit or adversely hinder the recovery of these other montane rivers. The SSC has recommended increased allocations to the upper Murrumbidgee River. The Office of Water will consider this issue with the Snowy Water Technical Advisory Group which includes the Snowy Scientific Committee.

## Introduction

The Snowy Mountains Hydro Electric Scheme altered the hydrology of many of the montane rivers in the Snowy Mountains. In the upper Murrumbidgee at Tantangara, 290GLy<sup>-1</sup> is diverted via an inter-basin tunnel to Lake Eucumbene (Ghassemi and White 2007) (Figure 1), historically resulting in 99 per cent of the average natural annual stream flow at this site being delivered from the river (Figure 2). The reduction in river flows has resulted in a significant reduction in river condition (Pendlebury *et al.* 1997; Marchant and Hier 1997; Davies *et al.* 2008) including the loss of hydraulic habitats and severe sedimentation of the riverbed, including infilling of riffles (Figure 3).

In order to improve river condition in the upper Murrumbidgee catchment, the SWIOID (2002) requires two environmental water allocations of up to 27 GLy<sup>-1</sup> (30% MANF) to the Murrumbidgee River below Tantangara and 12 GLy<sup>-1</sup> (78% MANF) to the Goodradigbee River as part of the montane river releases. Environmental flows to these rivers in the upper Murrumbidgee and Goodradigbee Rivers commenced in 2005. These releases are part of a wider program of environmental releases to montane rivers affected by the Snowy Scheme.

The Snowy Scientific Committee undertook a review of the adequacy of environmental flows to the upper Murrumbidgee River (SSC 2010). The review identified key issues and proposed seven recommendations dealing with the management of environmental flows from Tantangara Dam to the upper Murrumbidgee River.

This report provides a formal response to the Snowy Scientific Committee review in terms of key issues identified and the recommendations.

Figure 1. The upper Murrumbidgee River catchment showing the major water diversion structures. On average  $290 \text{ GLy}^{-1}$  are diverted from the upper Murrumbidgee at Tantangara to the Snowy Scheme (Ghassemi and White 2007).

