Report of the Independent Audit Group for Salinity

2013-14

Independent Audit Group for Salinity members:

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin

The Murray–Darling Basin Authority acknowledges and pays respect to the Traditional Owners, and their Nations, of the Murray–Darling Basin, who have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. The MDBA understands the need for recognition of Traditional Owner knowledge and cultural values in natural resource management associated with the Basin.

The approach of Traditional Owners to caring for the natural landscape, including water, can be expressed in the words of Darren Perry (Chair of the Murray Lower Darling Rivers Indigenous Nations) —

'the environment that Aboriginal people know as Country has not been allowed to have a voice in contemporary Australia. Aboriginal First Nations have been listening to Country for many thousands of years and can speak for Country so that others can know what Country needs. Through the Murray Lower Darling Rivers Indigenous Nations and the Northern Basin Aboriginal Nations the voice of Country can be heard by all'.

This report may contain photographs or quotes by Aboriginal people who have passed away. The use of terms 'Aboriginal' and 'Indigenous' reflects usage in different communities within the Murray–Darling Basin.

Auditors' foreword

Chair
Murray-Darling Basin Authority
GPO Box 1801
CANBERRA ACT 2601

Dear Chair

We have pleasure in submitting to you the Report of the Independent Audit Group for Salinity 2013-14.

This, the twelfth such audit of the Basin Salinity Management Strategy (2001-2015) covering the seventh 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* (Cwlth)).

This year, the modelled Morgan target of 800EC for 95% of the time was met for the fifth time in a row since it was set. In addition, the target of a 61EC reduction at Morgan was reached with the completion of the Murtho Scheme in South Australia, the commissioning of the upper Darling Scheme in NSW and the finalisation of the first phase of the Mildura-Merbein refurbishment. Both of these are key achievements of the Basin Salinity Management Strategy (BSMS).

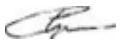
The BSMS is due to be completed in 2015. In line with our Terms of Reference, our recommendations in this audit focus on key issues that, in our view, are a priority for consideration in the development of the next phase of salinity management within the Basin. We hope our observations and our recommendations are of use to the jurisdictions and the MDBA as you develop BSMS 2030.

Once again, we were impressed with the collective commitment of staff from all the jurisdictions and the Authority to the salinity management in the basin and we extend our thanks for their cooperation and assistance.

We believe firmly that the BSMS and its predecessor, the Salinity and Drainage Strategy have been highly successful and are exemplars in natural resource management. The jurisdictions and the Authority should be proud of their achievements and should look to showcase their efforts in salinity management in the Basin and communicate their success to the community and internationally.

Yours sincerely





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Lead Auditor	Auditor	Auditor

Abbreviations

2CSalt	Upland Water and Salt Generation Model
ACT	Australian Capital Territory
BSMAP	Basin Salinity Management Advisory Panel
BSMS	Basin Salinity Management Strategy
BUA	Beneficial Use Approval
CEWO	Commonwealth Environmental Water Office
CMA	Catchment Management Authority
CSG	Coal Seam Gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cwlth	Commonwealth
EC	Electrical Conductivity (expressed in units of µS/cm)
EoVT	End–of–Valley Target
GL	gigalitre (1,000 ML)
HGL	hydrogeological landscapes
IAG–Salinity	Independent Audit Group for Salinity
ICM	Integrated Catchment Management
IQQM	Integrated Quantity and Quality Model (surface water model software)
LLS	Local Land Services
LTCE	Long Term Cap equivalent
LWMP	Land and Water Management Plan
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority
MDBMC	Murray–Darling Basin Ministerial Council
ML	megalitre (1,000 m^3)
MODFLOW	Modular Flow Model (groundwater model software)
MSM–BigMod	Monthly Simulation Model—Big Model (River Murray model software)
NRM	Natural resource Management
NSW	New South Wales
RCS	Regional Catchment Strategy
REALM	Resource Allocation Model (surface water model software)
RMIF	River Murray Increased Flow
SA MDB NRM	South Australian Murray–Darling Basin Natural Resource Management
SDS	Salinity Drainage Strategy

SIMRAT	Salinity Impact Rapid Assessment Tool
SIS	Salt Interception Scheme
Source	Water Quantity and Quality Model Software (eWater Ltd)
TLM	The Living Murray Program
WRP	Water Resource Plan

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Executive summary

Introduction

In August 2001, the Murray–Darling Basin Ministerial Council (MDBMC) launched the Basin Salinity Management Strategy (BSMS) (MDB 2001). Schedule B to the Murray–Darling Basin Agreement sets down the legislative framework for the implementation of the BSMS.

Schedule B provides for the appointment of 'independent auditors for the purpose of carrying out an annual audit', whose task is to review progress in implementing the BSMS.

The terms of reference for the IAG–Salinity (Appendix 1) and Schedule B (Appendix 2) require the IAG–Salinity to review progress on the BSMS both broadly and in terms of the steps laid down in the schedule and focusing on the specific measurement and recording of progress with the BSMS and the outcomes at 30 June each year. In this year, the penultimate year of the BSMS, the terms of reference also included providing a perspective, looking back and forward**.** The auditors were requested to look back over the audit process and forward to consider the requirements of the next BSMS period (2015 – 2030) and make suggestions about suitable audit arrangements for the next 15 years. This has been the major focus of this Audit report for 2013-14.

The three members of the present Independent Audit Group for Salinity (IAG–Salinity) were appointed in November 2014. This report presents their consensus view in undertaking the audit covering the 2013–14 financial year. The state contracting governments, the Australian Capital Territory (ACT) and MDBA submitted reports on their activities, valley reports, the status of five-year rolling reviews, and BSMS salinity register entries or adjustments. The Australian Government (Department of the Environment) also submitted a report related to environmental watering activities.

The audit process adopted by the IAG–Salinity included a review of the annual jurisdictional reports and the salinity registers, followed by meetings with representatives of the jurisdictions and with members of MDBA. The recommendations were developed and jurisdictions were given an opportunity to provide factual comments on the audit report.

The 2013-14 Context for BSMS Implementation

In 2013-14, with the Basin Plan in place and the BSMS in its penultimate year, the jurisdictions and the MDBA undertook the General Review of Salinity Management in the MDB (MDBA, 2014). Key drivers for the Review included expected changes in Basin salinity risk arising from water recovery and use under the Basin Plan and knowledge gained from 30 years of experience in managing salinity in the Basin.

Key conclusions from the General Review included:

- Actions taken under the BSMS have been successful in improving salinity levels in the river with the modelled Morgan target being met for the previous four years (i.e. at August 2014). This progressive improvement in salinity is directly attributable to mitigation works and measures
- Improvements in knowledge over the life of the BSMS have shown that:
  - Whilst all parts of the Basin contribute some salt to the rivers, the Mallee and parts of the Riverine Plains are the landscape areas which are the major sources of salinity

    - Groundwater levels in the dryland areas seem to be in a dynamic equilibrium reflecting wet-dry sequences. The degree of the long-term upward trend in most catchments that was predicted in the 1990s was not as dramatic as thought at the time and based on updated assessment in the late 2000s over an order of magnitude less in many catchments

- The recovery and use of Environmental Water under the Basin Plan will provide significant dilution benefits that would mean the delayed salinity impacts of current levels of development, under the current BSMS controls, would not affect the Morgan target until ~2080. This means there is a very significant safety buffer in the next phase of the BSMS
- Even with the dilution benefits provided by the environmental water, salt interception schemes (SISs) remain a critical part of the BSMS actions, particularly in periods of low flow and over extended dry periods. However, it appears that it is possible to operate the SISs at a reduced level of utilisation and meet the Morgan target over the period of the next phase of the BSMS (i.e. 2015 – 2030).

The outcomes of the General Review, the arrangements for the implementation of the Basin Plan and the utilisation of large volumes of environmental water are key factors that provide the context for the development of the next phase of the Basin Salinity Management (i.e. BSMS 2030), currently being undertaken and due for completion in 2015. The final critical issue is the budget pressures that all Governments are currently under and the consequent need to ensure that salinity management is cost-effective and efficient and balanced against salinity risk.

These issues were also a key factor dominating the implementation of the BSMS in its penultimate year. In 2013-14, the IAG-Salinity noted a number of key outcomes including:

- The Morgan target was met for the fifth year in a row. The modelled 2013-14 conditions showed that salinity remained under the Morgan target for 98% of time. This represents the best outcome ever reported under the BSMS
- All three states are in credit on the combined salinity registers (7.956, 6.850 and 7.502 $M/year for NSW, Victoria and South Australia respectively)
- The target of a 61EC reduction at Morgan was reached with the completion of the Murtho Scheme in South Australia, the commissioning of the upper Darling Scheme in NSW and the finalisation of the first phase of the Mildura-Merbein refurbishment
- The operation and maintenance of SISs focused on minimising running costs, in particular, the energy costs associated with pumping and the least efficient SIS, the Rufus River Scheme was left in standby mode after the 2011 high flow event. Even with this more efficient management approach, the SISs were responsible for the diversion of ~398 000 tonnes of salt away from the river
- For the first time, provisional entries were made on Register A for environmental water delivery and works and measures. The provisional entries comprise a credit of 24.4 EC for 570 GL water provision and a debit of 4.6 EC for the environmental works and measures associated with The Living Murray (TLM) project. The new provisional register entries for TLM alone are now accounting for about 13% of the full SIS benefit
- The Commonwealth Environmental Water Office reported delivery of 558GL of Commonwealth environmental water to the Lower Murray which contributed to maintaining salinity levels below the Morgan target

- All Jurisdictions were implementing major projects to meet their water recovery obligations under the Basin Plan. In addition, significant work was undertaken in redesigning farming systems across the Basin as part of the Australian Government's Water for the Future On–Farm Program. All jurisdictions were dealing with funding reductions in catchment management activities as a result of changing priorities at the state and federal government levels.

In 2013-14, jurisdictions were all starting to look forward to BSMS 2030 and giving priority to areas of implementation needed to be carried forward in the new strategy and identifying where activity was no longer needed or could be reduced and where activity could be sensibly modified to fit into the emerging implementation requirements.

In line with this and with the terms of reference for the 2013-14 Audit, the Auditors have focused their recommendations on key issues that will be a priority for consideration in the development of BSMS 2030. The rationale for these recommendations is covered in detail in Section 4 of the report. In addition, summaries of progress in 2013-14 and issues under each of the key elements are provided in Section 5 of the report.

Overview of 14 years of BSMS Implementation

The BSMS, which is now in its 14th year, has been highly successful, as has been shown in the General Review of Salinity Management in the MDB (2014) and demonstrated by the Morgan target being met for the past five years. This success may be attributed to both the run of climatic events and the implementation of the BSMS.

In the view of the IAG–Salinity, the BSMS has delivered the following benefits:

- A clear focus on providing good water quality at Morgan to provide for downstream assets, which has been successful
- Clear accountability of all jurisdictions for meeting the Morgan target
- A joint program of investment, which:
  - improved the quality of water in the River Murray to meet the target established at Morgan and protected most downstream assets from expected damage from salinity
  - enabled irrigation development to continue to occur with no further deterioration in salinity
  - enabled the water market to operate, allowing water to move to its highest value use with no further deterioration in salinity
- An agreed process for the allocation of benefits and costs between the joint venture and individual jurisdictions.

Table 1: Summary of measured salinity levels (EC) at Morgan, South Australia

Period	Time interval	Average	Median (EC)	95 percentile (EC)	Peak	% Time more than 800 EC
1 year	July 2013 - June 2014	355	349	590	650	0%
5 years	July 2009 - June 2014	346	327	585	687	0%
10 years	July 2004 - June 2014	390	377	624	768	0%
25 years	July 1989 - June 2014	482	451	780	1087	4%

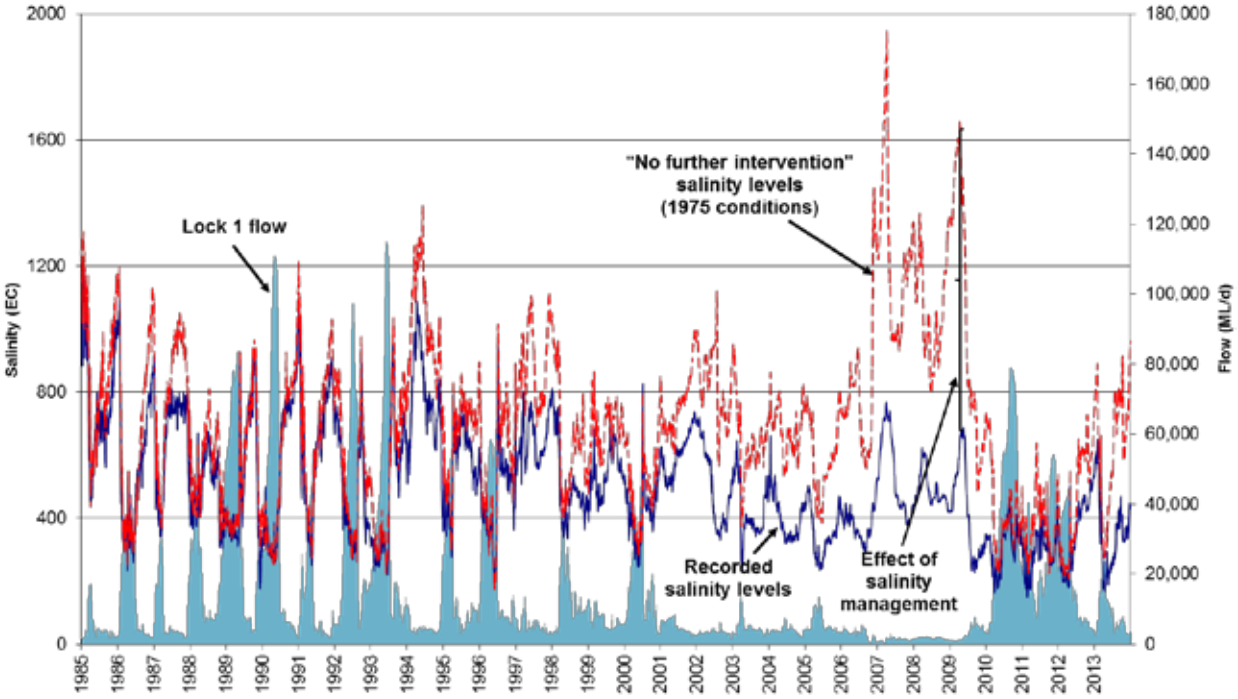

Figure 1: Effect of salinity management in the Murray–Darling Basin at Morgan, South Australia.

Note: Comparison of recorded mean daily salinity levels and modelled salinity levels without salt interception schemes, land and water management actions and additional dilution flows over a 27-year period (July 1985 to June 2014).

The strategy was designed to be adaptive to new knowledge and its governance and review processes ensured that this was undertaken seriously and successfully. The BSMS has provided a focus for the continuation of a collaborative joint effort between jurisdictions, which was maintained even through the highly charged period of Basin Plan development. The strategy has the confidence of the jurisdictions and their communities because of the transparency of the registers and the annual audit process.

However, the IAG-Salinity considers that, given the changing context for the next phase of the BSMS 2030, there are a number of important areas that should be retained, others which can be improved and a number where there is potential for stream-lining and more efficient processes. The IAG-Salinity offers the following recommendations for consideration in the development of the BSMS 2030.

These recommendations have been developed through discussions with the jurisdictions and the MDBA and the CEWO and review of their reports.

Recommendation 1: Communication

In the final year of the BSMS, in the lead-up to the endorsement by the Ministerial Council of the new BSMS 2030, jurisdictions and the MDBA should:

a) *develop a succinct summary of the success of the BSMS covering both environmental benefits and the economic benefits including the level of regional development which was made possible by the BSMS*

b) *hold a forum where the MDBA, jurisdictions and their delivery partners can showcase key achievements of their BSMS implementation programs.*

Recommendation 2: General Approach to BSMS 2030

In the development of BSMS 2030, the following key points should be considered:

a) *The benefits provided by the BSMS should be built upon and not lost*

b) *The BSMS 2030 should be built around the Basin salinity target at Morgan as a target for the shared water resources with the EoVTs acting as watch points for tributary inflows and incorporated into Water Resource Plans (WRPs)*

c) *A risk-based, cost-effective and adaptive approach should be undertaken in reviewing BSMS elements including:*

   i). *SIS operations*

   ii). *continuous improvement arrangements for modelling, data and knowledge generation*

   iii). *audit and reporting*

d) *The salinity registers are the agreed 'point of truth' providing a clear statement of the agreed impacts of measures and actions taken by jurisdictions that will either mitigate salinity or increase it and its likely future effects. They should be retained in Schedule B as a key element in the BSMS 2030 and include all relevant and material actions*

e) *In designing reporting, review and auditing arrangements, consideration should be given to ensuring these are cost-effective but frequent enough to require knowledgeable and ongoing capability within jurisdictions and the MDBA, providing the basis for 'institutional memory' given the long term cyclical nature of salinity*

f) *Uncertainty in our knowledge of the salinity and management processes should be recognised and where cost-effective, knowledge should be improved.*

Recommendation 3: BSMS 2030 Operational Protocols

Following the development of BSMS 2030, the BSMS Operational Protocols are revised to ensure they give effect to the new policy framework. In this revision, particular attention should be given to the appropriateness of the benchmark period, the baseline, the use of models and defining risk and uncertainty.

