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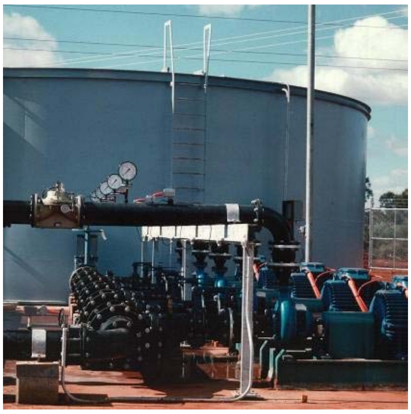
RIVERINE PLAINS SALINITY FRAMEWORK - PROJECT OVERVIEW AND SUMMARY REPORT



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1. INTRODUCTION

1.1 Project Scope

RPS Aquaterra and RM Consulting Group were engaged by the Murray Darling Basin Authority to undertake an '*Assessment of the Salinity Impacts on Changes to Irrigation in the Riverine Plains'*.

The Riverine Plains for the purposes of this study is defined as the areas upstream of the Murray River at Swan Hill and upstream of the Wakool River at Kyalite as shown on Figure 1.

The projects main objectives were to

- determine how best to identify, characterise and account for irrigation changes on the Riverine Plains in the context of the BSMS and the post 2015 operational plan.
- develop an *Irrigation Salinity Assessment Framework* (ISAF) to assess the salinity impacts of changes to irrigation water use on the Riverine Plains.

1.2 Background

While the initial impetus for an ISAF was expanded water trade and the potential salinity impacts arising from new development, a number of factors including effects of the drought and shifts in commodity markets have combined to alter the original focus and to create the need for a broader approach to assessing the effects of water use change on salinity. The driving forces have been, amongst other things:

- technological advances;
- land and water management plans;
- new water sharing arrangements;
- a decade of drought; and
- a vibrant water market.

While all these changes might be expected to have helped reduce rootzone drainage, and therefore base-flows, it is not yet clear, in the Riverine plains, what actual impact these actions have had on river salinity. Nor is there sufficient confidence that our understanding of these issues will enable us to assess the impacts of climate change, cyclic droughts and seasonal variability.

In addition to the changes at the farm-scale, structural adjustment measures are helping to improve the efficiency of irrigation delivery infrastructure thereby reducing seepage to groundwater systems and spillages into surface drainage systems. Those adjustment measures are also concentrating water use on to those parts of the landscape best serviced by the modernised infrastructure; this further confines the already reduced 'irrigation footprint'.

More profoundly, as part of the Commonwealth *Water for the Future* initiative, significant funding is being used to purchase water entitlements from willing sellers (mainly irrigators), for future environmental watering programs. For example, something in the order of 30 per cent of total water entitlements (by volume) will ultimately be purchased to recover water for the environment.

At face value it is unlikely that the existing suite of changes to irrigation will have increased river salinity relative to the baseline conditions; more likely it will have decreased irrigation-induced river salinity.

Appropriate imprecision in the quantum of any claimed Accountable Action and the quantum of any subsequent change of the Action could perhaps be used to underwrite a simplified accounting system for the framework. It could also be used to underwrite a lower monitoring burden into the future.

The following project structure was developed in order to work towards an ISAF which can incorporate some of the challenges posed by water use change.

1.3 Project structure

The project was completed in three key phases as described below. Each Phase has a supporting report, each of which is used to feed into this Project Summary report.

Phase I

To describe the body of knowledge changes in water use on the Riverine Plains in the context of Schedule B of the Murray-Darling Basin Agreement in order to develop a detailed understanding of how MSM-BigMod deals with the salt inputs from the Riverine Plains.

Phase II

Undertake a gap analysis in order to codify changes in water use on the Riverine Plains in terms of how different types of changes relate to the salinity Baseline, Register A, and Register B.

Phase III (a)

This phase undertook a risk assessment on the links between water use and salt mobilisation with emphasis on the following objectives:

- developing recommendations with regard to identifying geographical priority areas/zones with a view to assessing the suitability of the tools/models that should be employed for assessing the salinity impacts of irrigation in each of the areas or zones, and
- develop and test the draft ISAF using regional case studies

Phase III (b)

The final task was to provide documentation of an ISAF which will allow for further policy development and implementation.

1.4 Reporting

This report is an executive summary of the project and includes details described in the three key project reports including:

Appendix A

Assessing the Salinity impacts on changes to irrigation on the riverine plains - Phase One.

Appendix B

Assessing the Salinity impacts on changes to irrigation on the riverine plains - Phase Two Gap Analysis.

Appendix C

Assessing the Salinity impacts on changes to irrigation on the riverine plains - Phase Three Irrigation Salinity Assessment Framework.

1.5 Acknowledgements

The project was completed under the consultation and guidance of a Project Advisory Group. Members included Asitha Katupitiya (MDBA), Emmanuel Xevi (MDBA), Paul Pendlebury (NSW), Bryony Grice (Vic), Mark Wood (Vic), Carl Walters (GBCMA), Tim Shanahan (NCCMA), Judith Kirk (SA), Joel Vandepeer (SA).

Figure 1: Riverine Plains spatial extent

2. SUMMARY OF KEY ISSUES

2.1 Critical Issues and challenges

The current Murray Darling Basin salinity accountability requirements relating to the permanent transfer of water entitlements were written in contemplation of the outcomes of the *Interstate Water Trade Pilot Project*, which ran from 1998 to 2006. The pilot was confined to the Mallee regions of NSW, South Australia and Victoria. There, perennial horticultural crops prevail and irrigated crops are underlain by highly saline aquifers with direct hydrological connection to the River Murray; annual irrigation applications in the Mallee are stable and predictable. The characteristics of irrigation on the riverine plains are fundamentally different.

In addition, while interstate entitlement trade has only been possible on the riverine plains since 2006, intrastate entitlement trade has been possible since the 1990s, and temporary (allocation) trade was possible and widely used before the baseline date of 1988.

Consequently there is an emerging need to consider how changing patterns of water use should be assessed and whether they should be recorded in Register A, Register B or the Baseline. It is possible, for example, that natural variability within the existing irrigation 'footprint' could be deemed part of the Baseline and therefore not accountable.

The Authority, in collaboration with states, decided to develop an *Irrigation Salinity Assessment Framework* (ISAF) tailored to the characteristics of the riverine plains.

2.2 Building on existing salinity policy and knowledge

Accountable actions on the Riverine Plains were historically developed around infrastructure that allows irrigation to be sustainably managed. The key areas where broad scale irrigation has been linked with salt mobilisation include:

- Shepparton Irrigation Region surface and subsurface drainage
- NSW Land and Water Management Plans – Berriquin, Cadell, Denimein and Wakool
- Barr Creek Land and Water Management Plan and Barr Creek Lake Tutchewop Drainage Diversion Scheme
- Torrumbarry irrigation district throughflow actions including Koondrook weir returns, Lake Charm outfall, Lake Boga outfall and Torrumbarry 6/7 channel outfall.

The policy settings that give rise to current management practices at the Murray Darling Basin level include:

- Murray Darling Basin Agreement
- Salinity and Drainage Strategy 1988
- BSMS 2001 - 2015
- National Action Plan for Salinity and Water Quality 2000
- Water Act 2007

There are also a number of State policy settings with the current status being as follows:

- NSW – Taking on the Challenge: NSW Salinity Strategy 2000
- Victoria – Northern Region Sustainable Water Strategy 2009

2.3 BSMS register

The approach adopted for this assessment of current salinity accounting arrangements was to note that the impacts of all accountable actions are recorded on the BSMS register; all salt that is not accounted for through the register is considered to be within the baseline. Whether or not the effects of management activities are able to be determined with any confidence was the scope of work for undertaking a gap analysis on BigMod.

3. Gap Analysis of BigMod arrangements

The conduct of the gap analysis phase focussed on un-packing BIgMod in an attempt to understand where the real risks might emerge for the proposed ISAF. BigMod incorporates all measured salt loads (accounted) and is calibrated in each River reach by applying unaccounted salt loads to close the salt balance.

The range of accounted and unaccounted salt loads for the Riverine Plains zone are reported in previous studies are summarised as follows:

- Figure 2 shows the main tributaries that are modeled as inflows (water and salt). The magnitude of the salinity impacts (EC impact @ Morgan) mostly indicates the baseline conditions. Works and measures that are accountable actions are generally modelled as scenarios that alter the baseline model run with additional model inflows/outflows.
- Figure 3 shows the works and measures that represent the main irrigation related return flows. These are generally the focus for identifying where the impacts of water use change manifest themselves. It is noted that Bar Creek is orders of magnitude larger at 763 t/d than any other irrigation drain.

The areas that were identified as unaccounted salt loads were in-River reaches:

- Torrumbarry to Swan Hill 282 tonnes per day (average over benchmark)
- Yarrawonga to Kyalite 187 tonnes per day
- Yarrawonga to Torrumbarry 48 tonnes per day

What the unpacking process shows is that the irrigation related impacts are small compared to total baseline conditions and so separating the relative influence of irrigation change requires the signal-to-noise ratio in the data sets to be understood.

Analysis was completed on a reach by reach basis using a mass balance approach to identify broad trends or changes of note. The approach deliberately excluded a formal trend analysis as the nature of riverine plains data includes significant spatial, temporal and seasonal influences that cause significant variability and noise.

