MURRUMBIDGEE SURFACE WATER RESOURCE PLAN

Permitted Take Method for the Murrumbidgee (SS15)

Appendix B to Schedule F

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Andrew Davidson, Senior Modeller, NSW Department of Industry—Lands and Water

Abstract

The Basin Plan requires that every Water Resource Plan includes a method to calculate how much water may be taken in any water year. In the Murrumbidgee, this will be a combination of modelled and unmodelled forms of take. For the modelled forms of take, a method based on a model that represents the current behaviour of the system, in combination with a scaling step, will be used that will keep the permitted level of take at the sustainable diversion limit. For the forms of take currently without a model, it is proposed to use a long-term mean annual estimate of the take, as it was at the appropriate baseline level, as the annual permitted take.

On the basis that the local reduction amount in the Murrumbidgee is 320.0 GL/a, the shared reduction is 277.9 GL/a, and the SDL adjustment is 145.5 GL/a, the following results were obtained:

Form of take	Mean annual permitted take 1895-2009 (GL)
From a regulated river (excluding basic rights and D&S)	1630.9
From a watercourse	42.4
By floodplain harvesting	0.0
By runoff dams (excluding basic rights)	344.0
By runoff dams under basic rights	41.0
Net take by commercial plantations	116.0
From a regulated river or watercourse under basic rights	6.0
From a regulated river under domestic and stock licences	28.9
Total	**2209.2**

This report is written to inform readers, meet Basin Plan requirements, and to document the process for monitoring compliance with the Sustainable Diversion Limit.

Contents

Glossary

Term	Definition
APT	Annual permitted take
BDL	Baseline diversion limit (under the Basin Plan 2012)
Cap	The Murray–Darling Basin Ministerial Council cap on diversions
EFRG	Environmental Flows Reference Group
EWA	Environmental water allowance
ECA	Environmental contingency allowance
FPH	Floodplain harvesting
GL/a	Gigalitres per annum (year)
IQQM	Integrated Quantity and Quality Model
LTAAEL	Long-term average annual extraction limit
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
MDBSY Project	Murray–Darling Basin Sustainable Yields Project
PBP	Pre-Basin Plan
SDL	Sustainable diversion limit
WMA	*Water Management Act 2000* (NSW)
WRP	Water resource plan
WSP	Water sharing plan

Introduction

The Basin Plan 2012

The Murray-Darling Basin Plan 2012 (Cwlth), which was established under the *Water Act 2007* (Cwlth), has defined an environmentally sustainable level of take (or extraction) for each water resource unit in the Murray–Darling basin. These environmentally sustainable levels of take have been specified as long-term mean annual values, over a standard period of historical climate conditions (July 1895 to June 2009), of consumptive take and are called Sustainable Diversion Limits (SDL).

The water resource plans (WRP) developed as part of the Basin Plan process are required to include a mechanism to ensure that the long-term mean annual consumptive take would not exceed the SDL over a repeat of the standard period. Specifically, that this level of take would not be exceeded over a chosen reference period, given known development and the water sharing plan (WSP) rules in place. The compliance mechanism is a combination of a permitted take method, the *Sustainable Diversion Limit Reporting and Compliance Framework* (MDBA 2018b), and clauses in relevant WSPs that give effect to the first two parts.

Relationship between BDL and SDL

The SDL is most commonly referred to as a reduction in consumptive take from a baseline level. In the Basin Plan this baseline level of take is called the BDL (baseline diversion limit) and is defined as the long-term mean annual consumptive take that would have occurred if a valley was at the conditions on 30 June 2009 over the standard climate period (1895 – 2009). It can be applied on the basis of one SDL resource unit, such as the Murrumbidgee surface water SDL unit (SS15), or multiple SDL resource units. The statement “the SDL is 2750 (GL/a)” means that it is 2750 GL/a below the BDL for the whole of the Murray-Darling basin. Or, in a more general sense:

$$\overline{SDL} = \overline{BDL} - Required\_SDL\_Reduction$$

The bars over the SDL and BDL indicate that these are long-term mean annual values.

