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River Murray System Operations Review

Lindsay River Allowance Options Technical Report

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3.0	Final Report	07/02/11	ORWG9

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Executive Summary

The Lindsay River Allowance is part of the flow regime established over 30 years ago during a time of multiple years of plentiful water resource availability and annual, rather than continuous, accounting applied. The allowance rules and associated accounting were probably not developed to consider multiple extremely low water resource years. This issue was highlighted during the recent prolonged drought.

As a consequence of the recent severe drought from 2006 onwards the problems associated with the accounting of the allowance has been highlighted with the allowance becoming a contentious issue between Victoria and South Australia in recent years. The reduction of the allowance has been included in special water sharing deals, under the SOG (Senior Officials Group) and BOC (Basin Officials Group) processes, of 2007/08, 2008/09 and 2009/10.

Victoria and South Australia agree that some flows should continue to be diverted down the Lindsay River and are currently discussing how best to account for such flows.

South Australia considers the unused portion of the allowance, which returns to the River Murray as an important, but non-accountable component of South Australia's entitlement flow, a salinity abatement requirement especially during dry times and an important component of South Australia's policy of maintaining flow to the Lower Lakes and the export of salt from the system.

Victoria considers that the unused portion remain a Victorian resource to bolster reliability during droughts but to be used as an environmental flow at other times with no overall increase in Victorian diversions under the Cap. Victoria has also suggested that the Lindsay River Allowance should be considered under the Basin Salinity Management Strategy for salinity credits and debits.

Since the Lindsay River Allowance was established there have been a number of changes in this reach of the River Murray which has caused the need for such an allowance to be questioned. There are now a number of salinity interception schemes which are designed to remove a large proportion of the salt load entering the River Murray in this area, there are environmental works proposed which would facilitate the delivery of environmental water to the lower Lindsay River. However, the recent drought has shown that the allowance is important during dry period to keep the lower Lindsay River in good health and providing a base flow to South Australia which helps to maintain the connection of the weir pools along the lower Murray River.

Four simple options have been presented in this report which highlights some of the impacts/benefits associated with removing and/or reducing the dilution component of the Lindsay River Allowance. The four options that were modelled as part of this study were:

- Baseline conditions which treats the Lindsay River Allowance (and dilution) as per the 1979 decision;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is no payback by Victoria of the volume of Lindsay River dilution flow forgone;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is payback by Victoria of the volume of Lindsay River dilution flow forgone;

- The dilution component of the Lindsay River Allowance is removed with water being diverted down the Lindsay River just to cover losses and diversions.

These options broadly reflect how the Lindsay River Allowance has been modified under special water sharing deals during the recent drought.

The results from the modelled options above indicate that there are water savings when the Lindsay River Dilution flow is either reduced without payback or turned off completely (refer to summary Table 1). This has benefits to Victoria and to the regulated supply of water to South Australia, but negative impacts on the physical flow entering South Australia in the modelled scenarios as the model allows Victorian diversions to exceed Cap limits. Both Victorian and South Australian diversions have increased but at the expense of less flows through the lower Murray. In reality, Victoria and SA will have to comply with the Cap. Therefore there would be little to not increase in net long term diversions. This was not included in the model. Hence the impacts presented in this report are likely to represent the 'worse case' impacts.

Table 1 Summary of key results

	Pre-TLM Historic				Pre-TLM 2030 dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Diversions, GL/yr								
Mean NSW Murray diversion	1794.5	0.2	-0.1	0.4	1346.2	-2.9	-9.1	-3.5
Minimum NSW Murray diversion	560.8	0	0	-15.3	8.3	-1.4	-8.3	133.6
Mean Vic Murray diversion	1742.0	1.1	-0.5	7.7	1525.8	7.7	-23.6	27.5
Minimum Vic Murray diversion	586.8	60.7	-21.9	52.1	0.1	0	6.7	0
Mean SA Murray diversion	706.5	0.0	0.1	0.5	613.1	0.2	0.0	3.3
Minimum SA Murray diversion	194.4	0.0	0.0	0.0	165.8	0.1	-0.4	0.2
Flows, GL/yr								
Accounted SA flow	6228.9	0.6	0.6	55.3	3644.6	8.8	26.5	43.5
Physical SA flow	6294.8	-1.1	-0.4	-10.6	3710.8	-4.5	25.6	-22.7
Barrages flow	4450.2	-0.3	0.1	-9.7	1954.8	-3.9	23.9	-24.5
Salinity, EC								
Morgan mean	536.7	-0.1	-0.1	3.7	698.0	0.4	-0.5	5.0
Morgan 95th percentile	817	0	0	16	1134.5	5.0	3.5	-0.5

The impacts to NSW are interesting as on one hand they benefit by additional water in the system while on the other they are being impacted by changes in the distribution of where water is being stored (especially under the climate change runs).

Changes in the Lindsay River dilution will cause changes to propagate throughout the system. The modelling presented here show that all three states are affected by the options presented not just Victoria or South Australia.

The options themselves are simple and if these options were to be implemented additional work would have to be undertaken to modify the behaviour of the jurisdictions within the model to more accurately reflect their actual behaviour. How the model is currently

configured means that any additional water resources available within the model would increase diversions; this is not necessarily how jurisdictions would act if the allowance was changed.

The Lindsay River Allowance is mainly a political issue in which technical modelling as presented within this report may only play a minimal role in the final outcome. It is hoped that this report will add to the bilateral discussions currently being held between South Australia and Victoria. Ultimately any change in the Lindsay River Allowance would likely be part of a package of changes to be negotiated between all jurisdictions.

1 Introduction

The Lindsay River Allowance is part of the flow regime established over 30 years ago during a time of multiple years of plentiful water resource availability and annual, rather than continuous, accounting applied. The allowance rules and associated accounting were not developed to consider multiple extremely low water resource years. This issue was highlighted during the recent prolonged drought.

The measurement of South Australia's entitlement flow is governed by clause 89 of the Murray Darling Basin Agreement (the Agreement) which states that the volume of water SA has deemed to have received in any given month is the sum of the water flowing in the River Murray between the confluences of the Rufus and Lindsay Rivers within the River Murray (Gauging Station 426200) and the outflow from the Lindsay River. Because of the considerable challenges related to measurement of flow in such a flat reach the outflow from the Lindsay River is estimated as the flow entering Mullaroo Creek (at the Mullaroo Offtake) minus an allowance for a volume of water lost or diverted within the Lindsay River (i.e. the Lindsay River Allowance).

As a consequence of the recent severe drought from 2006 onwards the problems associated with the accounting of the allowance has been highlighted with the allowance becoming a contentious issue between Victoria and South Australia in recent years. The reduction of the allowance has been included in special water sharing deals, under the SOG (Senior Officials Group) and BOC (Basin Officials Group) processes, of 2007/08, 2008/09 and 2009/10.

While both Victoria and South Australia agree that some flows should continue to be diverted down the Lindsay River, there is a fundamental disagreement on the accounting of such flows. Victoria and South Australia are currently discussing how best to account for such flows.

South Australia considers the unused portion of the allowance, which returns to the River Murray, (as measured as the flow over Mullaroo Offtake reduced by the actual diversions of the Lindsay Point irrigators), as an important, but non-accountable component of South Australia's entitlement flow, a salinity abatement requirement especially during dry times and an important component of maintaining flow to the Lower Lakes and the export of salt from the system

Victoria considers that the unused portion remain a Victorian resource to bolster reliability during droughts but to be used as an environmental flow at other times with no overall increase in Victorian diversions under the Cap. Victoria has also suggested that the Lindsay River Allowance should be considered under the Basin Salinity Management Strategy for salinity credits and debits.

The other jurisdictions have expressed minimal interest in the matter, as they feel that there is little potential of a material impact on them.

This report provides an introduction of background and water accounting issues associated with the allowance. Four simple options will be presented which will be used to highlight some of the impacts/benifits associated with removing and/or reducing the allowance and provides comment on how well the MDBA's model are in modelling this reach of river.

The Lindsay River Allowance is mainly a political issue in which technical modelling as presented within this report may only play a minimal role in the final outcome.

1.1 Objective

The overall objective of the current study is to inform the bilateral discussions being undertaken between Victoria and South Australia on the Lindsay River Allowance issue. The report aims to do this by:

- providing an introduction of background and water accounting issues associated with the Lindsay River Allowance (specifically the dilution component of this allowance); and,
- presenting a number of relatively simple options for the Lindsay River dilution flow to show what impact changing the dilution component might have on third parties within the River Murray.

Four simple options have been modelled as part of this study being:

- Baseline conditions which treats the Lindsay River Allowance (and dilution) as per the 1979 decision;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is no payback by Victoria of the volume of Lindsay River dilution flow forgone;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is payback by Victoria of the volume of Lindsay River dilution flow forgone;
- The dilution component of the Lindsay River Allowance is removed with water being diverted down the Lindsay River just to cover losses and diversions.

These options broadly reflect how the Lindsay River Allowance has been modified under special water sharing deals during the recent drought.