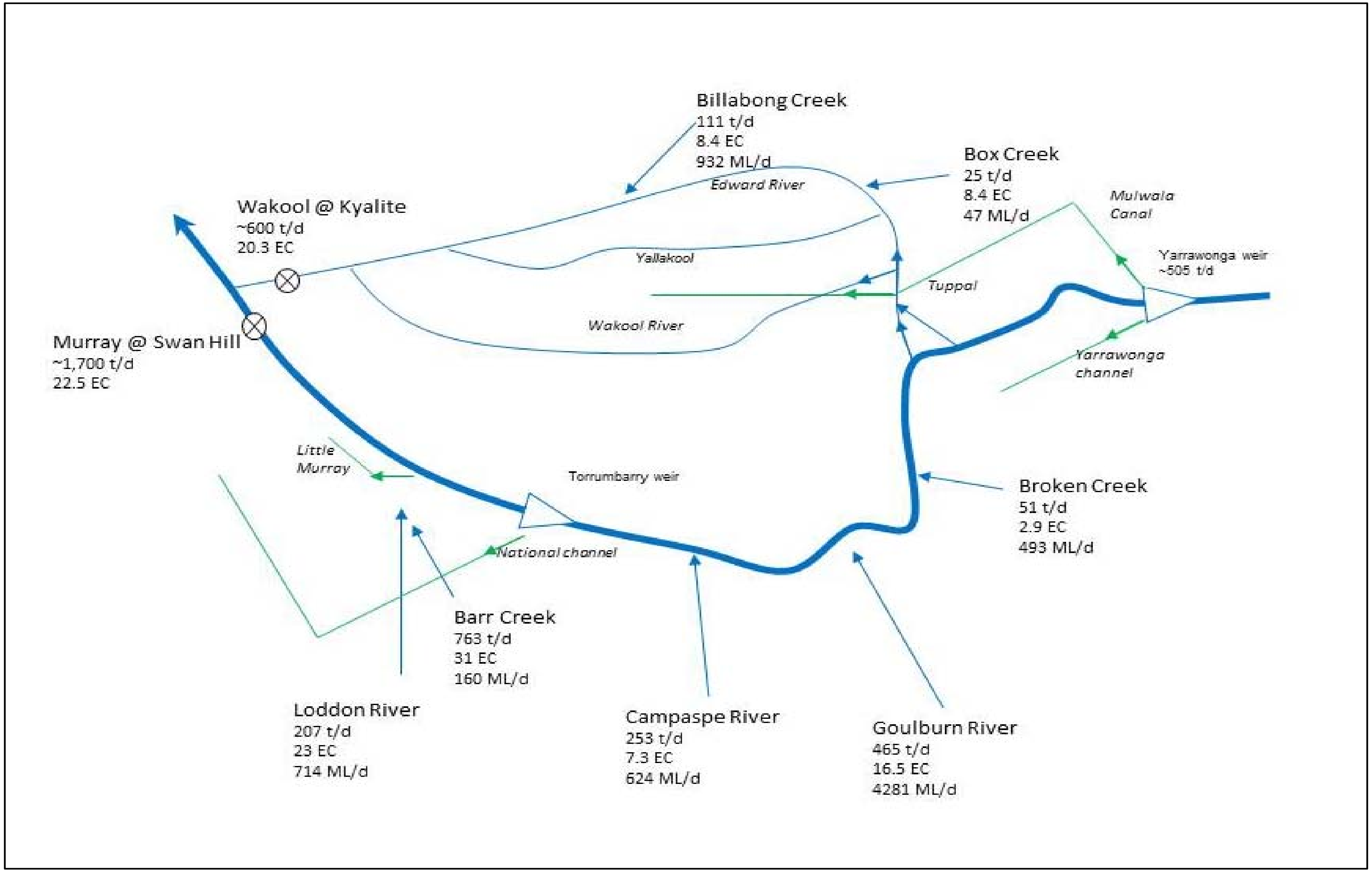

Figure 2: Schematic of BigMod tributary inflow sources over benchmark period

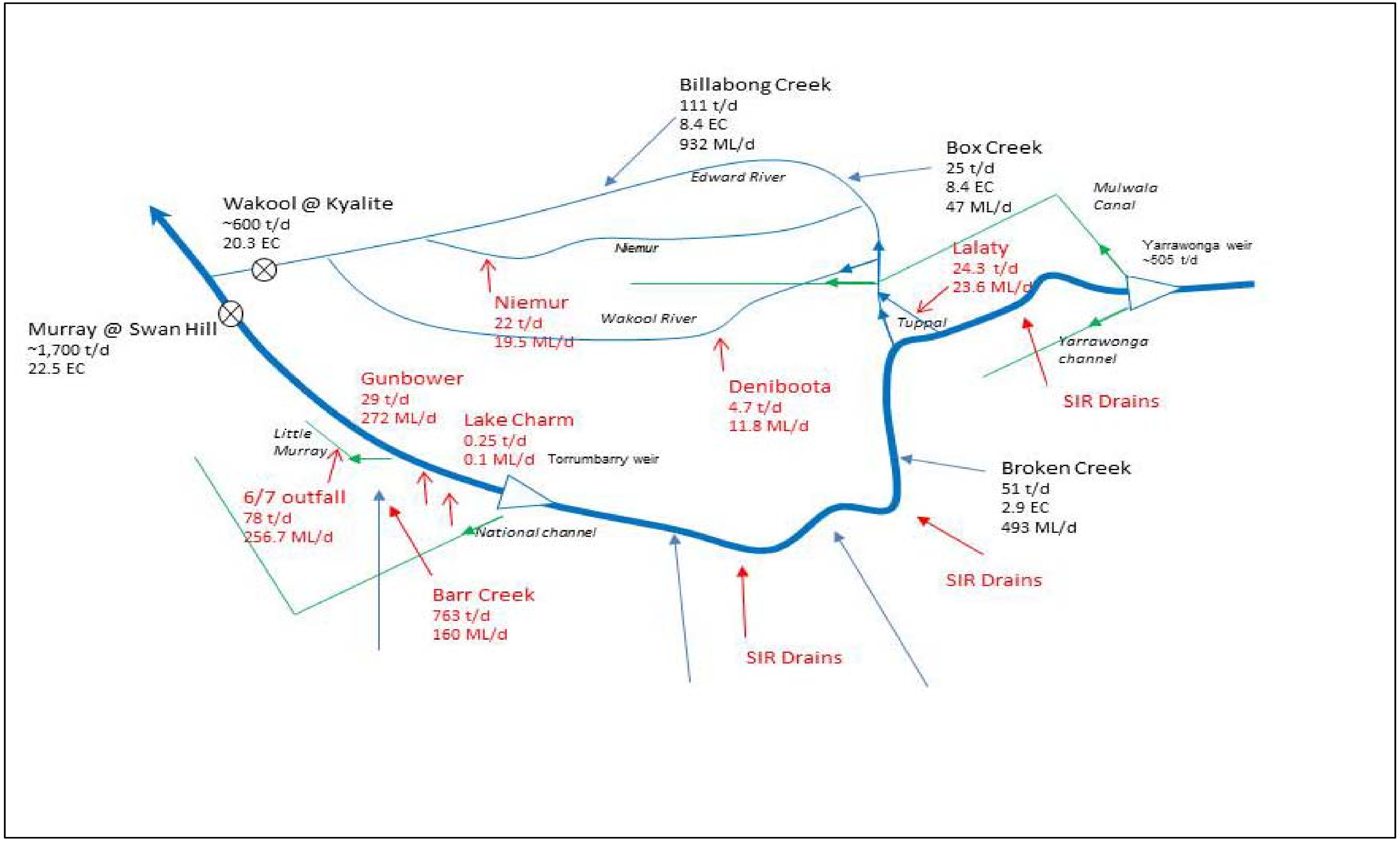

Figure 3: Schematic of BigMod drain inflow sources over benchmark period

Analysis of available raw data was completed on a large number of in-River sites as well as inflow sites (drains and return flows). The approach taken was to examine the time series data as well as a mass balance of salt loads to observe the effects of climates (wet/dry) periods. Figure 4 is the representation of the combined salt load (cumulative) for the Swan Hill and Kyalite sites. The key observations of this data are reflective of many of the Riverine Plains sites. These include:

- Consistent annual salt loads throughout the benchmark period until around 1997/98 – while floods show shifts in the trajectory of the graph the return to consistent gradients indicates a steady period of salt mobilisation.
- Declining annual salt loads from 1997/98 until mid-2000s mostly associated with reduced frequency of high flow events but also due to much lower seasonal variance
- Flattening of the gradient to negligible or even no salt loads beyond 2009 which corresponds to a period when many inflow sites (irrigation drains) dried up.

The analysis of all sites assisted in unpacking of BigMod to assess where the focus of further risks might be assessed and built in the ISAF.