Recommendation 4 – Environmental Water

a) *separate register entries on Register A for all Basin Plan water recovery projects which are likely to have a salinity impact as per the normal processes under the BSMS*

b) *a provisional entry on Register A for the delivery of environmental water recovered to date under the Basin Plan. Further work would then be undertaken over the next five year period to finalise the register entry including updating the final volume as required*

c) *a process for adding separate register entries for any additional significant environmental works that are built as a result of the operation of the adjustment mechanism*

d) *that BSMS 2030 includes the policy framework for the ownership and accounting of salinity debits and credits associated with environmental water recovery, delivery and works operation.*

Recommendation 5 – Salt Interception Schemes

In the development of BSMS 2030, consideration is given to taking a risk-based, responsive approach to the management of SISs that aims to reduce the operational costs of the management of SISs whilst still providing confidence in meeting the Morgan target over the long-term. This should take into account:

- *the efficiency of schemes and the consequences of closing systems down for periods of time*
- *the costs of running the scheme versus its effectiveness in reducing salinity impacts*
- *the costs and timeliness of restarting systems versus the potential impacts over time of not operating the system*
- *the practicality of running SIS in a responsive way.*

Recommendation 6 - Redefining EoVTs for BSMS 2030

The EoVTs provide useful reference points for salinity management and understanding and:

a) *EoVTs should continue into the future but should be revised for BSMS 2030 in light of a better understanding of salinity within valleys and where appropriate should be linked to requirements of local assets, which is consistent with a risk based approach*

b) *The EoVTs should be included, in some form, in WRPs*

c) *The protection of local catchment assets should be considered in WRPs. Assets located in high salinity impact sub-catchments should be identified and included as part of the reporting process, noting that additional salinity monitoring sites may need to be included to support this reporting*

d) *The effectiveness of EoVTs should be reviewed on a 5 yearly basis and where required adjusted.*

Recommendation 7 - Implementing a risk-based approach to Register entries

a) *To support a risk based salinity assessment, register entries should include a qualitative uncertainty assessment*

b) *Recognising the uncertainty in register entries, new register entries including their supporting models should be reviewed in 5 years*

c) *Review of established debit and credit register entries (post initial 5 year review) including their supporting models should be reviewed on the following basis:*

   i) *For high risk entries (i.e. entries with high impact (1 EC or more) and high uncertainty) where there is a change in salinity processes or there is new data - retain the 5 year review*

ii) *For high risk entries (i.e. entries with high impact (1 EC or more) and high uncertainty) where there is no change in salinity processes or no new data - move to a 7 year review*

iii) *For all other entries (i.e. low risk entries with small impact (<1 EC) or high risk entries with low uncertainty) – require internal reporting and consider the need for reviews as part of a major program review of BSMS 2030*

d) *Consolidation of small stable register entries.*

Recommendation 8 - Benchmark period

The BSMS benchmark period should be reviewed prior to the commencement of BSMS 2030 and a decision made by BOC as whether the benefits of changing the benchmark period outweigh the costs.

Recommendation 9 - BigMod model review

In the review of BigMod:

a) *The MDBA provide advice on the way that cumulative actions are configured in BigMod. Particular consideration should be given to:*

   i) *The chronological order of entries and alignment with the current BSMS operational protocols (MDBC, 2005)*

   ii) *Detail how reviews in register entries are implemented in the model*

b) *Given that the BSMS Operational Protocols (March 2005) are not clear on how to include reviews of salinity actions in the register, the model review should consider the sensitivity to the following interpretations of how to implement the register review changes:*

   i) *Initial entry updated for the change (Chronological order not changed)*

   ii) *Change included at the time of the review (Chronological order maintained for the change)*

   iii) *Revised salinity included at the time of the review (Chronological order changed to review date)*

c) *Given the likelihood of changes to operational practices of SISs in the future, the model review should provide advice on the adequacy of BigMod to be used for operational decisions, in particular the adequacy of the results from the model to inform the operation of salinity interception schemes*

d) *The BigMod Review should be made transparent to the IAG-Salinity auditors.*

Recommendation 10 - BSMS Baseline

In the development of BSMS 2030, consideration is given as to whether there is a need to set a new Baseline date at the commencement of BSMS 2030, and potentially at the commencement of any future BSMS stages.

Recommendation 11 - Coordinated development of models to support BSMS 2030

BSMS 2030 provides some overall direction on the development of the next generation of models for salinity management to facilitate a consistent approach to model development and their underlying conceptual basis.

Recommendation 12 - Monitoring

In the development of BSMS 2030, consideration is given to requiring jurisdictions to identify monitoring stations that are critical in providing data for:

- *BSMS 2030 reporting*
- *Modelling reviews*
- *Improving understanding of salinity processes in high priority areas of the Basin and that these stations are provided with policy status to ensure they are maintained as jurisdictions review their monitoring networks in the future.*

Recommendation 13 – Audit and Reporting Processes

In the development of BSMS 2030, consideration is given to:

- *Maintaining annual reporting on the registers through to the Ministerial Council*
- *Moving, in principle, to a biennial Independent Audit process (noting there may be utility in some annual audits over the early transition period)*
- *Changing the format of the audit process to provide a shared jurisdiction session for continuous improvement processes*
- *Holding a jurisdictional workshop biennially to share information, issues and best practice*
- *Stream-lining reporting between the BSMS 2030 and the Basin Plan.*

Recommendation 14 – 2015 BSMS Audit

a) *the Terms of Reference for the final audit in 2015 should ensure that it is aimed only at closing off the BSMS and is not as detailed as previous audits*
b) *consideration be given to linking it to a forum where the MDBA, jurisdictions and their delivery partners can showcase key achievements of their BSMS implementation programs.*

Recommendation 15 – Maintaining Institutional Memory, Capacity and Capability

The IAG-Salinity recommends that in the development of the BSMS 2030, consideration is given to embedding processes and incentives that will ensure that capacity and capability in salinity management is maintained within the MDBA and the jurisdictions.

Recommendation 16 - CSG Salinity Impacts

a) *in BSMS 2030, potential is provided to ensure that the impacts of CSG development on salinity within the Basin are broadly monitored and if and where necessary, are able to be managed within the new framework for salinity management*
b) *with respect to CSG water in Queensland:*
    - *In the next review of their Beneficial Use policy, Queensland should address a policy gap that omits salinity from consideration in approvals of new irrigation development*
    - *Queensland should adequately monitor potential salinity hazards arising through irrigation associated with CSG which will require a better combined monitoring database*
    - *The potential cumulative impacts of irrigation associated with CSG in Queensland needs to be assessed to determine if it is a threat to the Basin salinity program.*

The IAG–Salinity's opinion on 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

(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 NSW, Victoria and South Australia to be in net credit, while Register B shows NSW and South Australia to be in net credit with Victoria slightly in credit but close to neutral. For the combined registers, all three states are in credit. Queensland and the ACT do not have register entries.

Opinion on register balances

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

Opinion on MDBA's accuracy in maintaining the registers

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

The audit did not identify any requirement to update individual entries in the registers incorporated in this report.

Response to Recommendations from 2012-13 Audit

The jurisdictions and the MDBA outlined their responses to the recommendations of the 2012-13 audit recommendations. The IAG-Salinity noted that the MDBA and jurisdictions were generally supportive of the intent and direction of the recommendations and that many of the recommendations had been considered as part of the General Review of Salinity Management in the MDB (August 2014). All had been progressed to some extent and all were being further considered in the development of the BSMS 2030.

1. Introduction

Objectives and structure of the Basin Salinity Management Strategy

The Basin Salinity Management Strategy (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 (MDB). 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 MDB, and through that protect their water resources and aquatic ecosystems at agreed levels
3) control land degradation and protect important terrestrial ecosystems, productive farmland, 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* (Cwlth).

Schedule B supports effective salinity management by:

- promoting joint works, measures and other actions to reduce or limit the rate at which salinity increases within the MDB
- 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 of achievement of the end–of–valley target (EoVT) and the Basin salinity target at Morgan. Progress towards meeting the agreed EoVT and the land management objectives is assessed through annual reports from the contracting governments and MDBA. The reports include valley reports for the catchments where an EoVT has been adopted. The Independent Audit Group for Salinity (IAG–Salinity) conducts an independent annual audit of the reports and register entries, and of the performance of the contracting governments and MDBA.

A key driver of the BSMS is the principle of ‘capping’ increases in salinity in the MDB by a system of salt credits and debits managed by the participating governments through two major mechanisms. One is joint investment in salt interception schemes (SISs) and associated infrastructure; the other is investment in target setting and monitoring systems at the end–of–valley sites 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 it can monitor their effect on the EoVTs.

The nine 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 by 2015.

Terms of reference

The terms of reference of the IAG–Salinity of the BSMS are in Appendix 1 of this report. A summary of Schedule B, including its provisions concerning the audit of the BSMS, are in Appendix 2.

The development of the annual audit and reporting process has been a significant achievement for the BSMS. As set down in the Audit Plan, priority areas for review in this audit included the following:

1) **Registers:** those Schedule B accountabilities required to be reported to MDBA and to the Ministerial Council, particularly the auditors' assessment of whether the BSMS salinity registers are a fair and accurate record of the salinity impacts of actions.
2) **Reviews:** those rolling five–year reviews of register entries that are due to be completed and assessed; however, where the reviews have not been completed within the timeframes set down in Schedule B, some comment should be provided on:
   - the potential for improved estimates, given the available data and the development of analytical tools since the last assessment
   - the relative risks in terms of likelihood and consequence, compared with other salinity assessments that have been, or should be, undertaken by the contracting governments.
3) **2013–14 IAG–Salinity recommendations:** The recommendations made by the IAG–Salinity are based on the draft 2013–14 annual implementation reports provided by each contracting government and MDBA and the auditors' assessment of progress made against the 2012–13 recommendations. The assessment was to take into account that the MDBA and the contracting governments undertook a comprehensive review of salinity management in the Basin in 2013-14, following finalisation of the Basin Plan.
4) **Perspective, looking back and forward:** Given that the current BSMS is drawing to a close in 2015, Auditors were requested to look back over the audit process and forward to consider the requirements of the next BSMS period (2015 – 2030) and make suggestions about suitable audit arrangements for the next 15 years.

The steps taken by the IAG–Salinity in carrying out the 2013–14 audit included:

- assessing the annual reports of the jurisdictions
- reviewing Registers A and B with MDBA staff
- meeting with the representatives of the contracting governments and MDBA; these were essentially half–day meetings with the contact officers, their teams of managers

and specialists and, in some cases, managers of regional catchment management authorities (CMAs)

- discussing technical, scientific and policy issues with specialist staff from the jurisdictions and MDBA, seeking clarification or correction of misunderstandings
- providing the main draft text to jurisdictional contact officers for factual comments.

The format for the 2013-14 audit differed from previous audits in that it was conducted over a 3-day period instead of a 5-day period, and all meetings were held in Canberra.

2. Key Context for the Audit

The General Review of Salinity in the Murray-Darling Basin

In 2013-14, with the Basin Plan in place and the BSMS in its penultimate year, the jurisdictions and the MDBA undertook the General Review of Salinity Management in the MDB. Key drivers for the Review included expected changes in Basin salinity risk arising from water recovery and use under the Basin Plan and knowledge gained from 30 years of experience in managing salinity in the Basin. Outcomes of the General Review would feed into the development of the next stage of salinity management in the basin – the BSMS 2030, to be completed in 2015.

The Auditors were briefed on the outcomes of the General Review (finalised August 2014) and noted that it showed:

- Actions taken under the BSMS have been successful in improving salinity levels in the river with the modelled Morgan target being met for the last four years (at August 2014). This progressive improvement in salinity is directly attributable to mitigation works and measures. The benefits of these works are most profound in periods of low flow and over extended dry periods when river flows, without salt interception, would comprise a greater proportion of highly saline groundwater
- Improvements in knowledge have shown that :
  - Whilst all parts of the Basin contribute some salt to the rivers, the Mallee and parts of the Riverine Plains are the landscape areas which are the major sources of salinity
  - The salinity risk to shared water resources from the Northern Basin, parts of the Riverine Plains and Southern Uplands is relatively small
  - Groundwater levels in the dryland areas seem to be in a dynamic equilibrium reflecting wet-dry sequences. The degree of the long-term upward trend in most catchments that was predicted in the 1990s when the Salinity Drainage Strategy (SDS) and the BSMS were developed is not as dramatic as thought at that time. This means there is low risk to the shared water resources from land management in the dryland areas although there may be effects on local assets
- There are still delayed salinity impacts to come from the current levels of development but, under the current BSMS controls, these are not expected to impact on the Morgan target until at least 2035
- Currently, jurisdictions are collectively in credit on the salinity register with a 165 EC credit. Using existing projections, about 60 EC from this would be required to offset the delayed salinity impacts of current levels of development at 2050 and additional

mitigation action could be required by 2100 (although individual jurisdictions could go into debit before this date). However, there are significant uncertainties about when these salinity levels will be reached:

- The recovery and use of Environmental Water under the Basin Plan will provide significant dilution benefits that would mean the delayed salinity impacts of current levels of development, under the current BSMS controls, would not affect the Morgan target until ~2080. This means, subject to full water recovery, there is a very significant safety buffer in the next phase of the BSMS
- There are potential salinity risks from environmental watering with the mobilization of salt from the floodplain although these are likely to be managed through existing planning and operational controls. The effectiveness of these controls will need to be documented and monitored
- Even with the dilution benefits provided by the environmental water, SISs remain a critical part of the BSMS actions. Modelling shows that turning off the SISs completely results in a failure to meet the Morgan target now. However, it also shows that it may be possible to operate the SISs at a reduced level of utilisation and meet the target over the period of the next phase of the BSMS (ie 2015 – 2030).

The General Review concluded that there remained a firm need to maintain a dedicated joint salinity program post the BSMS to ensure that salinity risk continues to be managed effectively. However, its outcomes also raised the possibility that some salinity management controls in the BSMS could be potentially reduced. This is now being seriously examined by the jurisdictions and the MDBA in the development of the next phase of the BSMS (i.e. BSMS 2030), currently being undertaken and due for completion in 2015.

Approach for 2013-14 Audit

In developing recommendations in the 2013-14 audit, with the BSMS in its penultimate year, the Auditors were asked specifically to look backward and forward and make suggestions about suitable arrangements for the next 15 years to feed into the development of the BSMS 2030.

In developing the Audit report for 2013-14, the Auditors have focused on key issues that will be a priority for consideration in the development of BSMS 2030. These included matters that had been raised in the key findings and recommendations of the General Review and others that became apparent to the Auditors through the process. However, brief summaries of progress in 2013-14 and issues under each of the key elements are provided in Section 5.

3. Overview of 14 years of BSMS Implementation

The BSMS, which is now in its 14th year, has been highly successful, as has been shown in the General Review of Salinity Management in the MDB (2014) and demonstrated by the Morgan target being met for the past five years. This success may be attributed to both the run of climatic events and the implementation of the BSMS. In addition, all three states are in credit on the combined salinity registers.

In the view of the IAG–Salinity, the BSMS has delivered the following benefits:

- A clear focus on providing good water quality at Morgan to provide for downstream assets, which has been successful
- Clear accountability of all jurisdictions for meeting the Morgan target

- A joint program of investment, which:
  - improved the quality of water in the River Murray to meet the target established at Morgan and protected downstream assets from expected damage from salinity
  - enabled irrigation development to continue to occur with no further deterioration in salinity
- enabled the water market to operate, allowing water to move to its highest value use with no further deterioration in salinity
- An agreed process for the allocation of benefits and costs between the joint venture and individual jurisdictions.

Table 2: Summary of measured salinity levels (EC) at Morgan, South Australia

Period	Time interval	Average	Median (EC)	95 percentile (EC)	Peak	% Time more than 800 EC
1 year	July 2013 - June 2014	355	349	590	650	0%
5 years	July 2009 - June 2014	346	327	585	687	0%
10 years	July 2004 - June 2014	390	377	624	768	0%
25 years	July 1989 - June 2014	482	451	780	1087	4%

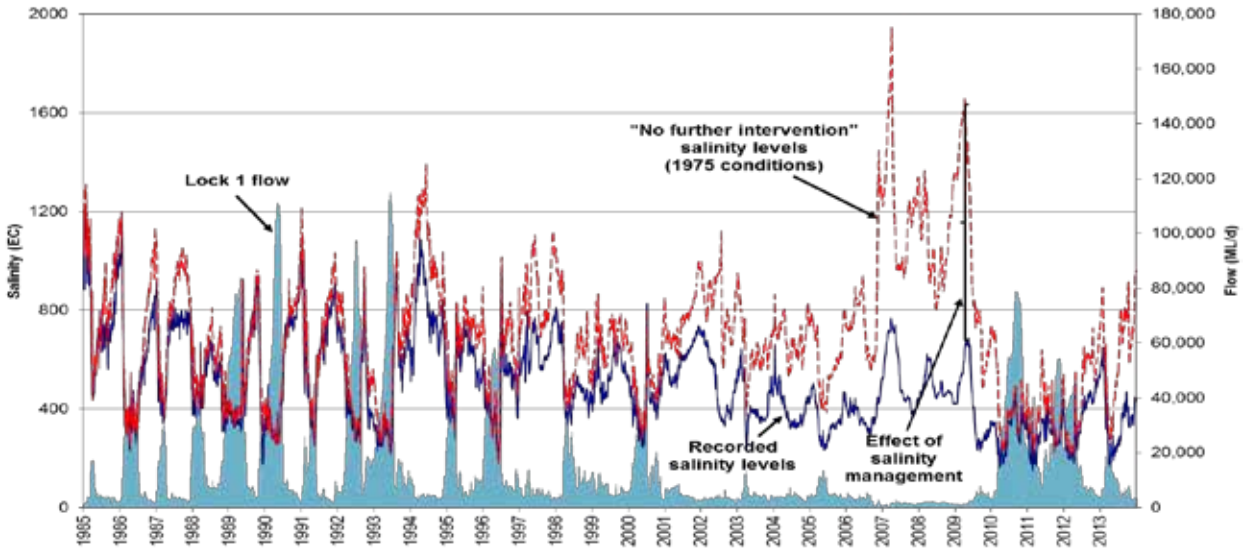

Figure 2: Effect of salinity management in the Murray–Darling Basin at Morgan, South Australia.