2 Background

The Lindsay River is an anabranch of the River Murray. The river breaks away from the main channel of the River Murray about 35km from the South Australian Border, flows south into Victoria and then rejoins the Murray just upstream of the border. Another Murray breakaway, Mullaroo Creek which flows from the Lock 7 weir pool, joins the Lindsay River about halfway along. A schematic diagram of the River Murray between Lock 6 and Lock 9 is shown in Figure 1.

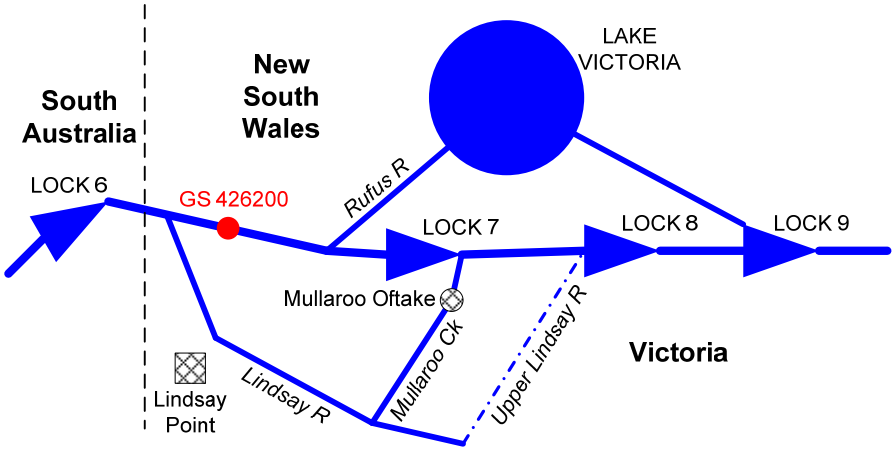

Figure 1 Location and schematic of the Lindsay River and Mullaroo Creek

During low flow conditions, and due to the influence of the Lock 6 weir pool, the flow to South Australia is calculated as the flow at gauging station 426200 plus the flow at Mullaroo Offtake minus the Lindsay River Allowance (91.3 GL/yr or 250 ML/day). During high flow conditions, the flow is assumed to be the flow at GS 426200. Because of the relatively flat topography of the area and low flow rates there have been issues associated with the measurement of flows to South Australia for a number of years.

The term "Lindsay River Allowance" is made up of three terms being:

- the diversions by Victorian irrigators along the Lindsay River ~14.6 GL/yr (~40 ML/day);
- the losses along the Lindsay River ~11.0 GL/yr (~30 ML/day); and,
- the residual flow that returns to the River Murray, referred to here as the Lindsay River dilution flow ~65.7 GL/yr (~180 ML/day).

Some indicative annual flow volumes are given above; however, the Lindsay River dilution flow will vary from day to day depending on diversion by irrigators and losses along the Lindsay River as it is the residual.

The total Lindsay River Allowance is 250 ML/day (91.3 GL/yr) that was agreed to by the River Murray Commission in 1979, and is an inflow to the Lindsay River. The Allowance was established for diversions and losses from Lindsay River and to supply an unaccounted dilution flow which would offset SA for the effects of the extra salt mobilised from Lindsay River floodplain.

This Lindsay River Allowance is treated as a Victorian diversion in regard to water accounting, and is supplied out of the water allocated to Victoria, and not accounted as part of South Australia's Monthly Entitlement. However, the Lindsay River dilution volume is not

treated as a Victorian diversion under the Cap, as only consumptive use is treated a diversion under the Cap.

2.1 History of the Lindsay River Allowance

In the 1960s and early 1970s, the diverters in Victoria experienced salinities in the lower Lindsay River of up to 3,000 EC. It was thought that the high salinities were due to groundwater-borne salt ingress to the Lindsay and Mullaroo systems.

In 1975, the Victorian Government and the River Murray Commission agreed to divert 250 ML/day (91.25 GL/year) down the Lindsay River, via Mullaroo Creek, to dilute the saline groundwater inflows for the purposes of:

- providing suitable quality water for the diverters on the Lindsay River; and
- minimising the salt impact on the water in River Murray downstream of Lindsay River, which is used by South Australia.

In 1977, an offtake structure was completed on the River Murray upstream of Lock 7 to divert water into Lindsay River. The structure was built too wide and too low so that when Lock 7 was at full supply level, 440 ML/day rather than 250 ML/day passed into the Lindsay River.

The initial agreement regarding the Lindsay River Allowance said only water in the mainstream of the Murray would count towards South Australia's Entitlement. The water diverted into the Lindsay River, via Mullaroo Creek, would count as a Victorian diversion.

Because of continuing anxiety about salinity, at the time the almond growers along Lindsay River objected to the structure being altered to diminish the flow.

In 1979 Victoria proposed, and the River Murray Commission agreed that the structure would stay, but that additional water over and above the original 250 ML/day (91.25 GL/year) would be counted as part of SA's Entitlement flow. In recent years the Mullaroo Creek Offtake structure has degraded allowing a flow of some 700 ML/day to pass into Mullaroo Creek dependent on the Lock 7 pool level. This additional flow is considered part of SA's entitlement flow.

The background document attached to the River Murray Commission decision recognised that Victoria could arrange alternative arrangements in the future (refer to Appendix A).

A relatively small portion of the Lindsay River Allowance is consumed by the diverters (up to 14.6 GL/yr) or as loss in the Lindsay River and Mullaroo Creek (11.0 GL/yr typically). The remainder approximately 65.7 GL/yr continues into SA as the Lindsay River dilution flow. The agreed accounting arrangements mean that the Lindsay River dilution flow is considered as an unaccounted flow to SA which is above its minimum entitlement.

The requirement to divert 91.25 GL into the Lindsay River remains even in severe droughts. This is the case even if there is no water allocated for irrigation, unless, by special agreement, the States (Victoria, NSW and SA) agree otherwise. When there is no water allocated to irrigators in the Lindsay River Reach the Lindsay River dilution flow could be as high as 80 GL/yr, however, this has never actually happened as there has always been some water diverted within this reach. The mean dilution flow for the years between the 2005/06 and 2009/10 water years has been estimated at 49 GL/yr, with a maximum flow of some 72 GL/yr in 2007/08 (refer to Table 6 below).

As an outcome of the special water sharing arrangements adopted for 2007/08, the Murray-Darling Basin Commission agreed that for the 2008/09 water year the Lindsay River Allowance would only be accounted as a Victorian diversion on a pro-rata basis in proportion

to Victorian High Reliability Water Share (HRWS) allocations without payback (the arrangements for 2007/08 were with payback). This agreement was only in place for one year pending the negotiation of new arrangements.

The water sharing arrangements adopted for 2009/10 by the Basin Officials Committee were an extension of the 2008/09 arrangements in that the Lindsay River Allowance is to be linked to the Victorian High Reliability Water Share allocations.

Specifically the Lindsay River Allocation was calculated as 30 ML/day plus 220 ML/day multiplied by the percentage allocation for Victorian HRWS as at the end of the month, applied for that month, less diversions. Until each State had received the 25 GL initial allocation which was set out in the Special Water Sharing Arrangements for 2009/10 the 30 ML/day component of the Lindsay River Allocation would be treated as conveyance water. Any advance created by this arrangement would be repaid from progressive improvements as set out in paragraph 16 of the Special Water Sharing Arrangements for 2009/10.

In 2010 the accounting issues associated with the Lindsay River Allowance was nominated by the Basin Official Committee members to be covered under the Review of the Agreement Process (see MDB Agreement Review Taskforce, April 2010).

The Review of the Agreement Taskforce suggested the following in relation the Lindsay River Allowance Issue:

> *The absence of an effective measuring capacity in the past has militated against resolution of this issue. With the measuring issue now being addressed this impediment should be removed. The jurisdictions involved and/or BOC need to determine whether the accounting processes should now be adjusted to deal with this matter or go further and adjust the shares in the Agreement.*
>
> *If South Australia and Victoria were able to come to a mutually agreeable resolution on this issue, it is likely to be accepted by NSW, so long as it did not impact on NSW's rights and entitlements.*

In response the above suggestion the Basin Officials Committee (meeting 7 - 27 April 2010):

- noted that Victoria considers that an agreement by the Committee on Lindsay River Allowance may still be required for 2010/11; and,
- noted that Victoria and South Australia will commence bilateral discussions on Lindsay River accounting issues.

Table 2 presents the volume accounted as the Lindsay River Allowance in the recent water years and the estimated diversions and Lindsay River dilution flows. This table assumes a constant annual loss of some 11 GL for every year, which was based on a guesstimate of the loss of 30 ML/day; that was adopted under the 2007/2008 Special Water Sharing Arrangements. The current gauging arrangements make it difficult to better estimates of the loss. These loss assumptions should be reviewed once new accurate gauging station information for the lower Lindsay is made available.