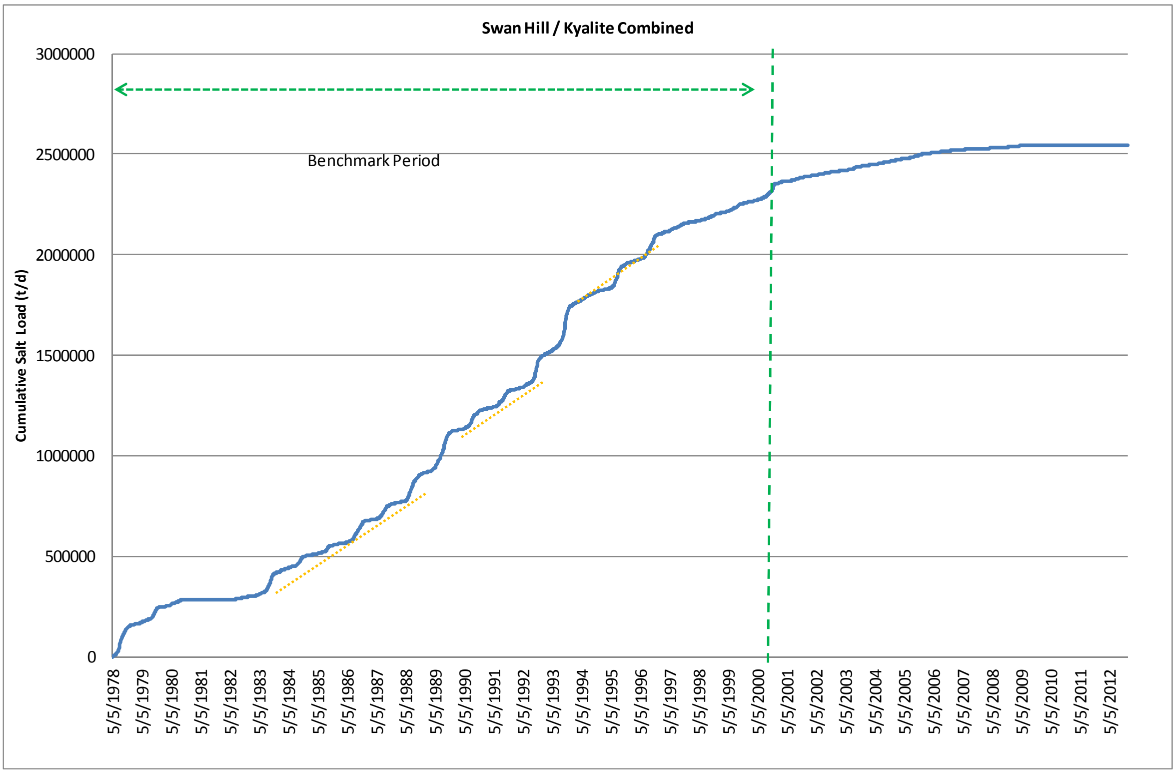

Figure 4: Combined Swan Hill / Kyalite sites - cumulative salt load

It should be noted that the data shown above is for two regulated River gauge sites and although a salt load reduction is a multiple of both flow and salinity the regulated nature of the main River channel provides a lower limit for flow that will not see the gradient of the graph flatten fully. What this means for reduced irrigation salinity is that the River may have reached a natural 'fresh' balance from around 2009 and the conditions that led to this are an indication of how far the benefits of reduced irrigation may be able to be applied.

4. DEFINING CHANGES IN WATER USE

Whilst salinity impact assessments have historically been completed to define the impacts of works and measures in a relatively static water management environment, the emerging impacts of water use change are inextricably linked to a range of factors including:

- Irrigation footprint change
- Irrigation application patterns including crop types and management of seasonal conditions
- Distribution efficiency including outfall management
- Seasonal water allocation policy and timing of seasonal allocation announcements
- Business enterprise decisions on whether to use or trade water

It follows that defining a change in water use has a number of potential perspectives. If viewed purely from a salt mobilisation and salinity accountability perspective it is obvious that the total volume of water applied to land (measured as total diversion or deliveries) in the Riverine plains has been shown to have reduced due to extended drought as well as water policy settings (see example in Figure 5). This does not necessarily indicate water use change, however.

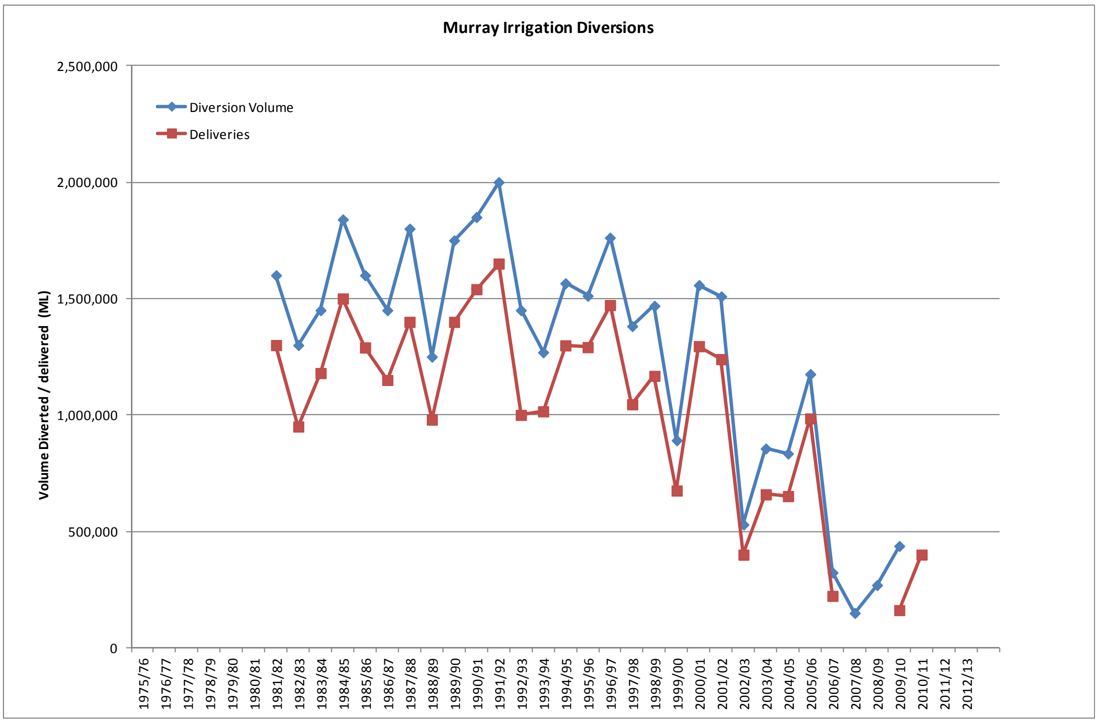

Figure 5: Murray Irrigation Limited Diversions and Water Use

The impact of climate variability is real and is encapsulated into any salinity impact discussion through the adoption of the benchmark period. Data shows that impacts during most of the benchmark period were relatively stable from one year to the next. However, the period after 2000 is where much of the variability has been observed and separation of the influence of the factors that contribute to water use change from climate related factors is a vital part of this project. Therefore defining the potential impacts of water use change after 2000 became a significant focus of this project.

The Cap on diversions to 1993/94 levels of development is the policy instrument that determines diversions on a year-to-year basis. The Cap provides a basis for establishing a static data set against which change can be identified. The analysis of each Cap valley was completed and changes in diversions were analysed. The predicted cap diversions, adjusted Cap diversions (for trade and environment) and actual diversions are shown below on a cumulative basis for Victorian Murray (Figure 6), Goulburn-Broken- Loddon (Figure 7) and NSW Murray (Figure 8).