Note: Comparison of recorded mean daily salinity levels and modelled salinity levels without salt interception schemes, land and water management actions and additional dilution flows over a 27-year period (July 1985 to June 2014).

The strategy was designed to be adaptive to new knowledge and its governance and review processes ensured that this was undertaken seriously and successfully. The BSMS has provided a focus for the continuation of a collaborative joint effort between jurisdictions, which

was maintained even through the highly charged period of Basin Plan development. The strategy has the confidence of the jurisdictions and their communities because of the transparency of the registers and the annual audit process.

Given the level of investment over the years in salinity management and the ongoing need for salinity management measures even with the reduction in salinity risk due to the Basin Plan, it is important that the success of the BSMS and its predecessor, the SDS, in managing salinity impacts is communicated to and understood by the community.

Recommendation 1: Communication

The IAG-Salinity recommends that, in the final year of the BSMS, in the lead-up to the endorsement by the Ministerial Council of the new BSMS 2030, jurisdictions and the MDBA should:

a) *develop a succinct summary of the success of the BSMS covering both environmental benefits and the economic benefits including the level of regional development which was made possible by the BSMS; and*

b) *hold a forum where the MDBA, jurisdictions and their delivery partners can showcase key achievements of their BSMS implementation programs.*

The IAG-Salinity suggests there may be some merit in associating the forum with the last BSMS Audit in late 2015.

The IAG-Salinity noted that there had been attendance by a number of Victorian CMAs at the 3rd International Salinity Conference held in California, presenting on the long term benefits and successes of salinity management in their regions. In our view, there is real scope to tell the integrated BSMS story to an international audience.

4. Reflections on the BSMS – recommendations for BSMS 2030

The General Review showed that with the environmental water recovered through the Basin Plan and with improved knowledge provided through the BSMS experience, the salinity risk to shared water resources is now reduced and it will be possible to meet the Basin target at Morgan over the next 15 years with some reduction in the level and cost of salinity management.

The IAG-Salinity agrees with these conclusions of the General Review but makes the following recommendation relating to the general approach for BSMS 2030.

Recommendation 2: General Approach to BSMS 2030

The IAG-Salinity recommends that the following key points be considered in the development of BSMS 2030:

a) *The benefits provided by the BSMS should be built upon and not lost.*

b) *The BSMS 2030 should be built around the Basin salinity target at Morgan as a target for the shared water resources with the EoVTs acting as watch points for tributary inflows and incorporated into (WRPs).*

c) *A risk-based, cost-effective and adaptive approach should be undertaken in reviewing BSMS elements including:*

   i). *SIS operations*

ii). *continuous improvement arrangements for modelling, data and knowledge generation*

iii). *audit and reporting.*

d) *The salinity registers are the agreed 'point of truth' providing a clear statement of the agreed impacts of measures and actions taken by jurisdictions that will either mitigate salinity or increase it and its likely future effects. They should be retained in Schedule B as a key element in the BSMS 2030 and include all relevant and material actions.*

e) *In designing reporting, review and auditing arrangements, consideration should be given to ensuring these are cost-effective but frequent enough to require knowledgeable and ongoing capability within jurisdictions and the MDBA, providing the basis for 'institutional memory' given the long term cyclical nature of salinity.*

f) *Uncertainty in our knowledge of the salinity and management processes should be recognised and where cost-effective, knowledge should be improved.*

The IAG-Salinity has considered a number of key issues that have arisen from discussions with jurisdictions, in the jurisdictional reports, in previous IAG-Salinity reports or in the recommendations of the General Review that will require careful consideration in the development of the new BSMS 2030. These are outlined in the following sections.

In addition, the IAG-Salinity also notes that with the development of a new BSMS 2030, the BSMS Operational Protocols (March 2005) will also need review to ensure they accord with the new policy positions. In relation to this, the IAG-Salinity consider there are, at least, four specific issues that will need to be considered and reviewed in the development of new Operating Protocols. These include the benchmark period, the baseline, general use of modelling and defining risk and uncertainty. These are discussed in more detail in the section on Modelling.

Recommendation 3: BSMS 2030 Operational Protocols

The IAG-Salinity recommends that following the development of BSMS 2030, the BSMS Operational Protocols are revised to ensure they give effect to the new policy framework. In this revision, particular attention should be given to the appropriateness of the benchmark period, the baseline, the use of models and defining risk and uncertainty.

Environmental Water

The IAG-Salinity has made recommendations over the past five years on the need to bring environmental water use into the salinity management and accounting framework (MDBA 2010, 2011, 2012, 2013, 2014). We noted that this was also included in a recommendation of the General Review.

The IAG-Salinity were pleased to see that in 2013-14, a start had been made on dealing with the significant policy issues associated with environmental water delivery and use. During 2013-14, provisional register entries have been made on Register A for both:

- the delivery of 570GL Long Term Cap Equivalent (LTCE) of The Living Murray (TLM) and River Murray Increased Flows (RMIF) water; and
- the use of TLM environmental works and measures.

Further work will now be undertaken over the next few years to finalise these entries. There is also agreement between jurisdictions at a high policy level over how the credits and debits associated with TLM water recovery and use will be shared amongst them.

However, the IAG-Salinity considers further work on the policy and accounting issues associated with the recovery and use of environmental water is critical. The General Review has shown that the recovery and use of environmental water under the Basin Plan will provide significant dilution benefits that would delay salinity impacts of current levels of development, under the current BSMS controls, would not affect the Morgan target until ~2080. This means that environmental water recovered under the Basin Plan could provide a significant safety buffer in the next phase of the BSMS which may enable reducing salinity management controls. This is fundamentally a 'game-changer' for BSMS 2030 and, as a result of this coupled with new knowledge, the actions in BSMS 2030 are likely to be very different to the current BSMS.

Because of its importance to the framing of future salinity management in the MDB, the IAG-Salinity considers that a key issue to be resolved in BSMS 2030 is the policy and accounting framework for the recovery and use of environmental water under the Basin Plan. This should also include the use of any works that are agreed as a part of the operation of the adjustment mechanism for the Basin Plan in 2016 and any salinity impacts associated with water recovery. In relation to this, the IAG-Salinity noted that Victoria will undertake an assessment of the GMW Connections program and associated on-farm water recovery programs in conjunction with the next iteration of the Shepparton Irrigation Area Salinity Management Plan.

Recommendation 4 – Environmental Water

The IAG-Salinity recommends:

a) *separate register entries on Register A for all Basin Plan water recovery projects which are likely to have a salinity impact as per the normal processes under the BSMS*

b) *a provisional entry on Register A for the delivery of environmental water recovered to date under the Basin Plan. Further work would then be undertaken over the next five year period to finalise the register entry including updating the final volume as required*

c) *a process for adding separate register entries for any additional significant environmental works that are built as a result of the operation of the adjustment mechanism*

d) *that BSMS 2030 includes the policy framework for the ownership and accounting of salinity debits and credits associated with environmental water recovery, delivery and works operation.*

The IAG- Salinity believes strongly that the policy discipline that has been applied in the past to register entries should be applied to all relevant aspects of environmental water management. We believe therefore that, as a policy principle, the major environmental works and the environmental water delivery volume should be entered as separate provisional entries on the register with the appropriate monitoring and modelling occurring over the next five year period. This should occur unless the works are operated as a coordinated single unit in which case a single register item for the coordinated unit would be sufficient. Once the entries have been confirmed on the register, consideration could be given in the future as to whether any of them could be further combined. The IAG–Salinity considers that the next five years is a period for learning how to operate the environmental watering works, both separately and together and understanding their separate and cumulative impacts. Given this, the IAG-Salinity considers that it would be premature to try to calculate an overall 'net' entry or to contemplate putting it into the baseline at this stage.

In relation to the real–time salinity threats associated with a specific environmental watering action, the IAG-Salinity considers that the current controls that the environmental water holders have in place are likely to be adequate to deal with any real-time salinity spikes. However, this should be monitored and if there appears to be an unexpected longer term salinity impact, it should be entered as an accountable action in the registers in the future.

SIS Management

The SISs are recognised as major contributors to the success of the BSMS. However, while the construction of the SIS schemes has been vital for the success of the BSMS, the General Review has shown that with environmental water recovered under the Basin Plan, it may be possible to operate the SISs at a reduced level of utilisation and meet the Morgan target over the period of the BSMS 2030. The new provisional register entries for TLM delivery flows alone are in the order of ~ 13% of the full SIS benefit. However, this will be fully assessed over the next five years and does not include any debits associated with the water recovery projects.

Governments are looking to optimise their operation, reducing running costs whilst still ensuring that the target at Morgan is met with confidence. The IAG-Salinity noted that in 2013-14, the operation and maintenance of SISs focused on minimising running costs, in particular the energy costs associated with pumping, and the least efficient SIS, the Rufus River Scheme was left in standby mode after high flows in 2011.

The IAG-Salinity notes that any permanent change to the operation of any one SIS will be an accountable action requiring adjustment of the register entry. The erosion of credits over the long-term by legacy of history impacts must be kept in mind during decision-making. In addition, as the IAG-Salinity was made aware of localised saline waterlogging when one SIS was switched off for a short time, individual response times must also be taken into consideration.

The IAG-Salinity recognises the important role that SISs have played and will continue to play in meeting salinity targets but also recognises the costs associated with running these systems. We note that the General Review recommended further investigation of a cost-effective adaptive management approach to the current SISs be undertaken in the development of BSMS 2030.

Recommendation 5 – Salt Interception Schemes

The IAG-Salinity supports the recommendation of the General Review in relation to SIS operation and recommends in the development of BSMS 2030 that consideration is given to taking a risk-based, responsive approach to the management of SISs that aims to reduce the operational costs of the management of SISs whilst still providing confidence in meeting the Morgan target over the long-term. This should take into account:

- the efficiency of schemes and the consequences of closing systems down for periods of time
- the costs of running the scheme versus its effectiveness in reducing salinity impacts
- the costs and timeliness of restarting systems versus the potential impacts over time of not operating the system
- the practicality of running SIS in a responsive way.

EoV Targets and Catchment Management Activities

The BSMS framework for managing salinity across the Basin includes EoVTs for each region. One of the key drivers for this, at the time of its development, was concerns of salt mobilisation occurring on a massive scale due to rising groundwater tables as a result of the major land use changes that had occurred across the Basin. At the time of commencement of the BSMS, it was predicted that ~3.4 million ha of land in the eastern and southern regions of the Basin would be salt-affected within 50 years (i.e. at 2050) and that average river salinities would rise significantly, endangering their use for irrigation and urban water supply within 20-30 years. The intention in the BSMS was that these EoVTs would be the key tool in managing tributary salinity inputs and that they drive land and water planning, action and investment within catchments. However, as we entered the Millennium Drought, it became apparent that the 1999 salinity audit had overstated the extent of the problem and salinity within the catchments was a cyclical phenomenon, responding to climate. As a result, the catchment communities did not really adopt these targets and funding went into SISs and improved irrigation practices, where greater gains could be made. In dryland areas, salinity became incorporated into catchment planning processes as one of a number of threats considered to local assets and action was only taken where it was a high priority. A review of EoVTs by MDBA in 2012 has indicated that the targets were over–engineered, considering the level of risk.

However, the IAG-Salinity in their 2012-13 report noted that jurisdictions are supportive of some aspects of the EoVT concept in salinity management in the Basin, particularly as a type of dash board indicator designed as a signal to governments and communities as to their contributions to impacts of land and water management actions within their valley. This was confirmed in discussions with jurisdictions in 2013-14 and particularly in terms of the requirements for Water Quality and Salinity plans within jurisdictional WRPs required under the Basin Plan.

Recommendation 6 - Redefining EoVTs for BSMS 2030

The IAG-Salinity considers that the EoVTs provide useful reference points for salinity management and understanding and recommends that:

a) *EoVTs should continue into the future but should be revised for BSMS 2030 in light of a better understanding of salinity within valleys and where appropriate should be linked to requirements of local assets, which is consistent with a risk based approach*

b) *The EoVTs should be included in some form, in WRPs*

c) *The protection of local catchment assets should be considered in WRPs. Assets located in high salinity impact sub-catchments should be identified and included as part of the reporting process, noting that additional salinity monitoring sites may need to be included to support this reporting*

d) *The effectiveness of EoVTs should be reviewed on a 5 yearly basis and where required adjusted.*

The Salinity Registers

The IAG-Salinity considers that the Salinity Registers established under Schedule B of the Murray-Darling Agreement have been fundamental to the success of the BSMS as the key accountability mechanism for jurisdictions. They represent the agreed ‘point of truth’, recording all actions which have been and will be taken to reduce or improve salinity in the shared water resources and incorporate their projected effectiveness over the long term.

The IAG-Salinity considers that they must be maintained with rigour in BSMS 2030. However, we note that the General Review considered there was potential for efficiencies in their management and that a risk-based approach to the operation of the registers could be considered. The IAG-Salinity agrees that there are opportunities for improvement and streamlining the processes for register entries and review, particularly given a number of existing entries have now been through at least one review process. We believe it is now possible to take a more risk-based approach to the management of entries on the registers.

Recommendation 7 - Implementing a risk-based approach to Register entries

The IAG-Salinity recommends:

a) *To support a risk based salinity assessment, register entries should include a qualitative uncertainty assessment*

b) *Recognising the uncertainty in register entries, new register entries including their supporting models should be reviewed in 5 years*

c) *Review of established debit and credit register entries (post initial 5 year review) including their supporting models should be reviewed on the following basis:*

   i). *For high risk entries (i.e. entries with high impact (1 EC or more) and high uncertainty) where there is a change in salinity processes or there is new data - retain the 5 year review*

   ii). *For high risk entries (i.e. entries with high impact (1 EC or more) and high uncertainty) where there is no change in salinity processes or no new data - move to a 7 year review*

   iii). *For all other entries (i.e. low risk entries with small impact (<1 EC) or high risk entries with low uncertainty) – require internal reporting and consider the need for reviews as part of a major program review of BSMS 2030*

d) *Consolidation of small stable register entries.*

Modelling

The development and management of salinity registers is dependent upon models, which include catchment models, river models and groundwater models. Different models are used by the various jurisdictions. For catchment modelling, the baseline is defined by analysis of historical data and projections modelled with 2CSalt (Stenson et al. 2005) and MODFLOW (McDonald and Harbaugh, 1989). River modelling is with IQQM (Simons et al. 1996), REALM (Diment 1991; Perera et al. 2005) and MSM–BigMod (Close 1996), although salinity routing is not implemented in all cases. Where groundwater is modelled, it is modelled using MODFLOW and SIMRAT (a rapid assessment analytical model). Surface water and groundwater interactions are not explicitly modelled, although a simple form of interaction is included in MODFLOW models. Modelling with MSM-BigMod underpins all register entries. For all elements of the BSMS, models are run over the ’benchmark period’ i.e. 1 May 1975 to 30 April 2000 which was defined as a "hydrologically representative" period of time designed to "standardise for climate variability".

Jurisdictions have now committed to the implementation of the *National Hydrological Modelling Strategy* where over time, they will move to a new modelling platform – *Source,* which will provide for the first time, a level of consistency amongst jurisdictional surface water models.

In the preceding section on Salinity registers, the IAG-Salinity recommended a more risk-based approach to reviewing existing Register entries including varying the period of required review

depending on the salinity risk, level of uncertainty and whether there had been any change in knowledge or circumstances. These recommended changes to review periods include reviewing the models that support the entries.

However, in addition to streamlining the review period for register entries, the IAG-Salinity considers that there are four other areas related to modelling where potential improvements are worth investigating. These are outlined below.

Benchmark period

The benchmark period is defined in the BSMS Operational Protocols (March 2005). It was intended that the benchmark period be reviewed in 2007 and every seven years thereafter: "The review may include extending the sequence to a longer period such as 30 years".

The benchmark period was originally selected based on availability of salinity data across the basin and choosing a representative climatic period. Since adopting this period, 14 years of additional data has been collected and the Basin has experienced a much drier period than exists in the benchmark period. The recent 14 year period includes the millennium drought, where models experienced conditions that were outside of their calibration bounds. The dry conditions have been beneficial for the main river in terms of salinity and improving our understanding on how salinity operates under dry conditions. On top of all of this is the influence of climate change on the climatic conditions of the Basin and the possibility that more recent history better reflects future climate.

The transition to BSMS 2030 provides a good opportunity to revisit the benchmark period. However there are consequences of changing this period. Models will need to be calibrated to the new period and there will be subsequent changes to the salinity registers.

In recalibrating models, there is an opportunity to improve the conceptualisation of models to better reflect our improved understanding of salinity processes and also to reduce model uncertainty. However, this comes at a cost and would need to be coordinated with model upgrades to support development of new water sharing plans. The IAG-Salinity notes that many of the surface water models are currently being upgraded to Source.

Adopting a new benchmark period will change salinity register entries. Should a decision be made to change the benchmark period, an agreed policy would need to be adopted to manage changes in salinity entries and the subsequent impacts on stakeholders, which may not be equitable.

Recommendation 8 - Benchmark period

The IAG-Salinity recommends the BSMS benchmark period should be reviewed prior to the commencement of BSMS 2030 and a decision made by BOC as whether the benefits of changing the benchmark period outweigh the costs.