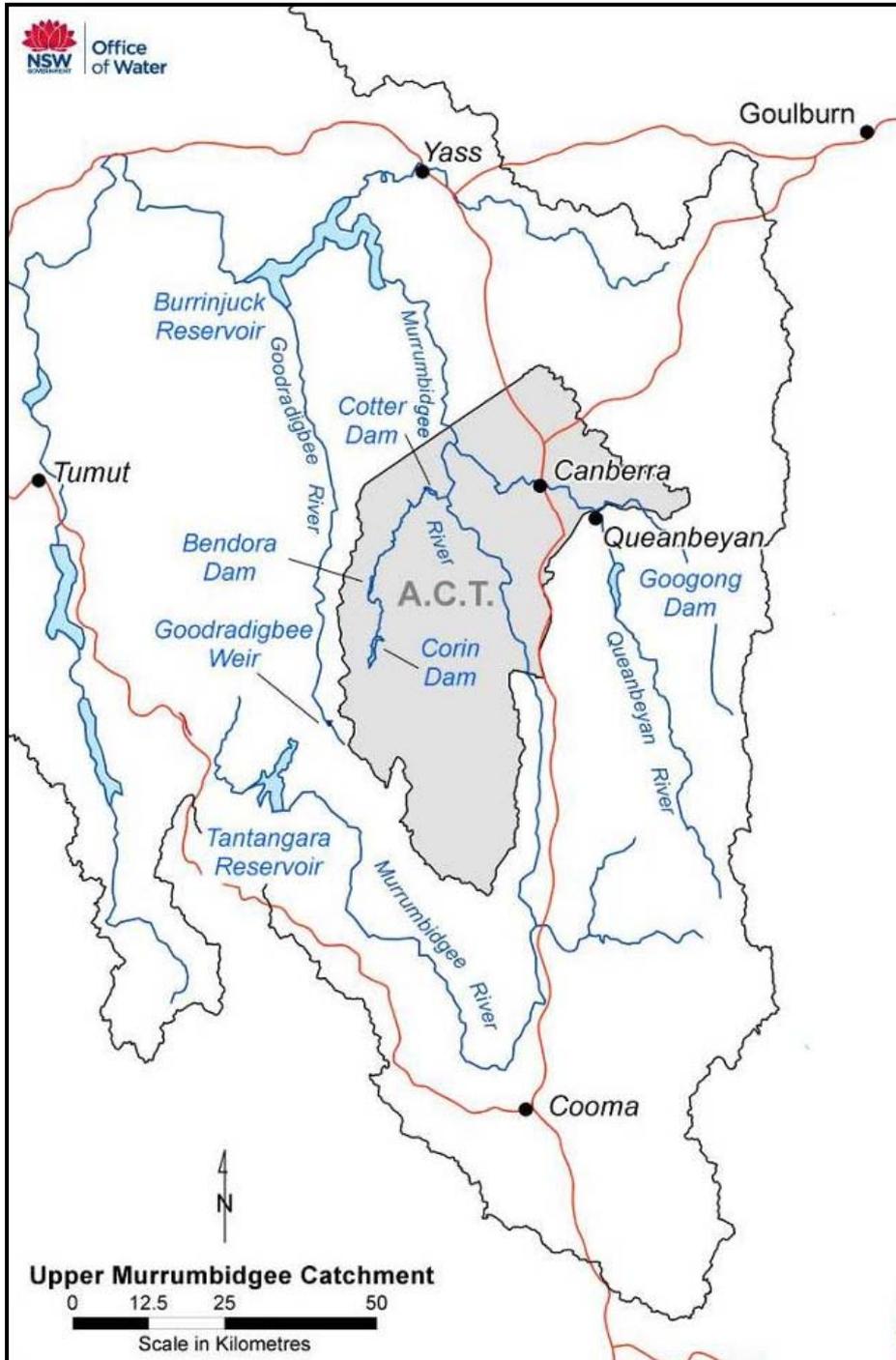


Figure 2. Modelled natural (grey) and current (black) flow in the upper Murrumbidgee River below Tantangara Dam, 1950 to 2005.

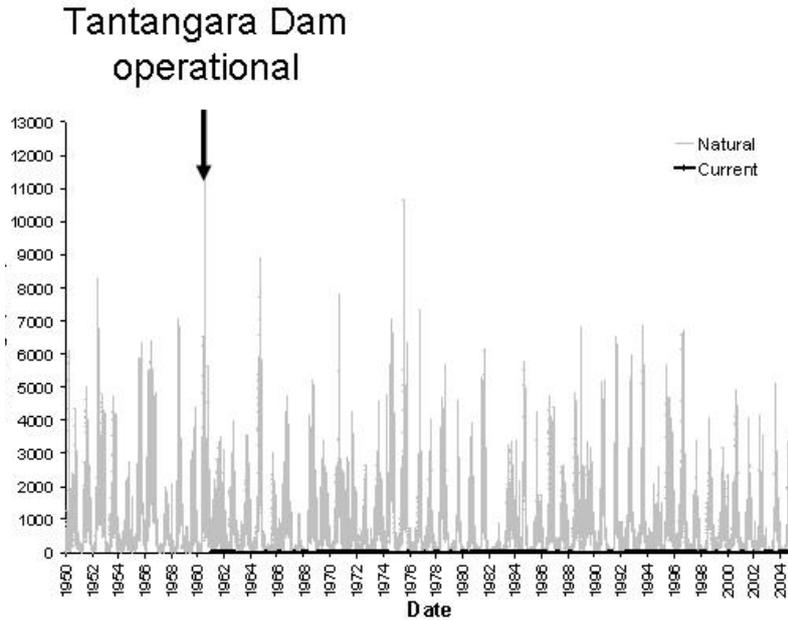


Figure 3. Comparison of the upper Murrumbidgee River with the unregulated upper Eucumbene River. Note the loss of hydraulic habitats in the Murrumbidgee River and the poor condition of riverbed downstream of Tantangara.



## Response to key findings of the Snowy Scientific Committee

### Environmental flow implementation

#### 'Only one of five previous flow recommendations implemented'

During the past 10 years south-east NSW including the Snowy Mountains experienced a period of record drought, resulting in much lower volumes of water availability in the western rivers that receive water from the Snowy Scheme. This has meant that the volume of water available against entitlements recovered for release under the program (Table 2) has been lower than the target release volumes in the Snowy Water Inquiry Outcomes Implementation Deed (SWIOID) 2002 and the Snowy Water Licence.

**Table 2. Environmental releases to Snowy montane rivers, 2005-2010. All values are in GL.**

Year	Targeted Releases					Actual Releases					Over/ Under
	SRIF	Tant.Dam	Goodr.	Total Montane	BPF	Tant.Dam	Goodr.	Total Montane	BPF	Total	
2002/05	0	0	0	0	Up to 2	0	0	0	9.3	9.3	3.3
2005/06	38	6.5	6	13.8	Up to 2	7.6	4.5	12.1	0	12.1	-1.7
2006/07	38	6.6	7	15.5	Up to 2	7.4	3	10.4	3.7	14.1	-5.1
2007/08	33	14.4	0	17.1	Up to 2	17.3	0	17.3	0	17.3	0.2
2008/09	38	6.6	7	13.6	Up to 2	6.5	4.7	11.2	5.7	16.9	-2.4
2009/10	38	4.2	12	16.2	Up to 2	4.3	7.3	11.6	3.2	14.8	-4.6

Note: Target SMRIF flows for individual sites did not sum to total target in first three years, as the total targets shown here were modified subsequently to reflect agreed accounting of overs/unders, and treatment of Base Passing Flows during drought.