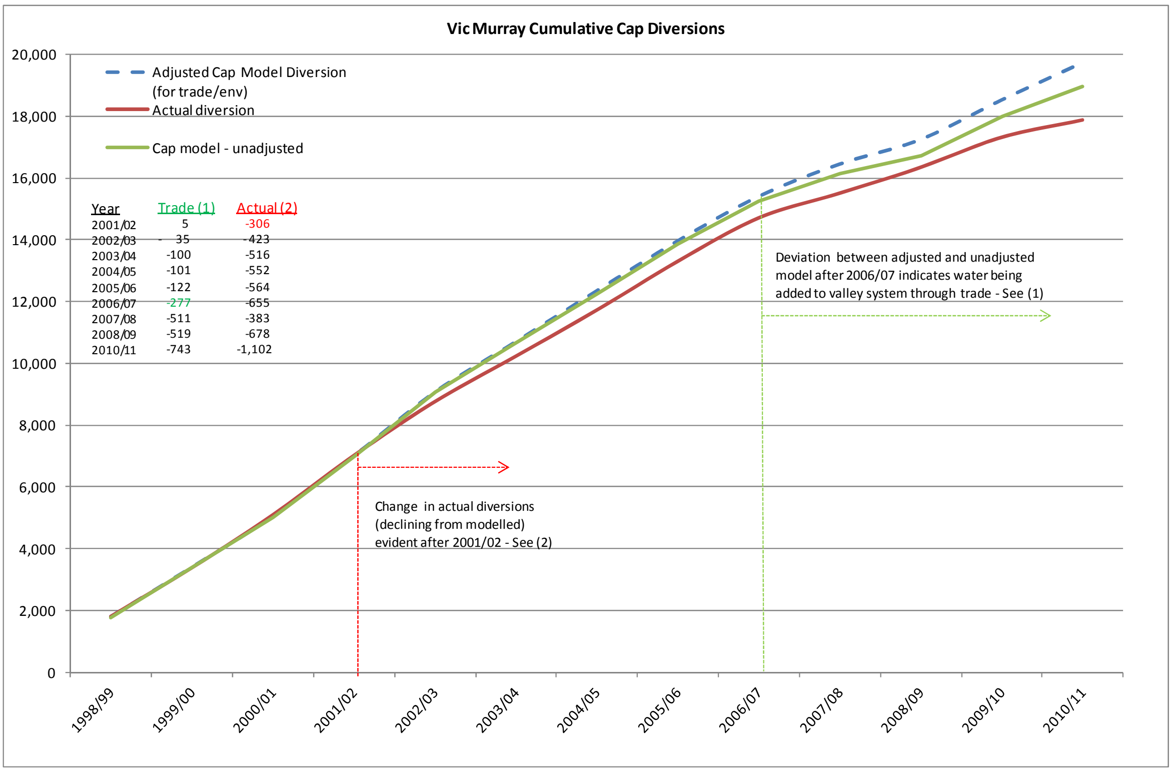

Figure 6: Victorian Murray Cap Valley Diversions

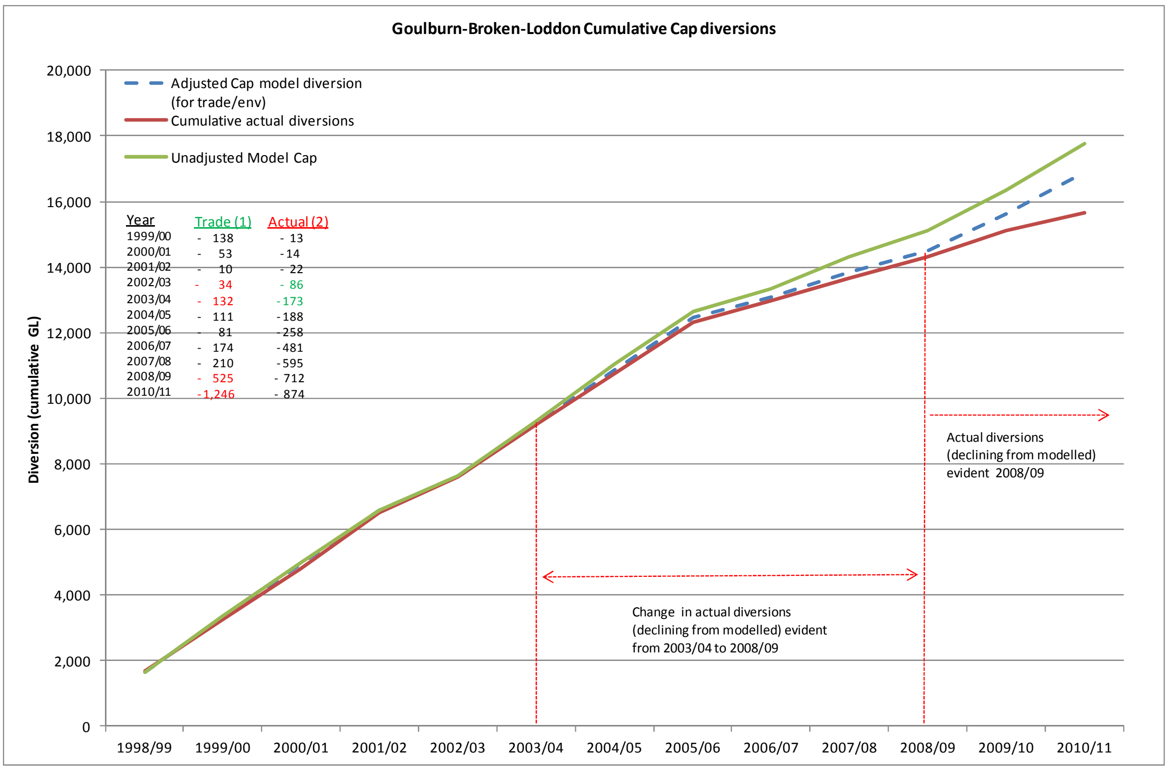

Figure 7: Goulburn-Broken-Loddon Cap Valley diversions

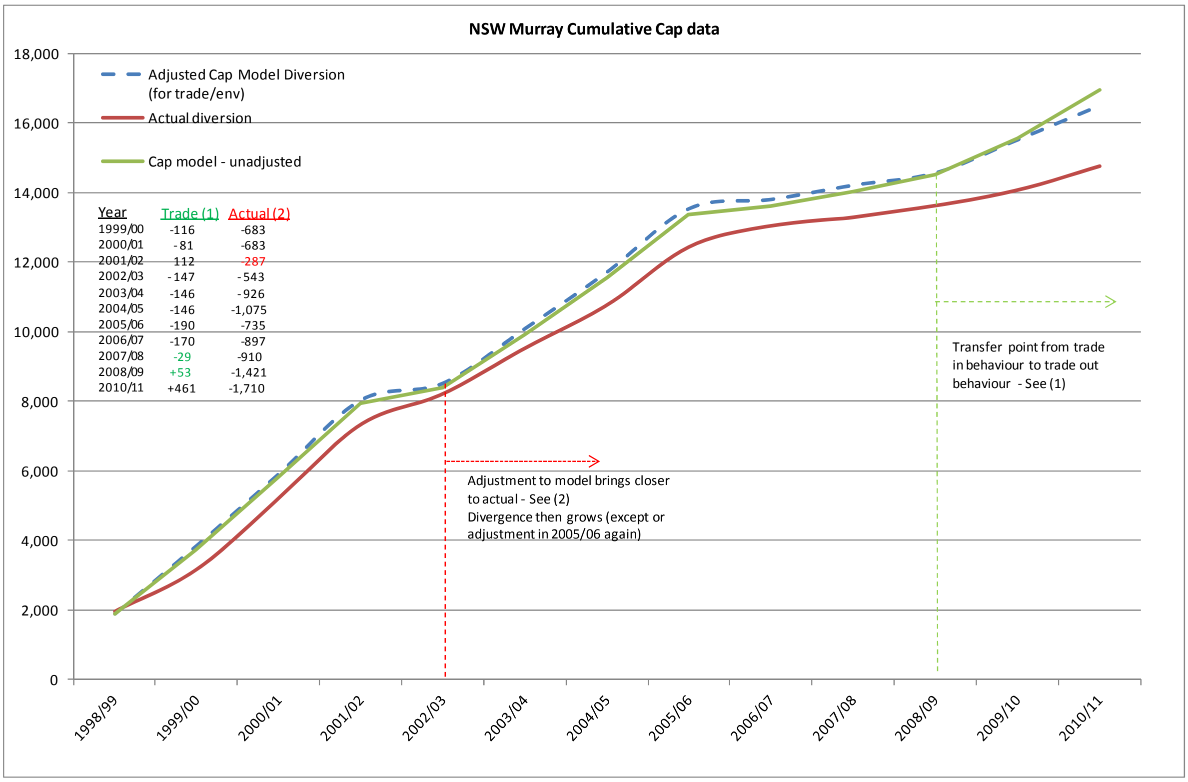

Figure 8: NSW Murray Cap Valley diversions

It is clear from the above graphs that annual diversions have been steadily declining in all Riverine Plains Cap valleys, even after the effects of water trade and environmental water are accounted for.

The linking of Cap valleys to irrigation districts is simpler in NSW than in Victoria. The Goulburn system has clearly had water traded out (from Figure 6) and it would appear that the majority of the impact on reducing diversions (Figure 9) has been observed in Shepparton. The Victorian Murray has seen trade inwards (Figure 6) yet despite river diversions declining (Figure 10) there does not appear to have been any change in the proportion of diversions between Murray Valley and Torrumbarry. This suggests that much of the activity for the Cap valley is likely to have been in the Sunraysia reach of the valley.

The analysis indicates that there is a difference between the effects of climatic variability and water use change. This means that any attempt at apportioning accountability for a Register claim will need to address the relative effects of variability, a baseline effect, with change resulting from an accountable action or implementation of a policy or management instrument.