Table 2 Lindsay River Allowance, Diversions and Dilution Volume

Water year	Description of the arrangement for the Lindsay River Allowance	Lindsay River Allowance GL/yr	Estimated Loss* GL/yr	Estimated Diversions** GL/yr	Estimated Lindsay River dilution GL/yr
2005/06	As per the 1979 agreement	91.25	10.95	10.51	69.79
2006/07	As per the 1979 agreement	91.25	10.95	12.14	68.16
2007/08	Was initially cut back due to drought conditions but was reinstated in Dec 08 and back dated as per the 1979 agreement.	91.50	10.95	8.41	72.14
2008/09	Cut back due to the special water sharing arrangements for 2008/09.	27.58	10.95	9.65	6.98
2009/10	Cut back due to the special water sharing arrangements of 2009/10.	51.41	10.95	10.93	29.53
2010/11	No special arrangements will apply. The Allowance will be as per the 1979 agreement	Will be determined over the course of the water year			

* Losses are based on an estimation of 10.95 GL/yr

** Diversion volumes sourced from lower Murray Water

2.2 Environmental Consideration

The Lindsay River System is an important part of the Chowilla Floodplain (including Lindsay-Wallpolla Islands) icon site. The Lindsay River forms the southern boundary of Lindsay Island which is an area of River Murray floodplain with a high ecological significance. The area supports a diverse range of aquatic, wetland depend and terrestrial species and is an important habitat for native fish, frogs, turtles and waterbirds. The Lindsay River is therefore an important environmental site in its own right.

Mullaroo Creek currently supports one of the most significant and robust populations of Murray cod in the lower River Murray. The Mullaroo Creek population of Murray cod makes Mullaroo Creek an important region to sustain the broader regional populations of Cod. The Mullaroo Creek system also provides important habitat for numerous other native fish species (Mallee CMA 2010). A key aspect of the habitat within the Mullaroo Creek/Lindsay River systems is the sustained moderate flows due to the "leaking" of flows from the elevated Lock 7 weir pool through the degrading Mullaroo Offtake structure.

Currently there is a proposal for a package of works to be build along the Lindsay River. Stage 1 of these works specifically targets the northern upper Lindsay River Inlet, the southern upper Lindsay River Inlet and Mullaroo Creek offtake. All of these structures use the water elevation differences between Lock 7 and Lock 6 to generate controlled environmental flows along the Lindsay River and Mullaroo Creek.

Of specific interest to this study is the proposal to replace the existing causeway at the Mullaroo Offtake to maintain flow rates independent of Lock 7 pool levels. The new regulating structure would allow for accurate measurement of the flow passing down this reach and hence may lead to better accounting of these flows. If the package of works results in improvements to the accounting of flow into the southern upper Lindsay River Inlet and the northern upper Lindsay River Inlet, then suitable allowance for losses in these reaches would be required as these reaches are not considered as part of the allowance.

A new gauge has also been established at the Lindsay River outlet that can now directly measure the flow to South Australia from the Lindsay River.

2.3 Salinity Considerations

One of the primary reasons for the original 1979 Lindsay River Allowance decision by the River Murray Commission was the potential for saline groundwater ingress into the Mullaroo Creek and Lindsay River reaches. During the very wet 1970's decade reports of salinity levels as high as 3,000 EC were reported in the lower reaches of the Lindsay River. Salinity levels as high as this would be unacceptable today.

Over the past decade, the salinity levels in the lower Lindsay River have declined. This is thought to be attributed to low river flows over this period (prior to late 2010 the last flow above 50,000 ML/day at the SA Border occurred in December 2001), construction of salt interception schemes (for example the salt interception schemes at Rufus River) and changes in irrigation watering and land management practices. There has also been the Lindsay River dilution flow which ensures that this reach of the river keeps flowing.

If changes are made to the accounting of the Lindsay River Allowance which changes the physical flows within Mullaroo Creek and the Lindsay River the issue of salinity would have to be evaluated and if found to be significant be addressed by other measures, such as the allocation of salinity credits to offset any negative salinity impacts.

2.4 Previous Work

There has been considerable technical work undertaken on the Lindsay River Allowance since its establishment in the late 1970's.

Victoria engaged SKM in 2008 to look at Lindsay River Allowance Options. The findings of this report are included as Appendix B.

An initial modelling study was undertaken by the River Murray Operation Review in 2009 (MDBA 2009). This study carried out preliminary modelling of the Lindsay River Allowance. The study reduced the Lindsay River Allowance based on various Victorian High Reliability allocation triggers.

Scenarios modelled as part of that initial study are that Victoria:

1. does not have to supply the allowance for parts of irrigation seasons if its allocations are below high security allocation triggers (50%, 80% and 100% of allocation to High Reliability Water Share);
    a. Without borrowing or payback of the Lindsay River Allowance
    b. With borrowing and payback of the Lindsay River Allowance
2. Supplies a reduced Allowance based on Victorian Allocation percentage. This reduction only occurs once the Victoria allocation falls below the trigger value (Again 50%, 80% or 100%);
    a. Without borrowing or payback of the Lindsay River Allowance
    b. With borrowing and payback of the Lindsay River Allowance
3. does not have to supply the allowance for parts of irrigation seasons if its allocations are below the high security allocation triggers in the 2030 dry Climate Change run. This Option is different from Scenario 1 in that inflows reflect climate change to 2030 (CSIRO's 2030 dry Scenario) (This run was without borrowing or payback);

4. no longer supplies the Lindsay River Allowance. Flows in the Lindsay River are unchanged and all return flows from the Lindsay river count towards South Australian Entitlement flow.

The results of this initial study showed only very small changes due to the options implemented. This was considered erroneous and so a decision was made to undertake additional work to update the Lindsay River Allowance mechanism within the MSM-BigMod model (specifically how the dilution component of the Lindsay River is treated and its relation ship to lower Lindsay River diversions). Also around this time Victoria and South Australia entered into bilateral discussion in relation to the Lindsay River Allowance and so the quite complicated options presented above, which required a lot of assumptions to be made by the MDBA staff working on the study, were simplified. If there is a future requirement to revisit these more complicated options they can be easily re-run in the future.

3 Option Assessment

This chapter presents the assessment of outcomes for four options to treat the Lindsay River dilution flow using the MDBA's hydrological modelling suite. The chapter discusses the options modelled and outcomes of the assessment method employed.

3.1 Assessment Method

The evaluation of the proposed options is being undertaken using the MDBA's hydrological modelling suite (MSM-Bigmod), which simulates different flow and management scenarios in the River Murray System and provides an indication of the associated impacts at a range of scales. The model is based on the historical record of inflows over the period June 1895 to July 2009 (114 years), but can also be configured to simulate various climate change scenarios over this period.

The modelling suite consists of two models, a monthly model MSM (Monthly Simulation Model) and a daily model BigMod. MSM's role in the MDBA's modelling suite is to calculate demands, allocations, entitlements and system operations within the upper River Murray. Once MSM has run it passes data into the daily model BigMod. BigMod routes flows and salinities within the regulated River Murray System upstream from the Barrages.

Inflows to the model from the major tributaries are based on modelled data for the relevant scenarios provided by New South Wales and Victoria.

3.2 Options for Assessment

Four simple options have been modelled as part of this study being:

- Baseline conditions which treats the Lindsay River Allowance (and dilution) as per the 1979 agreement;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is no payback by Victoria of the volume of Lindsay River dilution flow forgone;
- The Lindsay River diversions and dilution are reduced based upon Victorian High Reliability Water Share allocations and there is payback by Victoria of the volume of Lindsay River dilution flow forgone;
- The dilution component of the Lindsay River Allowance is removed with water being diverted down the Lindsay River just to cover losses and diversions.

All of the options above can be modified or added to if further options are developed in the future. Each of the options will be expanded upon below.

A comparison of these four scenarios will be shown under historical inflows as well as under a 2030 dry inflow sequence.

3.2.1 Baseline conditions

This scenario represents the original 1979 agreement of the Lindsay River Allowance. The assessment routine within the MDBA's model fits the provision of the Lindsay River Allowance into a sequence of Victorian water demands which are taken from Victoria's share of water resources. Firstly it provides around 200 GL for losses within Victoria, then the Lindsay River Allowance and then Victorian allocations. Because of this sequencing the model does reduce the allowance at certain times due to very low water availability.

Figure 2 presents the last 9 years of model data for the Lindsay River Allowance volumes under baseline conditions. In this figure the Lindsay River Allowance has been broken up into two components being the annual volume taken by diversions and losses (as estimated by the model) and the annual volume of Lindsay River dilution flow (simply the residual). Unfortunately the current model does not distinguish between diversions and losses hence these two series have been lumped into one series for the presentation below.

