1. Introduction

This is a study of the shallow groundwater flow systems in the West Gippsland region. The project is focussed on defining the groundwater processes causing salinity in the region and is a key recommendation of the draft West Gippsland Salinity Management Plan (WGCMA, 2005).

1.1 The extent and effect of salinity in West Gippsland

Details on the extent, significance, causes of salinity in the region along with a recommended list of management actions can be found in the current draft of the West Gippsland Salinity Management Plan (WGCMA, 2005). The information below is a summary of the information on the extent and significance of salinity taken from the plan.

There are just over 24,000 hectares of mapped land salinity in the region (Figure 1) and approximately 26,500 hectares of wetland or lake salinity (Figure 2) that has at least some human induced origin. There are still gaps in the mapping of land and water salinity so these areas of salinity are likely to be an underestimate. The estimates of land and wetland salinity have come from regional vegetation mapping and various wetland studies respectively. More information on the origin and accuracy of these estimates can be found in the draft West Gippsland Salinity Management Plan (WGCMA, 2005).

The key types and causes of salinity include:

- **Irrigation induced salinity on irrigated land and adjacent dryland areas:** Irrigation causes an increase in the volume of groundwater recharge resulting in an increase in water table levels bringing salt close to the surface. This process is most prevalent in the Macalister Irrigation District and adjacent dryland areas stretching from the Heyfield/Rosedale area in the west to Lake Wellington in the east.
- **Ocean induced salinity:** Sea water intrusions to the low lying tidal floodplains in South Gippsland and the Gippsland Lakes through the permanent entrance at Lakes Entrance; and
- **Dryland salinity:** The clearing of native vegetation and the subsequent planting of lower water using crops and pastures has resulted in an increase in groundwater recharge and down-gradient watertable levels. This type of salinity is most prevalent in the South Gippsland areas around Yarram, Inverloch and Wonthaggi and the northern areas around Rosedale and the Red Gum Plains region of the Bengworden/Meerlieu area.
- **Natural (primary) salinity:** Some of the coastal and wetland salinity was present prior to European settlement and is, therefore, a natural occurrence.

This study is focussed on the groundwater processes causing salinity. Therefore, ocean induced salinity and the natural or primary salinity is not considered in the rest of this study.

The focus in this study is on dryland and irrigation salinity caused by irrigation and/or the clearing of native vegetation. An important distinction needs to be made between “dryland salinity” and “irrigation salinity in dryland areas”. For instance, much of the salinity in the dryland Clydebank area west of Lake Wellington is irrigation induced resulting from the transfer of groundwater pressures from the up-gradient Macalister Irrigation District. Conversely, most of the salinity in the Bengworden area is dryland salinity resulting from land clearing.

Of the 24,000 ha of mapped salinity in the region, approximately 11,000 ha has at least some irrigation-induced component leaving approximately 13,000 ha of dryland or natural salinity. It is often difficult to distinguish between natural and induced salinity but it is expected that there is approximately 2,300 ha of natural salinity leaving approximately 10,700 ha of induced dryland salinity. The key areas of salinity include:

- The alluvial flats around the Tarraville, Yarram and Port Albert areas;
- The low lying hills and flats around the Wonthaggi and Inverloch areas;
- The low lying areas of the Red Gum Plains of the Bengworden and Meerlieu areas;
- The area in and around the township of Rosedale;
- The area around the southern margins of Lake Wellington and Lake Coleman; and,
- The Macalister Irrigation District and surrounding dryland areas.

Salinity has significant economic, environmental and social costs to the region's assets. The key economic impact of salinity is the loss in agricultural production of approximately $8.6 million per year and damage to infrastructure of approximately $2.2 million per year (SKM, 2004a). Also, the loss of environmental amenity, particularly the degrading of wetlands and rivers, can result in a decrease in tourism and the associated economic benefits to the local community. Read Sturgess (1999) estimated that the environmental and economic value of the wetlands may already have decreased by one third from the estimated value of the non-salinised state.