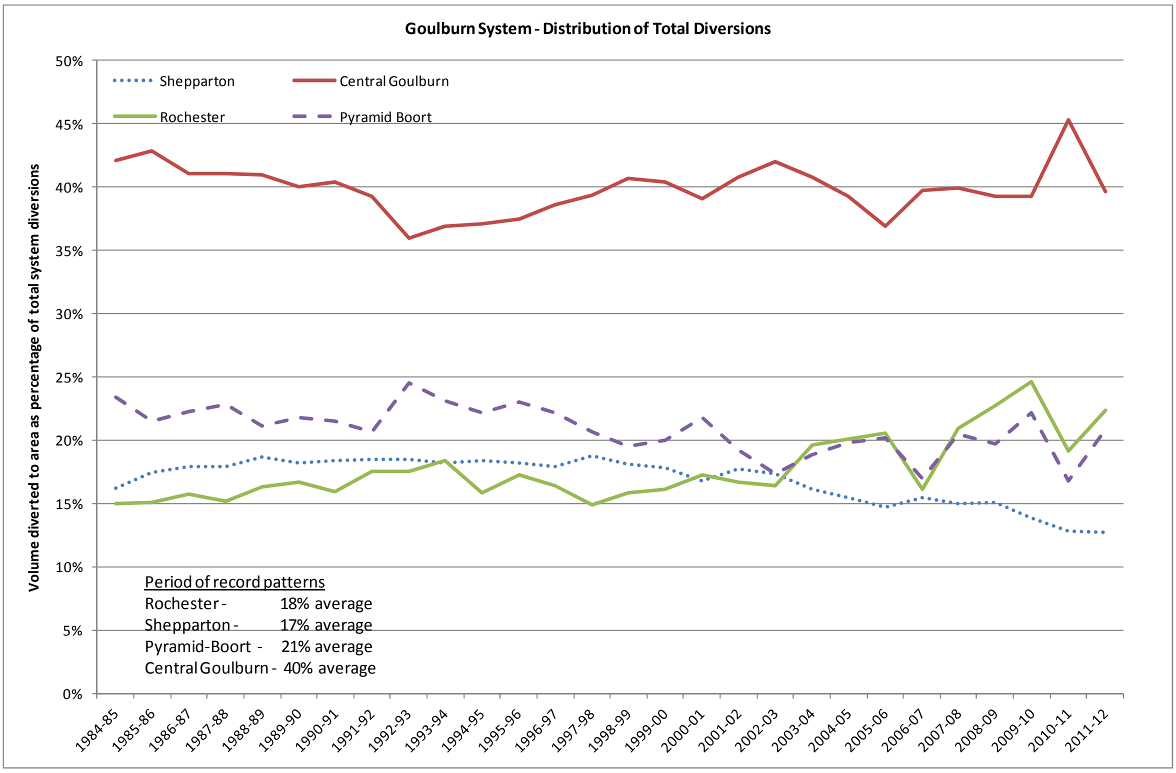

Figure 9: Goulburn system Irrigation District shares of total diversions

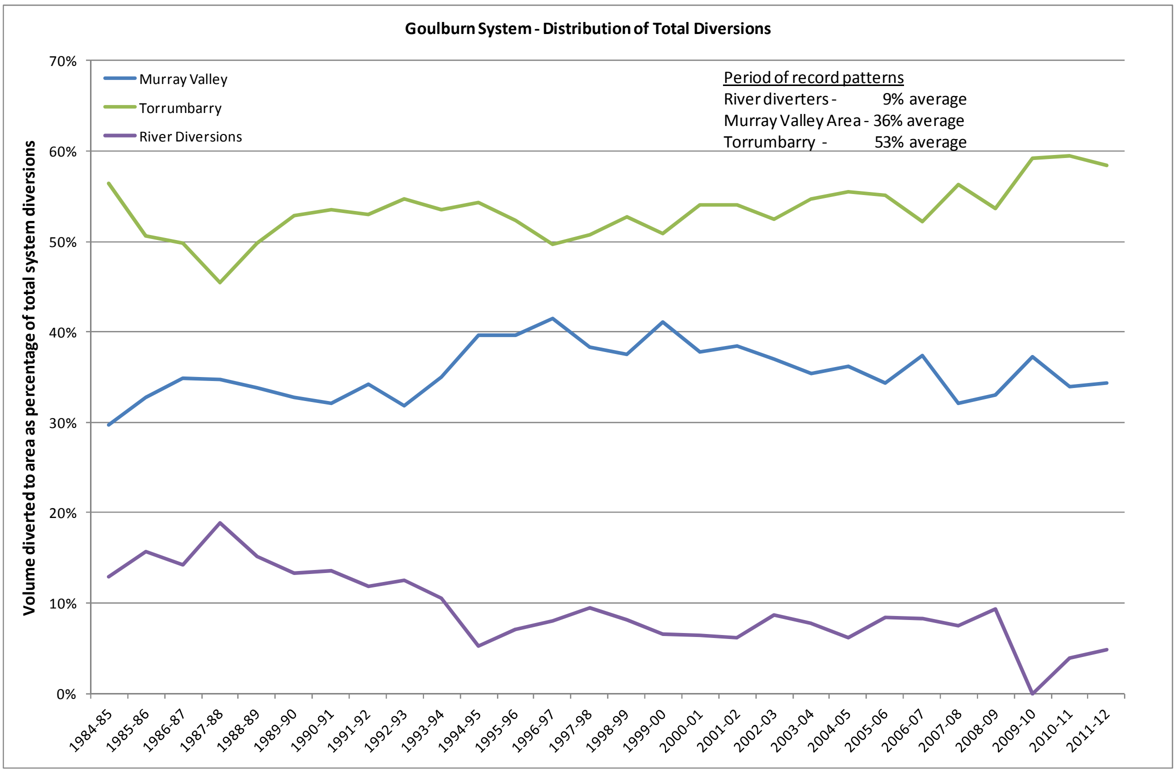

Figure 10: Victoria Murray Irrigation District shares of total diversions

5. UNDERSTANDING OF IMPACTS OF SALINITY CHANGES

The links between changes in water use and impacts on salt mobilisation are the core focus of the ISAF. The approach taken in this project was to determine overall risks (relating to accountability) and to develop a framework that considers the level of effort to assess accountability commensurate with the risk.

The process of identifying risks focussed on the unique and established relationships between water application and salt mobilisation in each irrigation district. The analysis of data sets for drains and tributaries then provides a scalable outcome for a water use adjustment scenario.

- Murray Valley Drains are a very small influence and the cessation of drainage discharge in recent times indicates that irrigation water use may not need to be reduced by a significant amount in order for salt discharge to the River to cease. Salt loads reduced to negligible levels during the post 1998 period. This provides an indication that the forecast reductions in future water availability may be a low priority for further assessment of irrigation related salinity impacts.
- Shepparton drains convey a mix of irrigation runoff, rainfall runoff, groundwater accessions and groundwater control pump discharge to receiving waterways. The results of historic assessments show that the works and measures that increase the flow and salinity of drainage water are modest. Whilst climatic influences have caused drying and reduced salt loads, the magnitude of water use change is unlikely to result in significant salinity changes and is therefore a lower priority for further assessment of irrigation related salinity impacts.
- NSW Drains have been shown to be different in that they were constructed shallow and do not generally intersect watertables. Combined with their ability to reduce accessions to watertable they generally do not have the same effect on salinity as say the Shepparton drains This provides an indication that the forecast reductions in future water availability may be a low priority for further assessment of irrigation related salinity impacts.
- Torrumbarry – The analysis of any data from this system is complicated due to the throughflow nature of the system. BigMod inputs from Lake Boga, 6/7 and Koondrook are all determined by irrigation system management and much of the Kerang Lakes is a salt balancing district. For the most part it is a salt sink. As a result the assessment of the impact of any changes is complex and requires more resources to complete.

  Previous work completed indicates that the potential debits and credits resulting from water use change may be significant and can result in debits and credits depending on the nature of the water use change. This suggests that there should be a higher priority on providing resources for the assessment of salinity impacts here.

The general approach adopted for the project was to apply existing knowledge of the links between water use and salinity above to undertake a risk assessment.

6. FRAMEWORK FOR ASSESSING FUTURE ACCOUNTABILITIES

6.1 Completion of a risk assessment

The framework for developing an ISAF was initially scoped by completing a risk assessment of the spatial and temporal risks associated with salt mobilisation. The following is a summary of considerations required to feed into a robust ISAF:

Spatial risks

Irrigation induced salt mobilization is relatively well understood across the Riverine Plains. Groundwater salinity, height of groundwater above the drain, drainage intensity, proximity to the river and river reach are the most important factors driving the EC impacts at Morgan arising out of irrigation in the Riverine Plains.

Relative to the eastern parts of the Riverine Plains, the western parts have higher groundwater levels, more saline groundwater and higher EC impacts at Morgan per tonne of salt exported to the river.

The assumptions underpinning BigMod suggest that the river salinity impacts of irrigation in the Riverine Plains are somewhere between 40.8 EC (all associated with irrigation drains) and 63.3 EC (incorporating 40.8 EC from irrigation drains plus an allowance of 22.5 EC for displacement of groundwater to the River from the Torrumbarry Irrigation Area).

The Torrumbarry Irrigation Area assumes a high priority in the establishment of the ISAF as around 85% of the irrigation salinity impacts in the Riverine Plains are generated there yet only accounts for around 10% of the irrigation water use on the plains. Within Torrumbarry there is one high impact zone, Barr Creek, where around 5% of the total water on the Riverine Plains is used.

In all other parts of the Riverine Plains outside Torrumbarry the salinity impacts of irrigation are broadly comparable and are much lower impacts on river salinity. Large changes in irrigation volumes (5 GL to 50 GL) are required there to trigger an accountable action under the BSMS – that is a change of plus or minus 0.1 EC at Morgan.

This lower priority and the potential to minimise transaction costs for monitoring, assessment and reporting suggests that there is no imperative to develop a complex ISAF for this region.

Temporal risks

The analysis carried out in Phases 1 and 2 of this project confirms that water and salt mobilisation in the period from 2000 to 2013 are much lower than in the benchmark period (1975-85 with river conditions of 1975 to 2000).

The 1975 to 2000 period was relatively stable in climatic terms; without extended droughts. By contrast, analysis of the post 2000 data provides evidence of many changes, some of which can be used to assess the risks associated with potential future changes.

The Phase 2 analysis shows that, based on experience in the recent drought, relative to the benchmark period, salt loads at the western end of the Riverine Plains would be up to 60% lower in a drier future while irrigation salt load exports would be up to 80% lower.

Victorian diversions during the seven-year drought period (2002/3 to 2008/9) may be indicative of long-term expectations under the Basin Plans Sustainable Diversion Limits (SDLs) for Victoria; the main difference being that, there was very low rainfall and in the absence of climate change, rain falling on the wet parts of the catchment would be expected to have a bigger impact on water tables than that experienced during the drought.