During this initial period of lower than expected water availability, releases were made to the Goodradigbee and Murrumbidgee Rivers as civil works were completed. The initial releases have been made ahead of the development of a comprehensive strategy for montane releases, and ahead of the availability of information from the Snowy Flow Response Monitoring and Modelling.

Prior to the 2008-09 water year, Office of Water scientists reviewed previous release strategies, and demonstrated the need to change the release strategy to the upper Murrumbidgee River system. Given the available water and the condition of the two rivers the Goodradigbee River was deemed to have a more responsive habitat than the Murrumbidgee River for the water available (Appendix A). In the case of the Goodradigbee River a release that mimicked the natural flow pattern was able to be achieved (i.e. 100% transparent) during the low flow period, and sufficient water was available to inundate the higher quality riffles of the Goodradigbee River (Figure 4).

The endangered Macquarie Perch requires a clean riffle substrate for laying eggs and is susceptible to silt (NSW Fisheries 2001), so by providing water to inundate riffles (i.e. a habitat susceptible to drying out) it was deemed that greater protection of the life cycle requirements of the fish could be achieved in the Goodradigbee River. This proposed outcome was intended to be consistent with the stated objectives of the SWIOID (2002), of protecting threatened species and protecting national park values.

Much more water was required to get a similar response in the upper Murrumbidgee given the poor condition of the riffles. It was not deemed practical with the available water to make a significant improvement in riffle condition. The focus of the release strategy was on protection first then rehabilitation, which is consistent with the conservation triage approach of Bottrill *et al.* (2008).

**Figure 4. Inundation of riffles in the Goodradigbee River during the 2008-2009 water year.**



Therefore, future assessments of water released to the Murrumbidgee River needs to be placed in a broader context of providing environmental water to both the Goodradigbee and the upper Murrumbidgee rivers. There is no dispute that the hydrology of the upper Murrumbidgee is significantly impaired and components of the rivers hydrology needs to be re-instated. With greater water available rehabilitation of the upper Murrumbidgee River needs to be considered in the context of protection and then rehabilitation of high quality habitat.

The rationale for the 2009 spring release to the upper Murrumbidgee River is outlined in Appendix A.

**Figure 5. Upper Murrumbidgee River post the 2009 spring release. As expected, limited sediment scour was observed in the reach below Tantangara dam. Note the heavy silt cover of the river substrate, but minor scour was observed in one location in the reach below Tuntangara.**



### 'Riparian releases may be contributing to maintaining of summer baseflows, short term variability'

The Office of Water agrees with this conclusion.

Further field based assessments coupled with modelling are required to determine an adequate low flow regime.

## Monitoring

### 'No securely funded monitoring project'

Funding of monitoring, research and modelling of the Snowy montane rivers is important to develop and provide feedback on release strategies. However, funds available for the Murrumbidgee River must be balanced against information requirements of all rivers in NSW.

The Office of Water has allocated funds to the Snowy montane rivers to develop a flow response monitoring and modelling program. Studies have commenced in the Snowy Montane Rivers program, which assess water quality response to flow releases (Figure 6; Bevitt and Williams 2010).

Subsequently, the Snowy montane rivers budget had to be re-allocated to address key research activities as identified by the SSC in the Mowamba River. Studies have commenced to assess the importance of the Mowamba River as an option to rehabilitate the Snowy River.