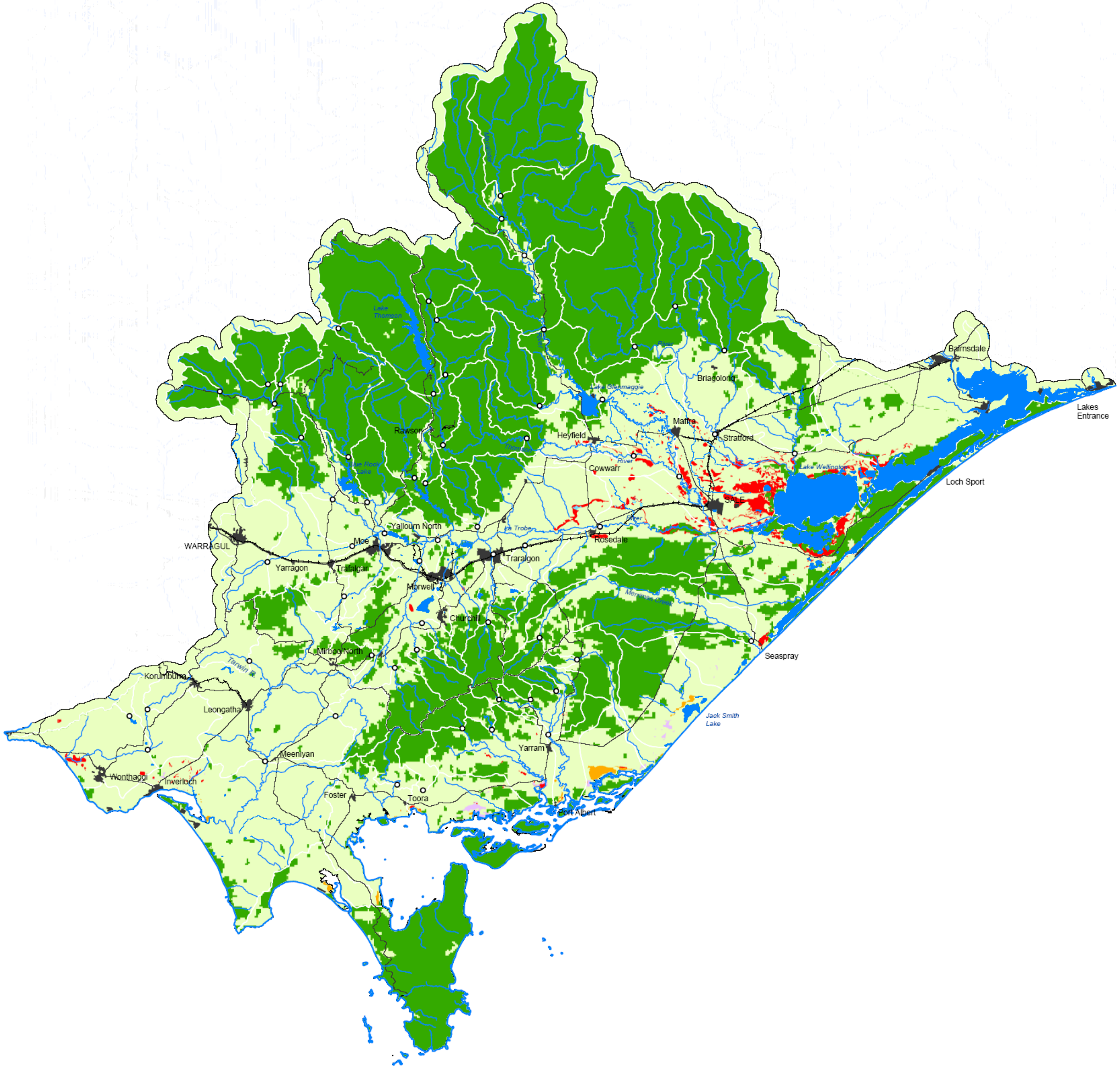
The main social impacts are the flow-on effects from reduced agricultural output including:

- Increased economic stress on farmers and their families;
- Increased unemployment; and
- Decreased economic and social well being of communities due to reduced farmer spending.

Environmental impacts of salinity are greatest for wetland and lake assets in the region. For instance, the opening of the permanent ocean entrance to the Gippsland Lakes at Lakes Entrance has resulted in the salinisation of Lake Wellington and many adjoining wetlands. Also, there are approximately 3,740 ha of native vegetation within mapped saline areas including 1,160 ha of native vegetation classified as rare, vulnerable, endangered or depleted.

Overall, stream water salinity generally complies with the environmental guidelines stated in the EPA's State Environment Protection Policy (Waters of Victoria) except for some tributaries of the Latrobe River in the Latrobe Valley/Rosedale area (Anderson's Ck, Bennetts Ck, Sheepwash Ck), Merrimans Ck at Seaspray, the Perry River and two drains in the Macalister Irrigation District (Bundalaguah Drain and Nuntin Ck).

More information about the extent and effect of salinity in the region can be found in the draft West Gippsland Salinity Management Plan (WGCMA, 2005).