The IAG–Salinity note that this issue was discussed in the General Review which recommended a review of the benchmark period in 2019 once key aspects of the Basin Plan had been finalised. However, in reviewing the BSMS benchmark period, the IAG-Salinity believe the following matters should be given particular consideration:

- How an increased benchmark period might reduce model uncertainty in future model calibrations
- How representative the benchmark period is of the longer historic climatic period

- The influence of climate change on the benchmark period and benefits associated with selecting a more recent period
- The sensitivity of results to salinity sequencing within the benchmark period
- Capturing longer term groundwater trends
- Cost-benefit analysis of changing the benchmark period.

We also note that if a new benchmark period is adopted, the following issues will need to be taken into consideration:

- How to fund recalibrating models, noting that most surface water models are currently being upgraded to Source to support development of WRPs as well as salinity management
- How to manage and coordinate the recalibration of models for the new benchmark period to support BSMS 2030
- How to manage changes in salinity register entries associated with the new period.

Calculating Register Entries

During the 2013-14 Audit process, the IAG-Salinity was made aware that, now that the BSMS target of 61EC reduction has been achieved through investment in SISs and there are now a significant number of entries on Register A, some issues can arise in the sequencing of cumulative actions and their subsequent reviews in BigMod, which can potentially impact on register entries. Specifically, the magnitude of the modelled salinity effect (EC at Morgan) for a given accountable action is contingent upon the sequence in which that action is activated in a BIGMOD run. It is accepted that concurrent actions must be included in a BIGMOD run for proper assessment of cumulative impacts. The BSMS Operational Protocols (March 2005) are not clear on this issue, other than prescribing a chronological order for the initial entry of an action on the registers. It is understood that, when a review is made of an action's register entry, the action retains its original position in the queue. However, when a register entry is revised, the BIGMOD simulation would not take into account the cumulative effects of actions that have arisen between the date of first entry on the registers and the date of review, for a given action.

Alternative approaches to sequencing are: (1) chronological sequencing with retention of position in the queue; (2) chronological order for initial entry on the registers, with repositioning at the end of the queue at the time of a review; (3) geographical sequencing in a downstream order. Any variation to the sequencing rule would perturb the register entries but, the magnitude of the effect is unknown to the IAG-Salinity.

The IAG-Salinity note that unless this is dealt with appropriately, there could potentially be substantial effects as large environmental water entries with significant uncertainty are added to the register and reviewed in the future. This would have implications for the stability of register entries and potential confidence in them.

The IAG – Salinity considers that this raises two issues. The first is the immediate need to provide clarity on sequencing for all the actions on the register taken under the BSMS. The IAG-Salinity note that BigMod is currently under review. We consider this provides an excellent opportunity to thoroughly consider and resolve this issue.

Recommendation 9 - BigMod model review

The IAG-Salinity recommend that in the review of BigMod:

a) *The MDBA provide advice on the way that cumulative actions are configured in BigMod. Particular consideration should be given to:*

   i). *The chronological order of entries and alignment with the current BSMS operational protocols (MDBC, 2005)*

   ii). *Detail how reviews in register entries are implemented in the model*

b) *Given that the BSMS Operational Protocols (March 2005) are not clear on how to include reviews of salinity actions in the register, the model review should consider the sensitivity to the following interpretations of how to implement the register review changes:*

   i). *Initial entry updated for the change (Chronological order not changed)*

   ii). *Change included at the time of the review (Chronological order maintained for the change)*

   iii). *Revised salinity included at the time of the review (Chronological order changed to review date)*

c) *Given the likelihood of changes to operational practices of SISs in the future, the model review should provide advice on the adequacy of BigMod to be used for operational decisions, in particular the adequacy of the results from the model to inform the operation of salinity interception schemes*

d) *The BigMod Review should be made transparent to the IAG-Salinity auditors.*

Any review of the BSMS Operational Protocols, as recommended by the IAG-Salinity in Recommendation 3, should ensure that the rules for entry of new actions on the registers and the rules for sequencing of modified actions on the registers during BSMS 2030 are made perfectly clear.

The IAG-Salinity consider the other key issue is a longer term policy matter regarding the baseline for BSMS 2030 and whether this should remain as is for the next fifteen years of the BSMS 2030 or whether the sequence of actions currently on the registers should be locked in as part of the Baseline Conditions, creating a new Baseline defined at the commencement of BSMS 2030. This effectively is what occurred in 2000 as the SDS transitioned to the BSMS. This is a significant policy matter which needs careful consideration.

Recommendation 10 - BSMS Baseline

The IAG Salinity recommends that in the development of BSMS 2030, consideration is given as to whether there is a need to set a new Baseline date at the commencement of BSMS 2030, and potentially at the commencement of any future BSMS stages.

Opportunity over period of BSMS 2030

Over the period of BSMS 2030 (i.e. 2015 to 2030), the IAG-Salinity consider there is an opportunity to update models and review procedures used in the current BSMS.

The IAG-Salinity has been advised by MDBA, Queensland, NSW and Victoria that they are in the process of upgrading surface water models to support Basin planning and, in this process, converting models to the nationally-adopted *Source*. This provides a good opportunity to coordinate model development for both salinity and water resource planning purposes. In the past many of the models were initially developed for water quantity then adjusted for salinity purposes. This has led to different models for salinity management and water resource

planning. There are significant gains in efficiency and process representation in providing a single model for both salinity management and water resource planning.

Since the start of BSMS, there has been a significant improvement in the understanding of the salinity processes within catchments. This improved understanding relates to identifying high salinity impact areas and understanding the processes that drive salinity in these areas. Previously, when the current generation of models were being developed, knowledge limitations constrained salinity model conceptualisations to regression-based relationships between flow and salinity. As understanding has improved, there is a good opportunity to better conceptualise and model the processes that are major drivers of salinity in valleys.

The use of water to support environmental outcomes has significantly changed flow regimes in rivers. From a salinity perspective, this is largely a positive outcome but is difficult to quantify as existing models were not conceptualised to consider this, as it was not significant at the time of model implementation. Recognising the importance of being able to model environmental flows from both a quantity and salinity perspective there is a good opportunity to conceptualise the next generation of models to assess the impacts of environmental flows. To better model and assess the impacts of environmental flows the interactions between rivers and floodplains need to be considered.

Largely groundwater models have been run independently of surface water models. This is driven by a different focus of salinity management with groundwater models largely developed to assess SISs and surface models concerned with tracking river salinity concentrations. To better represent the interaction between river and groundwater there is significant benefit in connecting these models together. Connecting the models will constrain calibration to reconcile the fluxes between the models and thus have a more defensible representation of the surface and groundwater interaction processes.

Given that over the period of BSMS 2030, jurisdictions will be upgrading their models to support their WRPs under the Basin Plan, the IAG-Salinity consider that this provides an opportunity to encourage and facilitate some convergence in model consistency and underlying conceptual basis and to make these as contemporary as possible.

Recommendation 11 - Coordinated development of models to support BSMS 2030

The IAG-Salinity recommends that BSMS 2030 provides some overall direction on the development of the next generation of models for salinity management to facilitate a consistent approach to model development and their underlying conceptual basis.

Specifically, the IAG believe that in developing the next generation of surface water models, particular consideration should be given to:

- *Developing models for both salinity and water resource planning purposes*
- *Jointly calibrating models for flow and salinity*
- *Where significant and applicable, including salinity processes within models rather than regression based relationships between flow and salinity*
- *Including processes to model salinity impacts of environmental flow management*
- *Ensuring consistency between Source groundwater fluxes and those generated by regional MODFLOW models.*

We also believe that:

- *Models should include estimates of uncertainty that can be used to guide uncertainty assessment associated with register entries*
- *In closing the water balance between rivers, floodplains and catchments consideration should be given to linking together river, floodplain and groundwater models. Particular attention should be given to linking models in areas where there is strong interaction between the river and groundwater, such as the lower Murray*
- South Australia should consider consolidation of the multiple MODFLOW models into a single MODFLOW-USG model.

Monitoring

As the IAG-Salinity noted in its 2012-13 report, data is the primary source of knowledge and provides the foundation for understanding processes, leading to the development of conceptual models that describe those processes. Data collected since the benchmark period has helped to refine model conceptualisations and subsequently lessen uncertainty in salinity estimates and projections.

Mandatory monitoring requirements under Schedule B (clauses 25–28) (MDBC 2005) are largely being met by the jurisdictions. However, as noted last year, clause 28 may need to be expanded to consider works and measures for environmental purposes, as the impact of those assets should be considered within the registers described in Schedule B.

All of the jurisdictions are continuing to review their monitoring networks to ensure they efficiently meet their planning and management needs and aren't funding any unnecessary or redundant monitoring stations. The IAG-Salinity is concerned that key gauges may be removed in this process and that this may affect future understanding of catchment processes, particularly in high salinity threat areas and environmental watering sites.

Recommendation 10 - Monitoring

The IAG-Salinity recommends that in the development of BSMS 2030, consideration is given to requiring jurisdictions to identify monitoring stations that are critical in providing data for:

- *BSMS 2030 reporting*
- *Modelling reviews*
- *improving understanding of salinity processes in high priority areas of the Basin*
- *and that these stations are provided with policy status to ensure they are maintained as jurisdictions review their monitoring networks in the future.*

Annual Audit Process and Review

The annual audit and reporting processes outlined in the BSMS and Schedule B have been applied over the past 14 years. In discussions and in their reports, the jurisdictions expressed support for the processes and considered they had been extremely useful over the years, providing a number of benefits over and above their primary purpose of ensuring accountability and transparency. These included:

- *Strengthening community and jurisdictional confidence in the outcomes of the BSMS by independent verification that actions required under the BSMS had been undertaken*

- *Providing a key impetus for continuing the commitment to salinity management and investment over the long-term*
- *Providing the means for continuous improvement in salinity management under the BSMS*
- *Demonstrating to the community, the ongoing government commitment to the long-term salinity management program*
- *Ensuring that jurisdictions maintain capability and an ongoing understanding of how the program is implemented in their jurisdiction*
- *Ensuring a high quality and focus on implementation over a long period of 15 years*
- *Providing an annual requirement for jurisdictions to coordinate and review their salinity management arrangements.*

Whilst a critical component of the accountability framework for salinity management, the importance of the annual audit and reporting process in maintaining the focus and commitment on implementation over the long term cannot be under-estimated.

In addition to understanding the significance of the regular audit, reporting and review processes as a key component of the BSMS implementation structure, the IAG-Salinity also examined how useful the recommendations coming from the Independent Audit Group over the BSMS period had been in achieving continuous improvement. The IAG-Salinity noted that of the 52 recommendations made by the Independent Auditors over the last five years, 33 had been completed and a further 12 had been substantially progressed with another 4 still being worked on. Only three had been considered to be redundant or superseded. (Appendix 4). This analysis shows the value of the process in contributing to and enforcing continuous improvement processes.

Given this, the IAG-Salinity considers that the processes should be retained in BSMS 2030. However, we note that the General Review recommended consideration of a risk-based approach to reviews and audit to improve efficiency. We recognise that the current arrangements are a significant annual administrative burden to both the jurisdictions and the MDBA and that it may be possible to reduce some of the administrative load whilst maintaining the benefits. In addition, we believe there is some benefit in jurisdictions coming together to share their experiences and discuss common issues. This occurred in the early years of the BSMS but has dropped away over the past decade.

Recommendation 13 – Audit and Reporting Processes

The IAG-Salinity recommends that in the development of BSMS 2030, consideration is given to:

a) Maintaining annual reporting on the registers through to the Ministerial Council

b) Moving, in principle, to a biennial Independent Audit process (noting there may be utility in some annual audits through the early transition period)

c) Changing the format of the audit process to provide a shared jurisdiction session for continuous improvement processes

d) Holding a jurisdictional workshop biennially to share information, issues and best practice

e) *Stream-lining reporting between the BSMS 2030 and the Basin Plan.*

The IAG-Salinity notes that the final audit for the BSMS is to be held in 2015. Given that the general review has been undertaken and BSMS 2030 will be close to completion, the IAG-Salinity considers that the final audit could be a 'light touch' process, focusing on closing off the BSMS period and minimising the administrative burden on reporting agencies. This could be established in the Terms of Reference for the 2015 audit and/or agreed by the Ministerial Council. There could be merit in associating with a forum where the MDBA and jurisdictions showcase the achievements of the BSMS.

Recommendation 14 – 2015 BSMS Audit

The IAG-Salinity recommends that:

a) *the Terms of Reference for the final audit in 2015 should ensure that it is aimed only at closing off the BSMS and is not as detailed as previous audits*

b) *consideration be given to linking it to a forum where the MDBA, jurisdictions and their delivery partners can showcase key achievements of their BSMS implementation programs.*

Maintaining Institutional Memory, Capability and Capacity

As previously noted, the IAG-Salinity consider that the BSMS (together with its predecessor, the Salinity and Drainage Strategy) is an exemplar of good natural resource management which has been able to keep operating and adapting over decadal cycles of salinity management. Part of the reason for its success and longevity is its structure and design:

- It has clear targets that are linked with accountable actions that were developed using the highest level of technical understanding at the time and with a strong understanding of the economic and environmental implications
- Many of these actions are implemented through regional land and water management programs with good community support
- It has a clear governance framework that has defined areas of joint and individual jurisdictional accountabilities which are then reflected in the cost-sharing arrangements for both capital works and its ongoing management
- It includes processes for continuous knowledge improvement and has a reporting and audit function that ensures it is being implemented and assessed for its effectiveness.

However, we are now moving into the fourth decade of salinity management in the Basin, in the aftermath of the Millenium Drought and with the prospect of a reduction in salinity risk over the medium term due to the Basin Plan. The challenge for governments is to maintain an adaptive and responsive salinity management regime given that salinity is a long-term cyclical issue, operating on decadal sequences linked to climate. A key part of this challenge is to maintain institutional and community memory and capability through periods when salinity is less of an issue and have triggers and the capacity to smoothly reinstate action when it worsens.

The issue of capacity and capability has been raised by the IAG-Salinity on a number of occasions in the past and it still remains a serious concern. The IAG-Salinity notes that the strong reporting, review and auditing processes have had a secondary benefit in ensuring that capability was maintained over the 15 year BSMS period to meet jurisdictional reporting obligations.

Recommendation 15 – Maintaining Institutional Memory, Capacity and Capability

The IAG-Salinity recommends that in the development of the BSMS 2030, consideration is given to embedding processes and incentives that will ensure that capacity and capability in salinity management is maintained within the MDBA and the jurisdictions.

Coal Seam Gas

Throughout the second half of the BSMS period, coal seam gas has emerged as an issue potentially having salinity impacts within the Basin and has been the subject of previous IAG-Salinity recommendations from 2007-08 to 2012-13. It is an area for which there has been rapid policy development in both NSW and Queensland.

Queensland released its revised Coal Seam Gas Water Management Policy in December 2012. The objective of the policy is to manage Coal Seam Gas (CSG) water as a first priority, for a purpose that is beneficial to one or more of the environment, existing or new users and existing or new water dependent industries. If this is not feasible, then the second priority is to treat and dispose of it in a way that minimises and mitigates impacts on environmental values. To reclassify CSG water as a resource rather than a waste, a Beneficial Use Approval (BUA) is required - either "general" or "specific". A general BUA has been developed based on conservative rules and developed through a rigorous approval process including risk assessment and public notification. Where this is applied, the level of regulatory oversight is then reduced. Although treated CSG water for irrigation is not inherently different from any other source of water, it differs in two important management aspects: (1) it is "invisible" water, in the sense that it is not counted in Basin Plan sustainable diversion limits (SDLs); and (2) it is a transient source of water, with a maximum lifetime of 20-25 years.

The IAG-Salinity was made aware of a large irrigation scheme being developed on the availability of CSG water, in which water recipients have the benefit of certainty of supply but are penalised if they do not take up their full quota of water each year. The IAG-Salinity suggest this be further examined within Queensland. If true, these types of arrangements could encourage inefficient irrigation practices with potential salinity impacts such as those seen in the past in other parts of the Basin.

To ensure that this does not result in either local or regional salinity problems, the IAG–Salinity considers it important to make sure that any approval process examines the likelihood and severity of increased groundwater recharge leading to more saline baseflows in streams within the region. Queensland assured the IAG-Salinity that the development of the General BUA for Irrigation did consider these issues. However, there is substantial evidence in other irrigation studies throughout the world that irrigation is a high risk activity for salinity, especially where the supply of water is guaranteed. On this basis, it is the view of the IAG-Salinity that monitoring of groundwater levels and stream salinities upstream and downstream of these locations should be implemented and as the number of CSG projects increases, it will be important to ensure that the cumulative impacts of increased irrigation activity are accounted for.

The IAG-Salinity is concerned that recent changes in Queensland policy have meant that salinity and other third party impacts of new irrigation development using treated CSG water are now no longer considered in any specific case-by-case approval process. The IAG-Salinity is also concerned that there appears to be no requirement for a Groundwater and Salinity Management Plan for any new irrigation developments, to ensure adequate monitoring of shallow groundwater levels and salinities.

In NSW, the volume of CSG water per well is several orders of magnitude lower than for Queensland wells. This is due to differences in geology, lateral distances to recharge sources, and vertical separation from prospective aquifers. Given the lower level of planned CSG development and the regulatory controls in place, CSG water in NSW is not likely to pose a significant risk to salinity.

In September 2014, the NSW Chief Scientist and Engineer released the final report of the independent review of CSG activities in NSW, following release of the draft report in July 2013. The main finding is that "the technical challenges and risks posed by the CSG industry can in general be managed through:

- careful designation of areas appropriate in geological and land-use terms for CSG extraction
- high standards of engineering and professionalism in CSG companies
- creation of a State Whole-of-Environment Data Repository so that data from CSG industry operations can be interrogated as needed and in the context of the wider environment
- comprehensive monitoring of CSG operations with ongoing automatic scrutiny of the resulting databy a well-trained and certified workforce
- application of new technological developments as they become available."[1]

In short, the risks associated with CSG exploration and production in NSW can be managed within the regulatory framework they have adopted.

