



Australian Government



MURRAY-DARLING BASIN AUTHORITY

Report of the Independent Audit Group for Salinity

2009–10

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December 2010

Published by Murray-Darling Basin Authority
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This report may be cited as: Report of the Independent Audit Group for Salinity

MDBA Publication No. 117/11

ISBN 978-1-921783-76-0 (on-line)
ISBN 978-1-921783-77-7 (print)

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AUDITORS' FOREWORD

February 2011

Chairperson
Murray–Darling Basin Authority
GPO Box 1801
CANBERRA ACT 2601

Dear Chairperson

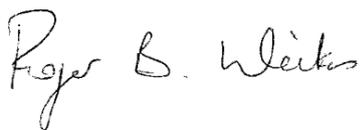
We have pleasure in submitting to you the Report of the Independent Audit Group for Salinity 2009–10.

This, the eighth such audit of the Basin Salinity Management Strategy 2001–2015, covering the third year of Phase 2, has been carried out in accordance with the provisions of Schedule B to the Murray–Darling Basin Agreement, (Schedule 1 to the *Water Act 2007* (Commonwealth)).

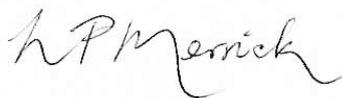
The continuing drought and substantial reductions in funding for salinity programs at state, Australian Capital Territory and regional catchment management level, as reported last year, present great challenges. This year the modelled Morgan target of 800 EC for 95% of the time was reached for the first time since it was set. This is a significant achievement for the Basin Salinity Management Strategy and should be celebrated. However the predicted increases in salinity in the out-years suggest that the Murray–Darling Basin Authority and partner governments need to continue to take the Basin Salinity Management Strategy seriously.

The achievements of the 12 months covered by this audit were very much a result of the strong commitment and expertise of the officers of the jurisdictions and MDBA who were engaged on the Basin Salinity Management Strategy. They worked collectively during the year to make progress on some important recommendations made in the last audit report. We extend our thanks for their cooperation and assistance.

Yours sincerely



ROGER WICKES
Lead Auditor



NOEL MERRICK
Auditor



ROGER SHAW
Auditor

ABBREVIATIONS

2CSalt	Landscape salinity model software
BSMS	Basin Salinity Management Strategy
EC	Electrical conductivity expressed in units of $\mu\text{S}/\text{cm}$
IAG-Salinity	Independent Audit Group for Salinity
IQQM	River model software [integrated quantity quality model]
MDBA	Murray–Darling Basin Authority
MODFLOW	Groundwater model software [modular flow model]
MSM-BIGMOD	Daily flow and salinity model for the River Murray
MTR	Mid-term review
REALM	Resource allocation model software

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EXECUTIVE SUMMARY

Introduction

In August 2001 the Murray–Darling Basin Ministerial Council (the Council) launched the Basin Salinity Management Strategy (BSMS)¹. In December 2008 the Murray–Darling Basin Commission (MDBC) was succeeded by the Murray–Darling Basin Authority (MDBA). Schedule C to the Murray–Darling Basin Agreement, which set down the legislative framework for the implementation of the BSMS, became Schedule B to the Murray–Darling Basin Agreement, which is Schedule 1 to the *Water Act 2007* (Commonwealth).

Schedule B provides for the appointment of ‘independent auditors for the purpose of carrying out an annual audit’, whose task is to review progress on implementing the BSMS. The three members of the current Independent Audit Group for Salinity (IAG–Salinity) were appointed in October 2008.

The terms of reference for the IAG–Salinity and Schedule B require IAG–Salinity to review progress on the BSMS both broadly and in terms of the steps laid down in the Schedule. The terms of reference also require it to focus on measuring and recording progress of the BSMS, and the outcomes at 30 June each year.

This report presents the consensus view that IAG–Salinity has reached in undertaking the audit covering the 2009–10 financial year. The following summarises the most important of our findings. The main text provides context, the findings and recommendations in detail.

The state contracting governments, including the Australian Capital Territory and the MDBA submitted reports on their activities, valley reports, the status of five-year rolling reviews and BSMS salinity register entries or adjustments. These reports contained the necessary information to make an assessment. The Australian Department of Sustainability, Environment, Water, Population and Communities also submitted a very brief report.

The audit process adopted by IAG–Salinity included reviewing these reports and the salinity registers and their supporting documentation. This was followed by meetings with staff representatives of the jurisdictions and MDBA. The recommendations were developed with their involvement.

The 2009–10 context for Basin Salinity Management Strategy implementation

In 2009–10, thinking on the BSMS has been influenced by the increasing rainfall in the northern Basin and recovery of the water levels in the River Murray, a continuing gap in funding, the purchase of large quantities of water by governments and the release of the *Guide to the proposed Basin Plan*. The long-term drought in the southern Basin has had a significant impact on the salinity of the region. The low river flows have led to significantly increased salinity levels in the Lower Lakes and the Coorong and many short-term decisions had to be made to manage the risks salinity posed to critical human water needs and the ecology of the region.

This is the first year that the Basin salinity target, as defined in Schedule B at Morgan of 800 EC for 95% of the time during the benchmark period, has been reached. The delivery of low salinity water from upstream storages down the River Murray and the operation of salt interception schemes to reduce salt inflows from regional watertables to the river meant that water quality has been good although river flows have been low.

The lack of high river flows for 14 years in the River Murray has meant that salt has not been exported from the Basin and is most likely building up along the river valleys. From previous experience, river salinities following a high river flow may increase significantly.

Watertable levels have been falling throughout the Basin during the drought but the recent higher rainfall may result in watertables rising quickly in previously salted areas. The impact of rising watertables on the landscape, irrigation and river salinities is unknown at this stage. The purchase of water from irrigation,

¹ Murray–Darling Basin Ministerial Council 2001, *Basin Salinity Management Strategy 2001–2015*, MDBC, Canberra.

the improvement of irrigation practice and the use of that water for ecological purposes can effect salinity outcomes within the Basin. The salt mobilisation that may occur from watering wetlands is currently being quantified, but the total impact is not yet known. The impact that retiring some irrigation activity may have on watertables and the accounting of salinity flows from these sites into the river is unknown. The manipulation of flow regimes with the large volumes of water now purchased for environmental watering may also have a positive impact if undertaken at the appropriate time. This has added to the complexity of managing salinity in the river. Protocols need to be developed for optimal operational efficiency.

The funding of salinity programs directly from national programs has not occurred during the current year. The lack of specific funding for salinity, together with lowered watertables during the drought reducing the visual expression of the salinity problem, has led many catchment management authorities to invest in more generic programs, reducing the momentum on tackling the salinity issue. Most states have maintained a program in salinity but it is evident that skilled staff numbers at a state level are reducing.

The *Guide to the proposed Basin Plan* was released at the time of the audit and, while not considered by the IAG–Salinity, it was pleasing to recognise from MDBA’s briefing to the IAG, that the proposed implementation will build on the work of the BSMS and that the Guide had embraced a number of the new directions proposed by the mid-term review and recommendations of previous audits.

Progress in implementing Schedule B – Items for special mention

Implementation of the Basin Salinity Management Strategy

It is evident that the implementation of the BSMS has progressed in three phases.

The first phase has been the implementation of the works and measures program where salt interception schemes were investigated and constructed. This, together with intense model development by the partners, has decreased uncertainty in the salinity registers. The works and measures program has been highly successful and will deliver a salinity reduction of greater than 61 EC at Morgan by 2012, and has the potential to deliver a further reduction of 50 EC. Beyond that there is little scope for any cost effective works and measures programs for mitigating salinity.

The second phase has been the considerable purchase of large quantities of water by governments and the use of that water for watering of ecological sites. The recent acknowledgement that there may be salinity accountability implications from doing this has led to a joint activity between the jurisdictions to understand the processes and start some analysis of the accountability for these actions.

The third phase is the remaining elements of the BSMS that relate to land-based mitigation. Further studies of catchments and sub-catchments, particularly the upper catchment areas, has demonstrated that with close analysis, priority catchments which contribute saline water can be selected for remedial investment. Using the tools developed by jurisdictions to prioritise catchments for investment across the Basin has greater merit than the current practice of investing small amounts of funds over large areas where the impact of those investments on salinity cannot be measured and accounted for.

Given the works and measures program is all but complete, a concerted effort into the land management elements of the BSMS may provide the opportunity to make progress on all the nine elements of the strategy.

Current salinity management in the Basin

During previous droughts, River Murray real-time salinities were much higher than those recorded in the current drought. The reduced salinities during the drought can be attributed both to the low salinity water coming from the main storages in the upper catchments and to the salt interception schemes protecting this water from regional salinity inflows. Table 1 shows that the model predictions for river salinity at Morgan over the benchmark period (1975–2000), are less than 800 EC for 95% of the time. This is the first time since the inception of the BSMS in 2001 that the Basin salinity target has been achieved. Figure 1 shows the effect of salinity management in the Murray–Darling Basin on salinity at Morgan, based on actual measurements and

predicted salinity if management had not occurred. Without management, salinity at Morgan would have been in the range 53 to 1,411 EC above the observed levels during 2009–10 and would have been destructive to most irrigated plantings and urban areas, including significant populations downstream of Morgan that source water from the River Murray.

These results show the relevance of the BSMS in protecting the assets of the Basin. It is important to continue to monitor these targets as irrigation footprints change and river flows adjust over time.

Table 1: The simulated salinity levels (EC) summary at Morgan, South Australia for baseline and 2010 conditions over the 1975–2000 benchmark period

Simulation period	Mean	Median	95 percentile	Percentage time over 800 EC	Percentage time less than 800 EC
Simulated baseline (1988) conditions over benchmark period (1975–2000)	665	666	1,058	28	72
Simulated 2010 conditions over benchmark period (1975–2000)	510	484	787	4	96

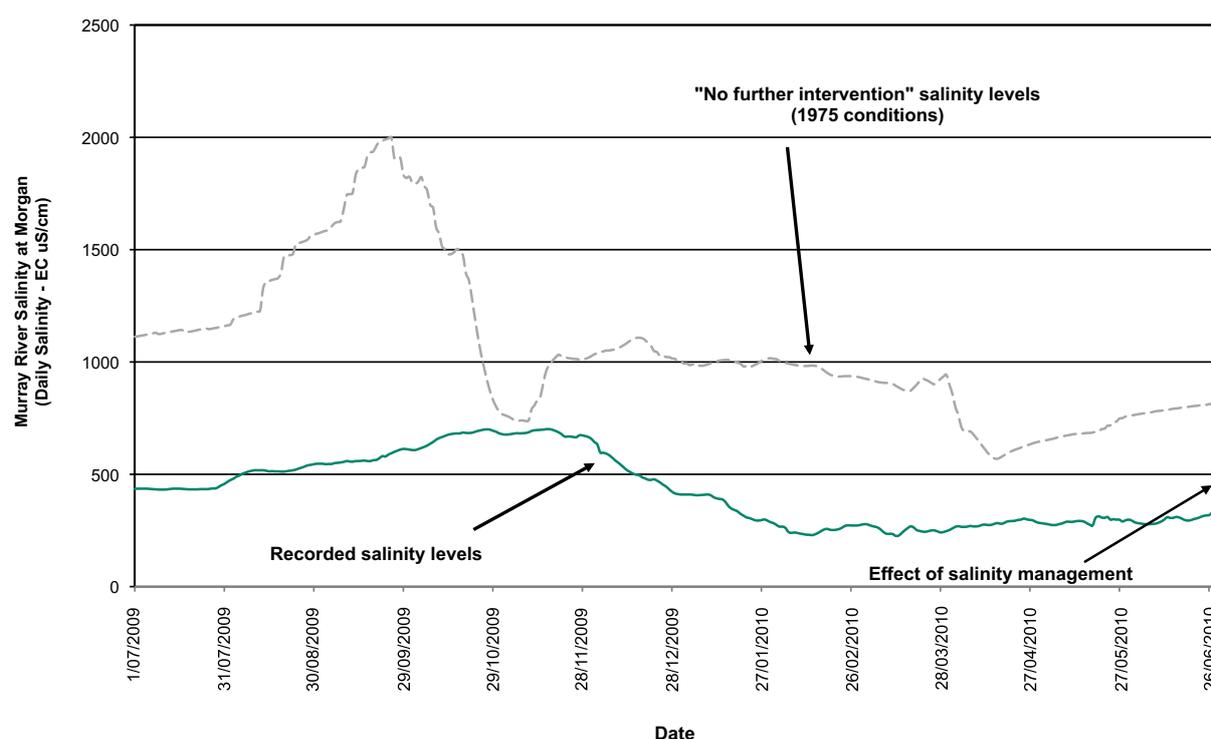


Figure 1: Mean daily salinity levels from July 2009–June 2010 compared to modelled salinity levels without salinity mitigation actions ('no further intervention' scenario). The difference is assumed to be the effect of salinity management.

Flood recession salt risks

The progress being made since the last audit has explored the risks of salt entering the rivers following a flood. This is timely with the recent changes in the weather patterns and increased flows through the Basin. It is essential that this work is completed and operational response plans are developed to manage flood recession salinity.