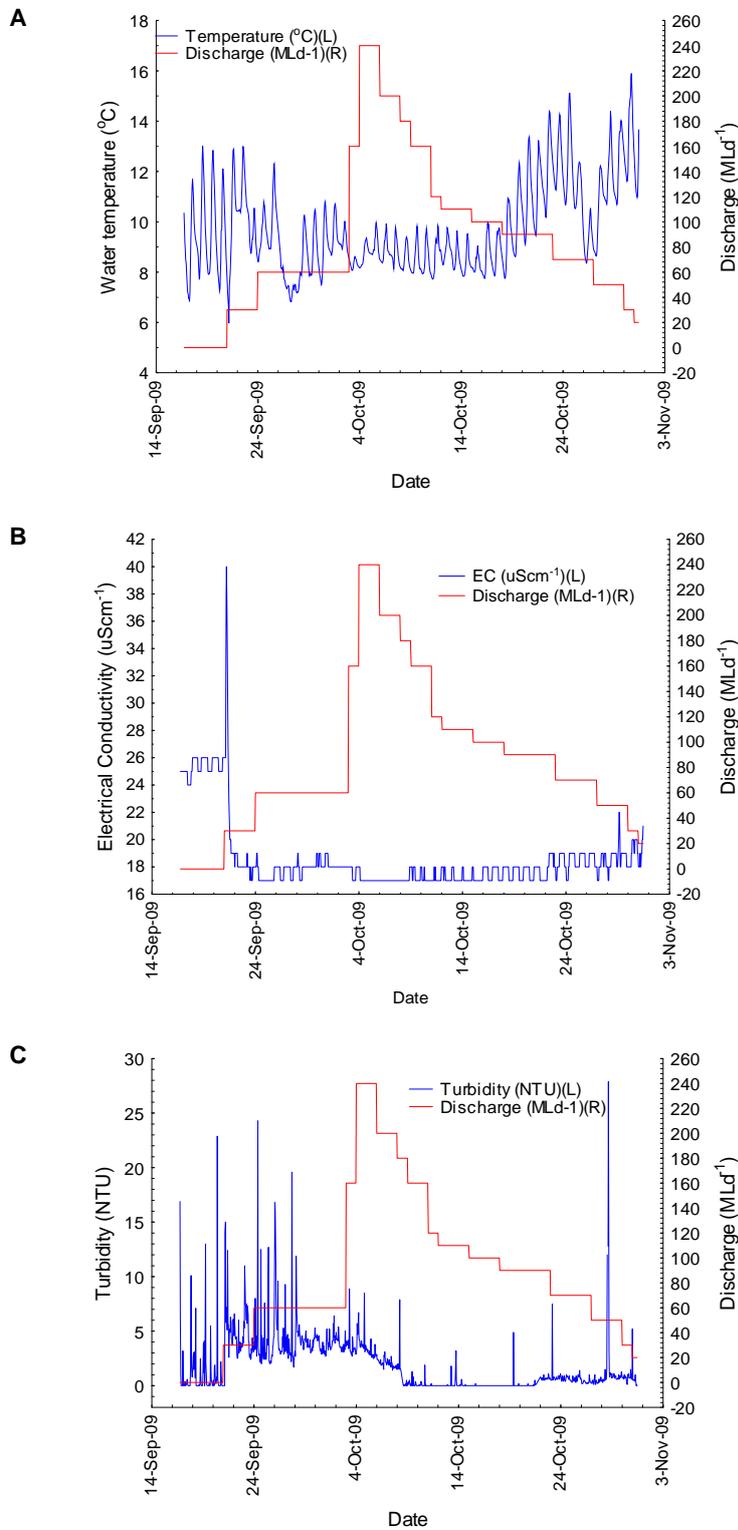
The Office of Water has been exploring alternative arrangements for additional funding the Montane Rivers component of the Snowy Flow Response Monitoring and Modelling program, in the Murray, Murrumbidgee and Snowy catchments. These alternative arrangements include potential joint projects with the Australian and ACT Governments and funding bids with other research agencies.

### 'Scope of existing studies are not directly related to the objectives of the Snowy Water Inquiry Outcomes Implementation Deed'

The Office of Water has been scoping studies to address the biodiversity objectives of the SWIOID, and this was partly the reason for the review undertaken by Williams and Russell (2009) to identify key aquatic biodiversity management issues. This review involved searching the literature, data bases and involved detailed interviews with national aquatic experts to prioritise the aquatic biodiversity management issues.

The review identified key biodiversity issues and prioritised these issues, for example, using environmental flows to protect available habitat for Macquarie Perch. The Office of Water has been scoping projects to address the assessment of geomorphic change in riffles and the response of Macquarie Perch to environmental flow releases, including the collection of data to assess movement of fine silt movement during the Spring 2009 event (Figure 6). The Office of Water has also submitted external funding applications with other research organisations. The implementation to date has been limited by available funding.

Figure 6. Changes in water quality variable (A) water temperature, (B) electrical conductivity and (C) turbidity associated with a spring 2009 flow release to the upper Murrumbidgee. (Source Bevitt and Williams 2010).



**'Existing state-wide condition monitoring inappropriate to measure flow response'**

The Office of Water agrees with the SSC that the existing state-wide resource condition monitoring programs are not suitable for assessing responses to environmental flow allocations. The state-wide resource condition monitoring programs were designed for another purpose.

### 'No integration of monitoring data'

The Office of Water has commenced the development of the montane rivers component of the Snowy Flow Response Monitoring and Modelling program. The NSW Government intends that this program be the main focus for monitoring, modelling and undertaking research for the Snowy montane rivers. Issues about data sharing and availability have commenced between key data holders and the Office of Water. A formal data sharing agreement exists between Snowy Hydro and the Office of Water and has been implemented.

The Office of Water has been collating relevant information (Williams and Russell 2009) and data available for the Snowy montane rivers. For example, the Office of Water on behalf of Snowy Hydro has reviewed the water quality data for the upper Murrumbidgee (Bevitt 2010).

Additionally, the Office of Water has compiled all of the available hydrological data for the Snowy Mountains, and commenced a regional scale analysis of this hydrological data, including an assessment of long term trends in hydrology.

The Office of Water has recognised this issue and has been actively interacting with key stakeholders to re-use the available data to improve the understanding of the Snowy montane rivers.