The low salt loads exported during the recent drought may, however, show some indication of the salt loads exported in a drier future – that is very low salt exports and potentially high claims for EC credits. For Victoria, the impacts of the drought provide a reference for a likely upper bound EC impact of both a very dry climate sequence and the implementation of the SDL.

It is important to note that the same would not apply for the Riverine Plains in NSW; the diversions there were lower in the recent dry period than would be expected under the proposed SDL. (In dry years water tends to trade from NSW rice-growing areas to Victorian dairying areas and horticultural areas in the three southern states. By contrast, in wet years, the trade tends to go the other way. These generalised trends are of course moderated by the short-term relativities between commodity prices). However, the indications are that peak water use will be lower, partly due to the consolidation of the water market and the use of carry over water, with water moving to years of lower water availability.

During wetter than benchmark periods salt loads are expected to be higher. For example, the salt loads from Torrumbarry during the relatively wet 1984-95 sequence (SKM 2006) were around 20% higher than the benchmark. The impact on River EC may be less of an issue, as river flows will be higher in wet periods.

Defining change

Defining changes in irrigation is problematic due to the need to differentiate underlying changes in long-term water use both from short-term variable changes and water access entitlement movements.

There is a policy setting that allows for a stationary data set to be used in order to remove the influence of this variability. Both Victoria and NSW operate under the Murray Darling Basin Cap on Diversions, and there are agreed and consistent, audited, processes used to define the cap volume and adjustments to it.

- In Victoria, the total volume of annual use limits on water-use licenses in the Riverine Plains irrigation districts are very high relative to normal usage which reflects the land-use being dominated by flood irrigation of pasture. They are also high relative to potential seasonal allocations against water entitlements. Consequently, they are conservative in the sense that if they were to be used as a surrogate for irrigation water usage they would overestimate salinity impacts – unless over time they were somehow reduced to reflect actual usage and/or land-use.
- In NSW the issue is much simpler; virtually all general security water is associated with usage in the Riverine Plains (as defined in the brief for this project) – consequently the cap-adjusted volume for NSW Murray general security water reflects more closely the maximum water available for use in the Riverine Plains. The exception will be wetter years when demand is low relative to the irrigation footprint.
- In NSW, changes in the cap-adjusted volume to NSW Murray reflect real changes in the maximum potential use and have the advantage of being audited and accepted by jurisdictions. The accumulated cap adjustments are a real indicator of change in the volume available for irrigation. The NSW cap falls as water is removed from the consumptive pool to be used, instead, for environmental flows.
- In Victoria the changes to the cap-adjusted volume in the Goulburn/Broken/Loddon also reflect real change and could be used in a similar manner to that discussed for NSW. It may be worth disaggregating that change down to individual districts, but this may not be a priority given that irrigation salinity impacts in those districts are all comparably low and the extent of change to date (for example, buybacks and water trade to the Mallee) is relatively evenly spread across the GMID. However, there would need to be consideration of disaggregation for any Goulburn entitlements that are used outside the Riverine Plains eg. Goulburn entitlement that is used in the Mallee.
- In terms of the Victorian Murray, change in the cap-adjusted volume is more difficult to apply meaningfully as a surrogate for actual annual use in the Riverine Plains. The Victorian Murray cap-adjusted volume includes the relatively large volume used for irrigated horticulture in the Mallee and a smaller volume delivered to the Wimmera-Mallee domestic and stock system. Moreover, the total volume used in the Victorian Murray has increased as Goulburn entitlements started to be used in the Mallee. Therefore this volume needs to be disaggregated between the Victorian Mallee and the Victorian Riverine Plains. The Victorian Riverine Plains needs to be further disaggregated to distinguish between Torrumbarry (both Barr Creek and the rest of Torrumbarry) and the Murray Valley irrigation areas. This process need not be complicated; it could be based on a five-year moving average of usage in each of these areas - as reported in the annual reports from the relevant water authorities. However, defining the baseline conditions for historic usage in each of these areas for the benchmark period would require some examination of historical usage in order to determine

the change If done, this would then be part of the five-year review cycle for register entries. DPI Victoria maintains a GIS database of water use for the GMID that could inform this.

- Once the SDLs are fully incorporated into the cap adjustments then there will be lower diversions and a credit claim is potentially possible as the diversions, in Victoria, might be broadly similar to the 2002/3-2008/9 drought sequence when salt exports were very low relative to 'average' climatic years. The actual accountability for any Register claim for SDL adjustments will need to be worked through between the Commonwealth and the relevant accountable jurisdiction

Dilution

- Salt loads in the Murray system will be diluted by increased environmental flows. Dilution will be significant; the current BSMS protocols call for a register item to account for it. In fact, there are already some Register A items for dilution flows; they reflect changes against the baseline conditions.
- For our purposes the destination of the environmental flows are unknown and so the dilution component cannot be determined. Therefore, the salinity impacts being contemplated for the Riverine Plains ISAF are based on two key assumptions. The first is that current diversions will continue. The second is that a significant component of the water previously being used will benignly evaporate; its disappearance will neither increase nor decrease river salinity.
- The second assumption is more implicit than explicit, and it is entirely reasonable in the context of water trade between irrigators in different irrigation districts. However, it must be made more explicit in the context of a significant volume being returned to the environment. In reality these reductions will be used to change the flow regime, in a yet to be determined manner.
- The impact of these additional dilution flows will be significant and may reduce the EC impacts along the river by a very large percentage.
- Based on our understanding of the Riverine Plains, and a very rough analysis this could feasibly be around 20% to 50% of current baseline flow EC impacts depending upon the flow regime.
- Another way to look at this would be to use the SIMRAT Look-Up table (URS et al 2004) to assess the dilution impacts for the transit of water. The transit impacts of 1,400 GL (30% of historic cap usage in the Riverine Plains meet the Basin Plan SDL) could be 70 EC credits, depending on timing and the destination of environmental flows.
- It is important to note here that the use of environmental water may in some circumstances increase river salinity. This may be the case for Chowilla, for example. Even so, moving the water to Chowilla would increase dilution flows in the Riverine Plains.
- These issues are ostensibly exogenous to this project, but the BSMS will need to have a clear position on this. For example, who will own the dilution credits? Should they perhaps be built into the River Operations credit and debit entries on Register A? Perhaps both water use and River Operations should be reviewed together?
- It is understood that the interstate trading rules specify how the salinity effects of interstate trades are to be accounted (though it is unclear to the present authors if these rules apply to areas outside the original interstate pilot project – Nyah to Goolwa – or indeed if they are still current). These are as follows (URS et al 2004 for the MDBC):
  - Any salinity debits or credits arising from the dilution effects of a trade into (or out of) South Australia are to be assigned to the upstream State involved in the transfer.
  - Any salinity debits or credits arising from the dilution effects of a trade between NSW and Victoria are to be shared equally between those two States.
- Any salinity debits or credits arising from changes to salt accessions are: (a) to be assigned in NSW and Victoria to the state in which the change occurs; and (b) to be treated as a requirement in SA for zero salinity impact.

6.2 Guidance for the application of the ISAF for Riverine Plains

The following section was developed at a workshop of the steering committee to discuss the application of the proposed ISAF.

Underlying BSMS principles

- Jurisdictions continue to be required to register individual actions, and cumulative actions, that increase Morgan salinity by 0.1 EC or more.
- Jurisdictions are responsible for deciding whether or not to register actions that decrease salinity at Morgan by 0.1 EC or more.
- Unless and until decreases in Morgan salinity are claimed as credits the benefits accrue by inference to the River
- All register entries must satisfy the BSMS operational protocol; they must be evidence based and peer reviewed.
- The effort involved in quantifying register entries must be commensurate with the risk and the relative impact of the defined change.

A framework for assessing water trade within the Riverine Plains outside Torrumbarry

- Investigations have confirmed that, other than the Torrumbarry Irrigation Area, the risk of salt being mobilised by irrigation is relatively consistent and therefore relatively neutral across the Riverine Plains. See Table 6.2
- Given the relative consistency of irrigation impacts across the Riverine Plains, and the dynamic nature of actual water use on the Plains, it is unlikely that a complex ISAF requiring extensive monitoring and evaluation could be justified as being commensurate with the risk.
- Water trade within the Riverine Plains outside Torrumbarry should be treated as salinity neutral.
- Monitoring of other changes in water use should involve low-cost assessments of the irrigation footprint and trends in actual water use.
- Departure credits can be claimed if a policy is in place to prevent the return of water to land.

A framework for assessing water trade into, out of, and within the Torrumbarry Irrigation Area

- The risk of salt being mobilised by irrigation in the Barr Creek subsystem of the Torrumbarry Irrigation Area is an order of magnitude greater than the other parts of the Riverine Plains. See Table 6.1.
- The Kerang Lakes subsystem of the Torrumbarry Irrigation Area may be acting as a significant salt sink. See Table 6.1.
- The salinity risks associated with changes in water use within the Torrumbarry system make it a priority area for future investigations.
- Water reforms since 1988 have on balance tended to reduce the total volume of water used for irrigation in Torrumbarry.
    a. The BSMS accountable actions associated with increased irrigation in the Mallee largely depended on the trade of entitlements out of Torrumbarry . In other words, there has been a net trade of water entitlement out of Torrumbarry, mostly to Victorian Mallee.
    b. Modernisation of the irrigation delivery system in Torrumbarry involves a rationalisation in the total area being serviced by the delivery system. The total irrigated area is being decreased.
    c. The CEWH has purchased entitlements from irrigators in Torrumbarry.
- On the balance of probabilities, accountable actions in Torrumbarry to date are likely to involve salinity credits rather than salinity debits.