Environmental watering

It is essential that the progress being made on the accountability for salinity impacts from environmental watering is continued and taken through to a conclusion. Environmental watering is taking place and the salt risks from this in-valley activity need to be determined. Purchasing water from irrigation schemes does not immediately provide salinity credits for the purchased water as it takes a long time for groundwater levels below a retired irrigated area to fall. Methods of delivering water into wetlands compared with natural flows over banks may have different effects on the concentration of salinity in the streams. Timing of river flows around an environmental watering can change the real-time instream water quality. There is a lot of goodwill by the jurisdictions for this work and it is important it is completed.

Land management strategies

Good information and tools have been developed to tackle the elements of the BSMS that target salinity management for the dryland areas of the Basin. The tools for prioritising those catchments that respond to land management strategies are maturing and it may be possible to measure the difference being made instream. It is important that the different approaches being taken by the jurisdictions are shared and common programs developed for the dryland areas across the Basin. A focus on the dryland would also assist the catchment management authorities to prioritise their work rather than, in some cases, continuing to invest small amounts in land management where the impact is not measurable. It may also lead to the policy makers understanding the return that can be achieved and lead to an increase in funding for dryland areas.

Salinity outlook

While Basin instream salinity has met the target at Morgan for the first time, the on-going risk from increasing salinity is still a concern. The BSMS forward predictions may have been too high given the improved information now available about the upland catchments, the current buy back of water for environmental use and the impending impact of climate change. It is important to again determine the salinity risk leading up to a revised BSMS as required in Schedule B for 2012. It is also important to develop a relationship between the accountable actions in the registers and the target at Morgan to determine whether the credits in the registers can be used for development without affecting the target at Morgan. In the meantime, as a precaution, IAG-Salinity suggests that it is important that the second round of 40 EC credits achievable from the works and measures program, as recommended in the mid-term review, be progressed while the impetus is there.

The IAG-Salinity's opinion regarding the balance of salinity credits and debits for each state

Schedule B, Clause 16 (1) provides as follows:

16. (1) A state contracting government must take whatever action may be necessary:

- (a) to keep the total of any salinity credits in excess of, or equal to, the total of any salinity debits, attributed to it in Register A; and*
- (b) to keep the cumulative total of all salinity credits in excess of, or equal to, the cumulative total of all salinity debits, attributed to it in both Register A and Register B.*

Register A currently shows New South Wales, Victoria and South Australia to be in net credit, while register B (including provisional items) shows New South Wales and South Australia to be in net credit, and Victoria slightly in debit. For the combined registers, all three states are in credit.

Opinion on register balances:

IAG-Salinity has examined the registers as provided for this audit, and has come to the opinion that New South Wales, Victoria and South Australia are in a net credit position.

In line with a recommendation of the IAG-Salinity's 2007–08 report, the methods of calculating the entries in registers A and B were harmonised in 2009–10.

The accuracy of the MDBA in maintaining the salinity registers

During 2010, the MDBA had a significant meeting with each of the jurisdictions and examined every line in the register. Decisions from the meetings were documented and with the current information the registers reflect the best information available at this time. Technical issues concerning some South Australian groundwater models prompted low confidence in the state's A and B register entries until the issues have been well sorted. Outstanding reviews of Victorian and Queensland entries are the subject of Recommendation 7 in this report.

Opinion on the MDBA accuracy in maintaining the registers:

The IAG-Salinity found no inaccuracies in the MDBA's maintenance of the registers, as provided for incorporation into this report.

Updating the MDBA's salinity registers

The audit did not identify any requirement to update individual entries in the registers incorporated in this report, aside from the matters that need addressing for the next audit, referred to above and in the main body of this report.

Recommendations

The following are the recommendations of the IAG-Salinity, given in two groups – high and normal priority. Within the high priority group, the recommendations are in descending order of priority.

The IAG-Salinity recommends:

High priority:

1. **Flood recession salinity risks:** That the MDBA, with advice from the Basin Salinity Management Advisory Panel, continue this program as a matter of urgency and prepare operational plans required to manage the salinity risks.
2. **Accountability for salt mobilisation by environmental watering:** That the MDBA with advice from Basin Salinity Management Advisory Panel complete a framework for accountability for the salinity effects of environmental watering to enable such actions to be entered onto the salinity registers.
3. **Re-assessing salinity risk in the Basin:** A comprehensive review of the currently projected salinity risk in the Basin for 2050 should be undertaken by the MDBA with advice from Basin Salinity Management Advisory Panel while the Basin Plan and the environmental watering plans are being developed as a first step in producing the next phase of salinity management. The review should take into account the re-assessment of salt loads from individual catchments, the water buyback, and climate change scenarios.
4. **Prioritising catchments and sub-catchments for salinity management:** The MDBA should facilitate assessment of currently available tools that prioritise catchments with high salinity outflows or salinity risk and allow the reduction in salinity outflows from the application of a range of recommended land and water management actions to be measured.
5. **Coal seam gas**
 - (a) Queensland should formally document and provide to the MDBA the policy framework and processes it is using to manage coal seam gas developments to minimise salinity risks to the Basin.
 - (b) New South Wales should report to the MDBA on its policy framework for coal seam gas developments in New South Wales, identifying the processes that can be used to minimise any potential salinity risk in the Basin.
6. **Joint works and measures program Pike River:** Pike River salt interception scheme construction should be implemented as a precautionary approach to salinity management in the Basin given the predicted 2050 salinity outcome based on current models and the minimal credits available from retiring irrigated lands show that the probability of meeting the Morgan Basin salinity target into the future is low.

7. Outstanding reviews of register items:

- (a) Queensland outstanding reviews of registers A and B items need to be progressed
- (b) All outstanding reviews of Victorian register B items need be completed, in particular the Goulburn Broken and Loddon catchments legacy of history salinity impacts should be assessed using detailed modelling
- (c) South Australia salinity groundwater modelling technical review be completed so it can be accepted by MDBA
- (d) New South Wales formally submits to the MDBA each of the register B valley five-year reviews so they can be finalised.

8. Resourcing of salinity in catchment plans: Funding for catchment plans to address salinity issues needs to be increased to ensure the skills, knowledge and actions built up during the first nine years of BSMS are not lost.

9. Relationship between registers and the target at Morgan: The consistency between the credit and debit balances of the registers and the target at Morgan needs to be established, taking into account the likely effects of environmental watering and the Basin Plan, given that 2010 is the first year that the target at Morgan has been met while register A has been in credit for each jurisdiction for some years.

10. Irrigation Salinity Accountability Framework: The MDBA, with advice from Basin Salinity Management Advisory Panel, facilitate the development of a consistent framework for the accountability of irrigation salinity impacts including improved knowledge of district-scale irrigation related groundwater recharge. MDBA should continue capturing the irrigation improvement measures and unbundling water from lands to inform this process. MDBA should promote irrigation as a special application case in revised groundwater modelling guidelines being prepared by the National Water Commission.

11. Salinity expertise for the Commonwealth Environmental Water Holder: To facilitate appropriate salinity accounting and operating conditions for environmental watering activities, and strategic water purchasing, the Commonwealth Environmental Water Holder should consider including skills in floodplain salt mobilisation on its Environmental Water Scientific Advisory Committee. Increased collaboration is also required between the Commonwealth Environmental Water Holder and partner governments to incorporate the considerable existing knowledge and expertise.

Normal priority:

12. Consistent Basin-wide land use databases: The MDBA should facilitate the development of a set of databases that describe land use at catchment scale across the Basin for use in prioritising dryland catchments for land management improvement.

13. Science skills audit to support the salinity program: MDBA and the jurisdictions should review their sources of science expertise to support the BSMS and propose strategies to enable the program to be supported with ongoing appropriate skills into the future.

14. Updating the valuations in the registers: That the registers reflect the current dollar value of the assets at risk and these be updated annually.

15. Defining the uncertainty in the register items: Uncertainties in the registers need to be more transparent and the meaning of high, medium and low confidences defined.

16. Recording the mitigation decisions required during the drought: That South Australia should document the recent actions taken (particularly below Lock 1) during the drought to mitigate the salinity issues and also the recent recovery within an ecosystem response and resilience context.

17. End-of-valley salinity-flow interpretations: That the MDBA facilitate a whole-of-basin analysis of salinity-flow hydrographs over the past wet season in order to provide insight into the natural processes that release salt to streams. This could involve synthetic models to demonstrate the key processes.

18. Environmental water and salt export: In developing environmental watering guidelines, multiple objectives such as the export of salt from the Basin and ecological health of the Coorong and Lower Lakes should be considered.

Determining priorities

The recommendations in this report were arrived at through a review of the jurisdictions' reports, the annual BSMS implementation reports, and past IAG-Salinity reports, followed by discussion with representatives of the jurisdictions and the catchment management authorities (where present). Most of the recommendations and their relative priorities were discussed with the relevant jurisdictions. The priorities arrived at, and the rationales for the priority ranking, are similar to those of the IAG-Salinity 2008–09 report.

Recommendations of previous IAG-Salinity reports

Important recommendations from the 2008–09 audit report not included above are:

Salinity targets below Morgan (Recommendation 4)

This recommendation has been covered by the proposals in the *Guide to the proposed Basin Plan* where drinking water guidelines will be applied in short-term targets down to Wellington, South Australia. A new recommendation has been made in this report to record actions taken during the drought to mitigate the salinity risk to communities below Lock 1 and its impact on the ecology.

Within-valley targets (Recommendation 5)

Some progress has been made in New South Wales but within-valley targets need to be rolled out across the Basin, as indicated in the new recommendations 4 and 17 above.

Water management for climate change and salt (Recommendation 8)

Progress has been made on common climate change scenarios by the MDBA and a published report is expected in early 2011.

Flood and high flow salt interception scheme rules (Recommendation 10)

The MDBA has undertaken a review of all salt interception scheme operations and is adjusting infrastructure installations so that all except two schemes can be operated under high flow conditions.

Alignment of BSMS with catchment action plans (Recommendation 11)

Some progress has been made in New South Wales but further alignment is expected from their pending salinity statement and review of catchment action plans and administrative arrangements.

Inclusion of Commonwealth Environmental Water Holder in the audit (Recommendation 14)

Progress has been made and ongoing discussion is expected to resolve the arrangements during 2010–2011 and is part of the new recommendations.

Previous audits

Finalising register entries with low confidence ratings (2007–8 Recommendation 7)

Completed for the New South Wales and Victorian Mallee Legacy of History entries.

Synergies in activities and funding (2007–8 Recommendation 10)

Still reliant on funding that may be available when the Basin Plan commences its implementation phase.

Harmonising entries in A and B salinity registers (2007–8 Recommendation 15)

Completed.

Salinity registers and targets for Queensland (2007–8 Recommendation 16)

Little progress has been made in completing the blank entries in the salinity registers and is part of the new recommendation 7 in this report.

BSMS mid-term review and Basin Plan

Develop methods to account for and achieve environmental outcomes from salinity mitigation actions through integration across MDBA programs

The Living Murray program has addressed this issue and it is also a part of the actions in the *Guide to the proposed Basin Plan*.

Support integration and alignment of national funding initiatives and reporting with regional catchment strategies that reflect BSMS objectives and integrated catchment outcomes

With the completion of the National Action Plan for Salinity and Water Quality there is no national program that directly funds salinity management.

Increased emphasis on catchment actions to address salt mobilisation and more innovative measures to deal with the effects such as real-time operation

This has been proposed in the *Guide to the proposed Basin Plan* where operational targets in the water quality and salinity management plan are proposed.

1. INTRODUCTION

Objectives and structure of the Basin Salinity Management Strategy

The BSMS provides a framework for communities and governments to work together to control salinity and protect key assets and natural resource values in the Murray–Darling Basin. Its objectives are to:

1. maintain the water quality of the shared water resources of the Murray and Darling rivers for all beneficial uses – agricultural, environmental, urban, industrial and recreational
2. control the rise in salt loads in all tributary rivers of the Murray–Darling Basin, and through that control, protect their water resources and aquatic ecosystems at agreed levels
3. control land degradation and protect important terrestrial ecosystems, productive farm land, cultural heritage, and built infrastructure at agreed levels Basin-wide
4. maximise net benefits from salinity control across the Basin.

The obligations that provide for the implementation of the BSMS are set down in Schedule B to the Murray–Darling Basin Agreement, which is Schedule 1 to the *Water Act 2007* (Commonwealth).

Schedule B supports effective salinity management by:

- promoting joint works, measures and other action to reduce or limit the rate at which salinity increases within the Murray–Darling Basin
- providing for the adoption of salinity targets
- establishing salinity registers to record salinity impacts and to allocate salinity credits and salinity debits to contracting governments
- providing for monitoring, assessing, auditing and reporting on progress in implementing the strategy.

Achievement of the BSMS objectives is measured not only through the salinity registers, but also through the degree to which end-of-valley targets and the Basin salinity target at Morgan have been achieved. Progress towards meeting the agreed end-of-valley targets and the land management objectives is assessed through annual reports from the contracting governments and MDBA. These reports include valley reports for the catchments where an end-of-valley target has been adopted. An independent annual audit of the reports and register entries, and of the performance of the contracting governments and MDBA, is provided by the Independent Audit Group for Salinity (IAG-Salinity).

A key driver of the BSMS is the principle of ‘capping’ increases in salinity of the Murray–Darling Basin by a system of salt credits and debits, managed by the participating governments through two major thrusts. One is joint investment in salt interception schemes and associated infrastructure, and the other is investment in target setting and monitoring systems at the end-of-valleys in concert with plans and actions to improve land management practices across the Basin. Victoria has set sub-targets for irrigation areas and upland systems so that they can monitor the effect of these on the end-of-valley targets.