## Governance arrangements

### 'Void in Water Management'

The Office of Water disagrees with the SSC that there is a void in water management in the upper Murrumbidgee River catchment. There are currently both existing programs as well as a number of areas where water management arrangements are being developed in response to the commencement of environmental releases from Tantangara Dam. Many of these latter arrangements require significant lead times to allow for coordination between governments, and consultation with local communities.

The following water management related activities are occurring in the upper Murrumbidgee River Catchment:

**Development of a water sharing plan for the upper Murrumbidgee.** Water sharing plans such as that currently being developed for areas in the Murrumbidgee Valley outside of the regulated river system below Blowering and Burrinjuck Dams are complex and require significant consultation with stakeholders across an area much larger than the reaches to the Murrumbidgee River above the ACT. The draft plan is scheduled for public exhibition in 2011 following nearly two years of preparatory work by the NSW Office of Water.

**Implementing the NSW and ACT cross border water agreements.** The upper Murrumbidgee River is also shared with the ACT. NSW and the ACT have negotiated a number of complex regional water sharing arrangements over the last five years, including the ACT – NSW Regional Management Framework (2006), Cross Border Water Resources MoU (2006) and the Queanbeyan Water Supply Agreement (2008). As part of the ACT's water security initiative, arrangements for additional releases from Tantangara Dam to the ACT, via the Murrumbidgee River are currently being negotiated. Whilst the primary function of these bulk water releases is to ensure the security of water supply for the greater Canberra area, these additional releases have the potential to provide impacts (positive or negative) to the environment.

**Murray-Darling Basin Agreement.** NSW is a major player in the management of the Murray-Darling Basin; 56 per cent of the Basin is in NSW. Flows from the Snowy Hydro Scheme into the Murray and Murrumbidgee Valleys is a significant contribution to water availability in each valley and are actively managed by the Office Of Water and State Water.

**Establishing and implementing two Snowy management working groups.** The Snowy Government Officials Committee and Snowy Water Technical Advisory Group were established specifically to improve communication and management between the NSW, Victorian and Commonwealth Governments in matters relating to the Snowy Scheme.

**Management of water access licences.** The Office of Water implements the management of water licences such as the Snowy Water Licence, water access licences in the upper Murrumbidgee and assists in the management of town water supply for Cooma.

**Provision of aquatic science advice to the Australian Alpine National parks.** The Office of Water assists with the provision of aquatic science advice to assist with aquatic biodiversity management in the high country.

It is likely that the next 18 months will see the culmination of many of the activities in the upper Murrumbidgee River, including the implementation of a water sharing plan, significantly larger environmental releases than those seen to date, and increased cooperative management of flows between NSW and the ACT.

The development of a Snowy Montane Rivers Strategy by the Office of Water, as envisaged in the SWIOID, is continuing, and will be another important step in water management for this area.

Continuing advice from the SSC will complement the Office of Water's ongoing activities in the upper Murrumbidgee River.

## Response to recommendations

The NSW Office of Water has considered the recommendations of the Snowy Scientific Committee and provided the following response to the seven recommendations regarding the adequacy of environmental flows to the upper Murrumbidgee River.

### Hydrology and hydraulics

#### Recommendation 1: 'Re-instate the gauge at Yaouk.'

Reinstatement of the former river flow gauge at Yaouk as recommended by the report would assist in understanding the hydrology of the Murrumbidgee below Tantangara. The Yaouk gauge (GS 410052) has an archival record of flows from 1939-63, and this period may be useful for guiding development of more natural environmental flow regimes below Tantangara Dam.

The installation of a gauge alone may not be sufficient to understand the nature of losses in the Murrumbidgee River below Tantangara and Yaouk. Additional gauging at various locations within the reaches between Tantangara and Yaouk may also be required.

The Office of Water has previously identified the need to re-instate a hydrometric station in this reach of the upper Murrumbidgee River and has gained funding to upgrade the hydrometric network. It's not possible to re-instate the gauge at the same location, but site selection and negotiations with land holders are completed. It is anticipated that a new gauge will be installed by July 2011 and that a temperature logger will also be installed to address the issue of the thermal regime of the river.

#### Recommendation 2: 'Accelerate the development of a hydraulic model for the upper Murrumbidgee River, and in particular from Tantangara Dam to Mittagang Crossing.'

The recommendation for accelerated development of a hydraulic model between Tantangara Dam and Mittagang Crossing is noted. The report does not consider the resourcing and logistics required to develop a detailed hydraulic model for such a long river reach capable of depicting the effects of decimetre to sub-decimetre changes in water level resulting from changes to environmental flows. On the basis of its internationally regarded experience in hydraulic modelling of environmental flows (Reinfelds *et al.* 2004, Haeusler and Bevitt 2007; Reinfelds *et al.*, 2010, Reinfelds and Williams 2011), the NSW Office of Water suggests that it will be more cost effective to capture LiDAR data over the entire reach and then using these and other GIS data, divide the reach into geomorphic smaller units based on channel gradients, geomorphological characteristics and geological boundaries and then develop a series of shorter hydraulic models.