Department of Primary Industries

West Gippsland shallow groundwater flow systems

LANDSALINISATION (type)

0 10 20 30 40 50 Kilometres

Catchment Boundaries

Gauge Stations

Salinity Type

- Induced or Secondary Salinity
- Natural or Primary Salinity
- Combination of Natural and Induced Salinity
- Unknown

NOTES:

Catchments.
Catchment boundaries have been compiled for the stream gauging stations shown. Along the coast, additional boundaries were compiled to differentiate stream basins downstream of the lowest gauge. All boundaries were hand drawn based on the 1:100,000 topographic map series. The boundaries have not been calibrated to the digital terrain model or the 1:25,000 data used for this project.

Salinity
Land salinisation data compiled from:
1) DNRE mapping in the South Gippsland region
2) WGCMA mapping in the Macalister Irrigation District and surrounds, and
3) DSE in all other areas.
Map first appeared in WGCMA (2004).

Refer to Sinclair Knight Merz document
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Figure 1

West Gippsland Salinity Management Plan

Wetland Salinity Type

Wetland salinity
- Induced or Secondary Salinity
- Combination of Natural and Induced Salinity
- Natural or Primary Salinity
- Unknown
- Non-saline

Wetland salinity type has been interpreted from comparison between the DSE GIS layers of wetland status in 1788 and 1994

Refer to Sinclair Knight Merz document WCMS\wc02655\technical\gis\Wc02655t005.apr; Wetlands 1994 (Layout) 2

Figure 2

1.2 What are groundwater flow systems and why are they important for management of dryland and irrigation salinity?

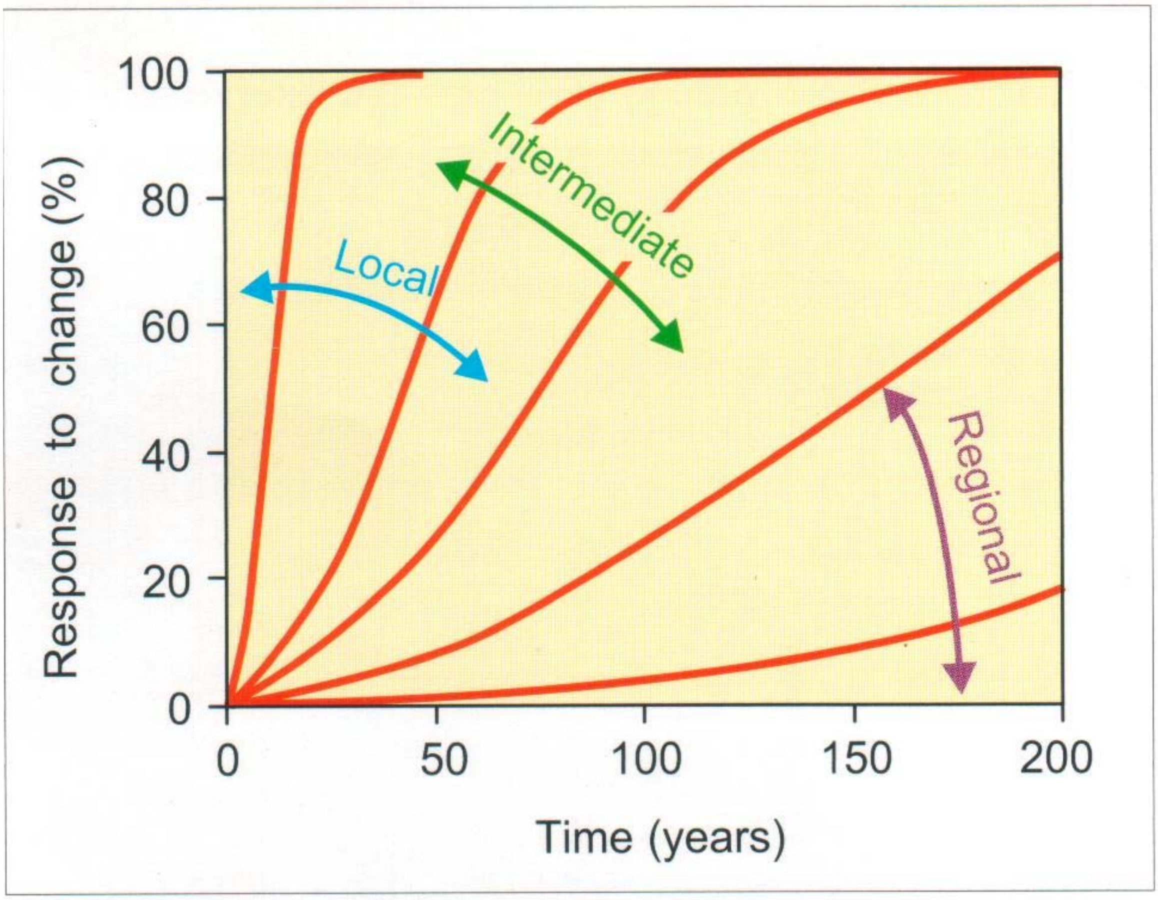
"Groundwater flow systems characterise similar landscapes in which similar groundwater processes contribute to similar salinity issues and where similar salinity management options apply" (Coram *et al.,* 2001).