The nine implementation elements of the BSMS are:

1. Developing capacity to implement the strategy.
2. Identifying values and assets at risk.
3. Setting salinity targets.
4. Managing trade-offs with the available within-valley options.
5. Implementing salinity and catchment management plans.
6. Redesigning farming systems.
7. Targeting reforestation and vegetation management.

8. Constructing salt interception works.
9. Ensuring Basin-wide accountability, monitoring, evaluating and reporting.

The BSMS commenced in 2001–02, and is scheduled for completion in 2015.

Terms of reference

The terms of reference of the IAG-Salinity of the BSMS are attached as Appendix 1. A summary of Schedule B, including its provisions concerning audit of the BSMS, is attached as Appendix 2.

Key to the terms of reference are principles for the audit, the provision that the audit will be conducted under an audit plan, and specification of the output required.

The terms of reference require the IAG-Salinity to review progress on the BSMS both broadly and in terms of the specific steps laid down in Schedule B, and also to focus on the specific measurement and recording of progress with the BSMS, and the outcomes to 30 June 2010.

As set down in the audit plan, priority areas for review in this audit include:

1. **Registers:** those Schedule B accountabilities required to be reported to Ministerial Council, particularly the auditors' assessment of whether the BSMS salinity registers are a fair and accurate recording of the salinity impacts of actions.
2. **Reviews:** rolling five-year reviews are due to be completed and assessed. However, where the reviews have not been completed within the timeframes set down by Schedule B, some comment should be provided on:
 - the potential for improved estimates given the available data and development of analytical tools since the last assessment, and
 - the relative risks in terms of likelihood and consequence, as compared with other salinity assessments that have been, or should be, undertaken by the partner government.
3. **BSMS mid-term review recommendations:** Some recommendations of the BSMS mid-term review were directed towards development of new strategies (e.g. development of options for real-time salinity management, catchment actions to deliver water quality targets and future joint works and measures program) in the second half of BSMS, 2008–2015.

However, the proposed Basin Plan was expected to be released before the 2010 salinity audit. Some of the mid-term review directions and recommendations and past salinity audit recommendations may have been included in the proposed Basin Plan.

Auditors may comment on the progress made to date by the BSMS program on mid-term review recommendations and directions with an understanding of the *Guide to the proposed Basin Plan*, allowing BSMS to set priorities from 2011–2015.

4. **2008–09 IAG-Salinity recommendations:** Based on the 2009–10 annual implementation reports provided, auditors to comment on progress made against the 2008–09 recommendations.

The steps taken by IAG Salinity in carrying out the 2009–10 audit included:

- assessing the annual reports of the jurisdictions
- reviewing registers A and B with MDBA staff
- travelling to each jurisdiction, meeting with the representatives of the contracting governments and the MDBA. These were essentially all-day meetings with the contact officers, their teams of managers and specialists and, in some cases, managers of regional catchment management authorities, and, at the majority of meetings, a member of the Murray–Darling Basin Community Committee.
- discussing technical and scientific issues with specialist staff from the jurisdictions and the MDBA, seeking clarification or correction of misunderstandings, and
- providing the main draft text to jurisdictional contact officers for comment.

2. IMPLEMENTATION OF THE BASIN SALINITY MANAGEMENT STRATEGY

Consistent with the format of annual BSMS reports as adopted by the jurisdictions and the MDBA, this chapter is organised under the nine BSMS elements. The IAG-Salinity's assessment of the need for action under different elements sometimes leads to the same recommendation. In the interests of readability, where a recommendation arises a second time, it is repeated.

The relative priorities of the recommendations are shown in the Executive summary. In this chapter, each recommendation is accompanied by its recommendation number.

Element 1: Developing capacity to implement the BSMS

The Authority and partner governments will administer a comprehensive 'knowledge generation' program to support Basin and within-valley planning and implementation.

The partner governments will assist catchment communities to implement national, Basin and state initiatives by improving access to and use of the knowledge and decision tools generated by investigations and salinity research and development. This process will be supported by further capacity building for catchment planning, including communication and education.

Skills

The catchment management authorities in Victoria and New South Wales and the Natural Resource Management Board in South Australia are continuing to promote and run training and educational programs for landholders and the community. These programs are generic and only indirectly include salinity mitigation. This is driven by the change in funding focus under the Caring for our Country program and the lower evidence of dryland and irrigation salinity through the ongoing drought. With the recent return of higher rainfalls and the reported large rises in watertable levels in some former salinity affected areas of New South Wales and Victoria, it is expected that the need for knowledge of salinity management will increase. This needs to be addressed through increased funding in the short-term otherwise the timeframe will be too long to retain experienced people involved in catchment planning.

Recommendation 8: Resourcing of salinity in catchment plans: *Funding for catchment plans to address salinity issues needs to be increased to ensure the skills, knowledge and actions built up during the first nine years of BSMS are not lost.*

The Government of South Australia in partnership with universities and Commonwealth Scientific and Industrial Research Organisation (CSIRO) have established the Goyder Institute to provide science to support policy decisions. This is a welcome enhancement of skills. Regional groups are still experiencing a skills shortage in field salinity processes and implementation. Victoria identified a potential lack of science skills for the future and, while successfully using retired staff, there is a need for ongoing access to salinity skills within a widening ecosystem framework. Victoria continues to ensure that salinity issues are documented and are integrated into landuse programs. The number of staff actively involved in salinity in Queensland has decreased to a low level and, with the implementation of other major programs in particular the Reef Plan, these skilled staff can no longer support the BSMS.

IAG-Salinity recommends that each jurisdiction consider the future needs for salinity expertise and identify options collectively and/or regionally to develop young people with these skills. The skills are required to continue both the BSMS and the Water Quality and Salinity Management Plan under the Basin Plan, as well as to address the salinity implications of environmental watering plans.

Recommendation 13: Science skills audit to support the salinity program: *MDBA and the jurisdictions should review their sources of science expertise to support the BSMS and propose strategies to enable the program to be supported with ongoing appropriate skills into the future.*

A range of options should be considered in developing staff skills, such as formal mentoring roles as currently used in some agencies; partnerships with government and research institutions; funding scholarships for postgraduate training using local or regional salinity issues with a career path for appointment; and the appointment of young scientists to deal with data interpretation across regional areas and across states.

The Commonwealth Environmental Water Holder established an Environmental Water Scientific Advisory Committee to provide independent scientific advice in November 2008. The business plan 2010-11 identifies the skills of the committee. “The current membership of this committee comprises eminent scientists and experts in fields such as hydrology, limnology, river operations management, river and floodplain ecology, and the management of aquatic ecosystems”. With the projected increase in the mobilisation of salt from environmental watering and possible long lag times, it is recommended that skills in floodplain salt mobilisation be added to this committee. The document A “Framework for Determining Commonwealth Environmental Watering Actions” as the basis for environmental watering dated December 2009 has limited reference to the salinity impacts of environmental watering. The Commonwealth Environmental Water Holder business plan 2010-11 identifies knowledge needs around six key themes. Salt mobilisation is not listed. Given the high priority recommendations by the IAG-Salinity report last year (Recommendation 1 Flood recession salt risks, and Recommendation 7 Accountability for salt mobilised by environmental watering), it is recommended that the salinity effects of environmental watering and possible long lag times is an equally important knowledge need for Commonwealth Environmental Water Holder. There is also a great deal of expertise available in the jurisdictions and this should also be accessed.

Recommendation 11: Salinity expertise for the Commonwealth Environmental Water Holder: *To facilitate appropriate salinity accounting and operating conditions for environmental watering activities, and strategic water purchasing, the Commonwealth Environmental Water Holder should consider including skills in floodplain salt mobilisation on its Environmental Water Scientific Advisory Committee. Increased collaboration is also required between the Commonwealth Environmental Water Holder and partner governments to incorporate the considerable existing knowledge and expertise.*

Knowledge and decision tools

Modelling approaches cover varying levels of sophistication that range from simple water balance algorithms to natural process models, with underlying analytical or numerical solution methods. Ultimately, the MSM-BIGMOD model is used to take jurisdictional IQQM, REALM, MODFLOW and SIMRAT simulated salt load inputs, route flows and salinities on a daily time step to the Murray mouth, with assessment of compliance with the Basin salinity target at Morgan in South Australia.

During the year, after a slow but rigorous process, the Eastern Mallee EM1.2 and EM2.3 groundwater models were accredited as ‘fit for purpose’ and were used to support new salinity register entries. The Eastern Mallee models had the benefit of an inter-jurisdictional expert panel that provided oversight through model development. This approach was not adopted for the South Australian groundwater models. IAG-Salinity is of the view that a similar approach should minimise the risk of adverse peer reviews and ensure consistency in modelling methods and scenario definition. Currently, accreditation of some South Australian models is delayed while peer review issues are resolved. It is understood that South Australia will adopt a similar approach to that used for the Eastern Mallee models in future to streamline the review and accreditation process.

The Australian Capital Territory baseline conditions model was also accredited. It is expected that the assistance of New South Wales will be required to upgrade the model to IQQM format.

The IAG-Salinity 2008-09 report included a recommendation to develop a conceptual model of the factors and interactions influencing flood-recession salt mobilisation from the floodplain. This was accomplished through a consultancy and a workshop, both of which were applauded by all jurisdictions.

North East and North Central catchment management authorities in Victoria continued to use the Investment Framework for Environmental Resources model in association with derivative and additional tools to assist in determining priorities for investment and environmental assets. The North Central Catchment Management Authority Dryland Management Plan has continued to use the Salinity Investment Framework III to focus investment around key assets at threat from salinity, where tangible outcomes can be achieved.

IAG-Salinity has some concern over the plan to develop a number of 1D models for the Shepparton Irrigation Region rather than an integrated 3D groundwater model, or the 2CSalt modelling approach used in New South Wales.

New South Wales has refined and expanded its hydrogeological landscapes framework as a tool to assist in identifying landscapes at risk from salinity and options for salinity management. In the past year, the tool has been used to guide urban salinity investment. The 2CSalt model has been used in conjunction with IQQM to examine a range of catchment management strategies in the Murrumbidgee catchment. There is scope for broader uptake of this methodology across the Basin. Already, other jurisdictions have expressed interest, but lack of staff for training and implementation is an impediment to broader adoption.

South Australia used and modified its River Murray Drought Water Allocation Decision Framework to assist in the allocation of water during the drought. South Australia is also preparing draft codes of practice for irrigation.

Queensland has been refining guidelines for assessing waters suitable for irrigation to provide guidance to coal seam gas companies on long-term sustainable and viable coal seam gas water disposal irrigation.

During the year, MDBA issued a significant report, 'Irrigated agriculture in the Mallee: Estimating root zone drainage' (Newman et al., 2009)², which compiled knowledge derived from literature and expert groups. It will have particular relevance during reviews of accredited models. The report offers support for previous IAG-Salinity recommendations to quantify uncertainty in salinity register entries based on process models. A related paper was presented at the Australian Irrigation 2010 conference (sponsored by the MDBA).

Resources

All jurisdictions reported low levels of funding for salinity activities in the past year. It is important that the BSMS is supported in the short-term.

Communication

Many catchment management authorities and regional bodies publish newsletters and fact sheets for the community as well as maintain effective websites on new developments and knowledge. The regular meetings of the Basin Salinity Management Advisory Panel have been very effective in fostering joint work and communication on initiatives and decisions. The meeting to jointly discuss the IAG-Salinity audit recommendations from last year was particularly successful in delivering action on many recommendations.

The joint workshops run in 2009–10 coordinated by the MDBA on some of the recommendations – *Flood recession salt risks* and *Accountability for salt mobilised by environmental watering* – brought together appropriate skills from across the partner governments and others. These workshops seem to have worked exceptionally well this year and IAG-Salinity strongly supports their continuance on other cross-basin issues for knowledge exchange and resolution of emerging concerns and maintaining the cooperative approach between the partners.

² Newman, B, Currie, D, Evans, R and Adams, T 2009, *Irrigated agriculture in the Mallee: Estimating root zone drainage*. MDBA publication No. 58/10, Canberra, 37p.

The flood recession salt risks need to be identified urgently and operational plans developed to manage the risk. It is well-documented that after a flood event salinity levels rise significantly as high EC water from floodplains and regional watertables flows back into the main channel. This could be an immediate problem given the recent change in weather patterns over Australia.

Recommendation 1: Flood recession salinity risks: *That the MDBA with advice from Basin Salinity Management Advisory Panel continue this program as a matter of urgency and prepare operational plans required to manage the salinity risks.*

IAG-Salinity identified that some jurisdictions were more advanced in different fields than others, and benefits could flow from sharing developments. Examples of significant activities during the past year include:

- the approach and developments in policy and management of coal seam gas and associated saline water in Queensland which is directly relevant to New South Wales and possibly Victoria in the future
- the catchment scale scenario modelling of sub-catchment salt exports under various simulated changed land management in New South Wales to identify the scale of interventions required
- the recent analysis of the ecological health of the Coorong in South Australia in relation to flow and salt export from the Murray Mouth
- the reporting methodology used in the Mallee, Victoria for assessing irrigation land changes and implications of reduced watering
- the irrigation efficiency program with younger irrigators in South Australia, and
- the over-subscribed re-education programs in Victoria.