- System modernisation will be completed sometime in the next five years; detailed investigations after modernisation is complete would reveal more certainty than investigations before it is complete.
- Changes in water use in Torrumbarry should be brought into the five-year review process. The first review should commence when modernisation is complete.
- The review process should be kept simple in the first instance. More detailed investigations could only be justified if the balance of probabilities suggested an increase in salinity impacts – or if Victoria wished to claim a credit.
- Monitoring should involve an assessment of the irrigation footprint and trends in actual water use.
- Departure credits can be claimed if a policy is in place to prevent the return of water to land.

A framework for assessing the dilution effects of environmental water purchases

- Preliminary analysis suggests that the dilution flows arising from environmental water purchases are far more important than departure credits.
- Dilution credits will need to find their own way onto the register. No action required in this study and is not considered further.

Table 6.1: Indicative change in ML required to generate a BSMS accountable action

Zones [1]	Low estimate		High estimate	
	EC impacts per 1,000 ML	Reduction in water (ML) required to generate a BSMS accountable action (0.1 EC)	EC impacts per 1,000 ML	Reduction in ML required to generate a BSMS accountable action (0.1 EC)
Torrumbarry outside Barr Creek			-0.1(uncertain)	1,000
Mallee LI1			0	na
Murray Valley Victoria	0.002	50,000	0.008	12,500
Shepparton/ Goulburn/ Loddon Victoria	0.002	50,000	0.015	6,667
Mallee LI2			0.020	5,000
NSW irrigation	0.003	33,333	0.024	4,167
Mallee LI3			0.050	2,000
Mallee LI4			0.070	1,429
Mallee LI5			0.100	1,000
Mallee LI6			0.150	667
Torrumbarry Barr Creek (more detailed sub-zoning with a range of impacts is possible as per SKM 2008)	0.080	1,250	0.160	625
Mallee LI7			0.200	500
Mallee HI1			0.300	333
Mallee HI2			0.350	286
Mallee HI3			0.400	250
Mallee HI4			0.450	222
Mallee HI5			0.500	200

[1] Zone sorted by high estimate impacts for Riverine Plains zones (note the figures for the Mallee zones are assumed here to be at the high end of whatever range is implicit in their reckoning – this would be consistent with the conservative nature of the Mallee zoning system)

7. IRRIGATION SALINITYASSESSMENT FRAMEWORK

7.1 Draft ISAF

The proposed ISAF is simple, but is based on decades of salinity assessment, modelling and calibration with data across the Riverine Plains.

It is:

ΔEC Morgan = ΔEC Morgan/GL in zone x ΔGL in zone

Its application involves 3 basic steps:-

1) Determine salinity zone and its salinity coefficient ΔEC Morgan/GL – Table 7.1
2) Determine irrigation water use change ΔGL for the zone – To be determined for specific Cap Valley, irrigation district or based on other defined area/s
3) Apply formula.

As previously discussed this provides an assessment of the salinity impact from water departure (recovery), but not arrival (use) or transfer.

Table 7.1: ISAF coefficients for evaluating long-term changes in total water use in the Riverine Plains (assuming no climate change)

Description	Recommended by SKM in 2006 ∆EC Morgan/GL ∆EC Morgan/GL	Drainage system	Proposed for ISAF in this report for use in calculating changes in irrigation	
			∆EC Morgan/GL Low estimate (excludes unaccounted salt loads)	∆EC Morgan/GL High estimate (includes part of the unaccounted salt loads)
All areas outside Torrumbarry	0.0 to 0.05. Use 0.0	NSW drains.	0.003 Based on 4.5 EC from BIgMOD NSW drains	0.024 from SKM 2006.
		Murray Valley	0.002 from BigMod (average of 9.8 EC over 4,200 GL)	0.008 from SKM 2006
		Shepparton / Goulburn System	0.002 (average of 9.8 EC over 4,200 GL) from BigMod	0.015 from SKM 2006
Torrumbarry outside of Barr Creek	- 0.1 EC/GL. Water use reductions increase river salinity	Kerang Lakes area and other parts of Torrumbarry outside of Barr Creek	Could be negative. But changes to the Torrumbarry system make SKM 2006 coefficient of -0.1 EC/GL less certain. **More detailed investigation required.**	Parts of this could be as high as Barr Creek given similar highly saline groundwater & drainage (e.g. irrigation adjacent to Lower Loddon & Pental Island). **More detailed investigation required.**
Barr Creek	0.15 +. Use 0.25	Barr Creek as defined by zones in SKM 2008	0.08 to guard against risk of double counting with Barr Creek Strategy (see next section). This represents the upper bound of the lowest impact zone within Barr Creek.	0.16 from SKM 2008 (see next section. A higher coefficient may be warranted in certain parts of Barr Creek and for increases in irrigation above the baseline.)

7.2 Testing of ISAF

The proposed ISAF is a first order of assessment to determine whether the scope of a larger investigation for a register claim is justified. The improved understanding of the differences between Torrumbarry and the rest of the Riverine Plains is useful in this regard.

The indicative salinity impacts results associated with each of these scenarios was determined by applying the body of knowledge as documented in the Phase I and Phase II reports to the following four future water use scenarios:

- Reduction of 30% in a high impact zone
- Reduction of 30% across all irrigation in the Riverine Plains
- Reduction of 30% across the low impact zones
- Cease all irrigation

The summary of the low and high estimates that are generated from application of the proposed ISAF across the whole of the Riverine Plains using *Water for the Future* scenarios is shown in Table 7.2 below.

Table 7.2: Summary of Scenarios

Scenario – GL reductions	**Low Estimate & % reduction from BigMod total of 40.8 EC for irrigation drains**		**High Estimate & % reduction from BigMod total of 63.3 EC (irrig drains+Torrumbarry gwater)**	
1) Highest Impacts zones -1400GL	-18.6 EC	-41%	-59.0 EC	-93%
2) Uniformly spread -1400GL	-7.6 EC	-19%	-30.8 EC	-49%
3) All from lowest impact zones -1400 GL	-2.8 EC	-7%	-16.7 EC	-26%
4) All irrigation ceases -4519 GL	-24.5 EC	-60%	-99.4 EC	-157%

The results from the fourth scenario suggests that across the Riverine Plains the low estimate coefficients underestimate impacts as they are only 60% of the irrigation drainage flows from BIgMod. On the other hand, the high estimate suggests the coefficients may overestimate impacts by 157%.

Compared to the BigMod impacts the high estimates overstate the impacts for NSW irrigation, Goulburn and the Murray Valley supplied areas, and understate Barr Creek when Torrumbarry groundwater from BigMod is included.

One of the significant issues not included in the scope of this work on the ISAF is the impact of dilution impacts which are known to be very significant and need further analysis.

The decision to pursue a more detailed investigation and a potential credit claim will need to be based on size of potential claim (guided by the ISAF), demand for credits, the complexity and cost of that investigation.

7.3 Documentation of recommended ISAF

The ISAF has been developed to manage risks associated with changes in water use on the RIverine Plains. It is recommended that the decision process shown in Figure 11 be adopted to continuously assess district scale water use changes and to determine what actions are reasonable for partner governments to take to ensure ongoing compliance with the accountabilities set out under the BSMS.

A number of tools are also available to support the decision process including:

- Salinity Impact Coefficients – Figure 12 and Table 7.3
- Cap water use, diversion and trading data – See Phase 2 report for analysis of changes in actual and modeled data. Jurisdictions will need to determine how this data is sourced and managed in more detail beyond this project.

  The Cap data is produced annually in hindsight and would require some disaggregation to provide accurate district scale water use. The option in Victoria is to utilize the Water Register which could provide up to date water accounting data.
- BigMod data files and model runs – Phase 1 and Phase 2 reports describe the context for assessing seasonal variability

7.4 Further policy development and implementation

The specific technical procedures for assessing water use change have not been prescribed in this project report beyond the decision process above. However, there is and need beyond the outcomes of this project to undertake further work to define:

- The timeframes/period over which water use change should be assessed. Based on the analysis completed the frequency at which water use would ideally be assessed for 'water use change' would need to be greater than say two years to enable emerging trends to be observed. There is also a 5-year review process in place for Register items that could be adjusted to make the link between irrigation district scale water use and salinity impacts more prominent. There may be data sets, however, that can be collated at an annual frequency as part of the annual audit process that may be beneficial.
- Any BSMS and/or Cap reporting mechanisms that might be formally adopted to support the implementation of the ISAF. The reporting requirements and mechanism adopted for tracing water use change will provide an indication of what data and model protocols are necessary to support the ISAF.
- The nature of any agreement amongst the MDB jurisdictions on the data sets and models that will be required to support the ISAF will ideally be formalized.
- Considerations for updating the BSMS protocol/s to recognize the importance of tracking water use at district scale.