Recommendation 16 - CSG Salinity Impacts

The IAG-Salinity recommend that:

a) *in BSMS 2030, potential is provided to ensure that the impacts of CSG development on salinity within the Basin are broadly monitored and if and where necessary, are able to be managed within the new framework for salinity management*

b) *with respect to CSG water in Queensland*

- In the next review of their Beneficial Use policy, Queensland should address a policy gap that omits salinity from consideration in approvals of new irrigation development
- Queensland should adequately monitor potential salinity hazards arising through irrigation associated with CSG which will require a better combined monitoring database
- The potential cumulative impacts of irrigation associated with CSG in Queensland needs to be assessed to determine if it is a threat to the Basin salinity program.

5. Implementation of the BSMS in 2013-14

As outlined in Section 2, in 2013-14, the Auditors focused on key policy issues that will be a priority for consideration in the development of BSMS 2030. These are covered in the preceding Section 4 together with the IAG-Salinity recommendations. However, brief summaries of

[1] http://www.chiefscientist.nsw.gov.au/coal-seam-gas-review/final-report-september-2014

progress in 2013-14 and specific issues under each of the key elements are provided in the following section.

2013-14 Salinity Outcomes

In 2013-14, the modelled salinity target at Morgan over the benchmark period (i.e. below 800EC for 95% of time) was met for the fifth year in a row. The modelled 2013-14 conditions showed that salinity remained under the Morgan target for 98% of time and that to a large extent, this was due to the management interventions undertaken under the BSMS. This 2013-14 achievement represents the best outcome ever reported under the BSMS.

Table 3: Simulated salinity (EC) summary statistics at Morgan, South Australia, for baseline and 2014 conditions over the 1975 to 2000 climatic period

Period	Time interval	Average	Median (EC)	95 percentile (EC)	% time greater than 800 EC	% time less than 800 EC
25 years	Modelled baseline conditions in the period 1975-2000	665	666	1058	28%	72%
25 years	Modelled 2013/14 conditions in the period 1975-2000	472	455	721	2%	98%

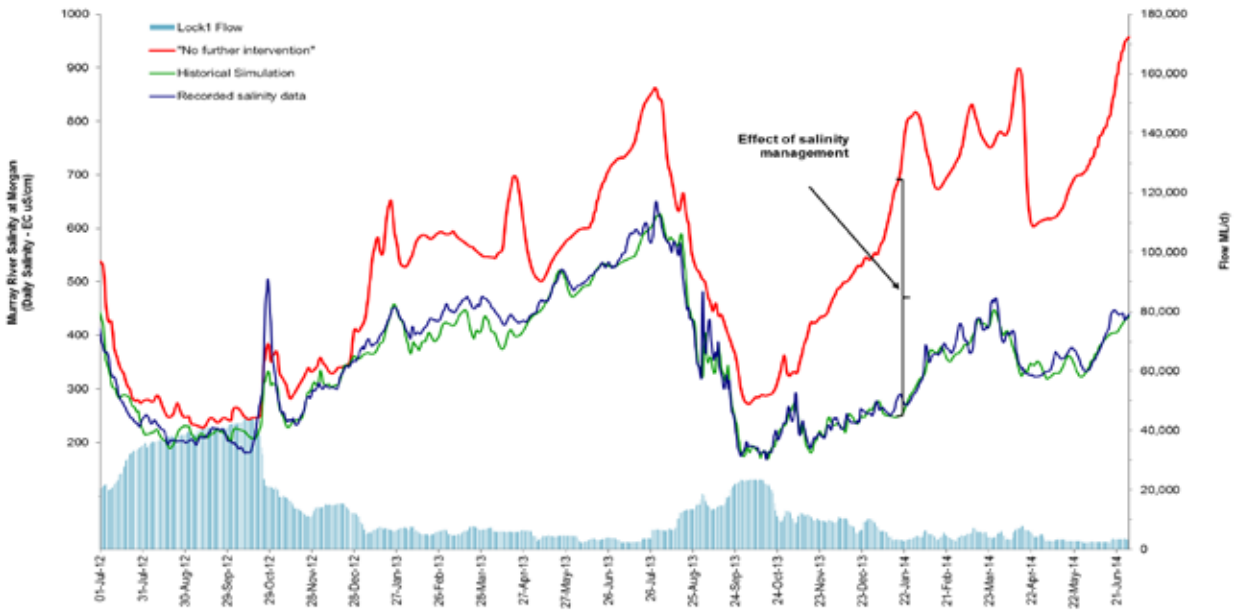

Figure 3: Mean daily observed salinity levels at Morgan from July 2011 to June 2013

Note: Mean daily observed salinity levels at Morgan from July 2011 to June 2013 (blue line) compared to modelled salinity levels for historical actions (green line) and modelled salinity levels without salt interception schemes, improved land and water management actions and additional dilution flows ('no further intervention scenario) (red line), and average daily River Murray flow (teal) between Lock 1 and Lock 2.

Consistent with this, actual river salinities recorded at Morgan in 2013-14 remained low, with an average daily salinity of 355EC and a peak daily salinity of 650EC. However, it was noted that in 2013-14, the Commonwealth Environmental Water Office (CEWO) reported delivery of 558GL

of Commonwealth environmental water to the Lower Murray which would also have contributed to maintaining salinity levels below target.

In 2013-14, the IAG-Salinity noted that for the combined registers, all three states are in credit (7.956, 6.850 and 7.502 $M/year for NSW, Victoria and South Australia respectively).

All jurisdictions reported on salinities against the EoVTs for the sub-catchments. These effectively provide a check on the level of salinity (load and concentration) coming from each catchment. There were no substantial issues arising from these reports.

Element 1: Developing capacity to implement the BSMS

MDBA and the 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.

Knowledge

As the BSMS draws to a close, it is clear that major advances have been achieved in the understanding of salinity risk and salt generation processes over the course of the BSMS. This provides an optimistic foundation for ongoing salinity management during BSMS 2030.

In the past few years, contracting governments in their annual implementation reports have started to show more graphs of stream EC responses with time in association with variable stream flows, with qualitative cause-and-effect analysis. As the responses are not always what would be expected, it is clear that there are still conceptualisation challenges in fully understanding salt generation and mobilisation processes. There appears to have been little, if any, quantitative attempts at replicating observed EC responses. There is now a considerable database of system responses that would benefit from targeted modelling.

In relation to further investigations undertaken during 2013-14, the IAG-Salinity noted that:

- Victoria commissioned a study in the Victorian Mallee region aimed at improving the Annual Use Limits seasonal adjustment process which had been required to be used over the last two years and finalised a report on maximum water application rates
- SA commenced a project through the Goyder Institute of Water Research to model salt dynamics on the River Murray floodplain. This project will assist in describing, prioritising and locating processes most likely to contribute to the mobilisation of floodplain salt
- NSW continued its research project 'Key Sites' to monitor salinity and groundwater at six sites
- Victoria is developing a Salinity Threat Mapping Tool and website that will enable landowners and agencies to access salinity and shallow groundwater related information, and so support the management of salinity within the Shepparton Irrigation Region
- Queensland has a range of ongoing groundwater investigations in the Condamine, Border Rivers and the Lower Balonne catchments

- ACT commenced a number of investigations as part of its $85M Basin Priority Project ‘Improving Long term Water Quality in the ACT and the Murrumbidgee River System’.

In addition to the work of the states, the CEWO also undertook some relevant investigations including producing a technical report ‘*An assessment of the contribution of environmental water provisions to salt and nutrient dynamics in the Lower Murray, November 2011-July 2012’*. This report includes changes in River Murray salinity due to Commonwealth environmental watering. The CEWO also provided details on monitoring programs currently being undertaken to evaluate the outcomes of environmental watering.

Modelling

With the BSMS coming to a close and the prospect of developing their WRPs to meet their Basin Plan obligations, jurisdictions are likely to complete conversions of existing models rather than undertake reviews on current models which will soon be obsolete. These will be progressed in the future within the new context of WRPs and the BSMS 2030. In particular, NSW proposed that updates of two due/overdue register entries be delayed until the Barwon Darling and Border Rivers models are converted to Source by July 2017.

The general transition of IQQM and REALM surface water modelling to a Source platform will force the issue of matching conceptual models with observed responses. The IAG-Salinity holds the view that conversion to Source should be accompanied by joint calibration to flow and salinity, rather than to flow alone followed by a hardwired salinity-flow relationship.

South Australia is the only state that places heavy reliance on MODFLOW groundwater models to estimate salt loads into the Murray River. These models are calibrated to groundwater levels and salt load, but not directly to groundwater salinity. Unlike surface water models, it is not reasonable to insist on joint calibration to flow and salinity. That would require the coupling of flow and solute groundwater models. This was attempted in the Buronga-Mildura-Merbein area some years ago (Merrick et al., 2005), and the conclusion was that salt load estimation by multiplication of groundwater-fluxes by a representative EC is a much simpler and equally accurate method.

During 2013-14, South Australia revised and updated the MODFLOW model of the Pike-Murtho reach. This means that SA now has a complete set of MDBA accredited groundwater models along the full length of the Murray River from the South Australian border to Wellington. The models have been used to quantify salt load impacts due to Mallee clearance, irrigation development, improved irrigation practices and rehabilitation of irrigation infrastructure, groundwater control and salt interception schemes. The need to update and maintain the separate models will continue to be a major burden for the South Australia modellers, especially when the periodic reviews are not synchronised.

The IAG-Salinity is of the view that South Australia should consider consolidation of the multiple MODFLOW models into a single MODFLOW-USG model (Panday et al., 2013). MODFLOW-USG (UnStructured Grid) (based on finite-volume theory) uses a flexible mesh that creates opportunities not possible with standard MODFLOW (based on finite-difference theory). In contrast with structured rectangular finite-difference grids, flexible meshes have a number of advantages. Firstly, they allow finer grid resolution to be focused solely in areas of a model that require it, as opposed to refinement over the entire grid, significantly decreasing cell count and consequently model run times. Secondly, spatial areas not required in the model (e.g. layer pinch-outs) may be omitted rather than deactivating cells or retaining "dummy" layers. Thirdly, flexible meshes allow cell boundaries to follow important geographical or geological features, more accurately modelling the physical system. Finally, the orientation of the flow interfaces

between cells may vary, allowing preferential flow directions to be modelled with higher accuracy.

With this approach, South Australia would be able to incorporate fine detail at SISs, along the river and on the floodplain, with coarser cells in the highlands. This single model could be used to retire reliance on SIMRAT for assessing the salinity impacts of new irrigation and obviate the planned rewrite of SIMRAT in an updated software code.

During 2013-14, the MSM-BIGMOD model was peer reviewed and updated to include simulation of TLM watering actions, the Chowilla salt inflow model and revised groundwater model outputs.

The IAG-Salinity has commented more generally and made recommendations on modelling to be considered in the development of the BSMS 2030 in Section 4.

Communication and Capability

All states have processes for communication with their regional Natural Resource Management (NRM) bodies and with communities through their regional bodies and CMAs. In addition, all states have programs for working with landholders to improve land management practices. The IAG-Salinity note that activities in 2013-14 included:

- SA completed the Lake Albert Scoping Study which investigated potential management actions with the local community to build environmental resilience to better cope with water level variability
- SA also commenced field trials with the community examining options for the large-scale treatment of salt affected soils across floodplains in the lower River Murray
- Victoria held a total of 20 sustainable agriculture workshops in the north east region for dryland farming attended by >400 land managers covering 315 farming entities. The workshops were aimed at improving soil structure, groundcover and improving soil health over more than 2100ha of farm land. Irrigator shed meetings were also held around the state. Waterwatch and community schools education activities were continued
- NSW focused on training particularly providing training to support the establishment of the LLSs (Local Land Services) in June 2013.

All jurisdictions reported concerns about retaining knowledge and capability in times of fiscal constraint, generational change and through a series of institutional restructures.

The IAG-Salinity has commented more generally and made recommendations on Maintaining Institutional Memory, Capacity and Capability to be considered in the development of the BSMS 2030 in Section 4.

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.

All jurisdictions outlined that the identification of values and assets at risk from salinity is undertaken through their natural resource management (NRM) planning processes. While the

process differs among jurisdictions, they all have the same general model. High–value economic, social and environmental assets are identified within catchments, together with key threats. On the basis of that identification, priorities are set for NRM activities and investment. Salinity is therefore treated as one threat among many and balanced against other catchment health targets and economic and social needs. In areas where salinity poses a significant risk to assets, it will be identified and addressed specifically. In areas where it is less of a threat, it will be dealt with as a general water quality issue. This holistic NRM planning process has evolved to meet the requirements of both the Australian Government's and state and territory governments' varying funding programs.

In terms of NRM planning, Victoria had completed their review of Regional Catchment Strategies in 2013. Regional Waterway Strategies are now being finalised. Both these regional planning processes outline regional key assets and values. They are revised every 7 years. This means that the current plans are up-to-date.

South Australia's assets are identified in the South Australian MDB NRM Plan (SA MDB NRM Board 2008), the South Australian Strategic Plan and the Water for Good Strategy of the South Australian Government. No further work was done on these in 2013-14 and South Australia indicated that that the next iteration of some of these would be undertaken as part of their planning for implementation of the Basin Plan.

Queensland reported that the Queensland Murray-Darling Committee, Condamine Alliance and South West NRM are currently updating their NRM plans with plans due for completion in 2015.

In NSW, more significant change has occurred. The eleven Local Land Services (LLS) organisations became operational on 1 January 2014. Since then, work has concentrated on bringing together relevant material from the pre-existing Catchment Action Plans (which had been updated in 2012-13) to cover the new boundaries of the LLSs and form Transitional CAPs for the new organisations. It is then intended that each LLS will develop a Local Strategic Plan covering all of its areas of activity. The IAG-Salinity considers that it is important that the LLSs who work within the Basin are made aware of the BSMS and their obligations under the MDB Agreement and ensure that salinity is adequately considered in the development of their new work programs.

In terms of salinity hazard mapping and management, NSW continued to implement their hydrogeological landscapes (HGL) process although for the most part, this was outside the Basin in 2013-14. Queensland undertook a number of groundwater investigations in the Condamine, Border rivers catchment and Lower Balonne region to identify and refine understanding of salinity risk. South Australia in partnership with the Australian government announced a $60M project to help prevent excessive salinity levels in the Coorong South Lagoon and continued to investigate long term and short term salinity risks associated with the operation of the Chowilla environmental regulator.

Element 3: Setting salinity targets

This element requires the adoption of EoVTs 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 EoVTs and determine within–valley targets and monitoring arrangements under salinity and catchment management plans.

All jurisdictions participated fully in 2012-13 in the review of EoVTs as required under Schedule B (*Review of end–of–valley targets: Phase 1* and *Review of end–of–valley targets Phase 2*). In

2013-14, they all participated in the General Review of Salinity Management in the MDB which again considered the question of the role of EoVTs. Given this, no new work was undertaken by jurisdictions in setting salinity targets. All monitored and reported in their End-of-Valley reports.

The IAG-Salinity has commented more generally and made recommendations on EoV Targets to be considered in the development of the BSMS 2030 in Section 4.

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 on the options with affected groups, industries and people through best practice planning processes.

As outlined above, all jurisdictions manage salinity in their NRM planning processes as one threat among many and balanced against other catchment health targets and economic and social needs. They manage any trade-offs and set priorities for investment and action in these processes. All jurisdictions outlined the tools they use to assist in making these decisions. These include INFER, multi-criteria analysis and the Policy Choice framework in Victoria and Multi-Criteria Analysis Shell for Spatial decision Support in NSW.

In addition, a number of specific projects were undertaken which had improved trade-off within regions. These included

- The NSW Office of Water continued to operate a 'Green Offset' scheme with the Norske Skog paper mill in Billabong Creek. The scheme allows the mill to discharge up to 2,500 EC water into the River Murray and is offset by an SIS scheme in Billabong Creek. This provides an estimated 0.1 EC benefit at Morgan to counter the effect of the paper mill discharges
- South Australia implemented its South Australian River Murray Annual Operating Plan which aims to integrate environmental water delivery with traditional consumptive water delivery and to mitigate any potential third–party impacts. Salinity was maintained below the identified targets in the Operating Plan for all of 2013-14 and salinity levels in Lake Albert decreased by ~900EC
- In Victoria, the Mallee CMA continued to guide new irrigation developments away from areas of high salinity impact through the implementation of the Mallee Regional Irrigation Land and Water Management Plan. Recent work has shown that this continues to be highly effective in encouraging development in the two lowest impact zones, with a substantial portion of the AULs being issued in these areas. Mallee CMA was provided with 3.29 EC of salinity credit to balance this irrigation development. The salinity impact from irrigation development is considered likely to be an over-estimate but will remain until further work is undertaken to show this definitively. In addition, the Mallee CMA continue to use a salinity impact assessment tool to predict the reduction of salt pushed into the river resulting from on-farm water use efficiency activities, providing a process to prioritise applicants for incentives.

Assisting with the achievement of salinity targets in South Australia was the delivery of Commonwealth environmental water. The CEWO advised that 578,228 ML of Commonwealth environmental water was delivered to the Coorong, Lower Lakes and Murray Mouth through the coordination of watering actions across the southern connected basin. This includes both direct transfers to South Australia and 374,167 ML of return flows from upstream watering actions.

Figure 4 shows the contribution of environmental water in the actual flow regime provided at the South Australian border. Whilst all environmental water deliveries have clear environmental targets, additional benefits such as reducing salinity are taken into account in decision-making on sites to be watered.