Modelled and unmodelled forms of take

The SDL for a SDL resource unit includes consumptive take by traditional diversions from regulated watercourses, take from unregulated watercourses, and interception activities in the catchment. The interception activities[1] are runoff dams (a reservoir that collects surface water flowing across land) and commercial plantations, both of which have potential to affect water availability in a valley if their level of development increases (CSIRO 2006). In the Murrumbidgee, the risks of these interception activities significantly increasing have been assessed as ‘low’ (see section 5.7 and Schedule D).

NSW has used a risk-based approach to concentrate on the traditional forms of diversion and as a result these are well measured and modelled, for the purposes of management. The other forms of take are relatively small, diffuse, do not change quickly; and are difficult, if not impossible, to directly measure. This leads to two forms of take: modelled and unmodelled. Unmodelled take uses estimates based on the best available information, for example, as calculated in the Murray–Darling Sustainable Yields Project (CSIRO 2008).

Expression of the SDL on an annual time step

To manage extraction in an SDL resource unit, the SDL needs to be expressed as a series of expected annual values that can be compared to what actually happened in that accounting period.

[1] There are other interception activities that are not significant in the Murrumbidgee such as floodplain harvesting and interception by mining activities, including coal seam gas mining.

In the Basin Plan, these annualised values of the SDL are called the annual permitted take (APT). The APT is required as the SDL is a long-term mean annual value and actual take varies from year to year as a result of variation in water user behaviour due to seasonal conditions, commodity prices and other factors.

If a fixed value for APT is used, then in years with good resource availability a valley would appear to be over the SDL even though irrigation development had not increased. This would trigger an intervention through the SDL compliance framework, despite the fact that in the long term extraction in the valley is under the SDL.

An ideal APT method will reproduce the long-term mean annual SDL over the reference period as required by the Basin Plan and also accurately describe year to year variations caused by the seasonal conditions of that year. This will help reduce the number of 'false positives' compliance events where an SDL compliance intervention is triggered despite there being no increase in development or systematic growth in use.

Purpose of this report

This report:

1. Provides readers with an explanation of what the permitted take method is and why it is required
2. Explains the theory behind the proposed method for modelled forms of take; to justify the adoption of the method against the requirements laid out in the Basin Plan
3. Describes the steps required to apply the method in enough detail that the process may be reproduced.

What is required of a permitted take method

The Basin Plan has two sections that specify what a permitted take method is required to do and what that method has to take into account.

Requirements under section 10.10 of the Basin Plan

Section 10.10 of the Basin Plan specifies what the method needs to do:

> *10.10 Annual determinations of water permitted to be taken*
>
> *(1) For each SDL resource unit in a water resource plan area, and for each form of take, the water resource plan must set out the method for determining the maximum quantity of water that the plan permits to be taken for consumptive use during a water accounting period.*
>
> *(2) The method for subsection (1) may include modelling, and must be designed to be applied after the end of the relevant water accounting period, having regard to the water resources available during the period.*
>
> *(3) The method must:*
>
> *(a) account for the matters in subsection 10.12(1); and*
>
> *(b) be consistent with the other provisions of the water resource plan.*
>
> *(4) The plan must also set out a demonstration that the method relates to the SDL of each resource unit in such a way that, if applied over a repeat of the historical climate conditions, it would result in meeting the SDL for the resource unit, including as amended under section 23B of the Act.*
>
> *(5) If, as a result of an amendment under section 23B of the Act, the SDL for a surface water SDL resource unit is expressed as a formula that changes with time, the SDL for subsection (4) is taken to be:*

(a) for a water accounting period beginning on or after 1 July 2019—the SDL as it stood on 30 June 2019; and

(b) for a water accounting period beginning on or after 1 July 2022—the SDL as it stood on 30 June 2022; and

(c) for a water accounting period beginning on or after 1 July 2024—the SDL as it stood on 30 June 2024.