Element 2: Identifying values and assets at risk

The partner governments will work with catchment communities to identify important values and assets throughout the Basin at risk of salinity, and the nature and timeframe of risk. This strategy emphasises the triple-bottom-line approach, requiring a balance between economic, environmental and social values. It necessarily recognises that living with salinity is the only choice in some situations.

In 2009, the modelled salinity target at Morgan was achieved for the first time, assisted by the actions taken under the BSMS. However South Australia has clearly shown in their annual report on the BSMS that the drought has resulted in both ecological and economic assets being at significant risk from salinity, especially below Morgan. Significant interventions had to be quickly decided and tradeoffs had to be made between asset classes. These included proposals to:

- flood the lakes with sea water
- build a temporary weir at Pomanda Island
- pipe water from further upstream to communities around the lakes
- build temporary channel flow regulators to manage acid sulphate soils
- pump hypersaline water out of the southern lagoon, and
- model a virtual weir concept at Wellington to protect water for critical human needs.

While the *Guide to the proposed Basin Plan* suggests changes to Basin management to insure against salinity increases in the Lower Lakes and Coorong, it is important that the experience and decision taken be properly documented in case there are future instances of high salinity in these internationally-recognised wetlands.

Recommendation 16: Recording the mitigation decisions required during the drought: *That South Australia should document the recent actions taken (particularly below Lock 1) during the drought to mitigate the salinity issues and also the recent recovery within an ecosystem response and resilience context.*

In the 2007–08 and 2008–09 audits, recommendations were made to set targets below Morgan. The jurisdictions supported these recommendations providing the Morgan target remained the compliance target. The *Guide to the proposed Basin Plan* proposes both operational targets for salinity and water quality through to Wellington South Australia as well as targets for exporting salt out to sea.

The extensive recent rain has seen a rapid increase in watertable levels in the hydrologically sensitive upstream catchments, and a return of salinity issues to the towns as well as to the biological assets in the lower Victoria and to the River Murray system. The Goulburn Broken Catchment Management Authority, for example, reported that groundwater levels had fallen in the Shepparton Irrigation District during the drought and through salinity mitigation measures. In 1996, 47% of the district's groundwater was within two metres of the surface. However, the recent rains had again raised the groundwater levels, indicating that salinity was still a threat. The North East Catchment Management Authority reported that without intervention the salinity of rivers in their area would increase and could rise from 180,000 tonnes of salt to 240,000 tonnes exported annually.

New South Wales reported on modelling they had undertaken of impacts from developments at different distances from the river, and were using this to develop salinity impact zones for the New South Wales Mallee. While there has been little new irrigation development during the drought, both the Victorian and New South Wales Mallee regions are attractive for new irrigation investments.

Queensland has been undertaking salinity audits on valuable assets in their catchments and has provided an update of an audit for the Condamine–Balonne catchment which now includes the salinity risks posed by the extraction of coal seam gas.

In summary, IAG-Salinity was impressed with the amount of continuing work being undertaken by the jurisdictions to review assets at risk in various catchments. IAG-Salinity was however concerned that the registers undervalued the assets being protected as the registers are presented in 2005 dollars. While upgrading the values to current prices does not change the relativities between the entries in the registers, it does give policy makers a better understanding of the value of the assets being protected, and provides a greater level of relevance for the achievements of the BSMS.

Recommendation 14: Updating the valuations in the registers: *That the registers reflect the current dollar value of the assets at risk and these be updated annually.*

Element 3: Setting salinity targets

This element requires the adoption of end-of-valley targets to protect values and assets while providing for targets to be revised, as new information becomes available. The partner governments will empower catchment management organisations to advise on end-of-valley targets and determine within-valley targets and monitoring arrangements, under salinity and catchment management plans.

All states except New South Wales listed end-of-valley targets for flow, EC and salt load this last year. It is understood that New South Wales targets have not changed from previous years and they will be reviewing them as a result of their 2007 uplands systems review. In general annual values for flow EC and salt load varied from the modelled targets. The drought in the southern part of the Basin resulted in the Campaspe and Loddon exceeding the end-of-valley targets due to sustained low flows. The Avoca, Wimmera and also Broken and Murray at Lock 6 were dry or had insufficient data. It is interesting that the heavy rainfall in Queensland and Northern New South Wales generated very high flows of good quality water – much needed by the Basin – but which resulted in short-term salt loads which were higher than the modelled targets.

Last year's Recommendation 11 *Alignment of BSMS with catchment plans* for New South Wales has been partially addressed this year. Some catchment action plans still have variations from BSMS targets but these are expected to be aligned following the completion of the Salinity Statement for New South Wales and the Natural Resources Commission's review of catchment management authorities and catchment action plans.

There are emerging issues about short-term targets and long-term averaged salinity targets. As reported last year in Recommendation 4 *Targets below Morgan*, real-time targets are required to manage salinity fluctuations and also for in-river flows in Victoria. This will become more important under the Basin Plan. Some jurisdictions expressed the strong need for operational targets below Morgan and the Morgan target in managing salinity in the Basin. This also addresses the BSMS mid-term review recommendation.

The five-year reviews of the BSMS end-of-valley salinity targets and sites are required under the BSMS clause 9 of Schedule B. Sinclair Knight Merz completed a review for the MDBA of the salinity targets in June 2010. While the review is yet to be approved by the MDBA, amongst the highlighted outcomes and recommendations are:

- the MDBA and jurisdictions have done a creditable job in end-of-valley monitoring and targets
- all existing end-of-valley sites be retained as well as the site at Morgan
- additional sites are established for the Edward and Wakool rivers.

These and other recommendations made in the review need to be discussed by Basin Salinity Management Advisory Panel.

Prioritising catchments

Recommendation 6 of 2007–08 IAG-Salinity, a recommendation of the BSMS mid-term review and last year's IAG-Salinity Recommendation 5 all agreed that end-of-valley targets be interpreted to better explain the natural processes driving salinity. The IAG-Salinity report 2007–08 identified a model for end-of-valley targets that could be used. The review of end-of-valley-targets did not specifically address this issue. With wetter conditions in parts of the Basin during the past year, an informative dataset is now on hand that shows the salinity response of the Basin to hydrological events. IAG-Salinity believes that it is important that end-of-valley salinity-flow hydrographs across the Basin be analysed and interpreted thoroughly to give a better understanding of the events that cause salt discharge into streams, and an appreciation of the dynamics of stream salinity. This should promote a better understanding of the catchments that are of greatest risk to increasing river salinity.

Recommendation 17: End-of-valley salinity-flow interpretations: *That the MDBA facilitate a whole-of-basin analysis of salinity-flow hydrographs over the past wet season in order to provide insight into the natural processes that release salt to streams. This could involve synthetic models to demonstrate the key processes.*

The use of models to interpret end-of-valley EC flow hydrographs to identify time trends and relationships to resource management and climate variability may help identify priority catchments for action. Also, 2Csalt modelling of catchments, as illustrated in New South Wales, is a further approach that will be useful in evaluating the impact of land management options on end-of-valley targets. Interpretation of end-of-valley targets will allow work to identify within-valley targets as required by BSMS and presented in last year's Recommendation 5 *End-of-valley salinity-flow interpretations/Salinity hot spots*. It is suggested that MDBA facilitate a review of existing suitable tools and the development of new tools to help prioritise catchments in collaboration with the jurisdictions.

Recommendation 4: Prioritising catchments and sub-catchments for salinity management: *The MDBA should facilitate the assessment of currently available tools that prioritise catchments with high salinity outflows or salinity risk and allow the measurement of the reduction in salinity outflows from the application of a range of recommended land and water management actions.*

Another emerging issue will be tracking the instream salinity distribution over time following environmental watering. Where an end-of-valley target site is established, there may be long lag times for mobilised salt from the unsaturated zones of floodplains in some river systems. An analysis protocol for end-of-valley targets will be most useful to detect small changes.

Below Morgan end-of-valley targets have a different meaning and use. South Australia has adopted several approaches to identify regions of significant salt input to the River Murray, including conducting run-of-river surveys, nanotem surveys and close interval EC surveys. The techniques are valuable to identify regions of significant salt accession to the Murray that require proactive management. The recent rains have resulted in rising bore water levels in or adjacent to previously salted areas in both New South Wales and Victoria. Monitoring these old bore networks presented some difficulties due to bore degradation. It is obvious that water levels in salted areas did not decrease sufficiently to even be close to a long-term 'reclamation point' for dryland salinity under changed land management and since the soil profiles are still quite wet in the affected areas, recharge has been quite rapid. The reduced rate of increase in the area of dryland salinity, as reported in last year's audit report, has been reversed quite quickly and some prediction of future salinity risk more closely tied to rainfall patterns is required, along with within-valley targets to maintain a watching brief on any adverse land based salinity impacts.

An emerging issue is the salinity baseline carried out in 1999 for the predicted impact of dryland salinity by 2100. The predicted response would appear to be higher than trends over the last 10 years would indicate. IAG-Salinity recognised that there were varying views on the level of risk that salinity posed to the Basin, and a number thought it was much lower than that predicted in the BSMS. It is important for the future of the Basin that this risk be re-defined so that the appropriate management strategies can be employed commensurate with the risk.

Recommendation 3: Re-assessing salinity risk in the Basin: *A comprehensive review of the currently projected salinity risk in the Basin for 2050 should be undertaken by the MDBA with advice from the Basin Salinity Management Advisory Panel while the Basin Plan and the environmental watering plans are being developed as a first step in producing the next phase of salinity management. The review should take into account, the re-assessment of salt loads from individual catchments, the water buyback, and climate change scenarios.*

Element 4: Managing trade-offs with available within-valley options

The states will analyse and review the best mix of land management, engineering, river flow, and living with salt options to achieve salinity targets while meeting other catchment health targets and social and economic needs. The states will assist communities to understand and agree the options with affected groups, industries and people through best practice planning processes.

Taking a broad overview, the BSMS in the first phase of its implementation, focused on engineering salt interception schemes because these provided a quick response to protecting the river from saline flows. The engineering options are now coming to a conclusion with only one economic site and a few small sites left. For the second phase, both the impacts of environmental watering and the potential mobilisation of salt stored within the valleys, where salt has accumulated on floodplains, are being investigated by the MDBA and the jurisdictions. The third phase is expected to concentrate on the elements of the BSMS around the land-based approaches to salinity management. There was much support for this from the jurisdictions and if undertaken would ensure all elements of the BSMS are well progressed.

IAG-Salinity is impressed with the progress made by a number of the states, particularly New South Wales where priority catchments in the uplands that contribute to instream salinity have been identified. Based on projected scenarios, the Murrumbidgee Catchment Management Authority will be able to set their land management priorities to improve instream salinity. Initial modelling is being undertaken to determine whether an EC credit can be applied at Morgan.

In the previous two audits, IAG-Salinity recommended that an assessment of the land management aspects be made so that targeted land management that results in a tangible benefit to in-stream salinity is investigated. This is still a priority.

Recommendation 4: Prioritising catchments and sub-catchments for salinity management: *The MDBA should facilitate currently available tools that prioritise catchments with high salinity outflows or salinity risk and allow the measurement of the reduction in salinity outflows from the application of a range of recommended land and water management actions.*

The increasing emphasis on environmental water allocation may be able to be used to ensure a range of ecological, economic and social needs of the Basin are met. The flow of this water down the system is currently unregulated but operational policies and guidelines may make it more useful for reducing salinity risk, ensure salt export from the Basin and help protect the ecological health of the Coorong and Lower Lakes. It is important to investigate whether a number of benefits can be achieved from the use of the environmental water including those facing the lower parts of the system. For example, the timing of the watering of wetlands may be undertaken in a manner that delivers high flow volumes downstream and exports salt from the Basin, improving the Coorong.

Recommendation 18: Environmental water and salt export: *In developing environmental water guidelines, multiple objectives such as the export of salt from the Basin and the ecological health of the Coorong and Lower Lakes should be considered.*

Element 5: Implementing salinity and catchment management plans

This strategy acknowledges gains made by existing plans, but requires actions in existing and new plans, or the plans themselves, to be assessed and reported against the end-of-valley and Basin targets and recorded on salinity registers. The partner governments will continue and enhance support for land and water management plans in irrigation regions. The partner governments will enhance support for development and implementation of integrated catchment management policy-compliant salinity and catchment management plans in dryland regions.

As reported last year, the drought conditions for the early part of the year and the cessation of Commonwealth funding for salinity has slowed progress on this element. Despite this, there was progress in some areas.

South Australia is developing a new salinity program and Victoria and New South Wales are also in the process of developing salinity management statements to address the issue. These are timely in relation to the proposed Basin Plan although increased funding for salinity activities may not be included. The Natural Resources Commission in New South Wales is also currently reviewing arrangements and accountabilities for catchment action plans. This may allow the ongoing issue of non-alignment of some BSMS end-of-valley targets with catchment action plans to be addressed and within-valley targets to be developed to address one of the Natural Resources Commission objectives: improving the resilience of landscapes.

IAG-Salinity is concerned that some recommended practices for dryland salinity management have limited long-term benefit. This has been reported in the past by Victoria and discussed in the IAG-Salinity report for 2007–08. The possible wetter period over the next few years will test some of these management strategies.