The report also does not recommend whether a 1D (HEC-RAS) or 2D (River2D) or combination 1D-2D hydraulic modelling approach is required. The NSW Office of Water is well placed to advise the Snowy Scientific Committee of the best approach for hydraulic modelling of environmental flows in the Murrumbidgee River below Tantangara Dam.

The NSW Office of Water has commenced topographic survey to aid the development of a hydraulic model for the reach of the upper Murrumbidgee River most affected by Tantangara Dam.

A project brief for the acquisition of LiDAR was established in 2009-10 and quotes were sought for the Snowy, Mowamba and upper Murrumbidgee Rivers. Given the cost of LiDAR, the agency could only support the purchase the LiDAR for the Snowy and Mowamba Rivers at that time. The NSW Office of Water is proposing to collect LiDAR for the upper Murrumbidgee River.

## Environmental release

**Recommendation 3: 'Explore possibilities for sharing SMRIF amongst the four montane rivers with the view to substantially increasing the proportion and hence also the volumetric allocation to the upper Murrumbidgee River.'**

The NSW government agrees that exploration of volumetric allocations amongst the Snowy montane rivers should be reviewed, in the context of making the best use of the available water. This is proposed through the development of a Montane Rivers Strategy, which is a requirement of the SWIOID. The Office of Water has commenced development of the Strategy, but there is further work required to fully consider the needs of the montane rivers nominated in the SWIOID. This Snowy Scientific Committee recommendation pre-empts the evaluation of the outcomes and risks to the other Snowy montane rivers.

The flow objectives in the SWIOID for both the Snowy River and the Snowy montane rivers need to be revised to incorporate more contemporary information (see discussion of recommendation 6, below). This recommendation also pre-empts the SSC's recommended review of river objectives for the Snowy montane rivers.

The proposed additional allocation of water to the Murrumbidgee River needs to be considered in a broader context of the needs of all the Snowy montane rivers. This should form the basis of the review of Table 1 of the SWIOID. These broader discussions have already commenced between Snowy Hydro Limited and the Office of Water to achieve the best environmental value for the water available, particularly given an improved understanding of these montane rivers and to ensure the expected outcomes can be achieved with the available water. This is expected to form part of the Montane River Strategy.

**Recommendation 4: 'Protect environmental releases first, by accelerating the development of water sharing plans: and second, by developing means for protecting environmental releases from consumptive use.'**

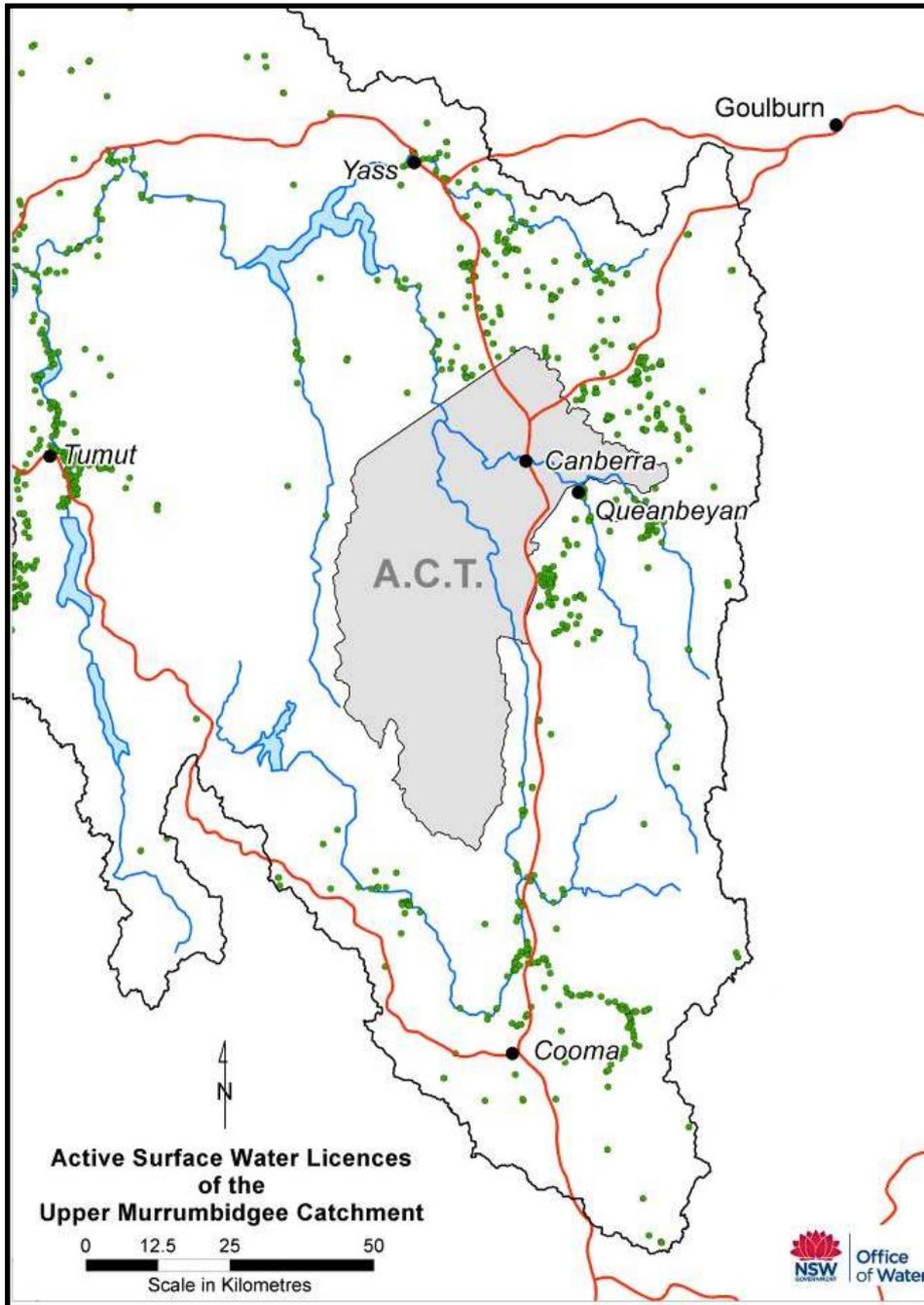
The issue of protecting environmental releases from Tantangara Dam has previously been identified by the Office of Water and discussed with the Snowy Scientific Committee. Two strategies have been employed by the Office of Water:

- i. short term response – the environmental water was released to the Goodradigbee River in 2008-2009 (see attachment A), and;
- ii. in the longer term – the establishment of a water sharing plan, that protects the environmental releases from Tantangara Dam from unregulated water access licence holders. The water sharing plan will provide a regulatory mechanism for the protection of environmental flows. The Murrumbidgee Water Sharing Plan will be exhibited in 2011 and is planned for gazettal by the end of 2011.

There are currently 448 unregulated water access licences, with 23.3 GL/year of entitlement in the upper Murrumbidgee River catchment in NSW (excluding the ACT) (Figure 7). Peak daily diversion rates are 217.9 MLd<sup>-1</sup> for all water sources above Burrinjuck Dam. The majority of these licences are irrigation 17,969 ML (77%), with town water licences comprising the second highest allocation 4,191 ML (18%). Within the Murrumbidgee I and Murrumbidgee II sub-catchments, there are 99 licences with 10,662 ML of entitlement per year (excluding the ACT). These access licences pose a potential risk that environmental water released to the Murrumbidgee River will be diverted for consumptive use. The protection of environmental flows is part of the development of concepts of 'water shepherding' being progressed by the NSW Office of Water and the Australian Government.

The protection of a portion of the river flows (the environmental flows released from Tantangara Dam in this case) is a complex issue. There will most likely be other tributary inflows occurring along the river that water users currently rely on for their irrigation enterprises and are entitled to divert. This issue is currently being considered in a number of NSW rivers. An approach is being developed in NSW to deal with the issue of protecting environmental water releases from consumptive uses. This work will be important to the operation of the Water Sharing Plan for the Upper Murrumbidgee River.

**Figure 7. Surface water licences in the upper Murrumbidgee River catchment. The Murrumbidgee I and II sub-catchments are those that contain the main stem of the river between Tantangara and the ACT.**



## Ecological management

Recommendation 5: 'Fund, commit to and implement a flow response monitoring program. A two tier approach to flow-response monitoring is suggested as a cost-effective model that separates long-term trend and contextual information from short-term flow related responses and tracking the status of listed aquatic species.'

The NSW Office of Water allocates a budget to a range of monitoring, research and modelling activities for the assessment of environmental water allocations, these activities are (i) measurement of long term changes in the river systems, (ii) better understanding the mechanisms of ecological response via short term research projects and (iii) the development of predictive capacities via modelling to further assist water allocation strategies. This strategy has been implemented for many years, in the four flow response monitoring programs in NSW (e.g. Regulated rivers, Unregulated rivers, Metropolitan rivers and the Snowy and montane rivers). The allocation of effort is dependent on the specific management questions being addressed.