This section requires the water regulator (Department of Industry Water) to include in the WRP a method to determine the volume of consumptive take that is allowed in the Murrumbidgee SDL resource unit (SS15) during a particular water year. The method can include modelling and it must produce a long-term mean annual value that is equal to or less than the SDL over the reference period. The method is also required to be adjustable for changes in the SDL as a result of works and measures that reduce the volume of recovery required to achieve the targeted environmental outcomes.

Requirements under section 10.12 of the Basin Plan

Section 10.12 of the Basin Plan describes what the method has to take into consideration while achieving the requirements of section 10.10:

10.12 Matters relating to accounting for water

(1) For paragraph 10.10(3)(a), the following matters must be accounted for:

(a) all forms of take from the SDL resource unit and all classes of water access right;

(b) water allocations that are determined in one water accounting period and used in another, including water allocations that are carried over from one water accounting period to the next;

(c) for a surface water SDL resource unit—return flows, in a way that is consistent with arrangements under the Agreement immediately before the commencement of the Basin Plan;

(d) subject to subsection (3)—trade of water access rights;

(e) water resources which have a significant hydrological connection to the water resources of the SDL resource unit;

(f) circumstances in which there is a change in the way water is taken or held under a water access right;

(g) changes over time in the extent to which water allocations in the unit are utilised;

(h) water sourced from the Great Artesian Basin and released into a Basin water resource, by excluding that water;

(i) water resources which are used for the purpose of managed aquifer recharge.

(2) Subject to this section, the method may account for other matters.

(3) For paragraph (1)(d), the water resource plan must account for the disposal and acquisition of held environmental water separately and in a way that does not affect the method under section 10.10.

This section provides a list of inputs that the permitted take method must consider in addition to the available water resources and the processes that the method must represent. In the Murrumbidgee, requirements (1)(h) and (1)(i) are not applicable. The remaining items in the above list at (1) require the following processes or inputs to be considered:

(a) All forms of take, both consumptive and non-consumptive.
(b) Carry-over of allocation.
(c) Return flows from irrigation areas and Nimmie-Caira.
(d) Inter-valley trade of consumptive allocation and entitlement.
(e) Connections between the Murrumbidgee and Murray systems.
(f) The method needs to be able to be modified when there are changes in the way water is used, for example, changes in the way held environmental water is managed.
(g) The method needs to produce an annual permitted take that is independent of the level of utilisation.

Section 10.12(3) prohibits the inclusion of trade of environmental allocation or entitlement in the method. Environmental trade is considered in section 6.12(1)(a) of the Basin Plan.

Theory of the proposed method

Modelled forms of take

Introduction

It is proposed to construct a permitted take method from two modelled scenarios:

1. The Baseline Diversion Limit
2. Current Conditions

The Current Conditions model will then be scaled (see below) and there will be correction for inter-valley trade of consumptive allocation and entitlement.

Why we are using models?

It is possible to construct a permitted take method that does not include modelling but it would be difficult to meet all of the requirements of section 10.12 of the Basin Plan. The model simulates all forms of take, return flows, and flows to and from the Murray system and has an explicit representation of the allocation accounting system. As such, it is possible to address items (a), (b), (c), and (e) in section 10.12(1).

Baseline diversion limit scenario

As the SDL is defined as an offset from the baseline diversion limit our method requires the baseline diversion limit scenario to set the value of the SDL.

Current conditions scenario

The ‘current conditions’ scenario best represents the way that surface water is currently being used. The scenario should be more capable of representing year to year variation in take than an older representation over the life of the WRP. Point (f) in section 10.12(1) can be addressed by updating the current conditions scenario to represent changes in the way water is being used. For example, as we gain a better understanding of how held environmental water is being used we can improve the assumptions used in the current conditions scenario.