Some widely publicised salinity management strategies have elements of ‘group think’ about effectiveness and are not evidence-based. Also, expectations regarding the results of interventions, often at considerable cost, can be greater than the achievable results. Where the extent of hydrological imbalance is very large, dryland salinity symptom management is the only solution. IAG-Salinity recommends that a database of land use and evidence of treatment effectiveness be developed to aid in future decisions.

Recommendation 12: Consistent Basin-wide land use databases: *The MDBA should facilitate the development of a set of databases that describe land use at a catchment scale across the Basin for use in prioritising dryland catchments for land management improvement.*

The major land management issue affecting Queensland is coal seam gas extraction, which is taking considerable effort to identify policy and operational conditions to allow government policy and strict environmental guidelines to be met. The magnitude of the currently projected industry is huge, with around 100 to 300 GL of groundwater to be extracted per year in the next few years until anticipated gas production levels are achieved. Ensuring the minimal impact on water systems, disposal of reverse osmosis treated water in irrigation and water supplies and managing the salt disposal will need adequate proactive monitoring. The salt from the groundwater after reverse osmosis is expected to be in the order of 250,000 to 400,000 tonnes/year with a considerable proportion probably requiring secure landfill. Interest in coal seam gas extraction in New South Wales will mean that policy and operational management will need to be considered at the earliest opportunity.

Groundwater extraction will peak before the gas extraction peak to release pressure in the coal seams. Changes to the appropriate Petroleum and Gas Act and Water Act are scheduled. The current Petroleum and Gas Act protects a statutory right to take and use associated water for authorised purposes which may impact on groundwater use in licensed water bores. However the requirement to ‘make good’ any impacts on farm bores from the coal seam gas operation will involve some currently unknown issues. IAG-Salinity notes that the National Water Commission released, in December 2010, a position statement on coal seam gas and water with 11 guiding principles.

Recommendation 5: Coal seam gas

- (a) Queensland should formally document and provide to the MDBA the policy framework and processes it is using to manage coal seam gas developments to minimise salinity risks to the Basin.*
- (b) New South Wales should report to the MDBA on its policy framework for coal seam gas developments, identifying the processes that can be used to minimise any potential salinity risk in the Basin.*

South Australia in its program to upgrade land and water management plans over the next few years, demonstrated the water use efficiency gains through the Pike Implementation Plan, which were achieved during the last few years, partly in response to decreased water availability. Further work is planned and an irrigation water use efficiency project is underway.

Modernisation of irrigation infrastructure in Victoria is expected to lead to considerable improvements in water use efficiency. It is possible that root zone salinity may increase due to reduced flushing associated with increased irrigation efficiency and should be monitored.

Element 6: Redesigning farming systems

The partner governments will coordinate and enhance research and development into new farming and forestry systems that deliver improved control of groundwater recharge in the high rainfall grazing, winter rainfall cropping, and summer rainfall cropping zones.

Over and above current programs the MDBA will enhance research and development into new industries based on salinised resources, such as broadacre saltland agronomy, saline aquaculture, and salt harvesting.

Each state has a range of training programs in irrigation and dryland farming techniques. New South Wales has implemented, through their catchment management authorities, training in dryland agriculture techniques. In Queensland the emphasis has been on investigating soil water loss and deep drainage in irrigation areas. In the rangelands the theme has been to improve grazing management to reduce scalding in the landscape. In Victoria, property planning in irrigation as well as dryland areas has occurred. In some irrigation areas this has been extensive, for example the Goulburn Broken Catchment Management Authority has 85% of the irrigation properties with a property plan from which investment in modern irrigation systems can be made. A similar approach has occurred in South Australia where extension activities have continued with farm salinity trials looking to manage the build-up of salt in the root zone, which occurs when there is reduced irrigation water applied to crops.

Research undertaken over the period of the BSMS has provided pasture and cropping options for saline areas. Aquaculture research has been undertaken, particularly in using the groundwater resource pumped from salt interception schemes, but to date there has not been any commercial uptake.

While a great deal of activity has occurred it is difficult to quantify the impact it is having on salinity in the Basin. IAG-Salinity suggests that an effort be made to prioritise catchments that are known to contribute to in-stream salinity, and the land use tools that can be used, including agronomic techniques, be assessed for their application in these priority areas. Recommendations under elements 3 and 4 support these suggestions. Funding for salinity management programs in Australia is not directly available as Commonwealth programs do not target salinity mitigation. However, there are multiple outcome programs in the Caring for Our Country strategy where a land-based salinity management program could be submitted.

Element 7: Targeting reforestation and vegetation management

The partner governments recognise the necessity for landscape change specifically targeted at salinity control. In order to facilitate such targeted change, where changed farming systems are not adequate, consideration may be given to financing native vegetation management, rehabilitation and land stewardship, and the commercialisation of short-rotation tree crops, particularly for the wheat belt.

Each year the jurisdictions report on new areas of vegetation that have been restored or planted. The jurisdictions have shown that there is a slow but steady increase in the area under managed and re-established native vegetation. Queensland has increased the area of vegetation managed outside the reserve system by 110,000 hectares, New South Wales by 95,000 hectares, Victoria by 6,800 hectares and South Australia by 6,900 hectares. In South Australia, the Murray Forests program has a potential 2,450 hectares earmarked for revegetation, and a great deal of research has been undertaken into finding suitable species for multiple use perennial plantings for Mallee areas.

While the continuing investment is securing vegetation and increasing the area through plantings, the area is small when considering the size of the Basin. Much of the investment is for multiple benefits including salinity management.

IAG-Salinity is of the opinion that if revegetation was targeted to high salinity yielding catchments as discussed in Element 4, then greater returns from the investment in terms of salinity management may occur and a targeted approach would provide a better opportunity to measure the impact on both salt mobilisation and water yield. This could generate salinity credits that could be included in the registers of the BSMS. A case study currently underway in the upland catchment of Murrumbidgee River in New South Wales indicates that this is possible. However, New South Wales demonstrated that the impacts from tree planting are not always intuitive and careful sequencing is required.

Element 8: Constructing salt interception works

The Authority will construct and operate new joint (partner government funded) salt interception works to protect Basin-wide assets and values, including the shared water resources of the Murray and Darling rivers. This will, based upon agreed cost sharing and benefit allocation principles, provide protection beyond the benefits from simply meeting end-of-valley targets. The benefits will continue to include salt disposal entitlements to offset the impacts of future actions that aggravate salinity.

Salt interception schemes constructed and operated along the length of the River Murray in three states are recognised as major contributors to the success of the first phase of the BSMS. This program of works is drawing to a close, as the targeted 61 EC reduction at Morgan is within reach (by 2011–12) (Table 2). The BSMS proposed that in the second seven years an additional program would be required to offset anticipated increases in river salinity and the mid-term review provisionally estimated that should be in the order of 40 EC.

During the 2009–10 year, the Waikerie 2L Salt Interception Scheme was commissioned and the Pyramid Creek scheme became fully operational. Both schemes are included on the 2010 salinity register. Three schemes are still under construction: Loxton, Darling and Murtho (in order of projected completion). When these schemes are in operation, the 61 EC target will have been met. In June 2010, construction of the Phase 1 Mildura–Merbein refurbishment was authorised.

The operating schemes account for 79% of the credit balance (interpolation to current year) on the 2010 Salinity Register A. About 30% of the credits accrued by the schemes are attributable to the Basin Salinity Management Strategy (previously 19%); the remainder is attributed to the previous Salinity and Drainage Strategy and is embodied in the BSMS baseline conditions.

All but three of the schemes achieved target salt load diversions at least 95% of the time during 2009–10. The weakest schemes are Mildura–Merbein (63%, previously 68%), Mallee Cliffs (80%, previously 85%) and Waikerie (93%, previously 96%).

Table 2: The salt interception schemes which deliver the 61 EC at Morgan under the first seven years of the BSMS

Jointly funded schemes		Completion date	EC change at Morgan
Victoria	Pyramid Creek	Completed	-5.06
South Australia	Bookpurnong	Completed	-11.7
New South Wales	Upgrade Buronga SIS	Completed	-0.60
South Australia	Waikerie	Completed	-10.15
South Australia	Loxton Floodplain	Completed	-7.90
South Australia	Loxton	2010	-10.40
New South Wales	Upper Darling	2010–11	-3.45
South Australia	Murtho	2010–11	-19.80
Total benefit			-69.15

The status of the second seven years of works and measures that would meet the proposal of a further 40 EC at Morgan, as recommended in the BSMS mid-term review, are provided in Table 3. The Pike River Salt Interception Scheme has been designed and, as reported last year, has a benefit cost ratio of 2.3, which is significant. Construction of part of the scheme has started with a small amount of funds from South Australia, but most of the construction is not funded. The proposal to rehabilitate the Mildura–Merbein has been investigated and through a good partnership approach to the project, approval has been given to construct phase 1 of the redevelopment. The Red Cliffs proposal is under review and not funded and the proposed extension of the Woolpunda scheme is in a feasibility stage.

Table 3: Summary of investigations to provide the 40 EC at Morgan recommended in the BSMS mid-term review

Schemes under investigation		Status	EC change at Morgan
South Australia	Pike River	Part funded	-32.70
Victoria	Rehabilitation Mildura–Merbein	Stage 1 funded	-10.50
Victoria	Redcliffs	Not funded	TBA
South Australia	Woolpunda (overland Corner)	feasibility	-3.80
Total benefit			-47.0

The IAG-Salinity understands that there is a reluctance to fund the outstanding schemes. It is the considered view of some jurisdictions, particularly New South Wales, that the salinity issues as predicted in the BSMS are not as severe as first thought. Recommendation 3 in this report suggests that this be properly investigated as the models still indicate that the probability of meeting the target at Morgan in future years is low. Hence IAG-Salinity considers that a precautionary approach would be to construct the Pike River Salt Interception Scheme as it has a high return for the investment.

Recommendation 6: Joint works and measures program Pike River: Pike River salt interception scheme construction should be implemented to provide a precautionary approach to salinity management in the Basin given the predicted 2050 salinity outcome based on current models and the minimal credits available from retiring irrigated lands show that the probability of meeting the Morgan target into the future is low.

The 2008–09 IAG-Salinity report also included a recommendation for a review of salt interception scheme operational rules to determine the feasibility of operating groundwater pumps continuously during high river flows. MDBA has undertaken a thorough review and has concluded that all but two of the operations can be modified to satisfy the IAG-Salinity recommendation. When the modifications are completed, the risk of exacerbated salt inflows during river flow recessions could be reduced.

Element 9: Ensuring Basin-wide accountability, monitoring, evaluating and reporting

The partner governments will demonstrate accountability by reporting to the Authority and Council through state end-of-valley report cards and MDBA salinity registers that record the salinity effects of actions, including salt interception schemes and salinity and catchment management plans.

The Council will receive audits every five years for each valley and MDBA register entry, assessing impacts on river salinity and progress towards targets, with the provision to require further action as necessary.

Annual reports of the contracting governments

The state and Australian Capital Territory contracting governments each provided draft annual reports that contained the necessary information for IAG-Salinity to make an assessment. The Australian Department of Sustainability, Environment, Water, Population and Communities provided a short note, summarising progress with the previous audit recommendation on assessing the risks of environmental watering of wetlands.

The BSMS draft annual report from New South Wales provided information from the catchment management authorities showing that many of the catchment action plans have objectives consistent with the BSMS, but there was little implementation occurring. The Murrumbidgee Catchment Management Authority was undertaking a significant program in assessing priority catchments for salinity management, but most catchment management authorities have generic programs which may assist in salinity mitigation but were not connected to end-of-valley targets. New South Wales is reviewing catchment management plans, but due to the

low expression of salinity in the landscape during the drought and the lack of specific funding for salinity, the probability of salinity getting a higher profile in revised catchment management plans is low. The presentations by New South Wales representatives to the auditors were informative and technically strong, but this cannot make up for a lack of timely and comprehensive regional reporting. Aside from this, the draft state reports were again of a high quality.

Annual reports should continue to include each of the nine elements of the BSMS, as in past practice. In the last audit, suggestions on the format of the reports were made and most jurisdictions took them up. However, New South Wales continues to provide a report with a good executive summary but the main body of the report does not have a coherent story of actions for the year.

Valley reports

Contracting governments must prepare an annual report for each valley for which an end-of-valley target has been adopted as outlined in Schedule B clauses 29 and 30. A protocol has been established for the information to be presented in these reports. The reports are to set out how the contracting governments are implementing actions to meet the targets and impacts on the targets.

The valley reports for 2009–10 again indicated varying levels of action and achievement. Each jurisdiction was lacking resources following the conclusion of the Commonwealth National Action Plan on Salinity and Water Quality and each was attempting to maintain the program from their own resources.

For a number of audits, New South Wales has not met the BSMS requirements for a table of future salinity projections in the annual report. As a result, auditors have been unable to make well-informed comment on the suggestion that the salinity risk in New South Wales has decreased against the original BSMS predictions. However, future projections do appear in Register B.

Victoria on the other hand has established a strong connection between the BSMS and its catchment management authority plans, and has maintained its investment in salinity management and end-of-valley reporting. Queensland had high river flows this year and has reported current and projected salt loads that are exported from its catchments. South Australia has provided information at Morgan but much of their management has been devoted to meeting the challenges of salinity mitigation below Lock 1 where no end-of-valley target has been set at this stage. The Australian Capital Territory continued to have problems as a result of a lightning strike to its key Halls Crossing gauge, and it is consequently modifying the station.