These, and possibly other items, will need to be considered by the MDBA and partner governments as part of the endorsement of the ISAF developed under this project

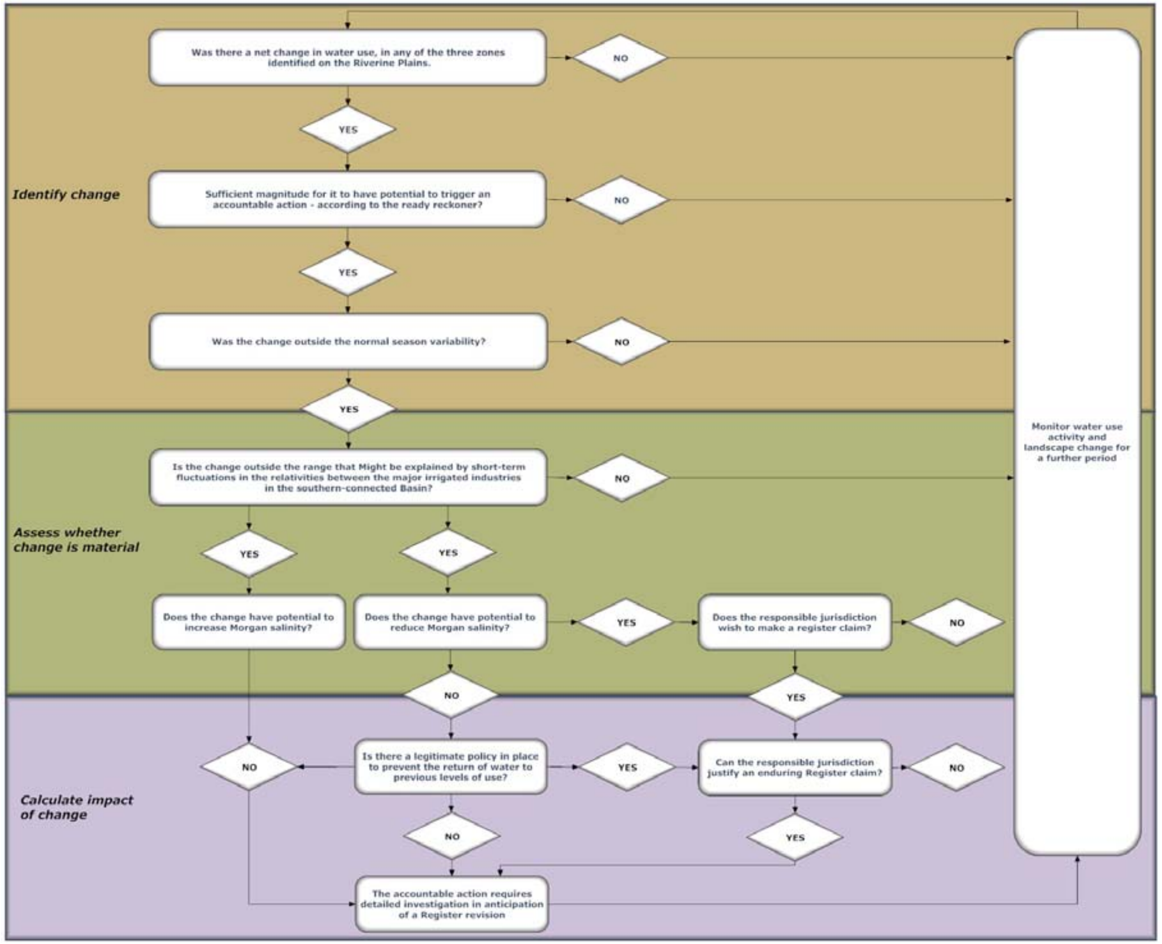

Figure 11: Recommended Riverine Plains Irrigation Salinity Assessment Framework

Figure 12: Proposed Riverine Plains Zoning map

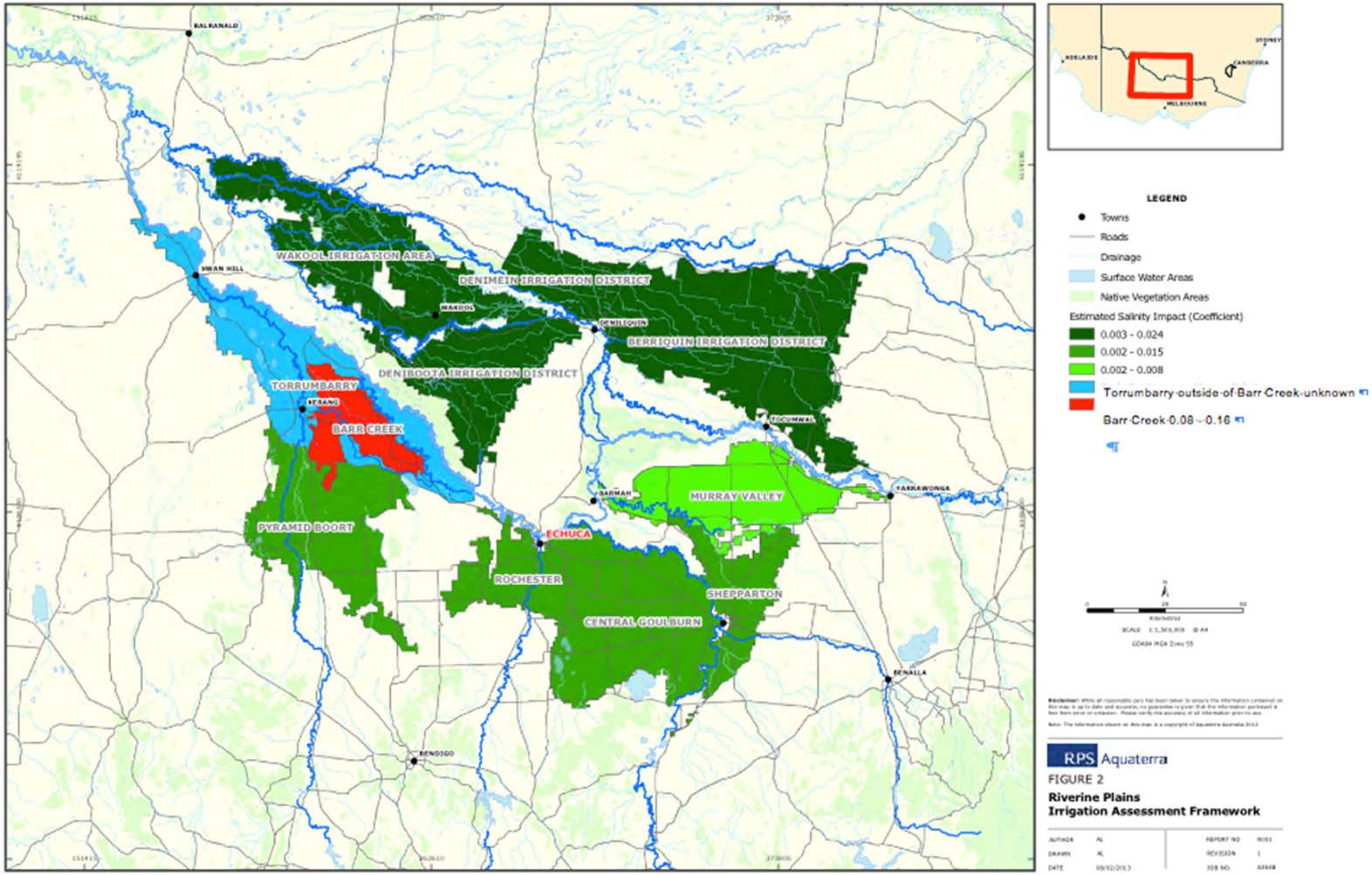

Table 7.3: ISAF coefficients for evaluating long-term changes in total water use in the Riverine Plains (assuming no climate change)

Zone	Description	Recommended by SKM in 2006 ∆EC Morgan/GL ∆EC Morgan/GL	Drainage system	Proposed for ISAF in this report for use in calculating changes in irrigation ∆EC Morgan/GL Low estimate (excludes unaccounted salt loads)	∆EC Morgan/GL High estimate (includes part of the unaccounted salt loads)
Green	All areas outside Torrumbarry	0.0 to 0.05. Use 0.0	NSW drains.	0.003 Based on 4.5 EC from BIgMOD NSW drains	0.024 from SKM 2006.
			Murray Valley	0.002 from BigMod (average of 9.8 EC over 4,200 GL)	0.008 from SKM 2006
			Shepparton / Goulburn System	0.002 (average of 9.8 EC over 4,200 GL) from BigMod	0.015 from SKM 2006
Blue	Torrumbarry outside of Barr Creek	- 0.1 EC/GL. Water use reductions increase river salinity	Kerang Lakes area and other parts of Torrumbarry outside of Barr Creek	Could be negative. But changes to the Torrumbarry system make SKM 2006 coefficient of -0.1 EC/GL less certain. **More detailed investigation required.**	Parts of this could be as high as Barr Creek given similar highly saline groundwater & drainage (e.g. irrigation adjacent to Lower Loddon & Pental Island). **More detailed investigation required.**
Red	Barr Creek	0.15 +. Use 0.25	Barr Creek as defined by zones in SKM 2008	0.08 to guard against risk of double counting with Barr Creek Strategy (see next section). This represents the upper bound of the lowest impact zone within Barr Creek.	0.16 from SKM 2008 (see next section. A higher coefficient may be warranted in certain parts of Barr Creek and for increases in irrigation above the baseline.)

APPENDIX A:
PHASE I REPORT

APPENDIX B:
PHASE II REPORT

APPENDIX C:
PHASE III REPORT