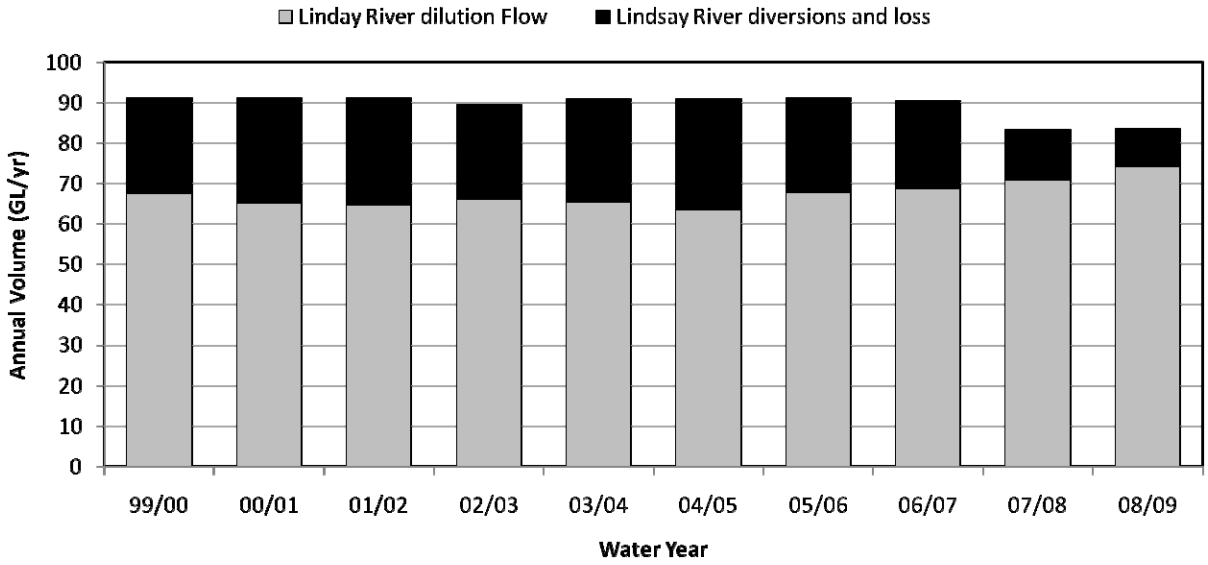

Figure 2 Lindsay River Allowance baseline conditions

As illustrated in Figure 2 the Lindsay River Allowance volume stays near constant at 91.25 GL/yr throughout the period. Both the proportion of diversions/loss and dilution change throughout the period in response the allocations in Victoria. The allowance has been reduced in the model by 5 GL (2008 and 2009) due to water scarcity. It is interesting to note that in these two years the volume of the dilution flow has increased compared to the other years within the period.

3.2.2 Lindsay River Allowance reduced with no payback

This scenario reduces the Lindsay River dilution flow by the Victorian High Reliability Water Share allocations and there is no payback by Victoria of the volume of Lindsay River dilution water that was forgone due to the reduction. This scenario is similar to the conditions in 2008/09 and 2009/10 water years where the Lindsay River Allowance was cut back in this way with no payback given.

Figure 3 presents the last 9 years of model data for the Lindsay River Allowance volumes under the scenario where the Lindsay River dilution is reduced based upon Victorian High Reliability Water Share allocations. Of interest in this figure is that there is a constant proportion between the dilution and diversion/loss component of the Lindsay River Allowance. As allocations are reduced in the last two years of the model both the diversion and the dilution volumes are reduced. The estimated loss component would be a relatively constant component of the diversion and loss series shown. There is no payback option in this scenario so there is no additional water for the dilution component.

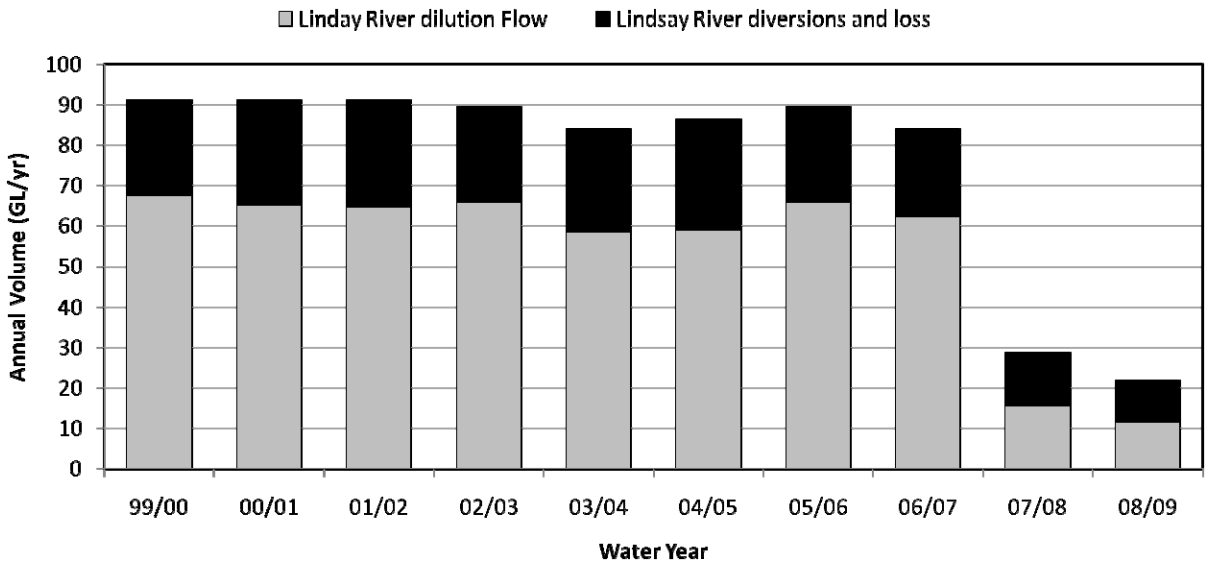

Figure 3 Lindsay River Allowance reduced with no payback

3.2.3 Lindsay River Allowance reduced with payback

This scenario reduces the Lindsay River Allowance flow by the Victorian High Reliability Water Share allocations and there is payback by Victoria of the volume of Lindsay River dilution water that was forgone due to the reduction. This scenario is similar to what eventuated in 2007/08, the resource conditions improved over the course of the year to allow all of the Allowance to be delivered in that year. However, no debts where carried over to the next year. In this modelled option debits are carried over to the following years which then have to be paid back.

Figure 4 presents a similar plot to that presented a Figure 3 except in this plot the model is keeping account of the volume owed to the dilution component and tries to payback this volume once a 100% HRWS allocation trigger is met.

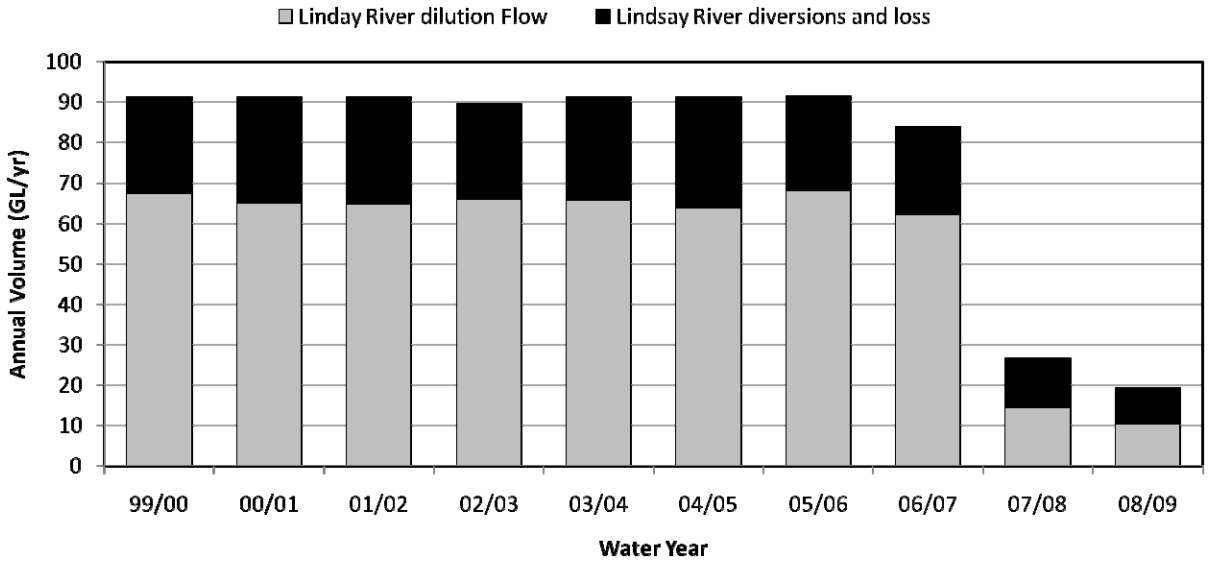

Figure 4 Lindsay River Allowance reduced with payback

In 2004 and 2005 water years there is water being paid back to the dilution component (refer to Figure 4). The model finishes theses runs with large volumes of water being owed by Victoria to the Lindsay River dilution.

3.2.4 No Lindsay River dilution

Under this scenario the dilution component of the Lindsay River dilution is removed completely with none of this water being paid back to the dilution from Victoria. The only water being classed in the model as the Lindsay River Allowance is the volume of water required to flow down the Lindsay to cover losses and diversions.