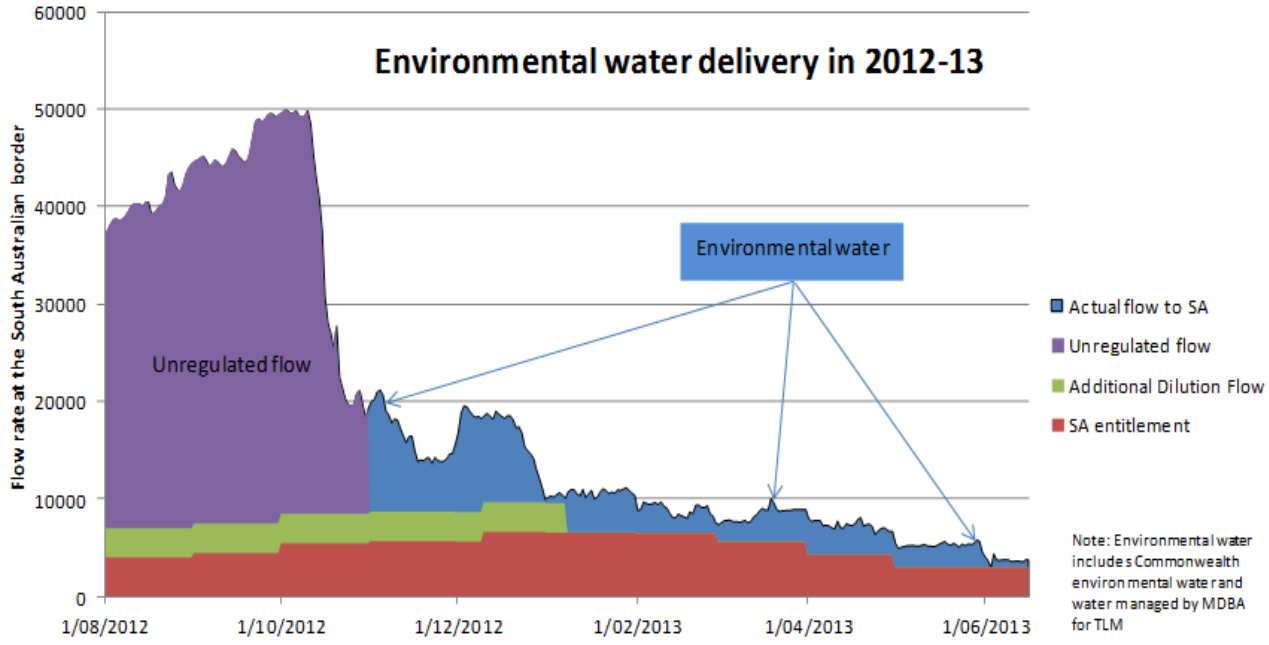

Figure 4: The contribution of environmental water in the actual flow in the River Murray at the South Australian border in 2012-13

In addition, the CEWO advised on the measures taken to avoid or mitigate any salinity spikes arising as a result of environmental watering. The IAG-Salinity consider that these measures are precautionary in nature and should be effective in managing potential salinity spikes. The IAG-Salinity noted that to date, no salinity spikes have occurred as a direct result of environmental watering.

Element 5: Implementing salinity and catchment management plans

This strategy acknowledges gains made by existing plans but requires that actions in existing and new plans, or the plans themselves, will need 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 LWMPs in irrigation regions. The partner governments will enhance support for development and implementation of Integrated Catchment Management (ICM) Policy–compliant salinity and catchment management plans in dryland regions.

All partner governments emphasised that salinity and catchment management is now undertaken as part of their broader regional NRM planning framework aimed at identifying the most effective suite of actions required to achieve agreed environmental, social and economic outcomes for their catchments. Therefore, specific salinity actions are only identified in areas where there is a high salinity risk potentially affecting high–value community assets.

It was also noted that on–ground action reflected changing government funding priorities. Since the commencement of the BSMS, the drought had mitigated much of the projected salinity problem. Consequently, governments (particularly the Australian Government) redirected their funding away from specific salinity programs, particularly in the dryland areas,

towards more contemporary priorities and in recent years have reduced their total NRM budgets as part of general budget tightening.

Nevertheless, all jurisdictions reported on the implementation of their salinity and catchment management plans. However, a common theme across all jurisdictions was a reduction in both State and Commonwealth funding for these types of activities.

Catchment plans

In Queensland during 2013–14, the three NRM bodies, Condamine Alliance, South West NRM and Queensland Murray Darling Committee, continued work with landholders on issues such as soil erosion and soil health with only the Queensland Murray Darling Committee undertaking specific salinity programs. In addition, work continued on the Great Artesian Basin Sustainability Initiative with a total over its life to date of 164 bores rehabilitated and 8755km of bore drains replaced with pipelines resulting in an estimated flow saving of 71GL per annum and a consequent reduction in salt mobilisation. Although this program ceased in June 2014, an ongoing allocation of funds was announced by the Federal Government in October 2014.

In NSW, action was funded through Caring for our Country and Catchment Action NSW. NSW outlined significant institutional changes that took effect on 1 January 2014 with the LLSs now the focus for NRM delivery, including salinity management, in NSW. During 2013-14, the new LLs are now implementing existing funding agreements.

In Victoria, all CMAs continued to carry out salinity actions funded through Caring for our Country and Victorian Government programs as part of their planned implementation of their RCSs and LWMPs in irrigation areas. In the dryland areas, 37,092ha of native vegetation was protected (a significant proportion of which comprised works in the Mallee for invasive species management), an additional 2,019ha of trees were established and improved cropping or grazing practices were implemented on 78,723 ha. In addition, all CMAs undertook a review of their Regional Waterway Strategies.

In South Australia, work is focused more in the irrigation areas that are the priority under the South Australian MDB NRM Plan.

Irrigation

Work in the irrigation areas progressed in Victoria and South Australia.

In Victoria, work continued under the Victorian Mallee Irrigation Region LWMP, which was endorsed during 2012 and the Loddon Campaspe Irrigation Region LWMP which was endorsed in October 2011. In the Goulburn-Broken, work commenced on the review of the Shepparton Irrigation Region Catchment Implementation Strategy. The IAG-Salinity was pleased to note that the next step had been taken in the Shepparton Irrigation Region Salt and Water Balance Project. This resulted in the development of a prototype for the Salinity Risk Management System (SRMS) which will be implemented as an interactive online portal for use by farmers and Government. It is aimed at informing and improving agency and landholder decision making about the threat of salinity across the Shepparton Irrigation Area (SIR). The website will provide the public with access to consistent, reliable and validated decision-making data and mapping tools to assist in understanding, identifying and managing their salinity threat. The SRMS will assist the management of groundwater in the shallow aquifer over a range of climatic conditions by enabling the level of public and private pumping to be better matched to the fluctuating hydraulic loading of the shallow aquifer. Coupled with this, was the implementation of a ‘low intensity’ management approach for the SIR shallow groundwater with the statutory

groundwater management plan replaced by a simpler, more adaptable and less costly set of local management rules.

The IAG–Salinity notes that during 2013–14, a seasonal adjustment was made to the annual use limits for irrigation across Victoria for the second year in a row, reflecting increased water demand due to unusual climate conditions. The process to implement a seasonal adjustment in the Mallee is outlined in the Mallee Irrigation Region LWMP. It is based on a review of climatic conditions and water usage at key times during the irrigation season, together with consultations with water customers. Given this, a study was undertaken in the Victorian Mallee region aimed at improving the Annual Use Limits seasonal adjustment process. The Mallee CMA also finalised a report on maximum water application rates, which included development of a method for determining maximum application rates for an extensive list of crops.

In South Australia, the River Murray Water Allocation Plan is being amended to include the South Australia Salinity Zoning Policy and revised water use efficiency principles. In addition, the South Australian Murray-Darling Basin Regional NRM Plan was revised and endorsed by government.

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

During 2013-14, significant work was undertaken in redesigning farming systems, mostly funded through the Australian Government's Water for the Future On–Farm Program, which provides funds for irrigation improvements in exchange for water entitlement savings to be transferred to the Commonwealth. This has continued to be strongly supported in Victoria, NSW, South Australia and Queensland. Each landholder entering the program must first develop a property management plan and show how the savings will be made. The adoption of new irrigation systems is enabling irrigators to more closely match real–time crop water requirements. In turn, this is reducing drainage below the root zone and minimising the discharge of saline water to the rivers. Together with the water buyback scheme, this is changing the footprint of irrigation along the river.

In 2013-14:

- In South Australia, the SA MDB NRM Board was successful in attracting in principle $30M to implement on-farm water savings potentially saving 17GL from over 150 farms of which ~ 11.5 GL will be returned to the environment
- In Victoria, whole farm plans were undertaken covering 17 829ha of irrigation farms and 67 103 ha of dryland farms. In addition, soil surveys covering 3650 ha were undertaken. Landforming was undertaken on 9120 ha of farms. Reuse systems were implemented servicing 6632 ha of irrigation farms and irrigation upgrades were implemented servicing 12 186 ha of irrigation farms
- Queensland has 44 projects involving $54.79M. To date, there has been water savings of 22.4GL with 11.7GL transferred to the CEWH

- In NSW the NSW Sustaining the Basin Irrigated Farm Modernisation program (STBIFM) invests funds provided by the Australian Government's "Sustainable Rural Water Use and Infrastructure" program in water use efficiency planning, industry capacity building and on-farm irrigation infrastructure modernisation within the NSW northern Murray Darling Basin. To date 111 Irrigated Farm Water Use Efficiency Assessments have been funded through the program. There have been 70 irrigation modernisation projects funded through two Rounds of STBIFM at a total cost of $37.22M, of which 40 are currently completed. These projects have identified water savings of 14.15GL, of which 9.5 GL have been transferred to the CEWH.

The IAG-Salinity noted that there have been significant changes in farming practice in dryland areas over the life of the BSMS, but there has not been a way of measuring an impact at Morgan. NSW indicates that the Murrumbidgee catchment is the only catchment that may potentially provide a measurable credit from dryland and irrigation farming system changes over the strategy. NSW is proposing to undertake the investigations to support evidence for measures under the Murrumbidgee WRP towards meeting salinity objectives and targets.

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.

This element recognises the importance of native vegetation in the management of salinity. The IAG-Salinity note that recently there have been changes to native vegetation legislation in Queensland and NSW. Changes to Queensland's vegetation management framework in December 2013 include:

- removing provision of high value regrowth from freehold and indigenous land
- creating three new clearing categories for high value agricultural land
- including some new exemptions.

NSW has introduced the new Native Vegetation Regulation 2013, which allows expanded exemptions to clear native vegetation without a property vegetation plan.

Reforestation can provide long-term benefits in terms of stabilising groundwater movement and thus discharge of saline groundwater to rivers. Relaxation of vegetation management rules has the potential to remove some of these benefits and thus increase salinity within rivers. This change in policy highlights the need to monitor the impacts of land clearing on salinity within the basin.

The IAG-Salinity note that there have been approximately 2,000 ha of state funded revegetation in Victorian regions.

Element 8: Constructing salt interception works

MDBA 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 provide protection beyond the benefits from simply meeting EoVTs, based upon agreed cost sharing and benefit allocation principles. The benefits will continue to include salt disposal entitlements to offset the impacts of future actions that aggravate salinity.

As the BSMS draws to a close, it is pleasing to note that the targeted 61 EC reduction at Morgan has been reached. The SISs are recognised as major contributors to the success of the BSMS. They operate along the length of the Murray River in three states, with one new scheme on the Darling River. In all, there are 324 production bores and 178 observation bores.

During 2013-14, the Murtho Scheme in South Australia was completed, the upper Darling Scheme in NSW was commissioned, and the first phase of the Mildura-Merbein refurbishment was finalised.

The 2013–14 year saw an increase in salt tonnage production from the SIS schemes of about 23% to about 398,000 tonnes. Five of the schemes achieved target salt load diversions at least 95% of the time during 2013–14. The Woolpunda, Waikerie and Loxton schemes operated at 94%, 88% and 86% respectively. A perverse outcome of environmental watering was that the Bookpurnong scheme, with 69% performance, was unable to meet targets due to high water tables caused by the watering. The Rufus River scheme was put into standby mode during the year due to reduced budget.

Following the General Review and as part of the development of the new BSMS 2030, jurisdictions and the MDBA are now looking at managing the SISs in a more cost-effective, responsive way whilst still ensuring the target at Morgan is met. The IAG-Salinity notes that any permanent change to the operation of any one SIS will be an accountable action requiring adjustment of the register entry. The erosion of credits over the long-term by legacy of history impacts must be kept in mind during decision-making. In addition, as the IAG-Salinity was made aware of localised saline waterlogging when one SIS was switched off for a short time, individual response times must also be taken into consideration.

The IAG-Salinity has commented more generally and made recommendations on the management of the Salt Interception Schemes to be considered in the development of the BSMS 2030 in Section 4.

Element 9: Basin–wide accountability

The partner governments will demonstrate accountability by reporting to MDBA and the Ministerial 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 Ministerial Council will receive audits every five years for each valley and Authority 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 contracting governments provide draft annual reports that contain necessary information for the IAG–Salinity to make an assessment. The Australian Government provides a summary of the work it has undertaken in progressing the recommendations from the previous audit, particularly the assessment of the effects of the environmental watering of wetlands on the salinity of the River Murray through contracts by the Department of the Environment.

Valley reports

Contracting governments must prepare an annual report for each valley for which an EoVT has been adopted, as outlined in Schedule B (clauses 29 and 30). A protocol has been established for information to be presented in the form of summary report cards. The reports are to set out

how the contracting governments are implementing actions to meet the targets and impacts on the targets. As the EoVTs pertain to the benchmark period, direct performance measures cannot be reported annually. Instead, statistics for real-time salinity and flow measurements are reported. As a result, annual reporting is more reflective of climatic conditions than a performance measure of effective actions as intended.

Report cards, in a standard format, were prepared by Victoria, South Australia and Queensland. As not all jurisdictions describe the climatic conditions over the reporting year, the report cards have little interpretive value when not considered in the context of climate. NSW does not use the report card format and does not report actual salinities / salt loads against the EoVTs, but prefers to report end-of-valley performance in the context of state-wide CAP targets. However, with the transition of CMAs to LLSs, individual reporting requirements have lapsed and the LLS organisation as a whole is to report globally each December. NSW again noted that the existing EoVTs, established in 1999, are no longer current in relation to estimates updated in 2009 to account for improved understanding of upland salinity behaviour.

Queensland experienced very dry conditions over the reporting year. As a result, stream flows and salt loads were low (less than 30% of targets), but EC was usually in excess of target levels. Victoria, on the other hand, reported salt loads lower than targets and EC below target values in general. South Australia reported EC values below target levels at Morgan and three downstream monitoring sites.

The presentations by jurisdictions to IAG-Salinity included many informative graphs of stream EC responses with time in association with variable stream flows. The interpretation of cause-and-effect, however, remains qualitative. In most cases there was an inverse relationship between flow and salinity, but not in all cases. As the responses are not always what would be expected, it is clear that there are still conceptualisation challenges in fully understanding salt generation and mobilisation processes.

Each jurisdiction is still attempting to maintain the program from its own resources, but budget pressures are being felt by most jurisdictions. Some of the impacts of the budget changes, such as reducing generalist staff who had maintained monitoring sites in more remote areas, require alternative ways of servicing monitoring installations.

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 MDBA have high confidence in it and are strongly committed to it. 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 entries by the Basin Salinity Management Advisory Panel (BSMAP), 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 MDBA, and the scrutiny given annually to each entry by the IAG–Salinity. The contracting governments 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 *Water Act 2007* proposes that the water allocation and quality issues are set for each area in the Basin by WRPs. Since the Act does not have power over the land management areas, the implementation of the Basin Plan will require a similar commitment and collaborative process as exists for the BSMS between MDBA and the contracting governments.

The IAG–Salinity is of the opinion that the accountability framework continues to maintain a Basin–wide focus on salinity.

Progress in improving salinity registers

The recovery of significant volumes of entitlement water for environmental activities is changing the use of water in the Basin. This activity has been included for the first time in 2013-14 on Register A in two provisional entries for the TLM Works and Measures, following an IAG–Salinity recommendation. The provisional entries comprise a credit of 24.4 EC for 570 GL water delivery and a debit of 4.6 EC for the use of water at sites with environmental works and measures. No attribution to the contracting governments has been made in the first instance. The IAG-Salinity notes that there is policy on how the TLM credits and debits will be shared but consider that for the water recovery under the Basin Plan, the governments will have to resolve this issue in due course.

Status of Registers A and B

MDBA, in conjunction with the jurisdictions, prepared a revised version of Registers A and B dated 9 September 2014 (see Appendix 3).

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

In 2013–14, no changes were made to the number of accountable actions on Register B, but seven new items were added to Register A:

- Item 16: Upper Darling SIS (-4.6 EC, interpolation to current year EC at Morgan)
- Item 17: Murtho SIS (-17.2 EC, interpolation to current year EC at Morgan)
- Item 18: TLM-RMIF 570 GL (-24.4 EC, interpolation to current year EC at Morgan)
- Item 19: TLM Works and Measures (+4.6 EC, interpolation to current year EC at Morgan)
- Item 30: RISI Stage 2 [NSW] (-3.8 EC, interpolation to current year EC at Morgan)
- Item 47: RISI Stage 2 [Vic] (-4.7 EC, interpolation to current year EC at Morgan)
- Item 58: SA Component of Murtho SIS (-0.4 EC, interpolation to current year EC at Morgan).