Scaling

If water use in the valley was the same as at 30 June 2009 and water recovery had removed the intended amount of potential consumptive take, then the long-term mean take from the current conditions model would be equal to the SDL. As the behaviour of water users has not remained stationary then it is unlikely that the current conditions model will return a level of take that is at the SDL. In the event that the model did reproduce the required SDL, there is still a requirement under section 10.10(5) to produce a permitted take method that can be adjusted for amendments to the SDL. To achieve this flexibility, it is proposed to scale the consumptive take simulated by the current conditions scenario in such a way that the long-term mean annual permitted take is equal to the required SDL.

To calculate the scaling factor, the BDL model is run over the standard period to get the mean annual consumptive take, $\overline{BDL}$. The current conditions model is run over the same period to obtain mean annual consumptive take, $\overline{CURR}$. A scaling factor is then calculated as follows:

$$k_{div} = \frac{\overline{BDL} - Required\_SDL\_Reduction}{\overline{CURR}}$$

A scaling factor ensures that the long-term mean annual permitted take will always be equal to the SDL, when calculated over the standard period. This meets the requirement in section 10.10(4) of the *Basin Plan* and, because the required SDL reduction is a parameter of the method, the requirement at 10.10(5) is also met.

Scaling makes the annual permitted take independent of the current level of utilisation and ensures that the method meets the requirements of 10.12(1)(g) as far as the permitted take method is part of the growth-in-use strategy. A permitted take method will only work as a growth-in-use strategy when used in conjunction with a SDL compliance mechanism and the necessary water sharing plan rules to give effect to the compliance outcomes.

Calculating an annual value for a particular water year

After the end of a water year, the input data for the current conditions model will be updated. The model will then be run over the period 1 July 2019 to the end of the current water year. The model will provide consumptive take for the last water year (t), $CURR_t$. The annual permitted take (APT_t) is then calculated from:

$$APT_t = k_{div} \times CURR_t$$

Adjustment for consumptive trade

When APT is compared to annual actual take, the water that has been traded between SDL resource units must be accounted for. If a future current conditions model explicitly simulates trade then adjustment is not required. The adjustment is only carried out for trade that is not modelled.

Inter-valley consumptive allocation (temporary) trade

APT is increased by the volume of unmodelled consumptive allocation traded into the Murrumbidgee and likewise decreased by the volume traded out of the Murrumbidgee. The annual permitted takes for the SDL resource units at the other end of the trades are adjusted in the same way. This results in no change in the sum of permitted takes across all of the SDL resource units.

Inter-valley consumptive entitlement (permanent) trade

APT is reduced by the volume of unmodelled actual consumptive take in other SDL resource units that uses a Murrumbidgee entitlement. Correspondingly, APT is increased by the volume of unmodelled actual consumptive take in the Murrumbidgee that uses an entitlement from another SDL resource unit.

Unmodelled forms of take

For the currently unmodelled forms of take, such as runoff dams, the APT uses a fixed number based on the best available information on the level of take by those components as at 30 June 2009. Likewise, until methods are developed to measure or infer the take by these forms the annual actual take will be deemed to be the same value.

Proposed method for Murrumbidgee (SS15)

Modelled forms of take

The category "quantity of water that can be taken from regulated rivers" is modelled. The model includes water that can be taken under all classes of water access rights in the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* (NSW); namely:

- Local water utility access licences
- Regulated river (high security) access licences and sub-classes
- Regulated river (general security) access licences
- Regulated river (conveyance) access licences
- Murrumbidgee Irrigation (conveyance) access licences
- Coleambally Irrigation (conveyance) access licences
- Supplementary water access licences
- Supplementary water (Lowbidgee) access licences

However, the model does not include take under basic rights or domestic and stock access licences.

Baseline diversion limit model

At the time of writing, the best available model[2] of the baseline diversion limit (BDL) is the Murrumbidgee IQQM model using the BIDGBDLA.iqq (Revision 112, CM9 Reference INT19/78842) system file. This model is described in *Murrumbidgee Regulated River System: Baseline Diversion Limit and Pre-Basin Plan Scenario Models* (DoI Lands and Water 2019, CM9 Reference INT19/64468 and Appendix A to Schedule F).