Figure 5 illustrates how the model is treating this scenario. As can be seen there is zero dilution component of the Lindsay River Allowance. The diversions are acting like any other Victorian diversion on the Murray and are moving up and down corresponding to Victorian High Reliability Water Share allocations. As with the other options the loss component would be a relatively constant component of the diversion and loss series shown.

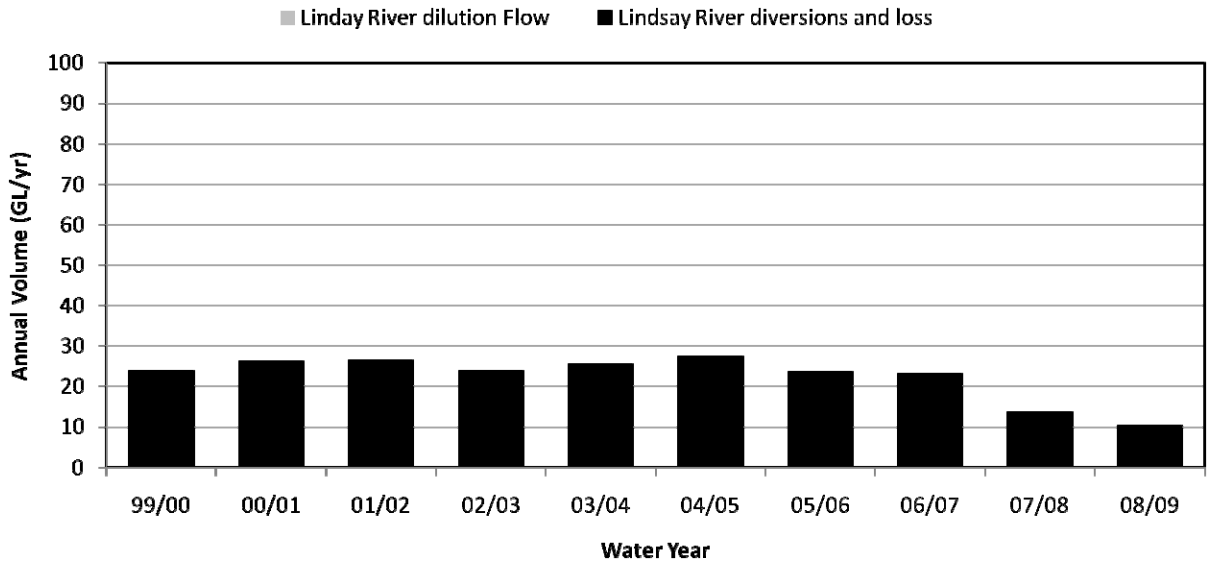

Figure 5 Lindsay River dilution removed with no payback

3.3 Modelling Results

The results of the implementing various options in providing the Lindsay River Allowance (as discussed above) within the MDBA's modelling suite MSM-BigMod will be presented within this section. Differences in key model variables will be presented which will be discussed in relation to: the outcomes for the upper States; the outcomes for SA; and, the outcomes for the River Murray System.

3.3.1 Model Runs

Table 3 lists the eight modelling runs that will be used to assess outcomes. The ID numbers included within this table provide a reference to the MDBA's database of model runs. The runs presented were chosen to show a wide range of conditions and enable the sensitivities of the proposed options to be evaluated. The pre-TLM run has been chosen as the reference run for this study as the post-TLM run has additional assumptions regarding Lindsay Island regulators which may confuse the analysis.

Table 3 Evaluation Options and Model Runs

	Pre-TLM Historical 0910 Benchmark	Pre-TLM 2030 Dry 0910 Benchmark
Baseline Conditions	*run ID 21594*	*run ID 21768*
Lindsay River dilution Reduced with no payback	*run ID 21731*	*run ID 21769*
Lindsay River dilution reduced with payback	*run ID 21752*	*run ID 21770*
No Lindsay River dilution	*run ID 21772*	*run ID 21771*

3.3.2 Option Results

The four options modelled and assessed by this study were broadly described and introduced above. This section looks further at these options by presenting water balances derived from the modelling results around the Lindsay River and the lower Murray. This has been done to provide greater clarity around the way the model reduces the dilution component of the Lindsay River Allowance.

Table 4 presents a flow balance in terms of average annual flows around the Lindsay River Allowance as well as some statistics about the frequency at which the Lindsay River Allowance has been reduced (< 91.25 GL/yr) as well as the annual volume of water owed to the allowance by Victoria.

Table 4 Flow balance around the Lindsay River Allowance for all model runs

Site*	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Lindsay River Allowance	**90.9**	**89.3**	**89.9**	**25.1**	**88.4**	**75.2**	**87.2**	**22.5**
Diversions and Losses (GL/yr)	-25.0	-25.1	-25.0	-25.1	-22.1	-22.2	-21.8	-22.5
Lindsay River dilution (GL/yr)	**+65.9**	**+64.2**	**+64.9**	**+0.0**	**+66.3**	**+53.0**	**+65.4**	**+0.0**
% of years the Lindsay River Allowance is reduced (%)	31.6	41.2	26.3	100.0	71.1	89.5	44.7	100.0
Average volume owed by Victoria to the Lindsay River dilution in June (GL/yr)	0	0	2.0	0	0	0	71.5	0
Volume owed by Victoria to the Lindsay River dilution at the end of the simulation (GL)	0	0	143.5	0	0	0	454.3	0

Table 4 shows that the volume of the Lindsay River Allowance does not change considerably for the first three options under historical flows, with only a small reduction in the Lindsay River dilution flow under these options. The last option (dilution flow turned off altogether), however does show a considerable reduction with the Lindsay River Allowance only being provided to cover diversions and losses along the Lindsay River. Under the 2030 dry climate change when the Lindsay River is reduced without payback there is also a noticeable reduction in the dilution flow.

An interesting secondary effect for those two runs which require payback is that the percentage of years the allowance is being reduced is less than the current conditions. If the dilution flow is reduced under these years the model will force Victoria to payback this water. If a decision was made to implement this option additional coding work would be required within the model to set bounds around Victoria's payback.

Figure 6 presents a percentage excedance plot of the volume of water owed by Victoria to the Lindsay River Allowance in June under the historical (run 21752) and 2030 dry (run 21770) payback options. As can be seen in this plot there is less than 5 percent of years in which Victoria owes the allowance substantial volumes of water under historic inflow conditions while under the 2030 dry conditions this has grown to 40% of years. Under both runs the model ends with the maximum volume owed to the allowance which is 143 GL and 454 GL for the historical and 2030 dry simulations respectively.

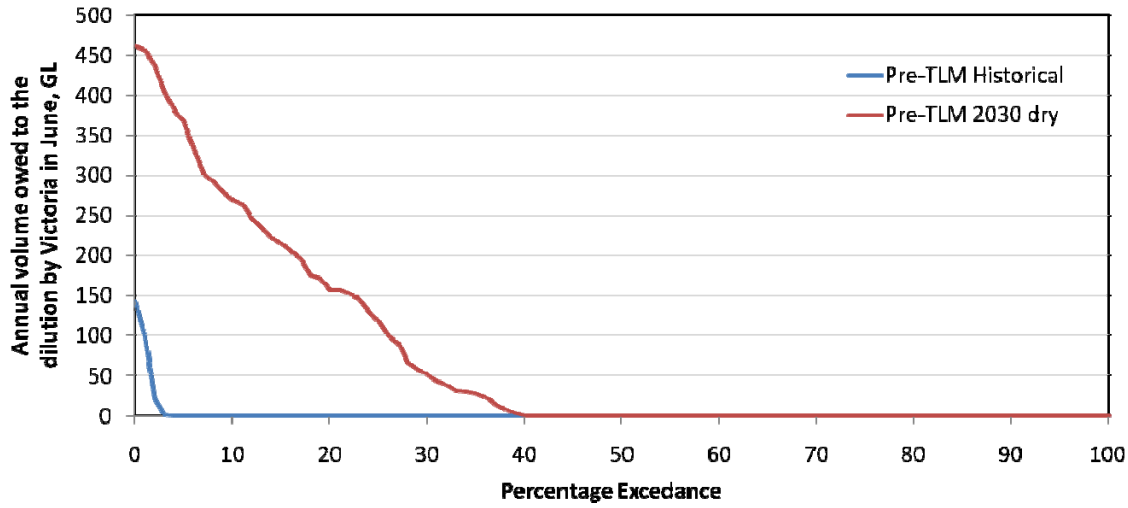

Figure 6 Volume of water owed by Victoria to the Lindsay River dilution for the two pay back options

Table 5 presents a flow balance around the lower Murray, specifically how the Lindsay River dilution interacts with the accounted and physical flows to South Australia. The data in this table was taken from the MSM-BigMod model result files.