Using this above strategy the NSW Office of Water has started to develop the Snowy Flow Response Monitoring and Modelling program for the Snowy Montane Rivers. To date the following investigations by The Office of Water have occurred in the upper Murrumbidgee below Tantangara:

- A short review of the water quality data for the Tantangara Dam (Bevitt 2010) was prepared on behalf of Snowy Hydro Limited.
- A water quality assessment of the spring 2009 release from Tantangara Dam (Bevitt and Williams 2010).
- Field topographic survey of the most hydrologically disturbed reach of the Murrumbidgee River, including mapping of water inundation patterns for different flow rates for the 2009 spring release.
- Invertebrate sampling using rapid assessment and qualitative techniques above and below Tantangara Dam.
- Additionally, studies had started to be scoped that look specifically the requirements of Macquarie Perch, including measuring a response to larger spring releases and expected changes in riffle habitat condition as per the review by Williams and Russell (2009). These studies ceased as resources that were planned to further develop the Snowy Flow Response Monitoring and Modelling Program for the Montane Rivers have been re-directed to address the request by the Snowy Scientific Committee to investigate the Mowamba River.

Available resources have been directed to priority areas including those identified by the SSC.

Recommendation 6: 'Schedule a review process for flow objectives and ecological priorities within the next five years, for 2015.'

The flow objectives in the SWIOWID for both the Snowy River and the Snowy montane rivers need to be reviewed. The current flow objectives need to incorporate more contemporary information. The objectives also need to define the expected outcomes of releases to both the Snowy and montane rivers.

The issue of revising the environmental objectives has been previously raised by the Office of Water with the Snowy Scientific Committee, and the Office of Water will be undertaking a review to provide greater certainty regarding ecological priorities for environmental water and to direct investment for future infrastructure upgrades.

Some of the ecological constraints that are likely to limit the ability of the montane rivers (including the upper Murrumbidgee River system) to recover need to be further explored as these constraints will influence the likely outcomes of future environmental water allocations.

**Recommendation 7: 'Develop a means for integrating the various demands on Tantangara releases whilst optimising flow release for environmental benefit.'**

The NSW Office of water is currently in discussions with the ACT Government and Australian Governments regarding environmental releases and bulk water transfers from Tantangara Dam. In other rivers in NSW bulk water transfers have the capacity to adversely influence the outcomes of environmental water allocations.

The primary purpose of future bulk water releases will be to secure urban water needs for the greater Canberra region, and environmental issues will need to be balanced against these requirements.

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## Appendix A. Previous Office of Water decisions to release environmental water to Snowy montane rivers in the Murrumbidgee River catchment.

In the 2008-09 water year, Office of Water scientists recommended sending the majority of available Snowy montane river increased flows to the Goodradigbee River rather than the Murrumbidgee River. This was undertaken for the following reasons:

The principle of protecting good habitat first rather than expending limited water on a highly degraded ecosystem was applied.

The Goodradigbee River has a higher capacity for recovery than the Murrumbidgee River as the in-stream habitat was in good condition, highly connected and only lacked water, whereas much larger volumes of water than available would be required to improve the condition of the bed of the Murrumbidgee River, particularly the maintenance of riffle habitat.

The Goodradigbee Weir would have less influence on downstream water quality than compared to the Tantangara Dam has on the Murrumbidgee River, thus providing a better quality water to the montane river.

The Goodradigbee Weir overtops and would nominally allow for downstream drift of aquatic plants and animals and carbon, thus it would not act as a severe physical barrier like Tantangara Dam. This is consistent with the Snowy Scientific Committee's argument for the use of the Mowamba River to aid recovery of the Snowy River.

The low flows were targeting the protection of riffle habitats by ensuring that they were inundated. Macquarie Perch lay eggs in riffles, and it is expected that a higher recruitment success would occur in riffles with low levels of silt. Thus meeting the objective in the SWIOID regarding protecting endangered species. The riffles in the Upper Murrumbidgee were deemed to be in too poor condition for the amount of water available to make any significant improvement. It is expected, that regular environmental flows greater than 1,000 Mld<sup>-1</sup> would be needed to improve the condition of the riffles in the upper Murrumbidgee.

The flows in the Goodradigbee River were less likely to be extracted with 875 Mly<sup>-1</sup> of entitlement in the lower river compared to 10,662 Mly<sup>-1</sup> of water access entitlement in the upper Murrumbidgee (sub-catchments I and II). Policies to protect the environmental releases still needed to be developed so as to protect the base flow releases particularly.

Increased flows in the Goodradigbee could potentially influence the transparency rules in Burrinjuck Dam, so potentially some of the environmental could be released further down the Murrumbidgee River system.

The remaining water was released into the Murrumbidgee River as a spring release, with a peak of approximately 250MLd<sup>-1</sup>. Although, insufficient to do any significant work of the riverbed, the rise was in the realm of allowing small scale fish movement over riffles and runs. The longer tail was intentional in that from fish movement studies by The Office of Water, it is apparent that native fish use the tail of the hydrograph for local scale movement and large scale migration.

Using the limited available water in this case, in a highly degraded river system, to increase base flow was not seen as the optimal environmental use of the water. This was based on past studies environmental flows in NSW, that show by just increasing the base flow does not lead to an improvement in condition, particularly if large flows are required to management a key constraint to recovery such as sediment deposition.