Knowledge of the type of groundwater flow systems that contribute to the discharge of groundwater in salinised areas is critical to developing management options that address the cause of the problem. The time taken for recharge control measures to affect discharge areas is largely dependent on the scale of the groundwater flow systems. Generally, the larger the scale of the groundwater flow systems, the slower the response to changes in recharge. Walker *et al*. (1999) classifies dryland catchments into three main groupings:

- Local flow systems – extend only a few kilometres along a groundwater flow path with a relatively rapid on-set of salinity post clearing. Response times to land management change to reduce recharge are relatively rapid (less than 50 years).
- Intermediate flow systems – approximately 5 to 50 kilometres in length and may take 50 to 100 years for dryland salinity problems to become evident post clearing. Response times to land management change to reduce recharge are in the range of 50 to 100 years.
- Regional flow systems – typically greater than 50 kilometres in length and may take in excess of 100 years for dryland salinity problems to become evident post clearing. Response times to land management change to reduce recharge are long (greater than 100 years).

The generalised groundwater responses to change are summarised in Figure 3 (from Walker *et al.,* 1999). Although the analysis by Walker *et al.,* (1999) relates to dryland catchments, a similar principle operates in irrigation areas although the process is accelerated through the addition of irrigation water. Figure indicates that local and intermediate groundwater flow systems respond to change more quickly than regional systems and any remediation options will therefore take effect more quickly. Therefore, management options used to reduce land and water salinity need to be targeted towards the types of groundwater flow systems contributing to the problem.

- **Figure 3: Response times to change for different scales of groundwater flow systems (from Walker *et al.*, 1999)**



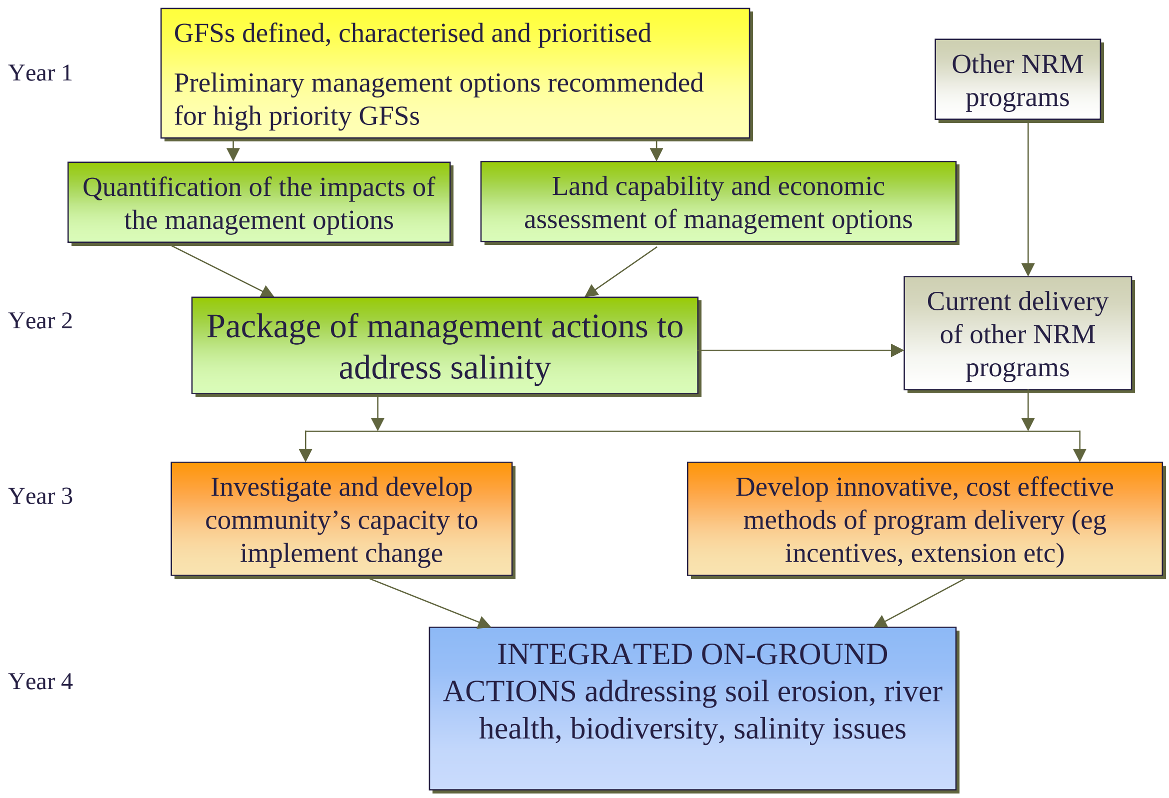
Defining groundwater flow systems is often dominated by the hydrogeological characteristics of the water table aquifer. Where the hydrogeological characteristics change along a groundwater flow path, it is possible for flow between groundwater flow systems. Thus, groundwater flow systems do not define specific groundwater flow cells but rather define areas of similar groundwater flow characteristics. However, it is important to note that the definition of groundwater flow cells is also very important for planning salinity management actions. Knowing the characteristics of groundwater flow systems can help define the groundwater flow cells.