At the top of Table 5 is the accounted SA flow. To this flow and dilution flow is added to get the physical SA flow. SA diversions and the losses in the lower Murray are then taken from the physical SA flow to get an end-of-system flow at the barrages. It is important to note that the model uses the accounted SA flow to determine South Australia's allocations and diversions, while the physical SA flow will be the driver for salinity, end-of-system flows and Lower Lake levels within the model.

Table 5 Water balance around the lower Murray for all model runs

Site*	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	Dilution flow reduced without payback	Dilution flow reduced with payback	Dilution flow turned off altogether	Baseline	Dilution flow reduced without payback	Dilution flow reduced with payback	Dilution flow turned off altogether
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Accounted SA flow	**6228.9**	**6229.5**	**6229.6**	**6284.2**	**3644.6**	**3653.4**	**3671.0**	**3688.1**
Lindsay River dilution	+65.9	+64.2	+64.9	+0.0	+66.2	+53.0	+65.4	+0.0
Physical SA flow	**6294.8**	**6293.7**	**6294.5**	**6284.2**	**3710.8**	**3706.3**	**3736.4**	**3688.1**
SA Diversions	-706.5	-706.4	-706.6	-707.0	-613.1	-613.3	-613.1	-616.4
lower Murray Losses	-1138.2	-1137.4	-1137.6	-1136.8	-1153.5	-1152.7	-1155.1	-1152.0
Barrages	**4450.2**	**4449.9**	**4450.3**	**4440.5**	**1944.2**	**1940.3**	**1968.1**	**1919.7**

*all flows shown are reported as mean annual flow (GL/yr)

The results in Table 5 show that as the Lindsay River dilution flow is reduced to zero the accounted and physical SA flow become equal, however overall the accounted flow has increased while the physical flow has decreased. This means that SA diversions would increase while actual flow through the system would decrease. The physical flow has decreased because of increased water resource availability in the upper States and hence greater diversions upstream due to the additional water available upstream. It should be noted that this is a modelling outcome because the model does not enforce the Cap. In reality, Victorian diversions would not increase overall. They would increase slightly during dry times but would reduce in wet periods to remain within Cap.

3.3.3 Outcomes for the upper States

An important aspect of assessing the proposals for the Lindsay River dilution flow is the assessment of outcomes for the upper States. This section will examine the impacts the four proposals for the way the Lindsay River dilution flow is treated has on the upper States specifically by examining the changes observed to the upper State's allocations and diversions as well as changes in system and internal spills. Model results for South Australia and the River Murray system appear in subsequent sections.

Table 6 presents NSW and Victoria's allocations for the eight scenarios modelled. The grey columns represent absolute values and they are the baseline conditions against which the other results are compared. The other columns in the table are shown as relative differences against the grey columns. So that impacts can be identified potential positive changes are coloured green while negative changes are coloured red.

Using historical system inflows (first four result columns of Table 6) to evaluate the options shows that there are mainly positive impacts for both upper States when the Lindsay River dilution flow is turned off completely and neutral impacts when the dilution is reduced and reduced with payback based on the Victorian allocation. Victoria has positive benefits when the dilution is turned off and does not have to be paid back.

Under the 2030 dry climate change scenarios (last four result columns of Table 6) the same trends are seen; however, the impacts are more pronounced. Again there are largely positive benefits for the upper States when the dilution flow is turned off or reduced without payback. When payback is required there are negative impacts for Victoria.

Table 6 Upper States allocations

	Pre-TLM Historic				Pre-TLM 2030 dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
NSW allocations								
Percentage of years NSW High Security allocations < 97% (Jun)	0	0	0	0	2.6	0	0	0
Mean NSW High Security % allocation (Jun)	99.1	0	0	0	96.3	0	-0.5	0.5
Mean NSW General Security % allocation (Nov)	81.9	0	0	0.3	43.1	-0.2	-0.6	0.1
Minimum NSW General Security % allocation (Nov)	1.3	1	0	-0.3	0	0	0	0.3
Mean lower Darling General Security % allocation (Nov)	87.4	0	0	0.1	72.5	0.2	0.1	0.3
Victorian allocations								
Percentage of years Vic High Reliability Water Share < 100% (Feb)	2.6	0	0	-0.9	22.8	0.0	1.8	-2.6
Mean Vic High Reliability Water Share % (Feb)	98.6	0.1	0	0.2	89.3	0.5	-1.1	1.3
Minimum Vic High Reliability Water Share % (Feb)	17	5	1	4	0	0	0	0
Percentage of years Vic Low Reliability Water Share < 100% (Feb)	22.8	-0.9	0	-3.5	74.6	0	1.8	-0.9
Mean Vic Feb Low Reliability Water Share % (Feb)	83	0	-0.1	1.7	30.7	0.2	-0.9	2.2

By reducing (without payback) or turning off the dilution component of the Lindsay River the upper States have more water to allocate hence the systems water availability goes up across the board. On the other hand when the dilution component is reduced with payback a debit of the water owed to the allowance is kept in the model and this water is paid back from the water resources of Victoria before additional allocation increases are provided. This should be a neutral exercise for NSW, but because this water debit and payback will interact with other system operations like internal spills, for example, there are some slight negative impacts for NSW's allocations. These impacts can also occur as a result of Victoria and NSW implementing water management arrangements to reduce their internal spills. These types of actions are within the current rules of the agreement and are considered acceptable.

Table 7 presents the impact changing the Lindsay River dilution component has on NSW and Victoria's diversions. As with the last table the grey columns represent absolute values while the other columns in the table are shown as relative differences against the grey columns. Positive changes are coloured green while negative changes are coloured red. Because the model rounds allocations to the nearest percentage small changes in allocation results can mean large changes in diversions. The modelling of diversion is very sensitive to the allocation determined by the model.

The same trend for Victoria is shown in Table 7 when the dilution is reduced without payback or tuned off completely there are positive outcomes for Victoria. This is the case when using either the historical inflows or the 2030 dry inflow sequence. If payback is required then Victoria's diversions are reduced because the model forces them to payback the allowance before they can allocate extra water to their irrigators. If the allowance is turned off or reduced without payback then Victoria benefits from the extra water it saves.

Table 7 Upper States' Diversions

	Pre-TLM Historic				Pre-TLM 2030 dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
NSW Diversions								
Mean NSW Murray diversion	1794.5	0.2	-0.1	0.4	1346.2	-2.9	-9.1	-3.5
Minimum NSW Murray diversion	560.8	0	0	-15.3	8.3	-1.4	-8.3	133.6
Mean NSW lower Darling diversion	134.9	0	0	0.4	105.2	0.1	-0.1	-0.1
Minimum NSW lower Darling diversion	12.7	0	0	0	11.2	0	0	0
Victorian Diversions								
Mean Vic Murray diversion	1742.0	1.1	-0.5	7.7	1525.8	7.7	-23.6	27.5
Minimum Vic Murray diversion	586.8	60.7	-21.9	52.1	0.1	0	6.7	0

*all diversions shown are reported as a mean annual volume (GL/yr)

Victorian diversions would not be allowed to increase due to the Cap on Diversions. However there would be increased diversions in dry times which would be offset by reduced diversions in the wetter periods. As a point of reference the modelled diversions under the Cap for the 1009 benchmark (as used within this study) by each of the three States respectively are:

NSW Cap = 1857.2 GL/yr
Victoria Cap = 1659.5 GL/yr
SA Cap = 675.5 GL/yr

The impacts on NSW are a little harder to explain. Under historical inflows NSW is generally benefiting from the allowance being turned off or reduced without payback. One exception to this in the minimum year (2006/07) NSW's diversions have been reduced by some 15 GL. This was largely accounted by the additional water in the system being used by NSW in earlier years (2005/06 and additional 3.3 GL was used in diversions) and the fact that Victoria diverted more water in the minimum year. Under the 2030 dry sequence there are considerable impacts for NSW's irrigators, however the 2030 dry simulation has a large number of assumptions which may not reflect a realistic long term scenario.

The reason for this negative impact on NSW diversions is shown in Table 8. This table shows the impact the modelled changes in the Lindsay River dilution have on storage spills including internal spills. Under the 2030 dry conditions there are considerable changes in the internal spills of Lake Victoria. NSW is losing out with a smaller spill volume from Victoria to NSW and a larger spill volume from NSW to Victoria within Lake Victoria.

Table 8 illustrates that there are more spills from Lake Victoria when the dilution component of the Lindsay River Allowance is reduced or turned off. This is due to the extra water saved and stored when the dilution is reduced or turned off.

Another interesting point that Table 8 shows is that any change in the Lindsay River dilution will cause changes right through the River Murray system. It also shows that the issue is just not a Victorian or South Australian issue, but it will also impact and affect the water resources of NSW.