All jurisdictions saw a rise in watertables following the increased rainfall in the Basin during 2010, and it is expected the priority for salinity management will increase.

Accountability for salinity under the BSMS and the Basin Plan

The BSMS system of accountability is undergoing continuous improvement each year and the jurisdictions and the MDBA have high confidence in it and are strongly committed to the process. It provides a framework of continuing incentives for each state to manage salinity in a manner that is beneficial to the whole Basin. The level of confidence in the registers is due to the clear and transparent method of debating and agreeing upon entries, the quality of the scientific work that has gone into the development and use of the models, meticulous documentation and record keeping on the part of the MDBA, and the scrutiny given annually to each entry by the IAG-Salinity. The contracting jurisdictions can see that each of them is contributing to salinity management in a balanced way without an inequitable burden falling on any one of them.

The IAG-Salinity supports the proposals in the *Guide to the proposed Basin Plan* to build on the BSMS when developing the Water Quality and Salinity Management Plan, as specified by the Commonwealth *Water Act 2007*. It is proposed that each water resource plan has a water quality management plan which describes the current conditions, identifies causes of degradation, and sets out management strategies and accounting arrangements. The *Water Act 2007* (Commonwealth) does not have power over the land management areas, so it requires a similar commitment and reporting arrangement between the MDBA and the jurisdictions if it is to work as well as the BSMS. The jurisdictions are all in favour of this cooperative arrangement continuing past the conclusion of the current BSMS.

The review of end-of-valley targets for salinity that was undertaken by the MDBA has confirmed that those used in the BSMS are appropriate and have been published in the *Guide to the proposed Basin Plan Volume 2* as a basis for the ongoing management of salinity. The BSMS audit did propose targets below Morgan and the guide describes what could be operational targets for water quality for human consumption as well as for the annual export of salt from the Basin to the sea, which is 2 million tonnes per annum. While there is a great deal of detail to be decided, the IAG-Salinity was assured that the excellent work of the BSMS would continue under the new arrangements when Schedule B of the Murray–Darling Basin Agreement (*Water Act 2007* (Commonwealth)) is revised.

The BSMS mid-term review and the Basin Plan

The MDBA released the *Guide to the proposed Basin Plan* just before this audit and the relevant components of the Water Quality and Salinity Management Plan are detailed in Chapter 6, Volume 2 of the guide. The Water Quality and Salinity Management Plan is to be pitched at a strategic level, and will be implemented through state and local water allocation plans which will set down regional and local actions necessary to put the BSMS or its variant into effect.

The recommendations of the mid-term review (relevant to this discussion), followed by IAG-Salinity comment on each in italics, are:

Policy recommendations

1. develop methods to account for and achieve environmental outcomes from salinity mitigation actions through integration across MDBA programs

The MDBA and the jurisdictions have already been implementing this through The Living Murray program. Under the Guide to the proposed Basin Plan, the elements 'sustainable diversion limit', 'environmental watering plan' and the 'water quality and salinity management plan' are to be prepared in a coordinated manner. Victoria is to be commended for encouraging transition of irrigation to lower salinity impact zones through a salinity levy coupled with unbundled water rights.

2. support integration and alignment of national funding initiatives and reporting with regional catchment strategies that reflect BSMS objectives and integrated catchment management outcomes

With the completion of the National Action Plan for Salinity and Water Quality, there is no direct national funding source for salinity. Most programs, and hence many catchment management authority activities, that provide salinity outcomes are a side benefit of more generic programs rather than focused on salinity-related catchment actions. The Basin Plan initiative now presents the opportunity to provide a framework for integrated physical and financial planning for better-targeted and designed catchment action programs, and for works and measures programs that will be able to address water quality, salinity and environment in an integrated manner. In this audit IAG-Salinity has recommended developing a process for prioritising saline catchments for targeted management strategies.

3. increase emphasis on catchment actions to address the causes of salt mobilisation and more innovative and sustainable measures, such as real-time options, to deal with the effects

In this audit the IAG-Salinity has recommended developing a process for prioritising saline catchments for targeted management strategies. The Water Quality and Salinity Management Plan component in the Guide to the proposed Basin Plan suggests targets for real-time operation in addition to the present modelled-95 percentile target at Morgan. The Morgan target is essential for long-term planning but is not structured for operational use.

Operational recommendations

1. the MDBA should complete the existing 61 EC joint works program
The MDBA is on track to achieve this by 2012.
2. That by June 2008, the MDBA develop a new works and measures program (provisionally estimated to be in the order of 40 EC) to offset anticipated increases in River salinity.

Further salinity interception schemes and other joint works and measures are ready for construction and will achieve most of the 40 EC but there has been no decision to fund the total package.

3. by December 2008, the MDBA should investigate options for:
 - real-time river operations that manage large salt loads mobilised to the river, and
 - real-time instream targets that are integrated with the accountability framework.

The Guide to the proposed Basin Plan *sets targets for real-time operations under the Water Quality and Salinity Management Plan which includes the water off-takes for critical human water needs (Section 86 of the Water Act 2007 (Commonwealth)) and targets for the export of salt to the sea.*

Science and technical understanding recommendations

1. hydrological datasets that reflect the latest research on climate change and climate variability should be developed and applied to modelling scenarios to ensure the best possible tools for predicting long-term salinity impacts

MDBA has undertaken the work and a report will be published by early 2011.

2. the Basin salinity target should be reviewed with consideration given to replacing the current target or setting complementary salinity targets that link more closely to the salinity registers and allow for adaptive real-time salinity outcomes

See operational Recommendation 3 above.

3. the MDBA should develop a robust and transparent investment framework that enables environmental and social impacts to be assessed when evaluating the benefits and disadvantages of salinity management measures, particularly joint works and measures proposals

This is being taken up by MDBA. The proposed Pike River salt interception scheme appears likely to have greater environmental benefits than most other similar schemes.

4. The MDBA should review the salinity registers with the objective of making them easier to understand, including consideration of environmental and social impacts (in addition to the economic impacts) and making them relevant to real-time salinity management.

The A and B registers were adjusted in 2010 using harmonised methods of calculating entries. As above, targets for real-time salinity management will be taken up by the Water Quality and Salinity Management Plan.

Progress in improving salinity registers

The harmonisation of the methods of calculating entries in registers A and B was completed during 2010 based on a linear interpolation (to the current year) of the predicted EC at Morgan between 2000 and 2015 and from 2015 to 2050. This did change a number of entries and these have been agreed by the jurisdictions.

IAG-Salinity has made three more recommendations in this audit which may improve the registers so that they become more useful to policy makers. The first is to describe the relationship between the registers and the target at Morgan, the second is to update the registers to current-day dollars as it is presented in 2005 dollars, and the third is to continue developing the accountability for salt mobilisation by environmental watering.

Progress has been made in identifying the potential salinity issues associated with environmental watering. There is a large amount of water available for watering the river's environmental assets, which are in river valleys where there is a potential for salt accumulation and, upon watering, driving saline water back into the streams. Purchasing water from irrigation areas does not necessarily provide immediate credits as it takes some time for the groundwater mounds beneath irrigation areas to reduce once the water is taken away. It is important that this work is completed.

Recommendation 2: Accountability for salt mobilisation by environmental watering: *That the MDBA with advice from the Basin Salinity Management Advisory Panel complete a framework for accountability for the salinity effects of environmental watering to enable such actions to be entered onto the salinity registers.*

The salinity risk to the river from irrigation is high and MDBA has been working on quantifying the amount of water that passes the root zone of plants and potentially back to the river. The MDBA has also been examining where the greatest salinity impacts from irrigation occurs. Irrigation is still a major salinity risk to the river. Irrigation on various sections of the river and the Mallee region still adds the greatest amount of salt to the river, i.e. about 50% of the salt in the river comes from an area about one-thousandth of the size of the Basin. A consistent framework for accounting for irrigation salinity across the Basin will enable credits and debits in the registers to be reported consistently.

The contribution of irrigation to salinity loads, the impact of unbundling of water rights and the savings from irrigation efficiency measures need to be understood and included in all modelling. The large volume of temporary water trade is not currently assessed for salinity impact. With the unbundling of water rights and relaxation on trade between the states, the transition from bundled water licence accountability to unbundled accountability will need to be considered for its impact on register entries. Victoria has demonstrated the effectiveness of a salinity levy coupled with salinity impact zones to direct new irrigation to areas of lower salinity impact.

Recommendation 10: Irrigation Salinity Accountability Framework: *The MDBA, with advice from the Basin Salinity Management Advisory Panel, facilitate the development of a consistent framework for the accountability of irrigation salinity impacts including improved knowledge of district-scale irrigation related groundwater recharge. MDBA should continue capturing the irrigation improvement measures and unbundling water from lands to inform this process; and MDBA should promote irrigation as a special application case in revised groundwater modelling guidelines being prepared by the National Water Commission.*

Status of registers A and B

The MDBA, in conjunction with the jurisdictions, prepared a revised version of registers A and B dated 22 October 2010, in time for this report (see Appendix 3).

Schedule B (within Schedule 1 *Water Act 2007* [Commonwealth]) provides that two salinity registers, registers A and B, must be established as the primary record of the accountability for river salinity for each of the jurisdictions, and of the Basin overall. Register A records the salinity credits/debits of the jurisdictions since the baseline date, which is 1 January 1988 for New South Wales, Victoria and South Australia, and 1 January 2000 for Queensland. Register B records any salinity impacts arising from actions before the baseline date, and the predicted future effects of actions aimed at delayed salinity impacts.

In 2009–10, five new items were added to Register A:

- Item 15: Wakerie Lock 2 salt interception scheme (-11 EC, interpolation to current year EC at Morgan)
- Item 25: New South Wales reduced irrigation salinity impact arising from changes to irrigation practices which have resulted in receding groundwater mounds (-3.5 EC, interpolation to current year EC at Morgan).
- Item 41: Victoria reduced irrigation salinity impact arising from changes to irrigation practices which resulted in receding groundwater mounds (-4.4 EC, interpolation to current year EC at Morgan).
- Item 46: South Australia component of Waikerie Lock 2 salt interception scheme (-0.8 EC, interpolation to current year EC at Morgan).
- Item 54: Irrigation development behind Waikerie Lock 2 salt interception scheme (0.8 EC, interpolation to current year EC at Morgan).

In 2009–10, two new items were added to Register B:

- Item 81: South Australia Irrigation Scheme Rehabilitation Register B (0.0 EC, interpolation to current year EC at Morgan, split from Register A).
- Item 82: South Australia Rehabilitation Register B unaccredited (0.0 EC, interpolation to current year EC at Morgan, split from Register A).

The rolling reviews have been proceeding and it is noted that Victoria has five outstanding in Register B. Two are significant and require proper modelling to determine the impact and should be undertaken as soon as possible. Queensland has not provided any entries to the register as yet, and these entries need to be completed. South Australia has undertaken the required reviews but MDBA needs to develop a process to resolve the technical differences.

Recommendation 7: Outstanding reviews of register items:

- (a) Queensland outstanding reviews of registers A and B items need to be progressed*
- (b) All outstanding reviews of Victorian register B items need be completed, in particular the Goulburn Broken and Loddon catchments legacy of history salinity impacts should be assessed using detailed modelling*
- (c) South Australia salinity groundwater modelling technical review is completed so it can be accepted by MDBA, and*
- (d) New South Wales formally submits to MDBA each of the register B valley five-year reviews so they can be finalised.*

There are 12 changes to Register A and nine changes to Register B from harmonising the methods of calculation between the two registers. There have also been some changes as a result of revising the splitting of entries between the A and B registers.

Net debit/credit status of the jurisdictions

Schedule B, Clause 16 (1) requires the state contracting governments to:

'take whatever steps may be necessary ... to keep the cumulative total of all salinity credits in excess of, or equal to, the cumulative total of all salinity debits, attributed to it in both registers A and B.'

The salinity registers dated 22 October 2010, as provided to the IAG-Salinity, show that New South Wales, Victoria and South Australia are in net credit on Register A (5.48, 5.02 and 2.98 \$m/year respectively). There has been an increase in the credit balance of New South Wales by about 60%, Victoria by about 50% and South Australia has remained about the same. On Register B, two of the three jurisdictions are in credit and one (Victoria) slightly in debit (0.40, -0.025 and 1.15 \$m/year respectively). For the combined registers, all three states are in credit (5.89, 4.99 and 4.13 \$m/year for New South Wales, Victoria and South Australia respectively). The combined net credit in terms of salinity effect is 161 EC.

Despite the healthy net credit for the past few years, the 2009–10 year is the first year in which the 95-percentile EC target at Morgan has been met. This prompted the IAG-Salinity to consider the relationship between net registers credit and the Morgan target, as illustrated in Figure 2.