1.3 The plan to address dryland salinity

The draft West Gippsland Salinity Management Plan outlines the key activities required to address salinity in the region. The dryland component of the plan notes that there is some information on the extent and significance of dryland salinity in the West Gippsland terrain, little investigation on the causes of salinity and almost no investigation of appropriate management options. The management options detailed in the current draft of the Plan are based on a very basic level of understanding of the causes of dryland salinity in the region. This project is focussed on providing more detail on the causes of dryland salinity to allow for future planning of appropriate management options.

The draft West Gippsland Salinity Management Plan outlines a "road map" for collecting the information required to ensure appropriate management options can be recommended (Figure 4). The road map also provides a plan to ensure that management options which address a number of other natural resource management issues are integrated to ensure multi-benefits are exploited as much as possible. This groundwater flow systems study is a key component of this overall road map.

- **Figure 4: "Road map" for addressing dryland salinity and other related natural resource management issues in dryland catchments (from the draft West Gippsland Salinity Management Plan (2004))**



1.4 Project scope

This project will characterise the groundwater flow systems in the West Gippsland region with specific focus on those systems causing dryland salinity. This requires a knowledge of a variety of physical characteristics such as local geology, hydrogeology, soils, vegetation, landform and climate.

Given the focus on salinity issues, this project is focussed only on the groundwater flow systems of the water table aquifer. The Gippsland area contains a very deep sequence of unconsolidated sediments with a number of significant regional aquifer systems. The deeper aquifers are only discussed in this study if they have direct relevance or connection to the water table aquifer. For example, there are some instances where recharge areas for the deeper aquifers are close to the surface and are part of the water table aquifer (eg on the margins of the Strzelecki Ranges in the Yarram area. Also, there may be instances where upward pressures from deeper aquifers influence the overlying water table. Conversely, in the Yarram region where the groundwater levels in the deeper Latrobe and Balook Formation Aquifers have been dropping for a number of years, there may now be a potential for downwards groundwater flow from the water table. However, there is very little data to support this process and it requires further investigation to confirm.

The objectives of the project are to:

- define and characterise groundwater flow systems in the region with specific focus on the systems causing salinity;
- broadly assess salinity management options suited to each of the key groundwater flow systems causing dryland salinity; and
- scope the next phase of the investigation involving a quantitative assessment of management option effects.

The key outcomes of the project will be:

- An increased agency and community awareness of Groundwater Flow Systems and the role the systems play in the appearance and management of salinity in the region; and
- NRM decision-makers will be equipped with the tools to assist in the prioritisation of impacts and works to manage salinity in West Gippsland.

1.5 Methodology

The method used to achieve the above objectives and outcomes included:

- Preparation of a ‘discussion document’ outlining an initial definition of the shallow groundwater flow systems in the region based on a broad literature review (SKM, 2005)
- Holding a workshop involving key technical, agency and community representatives;
- Revising the definition of the groundwater flow systems presented in the discussion document based on the feedback from the workshop; and
- Compiling information on the implications of the groundwater flow systems for salinity management and scoping the next phase of the process.

The workshop was held on the 24th and 25th February 2005 at Foster. The first day of the workshop concentrated on the definition and characterisation of the groundwater flow systems. The second day focussed on the key salinity management options for each of the priority groundwater flow systems.