The consumptive take is calculated from the model results using the *Listquan* file BDLTake.run (Revision 119, CM9 Reference INT19/78842) output time series _tot_irr_take.dvs. The model outputs that make up the consumptive take are described in Table 1.

Table 1 Consumptive Take in the BDL Scenario

Component of Take	Output in the model	Mean annual volume (GL)
Coleambally Irrigation net take	Gross diversion to Coleambally less the return flows by the Western Outfall Drain, Southern Outfall Drain, and Coleambally Escape	341.6
Murrumbidgee Irrigation	Gross diversions at the Main Canal at Berembed and Sturt Canal at Gogeldrie less return flows at: Roachs Escape, Yanco Main Southern Drain, and Gogeldrie Main Southern Drain (represented in the model as node 5)	1023.5
Regulated river diverters	Sum of the take of all irrigators directly on the Murrumbidgee River and those in the Yanco-Colombo Billabong system	445.5
Town water supplies	Sum of the take at all town water supplies, except Griffith[3]	12.9
Nimmie-Caira consumptive take	Deemed value[4]	173.9

[2] Subject to amendment once NSW and MDBA resolve their different opinions as to what constitutes the best available information.
[3] Griffith town water supply take is included in the Murrumbidgee Irrigation take.

(Lowbidgee area)		
Redbank consumptive take (Lowbidgee area)	58.28% of the regulated inflow to Redbank[5]	60.9
Inter-Valley Transfer[6]	Ordered value at the end of system	25.0
Total		**2083.3**

Current conditions model

At the time of writing, the best available model of current conditions is the Murrumbidgee IQQM pre-*Basin Plan* model represented by the BIDGPBPA.iqq (Revision 114, CM9 Reference INT19/78822) system file.

The Murrumbidgee pre-*Basin Plan* model is identical to the BDL except for:

- Changes to represent the new allocation rules for Murrumbidgee Irrigation (conveyance) access licences introduced in July 2011
- Post-processing to deem some of the consumptive take as environmental take, to represent water recovery after 30 June 2009.

These changes are described in *Murrumbidgee Regulated River System: Baseline Diversion Limit and Pre-Basin Plan Scenario Models* (DoI Lands and Water 2019, CM9 Reference INT19/64468).

The consumptive take is calculated from the model results using the *Listquan* file PBPTake.run (Revision 122, CM9 Reference INT19/78822) output time series _tot_irr_take.dvs. The model outputs that make up the consumptive and environmental take are described in Table 2. The environmental and consumptive take is combined as the model currently does not have an explicit representation of the post-2009 water recovery in it. For the purposes of representing different levels of final water recovery, the results were post-processed to achieve the desired level of consumptive take.

Table 2 Combined Consumptive and Environmental Take in the PBP Scenario

Component of Take	Output in the model	Mean annual volume (GL)
Coleambally Irrigation net take	Gross diversion to Coleambally less the return flows by the Western Outfall Drain, Southern Outfall Drain, and Coleambally Escape	341.6
Murrumbidgee Irrigation	Gross diversions at the Main Canal at Berembed and Sturt Canal at Gogeldrie less return flows at: Roachs Escape, Yanco Main Southern Drain, and Gogeldrie Main Southern Drain (represented in the model as node 5)	1023.6
Regulated river diverters	Sum of the take of all irrigators directly on	444.7

[4] Value from MDBA (2018a).
[5] Value based on distribution of entitlement shares between North Redbank, South Redbank, environmental, and non-environmental in MDBA (2018a) combined with the LTDLE factors from DoI (2019).
[6] The IVT in the BDL model represents a certain level of inter-valley trade. By adding it to the consumptive take in the Murrumbidgee we are correcting the model result to a 'no trade' level.