Table 8 Modelled differences in storage spills due to the Lindsay River Allowance options

Site	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Dartmouth Reservoir								
Mean annual Dartmouth Reservoir spill, GL/yr	79.6	0.0	0.0	1.0	5.4	0.0	0.0	0.9
Hume Dam								
Mean annual Hume Reservoir spill, GL/yr	1067.2	-0.2	-0.3	6.7	220.4	-0.4	-0.9	-2.1
Count of Vic to NSW spills	171	0	1	7	40	0	-3	2
Total Vic to NSW spills, GL	21319.5	-3.9	5.7	872.5	5002.6	-24.9	82.9	485.4
Maximum Vic to NSW spills, GL	562.8	0	0	0.4	404.0	0	27.4	0.3
Count of NSW to VIC spills	5	0	0	-2	5	0	2	0
Total NSW to VIC spills, GL	4.5	0	0	-1.8	23.9	-0.1	6.0	-1.1
Maximum NSW to VIC spills, GL	2.9	0	0	-0.6	12.9	0	0.3	-0.4
Lake Victoria								
Mean annual Lake Victoria spill, GL/yr	4216.2	0.5	-0.1	50.7	1813.0	6.6	28.8	29.9
Count of Vic to NSW spills	215	0	0	15.0	231	5	7	14
Total Vic to NSW spills, GL	10780.3	46.3	12.5	114.4	9833.5	-49.1	-87.4	204.6
Maximum Vic to NSW spills, GL	308.4	0	0	33.0	236.3	-0.7	-1.5	-4.1
Count of NSW to VIC spills	128	3.0	2.0	-7.0	151	7	6	-8
Total NSW to VIC spills, GL	3376.3	7.4	12.5	-402.4	3418.8	-2.9	118.4	-283.1
Maximum NSW to VIC spills, GL	171.1	0	0.6	-41.3	95.0	-0.1	0.5	8.7
Menindee Lakes								
Count of Vic to NSW spills	34	0	1	3	20	0	1	0
Total Vic to NSW spills, GL	545.7	3.6	3.5	51.5	407.0	-0.5	-24.1	71.2
Maximum Vic to NSW spills, GL	70.6	0	-0.1	3.4	90.1	0.2	-9.4	5.2
Count of NSW to VIC spills	17	0	-1	-2	15	-1	1	-1
Total NSW to VIC spills, GL	187.9	-1.4	-2.0	-17.3	334.1	15.1	28.7	-30.2
Maximum NSW to VIC spills, GL	53.0	0	0	-10.9	113.9	3.6	0.7	-7.1

Table 9 presents the changes in the frequency and duration of special accounting. There are only small changes to special accounting due to the changes in the Lindsay River dilution with only one additional year of special accounting being recorded both for NSW and

Victoria when the dilution component is turned off under the historical inflow sequence. Under 2030 dry inflow conditions there are changes for Victoria, in terms of special accounting, but again these are only small. Interestingly there are no changes in the frequency or duration of the time NSW spends in a period of special accounting.

Table 9 Modelled differences in Special Accounting due to the Lindsay Dilution Options

Site*	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
No. of years NSW under special accounting in May	50	0	0	-1	98	0	0	0
Maximum continuous years NSW under Special Accounting in May	12	0	0	-1	33	0	0	0
No. of years VIC under special accounting in May	12	0	0	-1	61	-1	1	-3
Maximum continuous years VIC under Special Accounting in May	3	0	0	0	19	0	0	-10

3.3.4 Outcomes for South Australia

Table 10 presents South Australia's entitlement and diversions for the scenarios modelled. The grey columns represent absolute values and they are the baseline conditions against which the other results will be compared. The other columns in the table are shown as relative differences against the grey columns.

As discussed above there are mainly positive impacts for the regulated supply to South Australia when the Lindsay River flow is either reduced or turned off completely. However it should be noted that Table 10 does not show the impacts on the physical flow to South Australia which has the potential to have impacts on water quality and the environment. This effect will be discussed below in relation to Figure 10.

Generally there is more water available to the upper States when the Lindsay River dilution is reduced or turned off which follows on that South Australian Entitlement restrictions will be smaller.

Table 10 South Australian Entitlement and Diversions

	Pre-TLM Historic				Pre-TLM 2030 dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
SA Entitlement								
Percentage of years SA entitlement restricted (all months) %	41.2	0.0	0.0	0.0	92.1	0.0	0.0	0.0
maximum annual SA restriction (all months)	974.0	0.6	-0.5	1.1	1240.1	-4.2	-1.0	26.9
mean annual SA restriction (all months)	51.8	0.0	-0.2	-2.2	324.7	-0.2	-0.1	-6.0
minimum annual SA flow (all months)	1002.8	22.6	47.2	40.6	724.0	13.1	10.3	-37.5
SA Diversions								
Mean annual SA Murray diversion (all months)	706.5	0.0	0.1	0.5	613.1	0.2	0.0	3.3
Minimum annual SA Murray diversion (all months)	194.4	0.0	0.0	0.0	165.8	0.1	-0.4	0.2

* unless otherwise stated all values shown are reported as a mean annual volume (GL/yr)

3.3.5 Outcomes for the River Murray System

The outcomes for the River Murray System will be given in terms of flows through the River Murray system (refer to Table 11) and salinity (refer to Table 12).

The changes in flows along the River Murray System due to the changes in the Lindsay River dilution are presented in Table 11. These results are mixed, when the dilution flow is reduced without payback or turned off there is a slight reduction in average flows right along the Murray, however, under the option where the dilution is payback there are increased flows along the system. When the Lindsay dilution is turned off there is one less order that has to be met from the River Murray Storages and hence the flows are reduced to compensate. When payback is required the order for Lindsay River dilution flow is still required just at a different time and bigger volumes, hence flows have slightly increased.

Table 11 Modelled differences in flows due to the Lindsay Dilution Options

Site*	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Doctors Point	5125.4	0.6	0.3	0.3	3704.1	0.5	-3.7	0.3
Yarrawonga	4851.2	-0.7	0.5	-3.2	3297.1	3.1	2.5	3.4
Euston	6331.3	-0.5	0.8	-6.9	3815.8	-2.6	22.8	-17.1
Burtundy	823.1	-0.1	0	-1.7	558.9	-0.4	0.4	-0.5
Darling Anabranch	138.5	0	0	0.2	83.0	0	-0.1	0.1
Accounted SA flow	6228.9	0.6	0.6	55.3	3644.6	8.8	26.5	43.5
Physical SA flow	6294.8	-1.1	-0.4	-10.6	3710.8	-4.5	25.6	-22.7
Lock 1 flow	5622.1	-1.1	-0.4	-11.0	3097.3	-4.7	25.9	-25.1
Barrages	4450.2	-0.3	0.1	-9.7	1954.8	-3.9	23.9	-24.5

*all flows shown are reported as mean annual flow (GL/yr)

Downstream of the SA Border there is a general decrease in flows this is due to an increase in diversions both upstream and downstream of the SA border. This may not comply with the current Cap and in future the sustainable diversion limits (SDL) The changes in SA accounted and physical flows were discussed above in relation to Table 5.

Table 12 presents the changes in the key salinity variables within the lower Murray and lower Darling. There are small changes evident which is mainly due to the reduction of physical flows moving through the lower Murray. There is negative correlation between salinity at Morgan and physical SA flows, hence when flows drop the salinity increases.

Table 12 Modelled differences in salinities due to the Lindsay Dilution Options

Site*	Pre-TLM Historical				Pre-TLM 2030 Dry			
	Baseline	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**	**Baseline**	**Dilution flow reduced without payback**	**Dilution flow reduced with payback**	**Dilution flow turned off altogether**
Run ID	**21594**	**21731**	**21752**	**21772**	**21768**	**21769**	**21770**	**21771**
Burtundy mean	455.9	1.0	1.0	2.1	471.0	0.1	0.1	0.6
Flow to SA mean	379.7	0.1	-0.3	2.1	467.2	0.1	-4.8	1.5
Flow to SA 95th percentile	570	0	0	6	723	3	-3	-1
Morgan mean	536.7	-0.1	-0.1	3.7	698.0	0.4	-0.5	5.0
Morgan 95th percentile	817	0	0	16	1134.5	5.0	3.5	-0.5
Mannum mean	545.4	0.0	0.0	3.1	730.8	0.4	-0.4	6.2
Mannum 95th percentile	840	1	1	17	1246	2	-6	2
Murray Bridge mean	568.4	0.0	0.0	3.8	778.1	0.6	-0.4	6.3
Murray Bridge 95th percentile	877	0	0	19	1345	0	-15	4
Milang mean	781.9	2.9	2.0	10.7	1568.0	27.4	-77.1	36.8
Milang 95th percentile	1378	0	0	42	3783	88.4	-583.7	98.1

*all salinities are reported in EC

4 Summary and Conclusion

This report had a number of objectives firstly it was to provide an introduction of background and water accounting issues associated with the Lindsay River Allowance (specifically the dilution component of this allowance) and secondly it presented a number of relatively simple options for the Lindsay River dilution flow. These options were designed to show what impact changing the dilution component might have on third parties if this flow was either turned off or reduced and they follow on from the recent special water sharing deals regarding the Lindsay River Allowance.