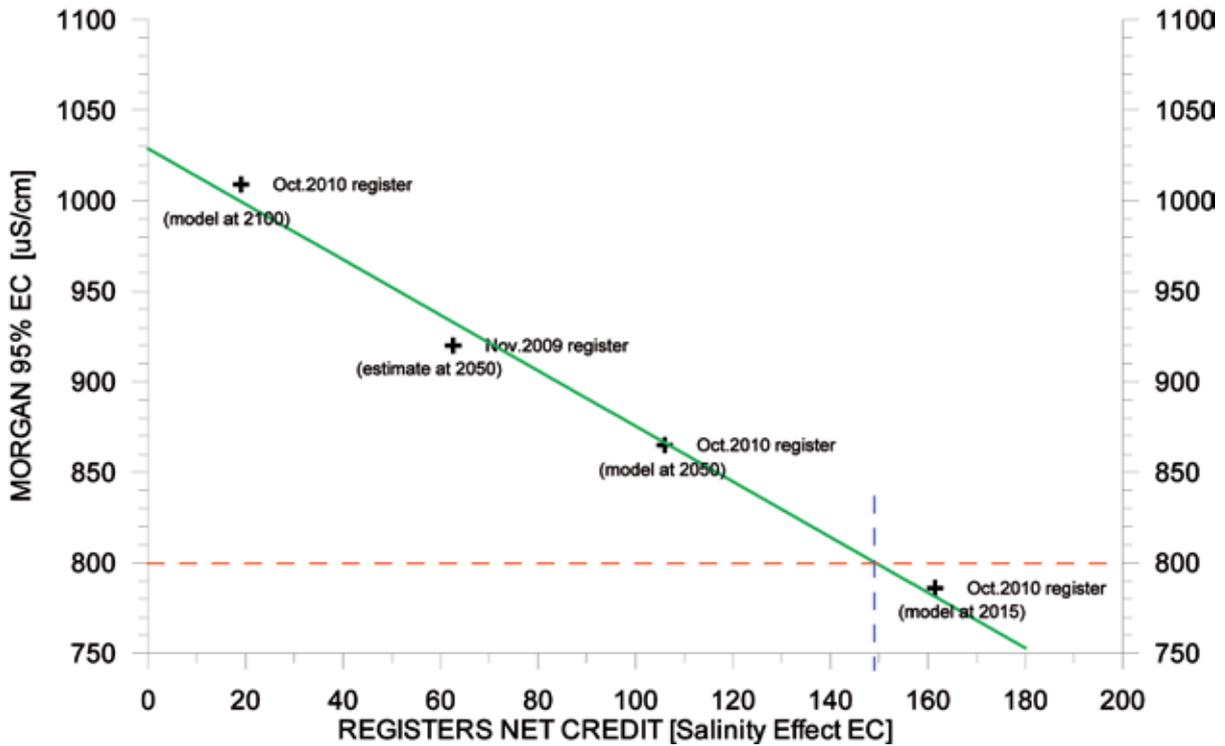


Figure 2: Modelled projections of Morgan 95% EC versus net credit on the registers

Modelling projections of Morgan 95-percentile EC have been made for various net credit scenarios (Figure 2) for current accountable actions continuing into the future. No account has been taken of environmental watering or benefits that might arise from implementation of the Basin Plan. This graph suggests that a net credit of about 150 salinity effect EC units would be required to satisfy the 800 EC target at Morgan. It would appear that the current requirement for jurisdictions to maintain a net positive credit on the registers needs to be reviewed as it appears inconsistent with the Morgan target.

Recommendation 9: Relationship between registers and the target at Morgan: *The consistency between the credit and debit balances of the registers and the target at Morgan needs to be established, taking into account the likely effects of environmental watering and the Basin Plan, given that 2010 is the first year that the target at Morgan has been met while register A has been in credit for each state for some years.*

Status of register entries

For the first time this year, provisional register entries have been included in balance totals. There are two provisional entries on Register A and four provisional entries on Register B, all related to South Australia and all due to a delay in model accreditation as a result of unresolved peer review issues. It is expected that MDBA will lead a process to ensure that accreditation happens as a matter of urgency.

Uncertainty in register entries

The salinity registers include a qualitative confidence rating of ‘very low’, ‘low’, ‘medium’ and ‘high’. The distribution of ratings is summarised in Table 4. For Register A, there is an increase in the number of entries rated high confidence and a reduction in those rated low. In Register B, entries for New South Wales and Victoria Mallee have been downgraded from medium to low, and South Australia entries based on unaccredited models are rated low on the registers but are listed in Table 4 as provisional. However, definitions of these ratings need to be developed by MDBA to ensure consistency in reporting entries.

Table 4: Number of entries in the registers with confidence ratings at the levels of 'high' to 'very low' and provisional entries with 'low' ratings.

RATING	REGISTER A [percentage]			REGISTER B [percentage]		
	2008	2009	2010	2008	2009	2010
High	60	60	69	0	0	0
Medium	23	23	21	83	88	69
Low	12	11	6	11	0	15
Very Low	5	0	0	6	0	0
Provisional	0	6	4	0	12	15

The IAG-Salinity 2007–08 report included an analysis of the causes of uncertainty, and advocated a more quantitative approach for new entries. This essentially involved running MSM–BIGMOD for both upper and lower extremes of salt load estimates to gauge the precision of the EC entries on the registers. This was articulated in a 2007–08 recommendation where it was proposed that a record of the possible Morgan EC range be placed in the confidence column of the registers. This recommendation was not acted upon due to the lack of a protocol for consistent application across all register entries.

It was proposed in 2008–09 report that MDBA modellers should routinely assess the uncertainty in new salinity effect register entries by repeating the MSM–BIGMOD runs for new items for upper and lower estimates of error bounds. The assessed uncertainty in EC should be regarded as indicative rather than absolute, and should be recorded in some indicative form (e.g. < 1 EC) as an additional entry in the confidence column in the registers. However, this also has not been done, due to the lack of a protocol for consistent application and concern over false precision.

The IAG-Salinity team is still of the opinion that some effort should be made to at least define the currently used qualitative indicators ('high', 'medium' and 'low') so that the reader has some confidence in what the registers are indicating with respect to uncertainty.

Recommendation 15: Defining the uncertainty in the register items: *Uncertainties in the registers need to be more transparent and the meaning of high, medium and low confidence ratings defined.*

APPENDIX 1: INDEPENDENT AUDIT GROUP FOR SALINITY – TERMS OF REFERENCE

Preamble

The Basin Salinity Management Strategy (BSMS) provides a framework for communities and governments to work together to control salinity and protect key natural resource values in the Murray–Darling Basin.

The Basin Salinity Management Advisory Panel oversees the monitoring, evaluation and reporting components, essential to ensure accountability of the partner governments and the MDBA under strategy implementation.

Auditing is an integral part of the BSMS in that it ensures a fair and accurate annual assessment of the partner governments' and MDBA's performances against Schedule B to the Murray–Darling Basin Agreement. The Schedule specifies that an independent audit group must be appointed by the Authority for the purpose of carrying out an annual audit. The responsibilities and process for the audit are set out in Clauses 29 to 34 – Part VII – Reporting, Audit and Review, and the scope of the audit is specified at Clause 34 (3) to (6).

Management of the audit each year will be directed through the preparation of an annual audit plan which will also identify priorities for that year.

Principles for the audit

For the purpose of the annual audits, the following principles are to apply:

1. Independence – the IAG-Salinity will reach a view by consensus. The findings and recommendations of the IAG-Salinity will be entirely those of the IAG-Salinity.
2. Support – administrative support will be provided by MDBA.
3. Provision of information – the IAG-Salinity shall base the audit on the information provided by the partner governments and the MDBA.
4. Quality assurance – the quality assurance in relation of the information provided is the responsibility of the information provider.
5. Timeliness – the timely provision of information by the partner governments and the MDBA is required if the audit is to progress satisfactorily.
6. Justification – the findings shall include a supporting rationale.
7. Prioritisation – the recommendations shall include a priority classification.
8. Continuous improvement – the IAG-Salinity shall encourage improvement through independent assessment of compliance against Schedule B obligations, while acknowledging that priority activities should be targeted towards areas of highest salinity risk.
9. Accountability – the IAG-Salinity will work as a team with a lead auditor responsible for the conduct of the audit and completion of the auditors' report. The lead auditor will provide the primary contact between the IAG-Salinity, the partner governments and the MDBA.

Annual audit plan

By 1 August each year, the Authority shall prepare, in consultation with the IAG-Salinity and the Basin Salinity Management Advisory Panel, an annual audit plan which involves the following steps:

1. The Authority requests and collates, within advised timeframes, appropriate information as specified in the annual audit plan from the partner governments and the Authority, and provides the collated information to the IAG-Salinity.
2. The IAG-Salinity consults with partner governments and the Authority, with the role of chair to be undertaken by the lead auditor, or as determined by the lead auditor.
3. The IAG-Salinity prepares and circulates, within advised timeframes, its draft audit report to the partner governments and the Authority for clarification and correction of facts,
4. The IAG-Salinity prepares and submits its final audit report to partner governments and the Authority, within advised timeframes.
5. The partner governments and the Authority provide formal responses to the IAG-Salinity recommendations, which are collated by the Authority as part of reporting to Ministerial Council, and also provided to the IAG-Salinity, within advised timeframes.
6. The lead auditor attends the relevant meeting of the Basin Salinity Management Advisory Panel at the time it considers the final audit report and the formal responses.

Outputs of the audit report

The IAG-Salinity shall:

1. Provide an annual audit report in accordance with the requirements of Schedule B, Clause 34; and
2. If required, provide a separate, brief report on any key issues arising from the audit beyond the explicit audit requirements of Schedule B.

Independent audit group membership

The IAG-Salinity is to be a skills-based group with appropriate qualifications and experience in natural resource management and auditing processes. The group is to consist of up to three members, each of which must demonstrate independence from the work that is being audited. It is envisaged that the IAG-Salinity will consist of one lead auditor and up to two other members. Conditions of appointment are set out in Clause 34 (1) and (2) of Schedule B.

Selection criteria

The following criteria are to be applied in appointing members to the IAG-Salinity so that collectively the team meets the criteria to the maximum extent practicable:

Essential criteria – preference is to be given to candidates with experience in the following areas:

1. the hydrological and hydro-geological behavior of the Basin's catchments and their connectivity within the Basin
2. the application of analytical models to natural resource management
3. the legislative frameworks that govern water and salinity management in the Basin
4. the processes within the Basin involved in the development, implementation, monitoring, evaluation and reporting of salinity policy and management.

Desirable criteria are:

1. an understanding of auditing natural resource management processes, policies and programs
2. an active professional network and rapport with institutional structures of relevance to salinity management in the Basin
3. familiarity with the technical assessment of salinity processes and impacts
4. an understanding of quality assurance processes for natural resource management information, policies and programs, and
5. experience in providing quality written reports and meeting deadlines.

Time commitment

The IAG-Salinity is expected to spend three–four weeks (generally during October and November) to undertake the annual audit under the following indicative timeframes:

1. up to one week for familiarisation with the available documentation
2. up to two weeks for consultation with state contracting and Australian governments, and the Authority, and
3. up to one week to prepare and refine the IAG-Salinity report.
4. the lead auditor may be required to commit to providing an additional five days service to fulfill other accountability responsibilities.

APPENDIX 2: BASIN SALINITY MANAGEMENT – SCHEDULE B

For purposes of this report, a summary and a key section from Schedule B of the Murray–Darling Basin Agreement which is Schedule 1 to the *Water Act 2007* (Commonwealth) have been included.

The purpose of Schedule B is to implement certain aspects of the BSMS; it consists of 12 parts.

Structure of Schedule B

Preliminary	Purpose, definitions and application to Queensland
Accountability for salinity impacts	Accountability of impacts, determining Baseline Conditions, meeting end-of-valley targets
Salinity targets	Basin Salinity Target, end-of-valley targets, review and amendment of end-of-valley targets
Joint works and measures	Joint program, Attribution of credits or debits, Authorisation, Participation by Queensland, and Australian Capital Territory, Coordination.
The Registers	Establishment, Obligations, Operating, Determining whether a proposal has a significant effect, Assessing salinity impacts, Estimating credits and debits, Attribution of credits and debits, Timing of entry onto the register, Trading and transfers between registers, Review and amendment of entries.
Monitoring	Obligations, End-of-valley targets, Program to monitor Accountable actions.
Reporting audit and review	State contracting governments, Valley reports, Commonwealth, Authority, Rolling five year reviews, Audit, Review of Schedule
Models	Models developed by Authority, Models developed by state contracting governments, Assessment and approval of certain models, Review of models.
Protocols	Authority's power to make protocols, Examples.
Default	Relationship with Part XI of the Agreement, Default by a state contracting government, Exception reports, Proposal for remedial action, Action by state contracting government.
Finance	State actions, Joint works or measures.
Transitional provisions	Former salinity and drainage works

Part VII of Schedule B requires that each partner government prepare an annual report based on the following essential elements:

1. accountable actions, proposals and joint works and measures
2. valley reports for each valley where an end-of-valley target has been adopted
3. rolling five-year reviews of valleys and actions undertaken in the last year
4. other activities to support BSMS implementation.

Part VII also provides for auditing. Subclauses 34 (3) to (6) provide the basic terms of for the annual auditing of the BSMS, as follows:

34 AUDIT

...

...