Only one five–year rolling review was completed in 2013–14, for Nyah to SA Border SMP - Irrigation Development, resulting in no material adjustment to the salinity register entry but a reduction in confidence rating from "High" to "Medium" in recognition of the entry being at the upper bound of salinity impact. One update (by 0.1 EC) occurred for SA Irrigation Development Based on Site Use Approvals.

A substantial number of reviews that are overdue are in process or are to be completed in 2014-2015. Two of the overdue NSW reviews are scheduled to coincide with completion of Source models by 2017, and another is awaiting completion of the SIMRAT review and model update. Queensland has submitted its two Register B reviews.

Net debit/credit status of the jurisdictions

As stated in Schedule B, 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.

The credits are defined in Schedule B as salinity benefits in $m/year values. The salinity registers dated 9 September 2014, as provided to the IAG–Salinity, show that NSW, Victoria and South Australia are in net credit on Register A. For the three jurisdictions, respectively, the increases have been 30%, 39% and 20% as a consequence of new entries on the register. Note that these increases do not take into account the net benefit of the TLM provisional entries.

On Register B, all three jurisdictions are now in credit. The salinity credits are 0.902, 0.100 and 2.422 $m/year for NSW, Victoria and South Australia, respectively. All credits have increased by more than 100%.

For the combined registers, all three states are in credit (7.956, 6.850 and 7.502 $m/year for NSW, Victoria and South Australia, respectively). The combined net credit in terms of salinity effect is 215 EC — an increase of 30% over the previous year.

This is the fifth year in a row that the modelled EC at Morgan has been under the Basin salinity target of 800 EC for 95% of the time (Table 3). However, the three previous IAG–Salinity reports cautioned that the target would be breached now and into the future if contracting governments realised their salinity credits in full. Maintaining the registers in credit balance, as required under Schedule B, is not necessarily consistent with future compliance with the Morgan target. A substantial positive credit (in the order of 100 EC) would be required for long–term compliance with the target. The advent of environmental watering as an accountable action on Register A will ease the situation.

Table 4: Modelled projections of Morgan EC for past and current registers

Year	Status	Registers A & B [$m/year]	Mean Morgan EC [mS/cm]	95-percentile Morgan EC [mS/cm]
1988	Benchmark		665	1058
2011	2011 Registers	24.732	508	786
2012	2012 Registers	24.322	501	781
2013	2013 Registers	25.305	491	781
2014	2014 Registers	28.488	472	721

Consolidation of Register A

As Register A currently has 60 entries, and the number of entries will increase as environmental watering actions are brought to the register, the appearance of the register is becoming unwieldy. The IAG-Salinity is of the view that some consolidation of entries could be made on Register A where those entries are small in magnitude. To this end, the IAG-Salinity has ranked the Register A credits and debits in Figure 5 (credits) and Figure 6 (debits). Figures 5 and 6 are colour-coded to show those accountable actions that give the least benefit (Figure 5) or greatest disbenefit (Figure 6) in red at the 20th percentile, and those that give the greatest benefit (Figure 5) or least disbenefit (Figure 6) in green at the 80th percentile.

Consideration could be given to consolidating individual entries that are no more than 1 EC. When this is done, 19 of the entries would condense to 7, saving 12 rows in the Register A table. The suggested consolidation of entries is summarised in Table 5 for credits and in Table 6 for debits.

Table 5: Suggested consolidation of Register A credit entries

Year	NSW	Victoria	SA	BSMS / SDS
2014 Register Number	22, 24, 27	40, 44, 45	53, 54, 58	10, 13
Combined Current Salinity Effect (EC)	-0.6	-1.3	-1.9	-0.7
Accountable Actions	Boggabilla Weir. Tandou pumps from Lower Darling. Permanent Trade Accounting Adjustment - NSW to SA.	Permanent Trade Accounting Adjustment - Victoria to SA. Church's Cut decommissioning. Mallee Drainage bore decommissioning.	SA Component of Loxton SIS. SA component of Waikerie Lock 2 SIS. SA Component of Murtho SIS	Changed MDBC River Operations after 2002. Improved Buronga SIS.

Table 6: Suggested consolidation of Register A debit entries

Year	NSW	Victoria	SA	BSMS / SDS
2014 Register Number	23, 28	33, 34, 35, 37, 38, 41	50, 51	7
Combined Current Salinity Effect (EC)	1.5	1.7	0.8	0.9
Accountable Actions	Pindari Dam Enlargement. NSW Sunraysia Irrigation Development 1997 to 2006.	Tragowel Plains Drains at 2002 level. Shepparton Salinity Management Plan. Nangiloc-Colignan SMP. Kerang Lakes/Swan Hill SMP. Campaspe West SMP. Woorinen Irrigation District Excision.	SA Irrigation Development Due to Water Trade. SA Irrigation Development Based on Site Use Approvals.	Changed Operation of Menindee and Lower Darling

Of course, each action would retain its identity and sequence in BIGMOD simulations. Only the appearance of the action in the register would change. An additional recommendation for consolidated entries is that the requirement for regular reviews be removed and the need for any further reviews considered as part of the mid-term review of BSMS 2030.

The IAG-Salinity has commented more generally and made recommendations on issues affecting the Salinity Registers to be considered in the development of the BSMS 2030 in Section 4.

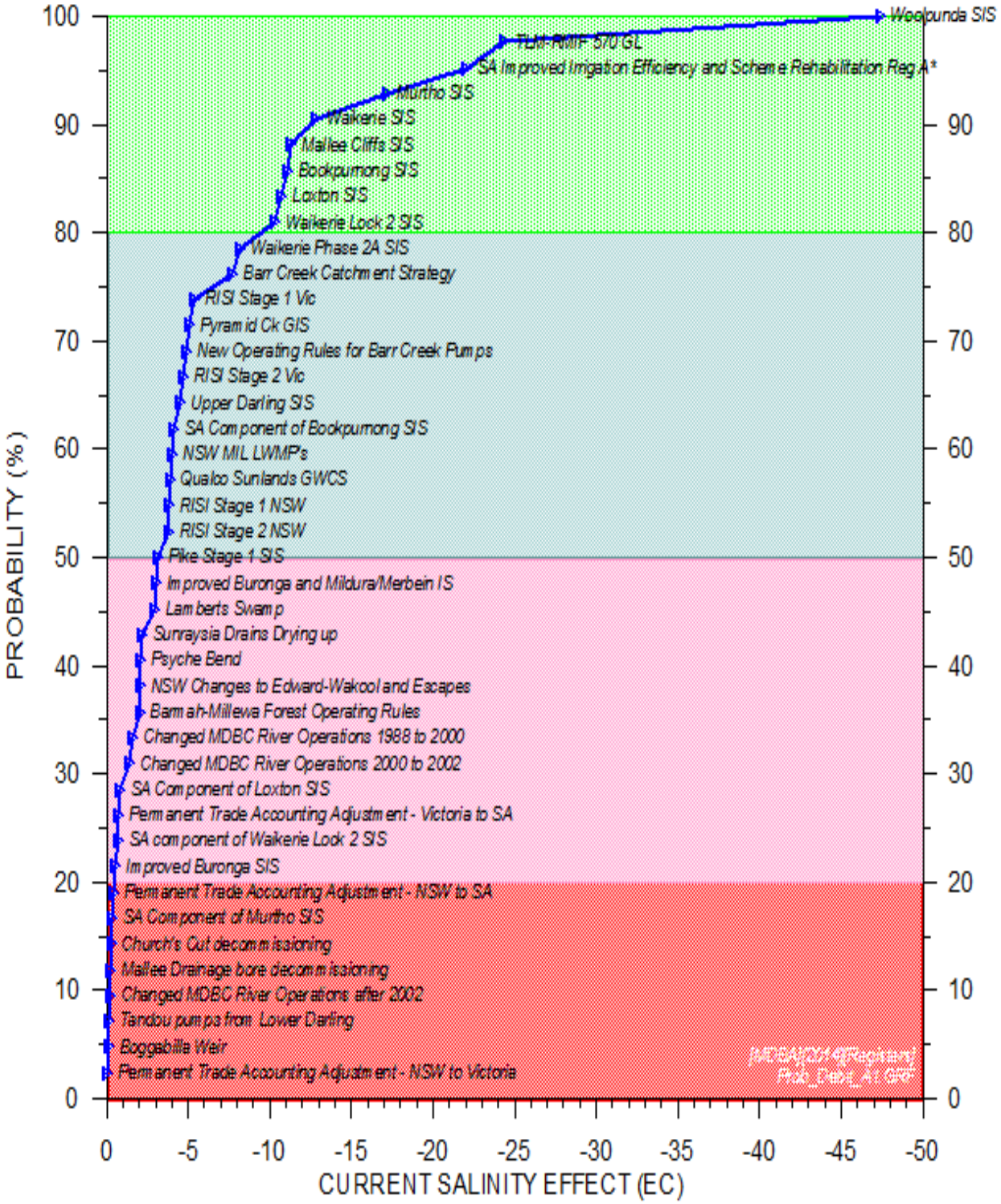

Figure 5: Ranked Register A Credit Entries

Figure 6: Ranked Register A Debit Entries

6. Response to Recommendations from 2012-13 Audit not considered elsewhere

All jurisdictions and the MDBA outlined their responses to the recommendations of the 2012-13 audit recommendations. The IAG-Salinity noted that the MDBA and jurisdictions were generally supportive of the intent and direction of the recommendations and that many of the recommendations had been considered as part of the General Review of Salinity Management in the MDB (August 2014). All had been progressed to some extent and all were being further considered in the development of the BSMS 2030.

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Appendix 1: Independent Audit Group for Salinity terms of reference

Preamble

The Basin Salinity Management Strategy (BSMS) agreed by the Murray–Darling Basin Ministerial Council in 2001 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 mandatory elements of BSMS are incorporated into Schedule B to the Murray–Darling Basin Agreement (Schedule 1 to the *Water Act* 2007).

Auditing is an integral part of the BSMS in that it ensures a fair and accurate annual assessment of the contracting governments' and Authority's performances against Schedule B. The Schedule B (clause 34) specifies that the Authority must appoint independent auditors to carry out an annual audit. These auditors together will henceforth be called the Independent Audit Group for Salinity or IAG–Salinity.

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) *Provision of information* — the IAG–Salinity shall base the audit on the information provided by the Contracting Governments and the Authority
3) *Quality assurance* — the quality assurance in relation of the information provided is the responsibility of the information provider
4) *Timeliness* — the timely provision of information by the contracting governments and the Authority is required if the audit is to progress satisfactorily
5) *Justification* — the findings shall include a supporting rationale
6) *Prioritisation* — the recommendations shall include a priority classification
7) *Continuous improvement* — the IAG–-Salinity shall encourage improvement through independent assessment of compliance against Schedule B obligations whilst acknowledging that priority activities should be targeted towards areas of highest salinity risk
8) *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 contracting governments and the Authority.

Roles and responsibilities of the IAG–Salinity

1) The IAG–Salinity will annually audit the performance of each state contracting government and the Authority as described in sub clauses 34(3)–(4) **Schedule B, *Water Act 2007.***
2) IAG–Salinity will report to the Authority on the audit undertaken under paragraph 1 above in accordance with sub clauses 34(5)–(6) of **Schedule B, *Water Act 2007.***

3) If required or when requested, the IAG–Salinity will provide separate reports to advise the Authority on any key issue arising from the audit beyond the explicit audit requirements of the Schedule B.

Appointment of the IAG–Salinity

1) The Authority may establish the IAG–Salinity as a committee under clause 203 of the Water Act 2007 (Cwlth) for the purpose of sub clause 34 (1) of Schedule B to the Murray–Darling Basin Agreement.
2) The IAG–Salinity will be an expertise-based body consisting of one Lead Auditor and as many other members, as determined by the Authority from time to time based upon the workload, expertise required for the audit and any other factor the Authority considers appropriate.
3) The appointment to the IAG–Salinity will:
    - Primarily be based on qualifications, knowledge and experience in natural resource management and auditing processes.
    - Be governed by the terms specified in sub clause 34(2) of **Appendix 2**
    - Be based upon individual contract(s) for one year (2013–14) with the possibility for extension up to 2015–16 on the terms and conditions agreed between the Authority and the appointee(s).

Operating arrangements

The IAG–Salinity will follow a consultative process for conducting the audit and may amend this process for reasons of transparency, adequacy and efficiency. The Authority office will provide technical and administrative support to the IAG–Salinity.

Appendix 2: Basin salinity management — Schedule B

A summary and a key section from Schedule B of the Murray–Darling Basin Agreement which is Schedule 1 to the *Water Act 2007*(Cwlth) have been included. The purpose of Schedule B is to implement certain aspects of the BSMS; and the following relates to the annual audit.

34. Audit

(1) The Authority must appoint independent auditors for the purpose of carrying out an annual audit under this clause.

(2) A person who is appointed as one of the independent auditors referred to in sub clause 34(1):

(a) Is appointed for such period and on such terms as are set out in that person's instrument of appointment.

(b) May resign by written notice addressed to the President.

(c) May only be removed from office during the period of that person's appointment by the Ministerial Council, on the recommendation of the Authority.

(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.

(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.

(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.

(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).

(b) May recommend to the Authority that the salinity impacts entered in Register A or Register B for an Accountable Action be varied.

(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).

Appendix 3: Salinity registers (as at September 2014)

Table 7: Salinity Register A as at September 2014

	AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	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)					Salinity Credits# (Interpolation to Current Year Benefits $m/year)							Commonwealth Contribution (EC)		5 Year Rolling Review				Confidence	
							2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)	NSW	Vic	SA	Qld	ACT	Total				Latest Review	Next Review	Status		Rating	Comment
	JOINT WORKS & MEASURES																									
	Former Salinity & Drainage Works																									
1	Woolpunda SIS	SDS	Jan 1991		-87	0	-47.4	-47.4	-47.4	-47.4	-47.4	0.729	0.729				3.890	1	11.8		2007	2012			High	Based on Salt loads in river
2	Improved Buronga and Mildura/Merbein IS	SDS	Jan 1991		-6	0	-3.0	-3.0	-3.0	-3.0	-3.0	0.140	0.140				0.748	2	0.8		2005	2010			Medium	Based on Salt loads in river
3	New Operating Rules for Barr Creek Pumps	SDS	Jul 1991		-8	0	-4.9	-4.9	-4.9	-4.9	-4.9	0.225	0.225				1.198	3	1.2		2011	2016			High	Rules need to be revisited 2007
4	Waikerie SIS	SDS	Dec 1992		-19	0	-12.8	-12.8	-12.8	-12.8	-12.8	0.198	0.198				1.057	4	3.2		2007	2012			High	Based on Salt loads in river
5	Changed MDBC River Operations 1988 to 2000	SDS	Apr 1993		-1	4	-1.6	-1.6	-1.6	-1.6	-1.6	0.150	0.150				0.797	5	0.4		2005	2010			High	
6	Mallee Cliffs SIS	SDS	Jul 1994		-17	0	-11.4	-11.3	-11.3	-11.3	-11.3	0.512	0.512				2.733	6	2.8		2013	2018			High	Based on 2012 Groundwater model
7	Changed Operation of Menindee and Lower Darling	SDS	Nov 1997		3	8	0.9	0.9	0.9	0.9	0.9	-0.146	-0.146				-0.776	7	-0.2		2005	2010			High	
8	Waikerie Phase 2A SIS	SDS	Feb 2002		-14	0	-8.0	-8.2	-10.7	-8.9	-8.2	0.113	0.113				0.602	8	2.1		2007	2012			High	
9	Changed MDBC River Operations 2000 to 2002	SDS	Feb 2002		-2	-1	-1.4	-1.4	-1.7	-1.9	-1.4	-0.139	-0.139				-0.740	9	0.3		2006	2011			High	
	Sub Total - Former Salinity & Drainage Works				-151	11	-89.6	-89.8	-92.6	-91.0	-89.8	1.783	1.783	0.000	0.000	0.000	9.508		22.4							
	Basin Salinity Management Strategy																									
10	Changed MDBC River Operations after 2002	BSMS	Dec 2003		1	7	-0.2	-0.2	-0.4	-0.4	-0.2	0.021	0.021	0.021			0.130	10	0.1		2005	2010			High	
11	Pyramid Ck GIS	BSMS	Mar 2006		-6	0	-5.1	-5.1	-5.2	-5.2	-5.1	0.230	0.230	0.230			1.402	11	1.3		2010	2015			High	Remodelled 2010
12	Bookpurnong SIS	BSMS	Mar 2006		-20	0	-8.2	-11.2	-16.0	-17.0	-11.1	0.207	0.207	0.207			1.266	12	2.8		2013	2018			Low	Reviewed 2013
13	Improved Buronga SIS	BSMS	Mar 2006		-1	0	-0.6	-0.5	-0.5	-0.5	-0.5	0.021	0.021	0.021			0.127	13	0.1		2006	2011			High	Remodelled 2006
14	Loxton SIS	BSMS	Jun 2008		-17	0	-10.5	-10.8	-11.1	-12.0	-10.8	0.206	0.206	0.206			1.255	14	2.7		2013	2018			High	Reviewed 2013
15	Waikerie Lock 2 SIS	BSMS	Jun 2010		-17	0	-12.7	-10.3	-11.3	-11.8	-10.3	0.115	0.115	0.115			0.700	15	2.6		2010	2015			High	
16	Upper Darling SIS	BSMS	Jun 2014		-4	0	-4.5	-4.6	-4.5	-4.5	-4.6	0.241	0.241	0.241			1.468	16	1.1		2014	2019			Low	Based on a reduction of 37.5t/d
17	Murtho SIS	BSMS	Jun 2014		-50	0	-13.7	-17.3	-29.8	-31.1	-17.2	0.529	0.529	0.529			3.226	17	4.3		2014	2019			Low	Based on 2006 Groundwater model
	Sub Total Joint Works under BSMS				-113	6	-55.5	-59.9	-78.8	-82.5	-59.8	1.569	1.569	1.569	0.000	0.000	9.572		14.9							
	Joint Works Sub Total				-264	17	-145.1	-149.7	-171.4	-173.6	-149.6	3.352	3.352	1.569	0.000	0.000	19.081		37.4							
	The Living Murray Works and Measures and Water for Rivers**																									
18	TLM-RMIF 570 GL	TLM	Jun 2014	3.696	-47	346	-24.4	-24.4	-24.4	-24.4	-24.4							18								Provisional (MDBA Technical report No 2014/12
19	TLM Works and Measures	TLM	Jun 2014	-0.902	5	0	4.6	4.6	4.6	4.6	4.6							19								Provisional (MDBA Technical report No 2014/12
	TLM Sub Total			2.794	-42	346	-19.8	-19.8	-19.8	-19.8	-19.8															
	STATE WORKS & MEASURES																									
	Shared New South Wales and Victorian Measures																									
20	Permanent Trade Accounting Adjustment - NSW to Victoria	50N50V	Jun 2006		0	0	0.0	-0.1	-0.1	-0.1	-0.1	0.000	0.000				0.000	20	0		2006	2011			High	No permanent trade since 2006
21	Barmah-Millewa Forest Operating Rules	50N50V	Mar 2002		-2	33	-1.9	-2.0	-1.9	-2.3	-2.0	0.188	0.188				0.376	21	0		2006	2011			High	
	Shared Measures Sub Total				-2	33	-2.0	-2.1	-2.0	-2.3	-2.1	0.188	0.188	0.000	0.000	0.000	0.376		0							
	New South Wales																									
22	Boggabilla Weir	NSW	Dec 1991		0	0	-0.1	-0.1	-0.1	-0.1	-0.1	0.042					0.042	22	0		2007	2012			Medium	Remodelled 2007
23	Pindari Dam Enlargement	NSW	Jul 1994		0	-17	0.7	0.7	0.7	0.7	0.7	-0.121					-0.121	23	0		2007	2012			Medium	
24	Tandou pumps from Lower Darling	NSW	Sep 1994		2	-3	-0.1	-0.1	-0.1	-0.1	-0.1	0.034					0.034	24	0		2005	2010			Medium	
25	NSW MIL LWMP's	NSW	Feb 1996		-4	57	-4.0	-4.0	-4.0	-4.0	-4.0	0.684					0.684	25	0		2010	2015			High	
26	NSW Changes to Edward-Wakool and Escapes	NSW	Jan 1990		-2	4	-2.0	-2.1	-2.0	-2.0	-2.1	0.368					0.368	26	0		2005	2010			High	
27	Permanent Trade Accounting Adjustment - NSW to SA	NSW	Jun 2006		-3	1	-0.5	-0.4	-0.4	-0.5	-0.4	0.108					0.108	27	0		2005	2010			High	No permanent trade since 2006
28	NSW Sunraysia Irrigation Development 1997 to 2006	NSW	Jul 2003		1	0	0.0	0.9	4.5	6.1	0.8	-0.187					-0.187	28	0		2007	2012			High	
29	RISI Stage 1	NSW	Jun 2010		-5	0	-2.7	-3.9	-4.1	-4.1	-3.8	0.830					0.830	29	0		2010	2015			Medium	Red Cliffs to Wentworth river reach
30	RISI Stage 2	NSW	Jun 2014		-4	0	-3.6	-3.8	-3.9	-3.9	-3.8	0.845					0.845	30	0		2014	2019			Medium	Colignan to Red Cliffs river reach