	the Murrumbidgee River and those in the Yanco-Colombo Billabong system	
Town water supplies	Sum of the take at all town water supplies, except Griffith	12.9
Nimmie-Caira environmental take (Lowbidgee area)	Deemed value	173.9
Redbank consumptive take (Lowbidgee area)	58.28% of the regulated inflow to Redbank	61.1
Inter-Valley Transfer	Ordered value at the end of system	25.0
Total		**2082.7**

Calculating the required scaling factor

Required SDL reduction

The required scaling factor is determined by the required reduction amount. As at 31 December 2018[7] the local reduction for the Murrumbidgee was 320.0 GL/a, the shared reduction was 277.9 GL/a, and the SDL adjustment was 145.5 GL/a. The net effect of these three components is a required SDL reduction of 452.4 GL/a.

Deducting the Nimmie-Caira take from the pre-Basin Plan (PBP) modelled take and assuming no post processing to represent water recovery gives a mean annual consumptive take of 1908.9 GL/a. The required SDL is 452.4 GL/a below the BDL of 2083.3 GL/a, which is 1630.9 GL/a. The unadjusted output from the PBP model is 277.9 GL/a too high and this represents the yet-to-be-modelled water recovery and SDL adjustments.

The required scaling factor is then the ratio of 1630.9 over 1908.9 or 0.85439.

Applying the method to a relevant water year

Updating the required inputs to the current conditions model

After the water year has finished, the inputs to the PBP model are updated to the end of the last water year. This includes updating the required inputs that come from the Murray system: NSW Murray effective allocations, NSW Lake Victoria storage volumes, and forecast South Australia surplus flow to May.

Running the current conditions model over the required period

The PBP model is then run from 1 January 2014 to 30 June of the last water year. The model is initialised with the historically observed storages volumes from 1 January 2014 and during the model run the storages are reset to the historically observed volumes as at 30 June 2019 at the corresponding point in the model run. This first part of the model run is designed to mirror the conditions at setup of the BDL model, as at 1 January 1890, and with storages reset at 30 June 1895.

[7] *Murray-Darling Basin Sustainable Diversion Limits - estimate at 31 December 2018* retrieved from https://www.mdba.gov.au/sites/default/files/pubs/Sustainable-Diversion-Limits-31-December-2018-surfacewater.PDF

Post-processing the model results to correct take to the required SDL

After running the PBP model, the consumptive take is calculated for the last water year by running the PBPTake.run Listquan file. The annual total is multiplied by the scaling factor, thereby producing the annual permitted take, which is still not adjusted for consumptive inter-valley trade.

Adjusting the post-processed results for trade

By including an IVT volume in the calculated take for both the BDL and PBP models, we have set the inter-valley trade to zero in both cases. We then correct the consumptive take for consumptive trade.

Inter-valley consumptive allocation (temporary) trade

APT is increased by the volume of consumptive allocation traded into the Murrumbidgee and likewise decreased by the volume traded out of the Murrumbidgee.

Inter-valley consumptive entitlement (permanent) trade

APT is reduced by the volume of consumptive take in other SDL resource units using a Murrumbidgee entitlement. The annual permitted take is increased by the volume of consumptive take in the Murrumbidgee using an entitlement from another SDL resource unit.

Unmodelled forms of take

Adopted values of permitted and actual take

For the forms of take currently unmodelled, the long-term mean annual values in Table 3 have been adopted. Unless otherwise noted, these values have been taken from MDBA (2018c) and are the best available information.

Table 3 Adopted values of permitted and actual take for unmodelled forms

Form of take	Mean annual volume (GL)
From a watercourse	42.4
By floodplain harvesting	0.0
By runoff dams (excluding basic rights)	344.0
By runoff dams under basic rights	41.0
Net take by commercial plantations	116.0
From a watercourse under basic rights[8]	6.0
From a watercourse under domestic and stock[9]	28.9
Total	578.3

[8] Assumes full utilisation of the entitlements on issue.
[9] Based on the mean annual usage 2004 to 2017 with 1000 ML/a deducted for Water for Rivers as per DoI (2018).