The Lindsay River Allowance was established over 30 years ago during a time of plentiful water resource availability and annual, rather than continuous, accounting applied. During this time there were also high flow years and elevated salinity levels in the lower Lindsay River. Since its establishment there have been a number of changes in this stretch of the River Murray which may have reduced the need for such an allowance. There are now a number of salinity interception schemes which are designed to remove a large proportion of the salt load entering the River Murray in this area, there are environmental works proposed which would facilitate the delivery of environmental water to the lower Lindsay River. However, the recent drought has shown that the allowance is important during dry periods to keep the lower Lindsay River in good health and providing a baseflow to South Australia which helps to maintain the connection of the weir pools along the lower Murray River.

The options developed and coded into the MSM-BigMod for this study indicate that there are water savings when the Lindsay River dilution flow is either reduced without payback or turned off complete. This has benefits to Victoria and to the regulated supply of water to South Australia, but negative impacts on the physical flow entering South Australia. Both Victorian and South Australian diversions have increased but at the expense of less flows through the lower Murray.

This increase in diversions was seen as major issue for the modelling undertaken for this study. In reality Victoria and South Australia would not be allowed to increase diversions above their Cap level and so the water savings evident from the Lindsay Allowance would go towards extra spills in the system and would have increased both South Australian and Victorian reliabilities.

The impacts to NSW are interesting on one hand they benefit by additional water in the system while on the other they are being impacted by changes in the distribution of where water is being storage (especially under the climate change runs).

Changes in the Lindsay River dilution will cause changes to propagate throughout the system. The modelling presented here show that all three States are affected by the options presented not just Victoria or South Australia.

The options themselves are simple and if these options were to be implemented additional work would have to be undertaken to modify the behaviour of the jurisdictions within the model to more accurately reflect their actual behaviour. How the model is currently configured means that any additional water resources available within the model would increase diversions; this is not necessarily how jurisdictions would act if the allowance was changed and the Cap on diversions would have to be taken into account.

The Lindsay River Allowance is mainly a political issue in which technical modelling as presented within this report may only play a minimal role in the final outcome. It is hoped that this report will add to the bilateral discussions currently being held between South Australia

and Victoria. Ultimately any change in the Lindsay River Allowance would likely be part of a package of changes to be negotiated between all jurisdictions.

References

MDB Agreement Review Taskforce, April 2010, Scoping Report Stage 1a, Murray Darling Basin Agreement Review Taskforce.

MDBA, 2009, Initial evaluation report - Options for the Lindsay River Allowance, MDBA Water Resources Technical Report No. 2009/06

Mallee CMA, 2010, Upper Lindsay Watercourse Enhancement Proposal – Lindsay Island Works Stage 1, MDBA Living Murray Environmental Works and Measures Plan.

Appendix A – Operating Rule – Lindsay River Allowance

EXTRACTS OF MINUTES OF MEETING NO. 267 ,

HELD ON 21st March, 1979.....

12. RMC:2127 LINDSAY POINT - MODIFICATION OF MULLAROO OFFTAKE CREEK REGULATOR

The Commission agreed the proposition put forward by the State Rivers and Water Supply Commission in a letter of 1st February, 1979:-

1. that the Mullaroo Offtake be left as it is, viz. that under present conditions a flow of approximately 440 Ml/d passes down Mullaroo Creek with Lock 7 at full supply level;

2. that the flow passing the Mullaroo Offtake be recorded by use of a continuous recorder or simply a rating table related to the Lock 7 pool level;

3. that the flow so recorded be adjusted by a constant amount of 250 Ml/d representing Victorian usage;

4. The South Australian entitlement as measured at the gauging station immediately downstream of the Rufus River Junction be adjusted downwards by the difference between the flow over the Mullaroo Offtake and 250 Ml/d allowance for Victorian diversions.

MEETING NO. 267

AGENDA ITEM NO. 12

RMC:2127

LINDSAY POINT - MODIFICATION OF MULLAROO OFFTAKE CREEK REGULATOR

Since the decision taken on 17th August 1978 that the offtake structure be modified to achieve the original intention of providing a flow of 250 Ml/d, the Lindsay Point Almonds Pty. Ltd., have written to the Commission asking that the Commission reconsider this action to restore the offtake, and suggesting an adjustable structure for water control. Pending a report from the Victorian Constructing Authority action to modify the structure was deferred.

In a letter of 1st February 1979, copy attached, the Victorian Constructing Authority sees the solution to the problem as:-

1) Leaving the Mullaroo Offtake as it is, and

2) Recording the flow passing the Mullaroo Offtake, and

3) Adjusting the flow so recorded by a constant amount of 250 Ml/d representing Victorian usage, losses in the Mullaroo/Lindsay System and a reasonably generous non-accountable return flow from Victoria to South Australia. (It is understood that the maximum diversion rate for irrigation would be about 100 Ml/d for the total authorised development of about 1000 Ha.)

An adjustable control is not favoured because of its cost and dubious benefits.

The matter is seen as one which mainly concerns Victoria and South Australia.

When flows to South Australia are on entitlement and Lock 7 is at full supply level the flow into the Mullaroo is about 440 Ml/d. If the South Australian entitlement, as measured at the gauging station immediately downstream of the Rufus River junction, is adjusted downwards by the difference between the 250 Ml/d and the flow over the Mullaroo Offtake, the share of River Murray Commission resources available to New South Wales would not be affected.

South Australia has previously agreed to the proposal for a modification of the Mullaroo Offtake to allow a flow of 250 Ml/d when Lock 7 was a full supply level, presumably on the basis that this flow was regarded as a Victorian diversion and did not affect South Australia's entitlement.

Appendix B –Lindsay River Allowance Options Modelling by SKM

Victoria has previously embarked on studies to identify alternative measures to manage the saline groundwater ingress to the Murray whilst maintaining suitable supply to the Lindsay River diverters

With the recent dry conditions, and predicted impacts on water reliability from climate change, there are renewed drivers for options which could potentially free up about 70 GL normally allocated to the Lindsay River Allowance for reallocation within Victoria. In 2008, SKM was engaged by DSE to re-examine the options for a salt interception scheme including updating the costs and estimation of the salt impacts on the Murray. Other options were also examined. SKM looked at four options, all of which would remove the need for Victoria to provide the current Lindsay River Allowance whilst maintaining suitable water supply to the private diverters, at a maximum of 500 EC. A summary of the options is provided in Table 13 below.

Table 13 Summary of options investigated by SKM (SKM, 2008)

Option	Description	Costs (PV at 4% over 30 years)	EC Impact	Savings to Victoria (GL)
1	Pipeline to Diverters of 150ML/day capacity	$29.6M	2.0 EC debit	70 GL
2	Interception Scheme with disposal to NSW	$50.8M	2.4 EC salinity benefit	70 GL
3	Interception Scheme with disposal to Victoria	$78.6M	2.4 EC salinity benefit	70 GL
4	900 ML/day consistent environmental flow by rerouting the River Murray flow	No major works required	2.0 EC debit	70 GL

All of these options are described briefly below in SKM's order of preference.

Option 4 – Environmental Flow

The study concluded that the most economical option to recover the dilution flow is to permanently divert 900 ML/day of water from the main channel of the River Murray, down the Lindsay River, via Mullaroo Creek. This could be split as 450 ML/day via the Upper Lindsay River and 450 ML/day via Mullaroo Creek. The environmental flow would result in the water salinities in Lindsay River being maintained around 500 EC, suitable for the needs of the Lindsay River Diverters

The design environmental flow of 900 ML/day was based on groundwater investigations that indicated that flows less than 450 ML/day in the upper Lindsay River would result in the formation of saline pools. New offtake structures, capable of varying the flow would be required at the heads of Lindsay River and Mullaroo Creek. Fish ladders would be incorporated into the design.

This option would require the MDBA to recognise the Lindsay River as a main carrier for delivering water to South Australia and as it would result in a change in the flow regime along the main branch of the River Murray, environmental approvals may be required. Arrangements would need to be made to account for any additional losses from this option.

Use of the savings upstream would require Victoria to incur a salinity debit of 2.0 EC, which would have to offset from Victoria's pool of credits. This option would maximise the en-route

benefits of consumptive water as it would maintain and possibly enhance the current high environmental values in the Lindsay/Mullaroo system.

Option 1 – Pipeline to Diverters

The second most favourable option modelled by SKM is to construct a pipeline from the Murray to supply the diverters along Lindsay River. This option assumes the saline water from the Lindsay River is sufficiently dispersed before the pipeline offtake to supply the diverters. A pipeline capacity of 150 ML/day had been adopted for the option analysis. This includes a 20% Allowance for future expansion. This option would cause Victoria to incur a 2.0 EC debit, which would have to offset from Victoria's pool of credits.

Option 2 and 3 – Salt Interception Scheme

SKM (2008) found a salt interception scheme on either the Victorian or NSW sides of the River Murray the least favoured of the options examined. They cited the high cost and the uncertainty surrounding flows in the Lindsay River and Mullaroo Creek. SKM found that even with the salt interception schemes flows below 200 ML/day could see the formation of stratified saline pools from groundwater interaction. Implementing either of these options would however provide Victoria with EC credits.