	AUTHORITY REGISTER A (Accountable Actions)	Type	Date Effective	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)					Salinity Credits# (Interpolation to Current Year Benefits $m/year)						Commonwealth Contribution (EC)	5 Year Rolling Review			Confidence	
							2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)	NSW	Vic	SA	Qld	ACT	Total			Latest Review	Next Review	Status	Rating	Comment
31	NSW S&DS Commitment Adjustment	NSW	Nov 2002		0	0	0	0	0	0	0	0.910					0.910	31	0					
	New South Wales Works and Measures				-15	43	-12.4	-12.9	-9.4	-8.0	-12.9	3.514					3.514		0					
	Victoria																							
32	Barr Creek Catchment Strategy	Vic	Mar 1991		-12	0	-7.7	-7.7	-7.7	-7.7	-7.7		1.963				1.963	32	0	2013	2018		High	Reviewed 2013
33	Tragowel Plains Drains at 2002 level	Vic	Mar 1991		1	1	0.2	0.2	0.2	0.2	0.2		-0.022				-0.022	33	0	2013	2018		High	Reviewed 2013
34	Shepparton Salinity Management Plan	Vic	Mar 1991		0	24	1.4	1.4	1.5	1.5	1.4		-0.383				-0.383	34	0	2008	2016		Low	Exclude private pumps
35	Nangiloc-Colignan S.M.P.	Vic	Nov 1991		-1	1	0.4	0.4	0.4	0.4	0.4		-0.102				-0.102	35	0	2013	2018		High	Reviewed 2013
36	Nyah to SA Border SMP - Irrigation Development	Vic	Jul 2003		21	0	13.8	13.8	13.7	13.7	13.8		-3.250				-3.250	36	0	2014	2019		Medium	Data updated to 2013, Entry represents the upper bound of salinity impact
37	Kerang Lakes/Swan Hill Salinity Management Plan	Vic	Jan 2000		2	4	1.1	1.6	1.1	0.9	1.6		-0.370				-0.370	37	0	2010	2015		High	Remodelled 2006
38	Campaspe West SMP	Vic	Aug 1993		1	0	0.4	0.3	0.4	0.3	0.3		-0.077				-0.077	38	0	2010	2015		High	
39	Psyche Bend	50V50C	Feb 1996		-4	0	-2.1	-2.1	-2.1	-2.1	-2.1		0.237				0.474	39	1.0	2011	2016		Medium	
40	Permanent Trade Accounting Adjustment - Victoria to SA	Vic	Jun 2006		0	2	-0.7	-0.8	-0.8	-1.0	-0.7		0.184				0.184	40	0	2005	2010		High	No permanent trade since 2006
41	Woorinen Irrigation District Excision	Vic	Sep 2003		0	-2	1.3	0.8	1.0	1.2	0.8		-0.229				-0.229	41	0	2010	2015		High	
42	Sunraysia Drains Drying up	Vic	Jun 2004		-2	-4	-2.1	-2.2	-2.1	-2.1	-2.2		0.637				0.637	42	0	2011	2016		Medium	
43	Lamberts Swamp	Vic	Jun 2004		-5	0	-3.0	-3.0	-3.0	-3.0	-3.0		0.625				0.625	43	0	2011	2016		High	
44	Church's Cut decommissioning	Vic	Mar 2006		1	0	-0.4	-0.3	-0.3	0.0	-0.3		0.097				0.097	44	0	2010	2015		High	Remodelled 2010
45	Mallee Drainage bore decommissioning	Vic	Jun 2008	0.057	0	0	-0.1	-0.3	-0.3	-0.3	-0.3							45	0	2013	2018		Low	Reviewed 2013
46	RISI Stage 1	Vic	Jun 2010		-8	0	-2.0	-5.5	-6.8	-7.1	-5.4		1.249				1.249	46	0	2010	2015		Medium	Red Cliffs to Wentworth river reach
47	RISI Stage 2	Vic	Jun 2014		-6	0	-4.4	-4.7	-5.0	-5.1	-4.7		1.051				1.051	47	0	2014	2019		Medium	Colignan to Red Cliffs river reach
48	Victorian S&DS Commitment Adjustment	Vic	Nov 2002		0	0	0.0	0.0	0.0	0.0	0.0		1.600				1.600	48	0					
	Victoria Works and Measures				-14	25	-3.8	-7.9	-10.0	-10.3	-7.8		3.210				3.447		1.0					
	South Australia																							
49	SA Irrigation Development Based on Footprint Data*	SA	Jul 2003		7	0	-3.6	5.8	33.9	72.8	5.4			-0.633			-0.633	49	0	2015	2020		Low	
50	SA Irrigation Development Due to Water Trade	SA	Jun 2006		0	0	0.1	0.5	16.2	32.2	0.5			-0.149			-0.149	50	0	2003	2008		High	
51	SA Irrigation Development Based on Site Use Approvals	SA	Jun 2010		0	0	-0.1	0.3	16.9	93.0	0.3			-0.055			-0.055	51	0	2013	2018		High	Based on Site Use Approval up to 2014
52	SA Component of Bookpurnong SIS	SA	Mar 2006		-7	0	-3.0	-4.1	-5.9	-6.3	-4.1			0.462			0.462	52	0	2013	2018		High	Reviewed 2013
53	SA Component of Loxton SIS	SA	Jun 2008		-1	0	-0.8	-0.8	-0.8	-0.9	-0.8			0.095			0.095	53	0	2013	2018		High	Reviewed 2013
54	SA component of Waikerie Lock 2 SIS	SA	Jun 2010		-1	0	-1.2	-0.7	-2.0	-2.6	-0.7			0.047			0.047	54	0	2010	2015		High	
55	SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg A*	SA	Jan 2000		-36	0	-20.2	-22.1	-26.3	-21.3	-22.0			2.931			2.931	55	0	2012	2017		Low	
56	Qualco Sunlands GWCS	SA	Sep 2004		-5	0	-1.8	-4.0	-6.5	-7.5	-3.9			0.265			0.265	56	0	2007	2012		High	
57	Pike Stage 1 SIS	SA	Jan 2012		-5	0	-1.4	-3.2	-3.3	-3.4	-3.1			0.481			0.481	57	0	2012	2017		High	
58	SA Component of Murtho SIS	SA	Jun 2014		-1	0	-0.3	-0.4	-0.6	-0.6	-0.4			0.066			0.066	58	0	2014	2019		Low	
	South Australia Subtotal				-47	0	-32.2	-28.7	21.5	155.3	-28.8			3.512			3.512		0					
	Queensland																							
59	Land Clearing Post 2000	Qld	Jul 2005	TBD														59		2013				
60	Irrigation Development Post 2001	Qld	Jul 2005	TBD														60		2013				
	Queensland Subtotal				0	0																		
	Balance - Register A				-342	119	-195.6	-201.4	-171.2	-38.8	-221.0	7.054	6.750	5.081	0.000	0.000	25.064		39					

Registers Explanatory Notes

TBD - To be determined

^Salinity Effect - Increase or decrease 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 comprised of multiple MODFLOW model outputs accredited at various times. As such they are not reviewed and updated in their entirety in one year but the component models are updated in line with their 5 year review dates. The review year reflects the latest model review.

Some of the totals are affected by rounding

** Assessments based on preliminary reports. Further work is required on how these assessments are presented in the register. Salinity impacts not included in the totals.

Total Register A of $25.064m/yr excludes transfers to Register B

Table 8: Salinity Register B as of September 2014

	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)						Salinity Credits (Interpolation to Current Year Benefits $m/year)							Commonwealth Contribution (EC)		5 Year Rolling Review				Confidence	
							2000	2015	2050	2100	Modelled Current Conditions (Interpolation to Current Year)		NSW	Vic	SA	Qld	ACT	Total				Latest Review	Next Review	Status		Rating	Comment
	Transfers from Register A												1.183	0.944	2.739	0.000	0.000	4.866									
	New South Wales																										
61	Darling Catchment Legacy of History - Macquarie	NSW	Jan 2000		0	0		0	0.1	0.3	0.4		-0.032					-0.032	61			2010	2015	In Progress		Medium	
62	Darling Catchment Legacy of History - Macintyre	NSW	Jan 2000		0	0		0	0	0	0		0.000					0.000	62			2010	2015	In Progress		Medium	
63	Darling Catchment Legacy of History - Gil Gil Ck	NSW	Jan 2000		0	0		0	0.0	0.0	0.0		-0.001					-0.001	63			2010	2015	In Progress		Medium	
64	Darling Catchment Legacy of History - Gwydir	NSW	Jan 2000		0	0		0	0.0	0.0	0.0		-0.002					-0.002	64			2010	2015	In Progress		Medium	
65	Darling Catchment Legacy of History - Namoi	NSW	Jan 2000		0	0		0	0.2	0.4	0.5		-0.047					-0.047	65			2010	2015	In Progress		Medium	
66	Darling Catchment Legacy of History - Castlereagh	NSW	Jan 2000		0	0		0	0.0	0.0	0.1		-0.006					-0.006	66			2010	2015	In Progress		Medium	
67	Darling Catchment Legacy of History - Bogan	NSW	Jan 2000		0	0		0	0.1	0.2	0.3		-0.024					-0.024	67			2010	2015	In Progress		Medium	
68	Lachlan Legacy of History	NSW	Jan 2000		0	0		0	0	0	0		0.000					0.000	68			2010	2015	In Progress		Medium	Little connection to Murrumbidgee
69	Murrumbidgee Catchment Legacy of History	NSW	Jan 2000		0	0		0	0.1	0.2	0.2		-0.017					-0.017	69			2010	2015	In Progress		Medium	
70	NSW Mallee - dryland	NSW	Jan 2000		0	0		0	0.3	1.3	3.6		-0.061					-0.061	70			2010	2015			Low	
71	NSW Mallee - Pre 88 Irrigation	NSW	Jan 2000		0	0		0	0.4	1.2	2.3		-0.091					-0.091	71			2010	2015			Low	
	Victoria																										
72	Campaspe Catchment Legacy of History	Vic	Jan 2000		0	0		0	0.1	0.2	0.3			-0.025				-0.025	72			2011	2016			Medium	
73	Goulburn Catchment Legacy of History	Vic	Jan 2000		1	-5		0	0.5	1.1	1.6			-0.108				-0.108	73			2013	2018			Medium	Reviewed 2013
74	Loddon Catchment Legacy of History	Vic	Jan 2000		1	-1		0	1.0	1.5	2.3			-0.232				-0.232	74			2013	2018			Medium	Reviewed 2013
75	Kiewa Catchment Legacy of History	Vic	Jan 2000		1	0		0	0.1	0	0.0			-0.037				-0.037	75			2011	2016			Medium	
76	Ovens Catchment Legacy of History	Vic	Jan 2000		0	0		0	0	0.6	1.3			0.000				0.000	76			2011	2016			Medium	
77	Victorian Mallee - dryland	Vic	Jan 2000		1	0		0	0.6	2.2	5.9			-0.133				-0.133	77			2010	2015			Low	
78	Victorian Mallee - Pre 88 Irrigation	Vic	Jan 2000		3	0		0	1.4	4.7	8.3			-0.309				-0.309	78			2010	2015			Low	
	South Australia																										
79	SA Mallee Legacy of History - Dryland*	SA	Jan 2000		7	0		0	4.1	14.5	32.8				-0.400			-0.400	79			2012	2017			Medium	
80	SA Mallee Legacy of History - Irrigation*	SA	Jan 2000		78	0		0	46.6	86.9	113.3				-5.917			-5.917	80			2012	2017			Low	
81	SA Improved Irrigation Efficiency and Scheme Rehabilitation Reg B*	SA	Jan 2000		-83	0		0	-49.6	-93.8	-115.4				6.000			6.000	81			2012	2017			Low	
	Queensland																										
82	Queensland Legacy of History	Qld	Jan 2000	TBA															82			2007					Low Impact - Long lag times
83	Queensland Irrigation Development pre 1 Jan 2000	Qld	Jan 2000	TBA															83								Modelling required
	Balance - Register B			0.000	8	-6	0.0	6.0	21.5	57.9	5.8		0.902	0.100	2.422	0.000	0.000	3.424									
	Balance - Registers A & B				-334	113	-195.6	-195.4	-149.7	19.1	-215.2		7.956	6.850	7.502	0.000	0.000	28.488									
	Modelled Current Status				721	5,085	471	472	535	710	472																

Registers Explanatory Notes

TBD - To be determined

^Salinity Effect - Increase or decrease 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 comprised of multiple MODFLOW model outputs accredited at various times. As such they are not reviewed and updated in their entirety in one year but the component models are updated in line with their 5 year review dates. The review year reflects the latest model review.

Some of the totals are affected by rounding

** Assessments based on preliminary reports. Further work is required on how these assessments are presented in the register. Salinity impacts not included in the totals.

Total Register A of $25.064m/yr excludes transfers

Appendix 4: Outcome of audit recommendations since BSMS mid-term review in 2008

Table 9: Outcome of audit recommendations since BSMS mid term review in 2008

Audit year	Number of Recommendations / priority	Completed	Partially completed	Continuing	Redundant or superseded	Remarks
2008-09	9 – high priority 5 – normal priority	9	4		1	All high priority recommendations were completed. Many of the recommendations which related to salinity registers were actioned in a short time. Other recommendations involved development of concepts, and became multi-year tasks. The multi-year tasks were fully or partially completed and considered in the development of the draft Basin Plan.
2009-10	11 – high priority 7 – normal priority	13	4		1	Most recommendations were completed, mainly by means of finalising reports. All multi-year tasks were at least progressed via the evolving understanding of the underlying concepts involved.
2010-11	8	2	3	2	1	Most recommendations involved issues addressed by drafting of the Basin Plan or progressing multi-year, or recurring, tasks. Progress made on most items.
2011-12	5	3	1	1		Finalising the Basin Plan provided completion of some of the recommendations with multi-year tasks. Progress was made on other recommendations while completing the key tasks.
2012-13	7	6		1		Most of the recommendations with multi-year tasks were brought to conclusion. All one-year tasks were also completed.
TOTAL	**52**	**33**	**12**	**4**	**3**	