- (3) The independent auditors must together carry out an annual audit of:
 - (a) the report of each review conducted in the preceding financial year by each state contracting government and by the Authority under sub-clause 33(1) and 33(3), respectively; and
 - (b) Register A and Register B.
- (4) The independent auditors must, in each audit, reach a view by consensus about:
 - (a) the performance of each state contracting government and of the Authority in implementing the provisions of this Schedule in the relevant year; and
 - (b) whether the Authority has fairly and accurately recorded the salinity impacts of each action entered in Register A or Register B during the relevant year.
- (5) The independent auditors must prepare a report setting out:
 - (a) the findings of each audit; and
 - (b) any recommendations made by the independent auditors arising from that audit.
- (6) Without limiting sub-clause 34(5), a report:
 - (a) must set out the view reached on each of the matters referred to in sub-clause 34(4); and
 - (b) may recommend to the Authority that the salinity impacts entered in Register A or Register B for an Accountable action be varied; and
 - (c) may set out a finding that the total salinity credits are not equal to, or do not exceed, the total salinity debits attributed to a state contracting government in Register A, contrary to paragraph 16(1)(a).

Protocols

Part IX of the Schedule provides powers for the Authority to make protocols 'desirable or convenient to give effect to this Schedule'. The Authority has accordingly prepared and promulgated a set of protocols. These provide procedures and guidelines to assist the participating jurisdictions in implementing the BSMS.

APPENDIX 3: SALINITY REGISTERS (AS AT 22 OCTOBER 2010)

Salinity Registers A and B

Real Register Number	AUTHORITY REGISTER A (Accountable Actions)						Salinity Effect (EC at Morgan)					Modelled Current conditions (Interpolation to Current Year)
	Type	Date Effective	Provisional Salinity Credit (\$m/yr)	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	2000	2015	2050	2100			
	JOINT WORKS & MEASURES											
	Former Salinity & Drainage Works											
1	1	Woolpunda SIS	SDS	Jan 1991		-87	0	-47.4	-47.4	-47.4	-47.4	-47.4
2	2	Improved Buronga and Mildura/Merbein IS	SDS	Jan 1991		-6	0	-3.0	-3.0	-3.0	-3.0	-3.0
6	3	New Operating Rules for Barr Creek Pumps	SDS	Jul 1991		-8	0	-4.9	-4.9	-4.9	-4.9	-4.9
9	4	Waikerie Interception Scheme	SDS	Dec 1992		-19	0	-12.8	-12.8	-12.8	-12.8	-12.8
18	5	Changed MDBC River Operations 1988 to 2000	SDS	Apr 1993		-1	4	-1.6	-1.6	-1.6	-1.6	-1.6
12	6	Mallee Cliffs Salt Interception Scheme	SDS	Jul 1994		-21	0	-13.3	-13.3	-13.3	-13.3	-13.3
19	7	Changed Operation of Menindee and Lower Darling	SDS	Nov 1997		3	8	0.9	0.9	0.9	0.9	0.9
23	8	Waikerie SIS Phase 2A	SDS	Feb 2002		-14	0	-8.0	-8.2	-10.7	-8.9	-8.1
25	9	Changed MDBC River Operations 2000 to 2002	SDS	Feb 2002		-2	-1	-1.4	-1.4	-1.7	-1.9	-1.4
		Sub Total – Former Salinity & Drainage Works										
		Basin Salinity Management Strategy										
31	10	Changed MDBC River Operations after 2002	BSMS	Dec 2003		1	7	-0.2	-0.2	-0.4	-0.4	-0.2
37	11	Pyramid Ck GIS	BSMS	Mar 2006		-6	0	-5.1	-5.1	-5.2	-5.2	-5.1
40	12	Bookpurnong Joint Salt Interception Scheme	BSMS	Mar 2006		-21	0	-13.6	-11.7	-11.2	-11.3	-12.2
41	13	Improved Buronga Scheme	BSMS	Mar 2006		-1	0	-0.6	-0.5	-0.5	-0.5	-0.5
49	14	Loxton SIS	BSMS	Jun 2008		-12	0	-6.8	-8.1	-7.2	-6.9	-7.7
53	15	Waikerie Lock 2 SIS	BSMS	Jun 2010		-17	0	-12.7	-10.3	-11.3	-11.8	-11.0
		Sub Total Joint Works under BSMS										
		Joint Works Sub Total										
		STATE WORKS & MEASURES										
		Shared New South Wales and Victorian Measures										
20	16	Permanent Trade Accounting Adjustment – NSW to Victoria	50N50V	Jun 2006		0	0	0.0	-0.1	-0.1	-0.1	-0.1
24	17	Barmah-Millewa Forest Operating Rules	50N50V	Mar 2002		-2	33	-1.9	-2.0	-1.9	-2.3	-2.0
		Shared Measures Sub Total										
		New South Wales										
44	18	Boggabilla Weir	NSW	Dec 1991		-1	0	-0.1	-0.1	-0.1	-0.1	-0.1
56	19	Pindari Dam Enlargement	NSW	Jul 1994		0	-17	0.7	0.7	0.7	0.7	0.7
14	20	Tandou pumps from Lower Darling	NSW	Sep 1994		2	-3	-0.1	-0.1	-0.1	-0.1	-0.1
16	21	NSW MIL LWMP's	NSW	Feb 1996		-4	57	-4.0	-4.0	-4.0	-4.0	-4.0
17	22	NSW Changes to Edward-Wakool and Escapes	NSW	Jan 1990		-2	4	-2.0	-2.1	-2.0	-2.0	-2.0
21	23	Permanent Trade Accounting Adjustment – NSW to SA	NSW	Jun 2006		-2	1	-0.5	-0.4	-0.4	-0.5	-0.4
29	24	NSW Sunraysia Irrigation Development 1997-2006	NSW	Jul 2003		1	0	0.0	0.9	4.5	6.1	0.6
55	25	RISI NSW	NSW	Jun 2010		-5	0	-2.7	-3.9	-4.1	-4.1	-3.5
26	26	NSW S&DS Commitment Adjustment	NSW	Nov 2002		0	0	0.0	0.0	0.0	0.0	0.0
		New South Wales Works and Measures										
		Victoria										
3	27	Barr Creek Catchment Strategy	Vic	Mar 1991		-12	0	-7.7	-7.7	-7.7	-7.7	-7.7
4	28	Tragowel Plains Drains at 2002 level	Vic	Mar 1991		1	1	0.2	0.2	0.2	0.2	0.2
5	29	Shepparton Salinity Management Plan	Vic	Mar 1991		1	27	2.3	2.3	2.3	2.3	2.3
50	30	Nangiloc-Colignan S.M.P.	Vic	Nov 1991		0	1	0.5	0.3	0.4	0.3	0.4
10	31	Nyah to SA Border SMP - Irrigation Development	Vic	Jul 2003		17	0	11.3	11.3	11.2	11.2	11.3

						Factors for allocating transferred credits to Register B									
AUTHORITY REGISTER B (Delayed Salinity Impacts)						Type	Year of Predictions	Provisional Salinity Credit (\$m/yr)*	Current Impact on Morgan 95%ile Salinity (EC)	Impact on Flow at Mouth (GL/y)	Salinity Effect (EC at Morgan)				Modelled Current conditions (Interpolation to Current Year)
											2000	2015	2050	2100	
Transfers from Register A															
New South Wales															
200	57	Darling Catchment Legacy of History - Macquarie	NSW	Jan 2000		0	0	0.0	0.1	0.3	0.4	0.1			
201	58	Darling Catchment Legacy of History - Macintyre	NSW	Jan 2000		0	0	0.0	0.0	0.0	0.0	0.0			
202	59	Darling Catchment Legacy of History - Gil Gil Ck	NSW	Jan 2000		0	0	0.0	0.0	0.0	0.0	0.0			
203	60	Darling Catchment Legacy of History - Gwydir	NSW	Jan 2000		0	0	0.0	0.0	0.0	0.0	0.0			
204	61	Darling Catchment Legacy of History - Namoi	NSW	Jan 2000		0	0	0.0	0.2	0.4	0.5	0.1			
205	62	Darling Catchment Legacy of History - Castlereagh	NSW	Jan 2000		0	0	0.0	0.0	0.0	0.1	0.0			
206	63	Darling Catchment Legacy of History - Bogan	NSW	Jan 2000		0	0	0.0	0.1	0.2	0.3	0.1			
207	64	Lachlan Legacy of History	NSW	Jan 2000		0	0	0.0	0.0	0.0	0.0	0.0			
208	65	Murrumbidgee Catchment Legacy of History	NSW	Jan 2000		0	0	0.0	0.1	0.2	0.2	0.0			
215	66	NSW Mallee – dryland	NSW	Jan 2000		0	0	0.0	0.3	1.3	3.6	0.2			
217	67	NSW Mallee – Pre 88 Irrigation	NSW	Jan 2000		0	0	0.0	0.4	1.2	2.3	0.3			
Victoria															
209	68	Campaspe Catchment Legacy of History	Vic	Jan 2000		0	0	0.0	0.1	0.2	0.3	0.1			
210	69	Goulburn Catchment Legacy of History	Vic	Jan 2000		0	0	0.0	0.6	12.3	12.3	0.4			
211	70	Loddon Catchment Legacy of History	Vic	Jan 2000		0	0	0.0	0.3	4.9	10.0	0.2			
212	71	Kiewa Catchment Legacy of History	Vic	Jan 2000		0	0	0.0	0.1	0.0	0.0	0.1			
213	72	Ovens Catchment Legacy of History	Vic	Jan 2000		0	0	0.0	0.0	0.6	1.3	0.0			
214	73	Victorian Mallee – dryland	Vic	Jan 2000		1	0	0.0	0.6	2.2	5.9	0.4			
216	74	Victorian Mallee – Pre 88 Irrigation	Vic	Jan 2000		2	0	0.0	1.4	4.7	8.3	0.9			
South Australia															
218	75	SA Mallee Legacy of History – Dryland	SA	Jan 2000		5	0	0.0	4.0	13.6	30.4	2.8			
57	76	SA Mallee due to clearing unaccredited*	SA	Jan 2000		0	0	0.0	0.2	1.2	3.3	0.2			
219	77	SA Mallee Legacy of History – Irrigation	SA	Jan 2000		59	0	0.0	46.9	87.2	113.2	32.9			
58	78	SA Impact of Pre-1988 Irrigation unaccredited*	SA	Jan 2000		-1	0	0.0	-1.4	-1.7	-1.5	-1.0			
220	79	SA Improved Irrigation Efficiency Reg B	SA	Jan 2000		-61	0	0.0	-48.5	-91.8	-110.5	-34.0			
60	80	SA Improved Irrigation Efficiency Reg B unaccredited*	SA	Jan 2000		0	0	0.0	-0.1	-0.9	-2.8	-0.1			
221	81	SA Irrigation Scheme Rehabilitation Reg B	SA	Jan 2000		0	0	0.0	0.0	0.0	-1.2	0.0			
62	82	SA Rehabilitation Reg B unaccredited*	SA	Jan 2000		0	0	0.0	0.0	0.0	0.0	0.0			
Queensland															
83		Queensland Legacy of History	Qld	Jan 2000		TBA									
84		Queensland Irrigation Development pre 1 Jan 2000	Qld	Jan 2000		TBA									
Balance – Register B						0.000	5	0	0.0	5.3	36.0	76.3	3.7		
Balance – Registers A & B							-263	123	-160.2	-161.5	-106.0	-19.1	-161.1		
Basin Salinity Target (Morgan) – Modelled Current Status							787	5,094	506	505	514	647	510		

Registers Explanatory Notes

TBA – To be assessed

Salinity Effect – Increase in average salinity at Morgan in EC

Salinity Credits – Unit of account of Salinity and Drainage Strategy = Reduction in Salinity Costs (\$m/year March 2005 values)

*These entries are based on the unaccredited models (Berri-Renmark and Pyap-Kingston)

Some values are affected by rounding to the nearest decimal

	0.243	0.194	0.563	0.000	0.000	
Salinity Credits (Interpolation to Current Year Benefits \$m/year)						
	NSW	Vic	SA	Qld	ACT	Total
	0.578	0.461	1.339	0.000	0.000	2.379
	-0.023					-0.023
	0.000					0.000
	-0.001					-0.001
	-0.001					-0.001
	-0.034					-0.034
	-0.004					-0.004
	-0.017					-0.017
	0.000					0.000
	-0.012					-0.012
	-0.015					-0.044
	-0.066					-0.066
		-0.018				-0.018
		-0.092				-0.092
		-0.064				-0.064
		-0.027				-0.027
		0.000				0.000
		-0.063				-0.096
		-0.224				-0.224
			-0.326			-0.326
			-0.021			-0.021
			-4.044			-4.044
			0.116			0.116
			4.080			4.080
			0.009			0.009
			0.000			0.000
			0.001			0.001
	0.404	-0.025	1.154	0.000	0.000	1.469
	5.885	4.994	4.129	0.000	0.000	23.799

5 Year Rolling Review		
Latest Review		Status
1999	2004	In Progress
2010	2015	
2010	2015	
2003	2008	
2003	2008	
2003	2008	
2003	2008	
2003	2008	
2003	2008	
2010	2015	
2010	2015	
2010	2015	
1998	2003	
2004	2009	
1998	2003	
2009	2012	In Progress
	2010	

Confidence	
Rating	Comment
Medium	Little connection to Murrumbidgee
Low	
Low	
Medium	
Medium	
Medium	Remodelled 2006
Medium	
Medium	
Low	
Low	
Medium	
Low	Provisional entries (unaccredited models)
Medium	
Low	Provisional entries (unaccredited models)
Medium	
Low	Provisional entries (unaccredited models)
Medium	
Low	Provisional entries (unaccredited models)
	Low Impact – Long lag times
	Modelling required



Australian Government



**MURRAY—
DARLING**
BASIN AUTHORITY