SDL demonstration scenario

Demonstration that the annual permitted take meets the SDL

The Basin Plan requires that a demonstration that the application of the annual permitted take method over the reference period of 1895 to 2009 meets the SDL.

To do this, the proposed annual permitted take method was applied to the period 1895-2009 and the results shown in Figure 1 were obtained. The mean annual value for the period July 1895 to June 2009 is 1630.9 GL, which is equal to the regulated river component of the SDL.

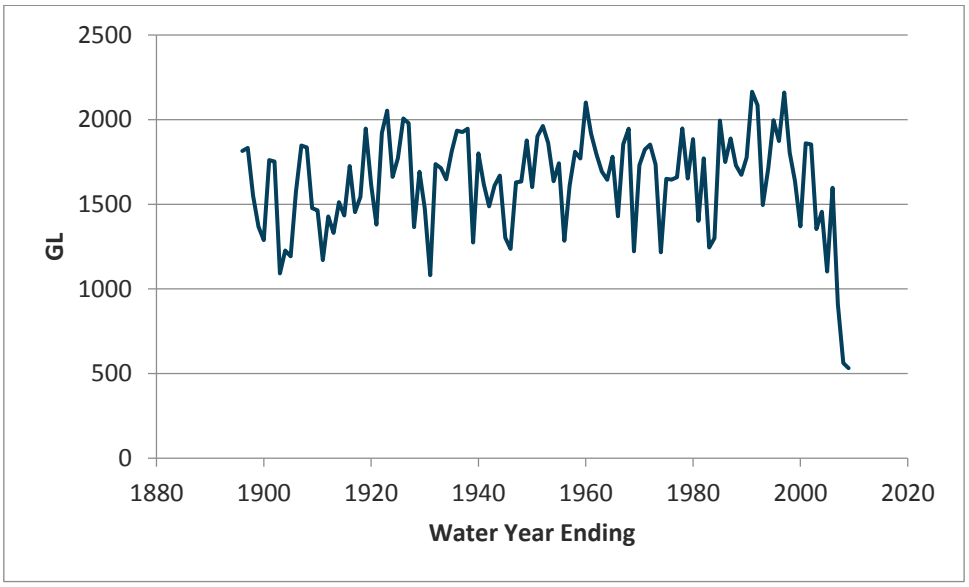

Figure 1 Annual Permitted Take Regulated River

References

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2006, *Risks to the Shared Water Resources of the Murray-Darling Basin*, MDBC Publication 22/06, MDBC, Canberra.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2008, *Water availability in the Murray-Darling Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project*, CSIRO, Canberra.

Murray–Darling Basin Authority (MDBA) 2018a, *Re-assessment of the Commonwealth's acquisition of Nimmie-Caira entitlements*, Draft version 20 July 2018, MDBA, Canberra.

Murray–Darling Basin Authority (MDBA) 2018b, *Sustainable Diversion Limit Reporting and Compliance Framework*, MDBA publication no: 37/18, MDBA, Canberra.

Murray–Darling Basin Authority (MDBA) 2018c, *Murray-Darling Basin Baseline Diversion Limits - estimate at 30 September 2018*, MDBA, Canberra, https://www.mdba.gov.au/sites/default/files/Baseline-diversion-limit-for-surface-water.pdf.

NSW Department of Industry (DoI) 2018, *Water reform technical report: Derivation of LTDLE factors in NSW*, DoI, Parramatta, https://www.industry.nsw.gov.au/__data/assets/pdf_file/0019/162181/techncial-paper-derivation-technical-factors-nsw.pdf.

NSW Department of Industry (DoI) 2019, *Long-term diversion limit equivalence factors for Redbank*, Water management information sheet, DoI, Parramatta, https://www.industry.nsw.gov.au/__data/assets/pdf_file/0015/213711/Long-term-Diversion-Limit-Equivalence-Factors-for-Redbank-North-and-South,-Murrumbidgee-River.pdf.