A New Direction for Salinity Management in Western Australia: A Consultative Review

A report for the Department of Primary Industries and Regional Development

March 2019

Executive summary

In May 2018, the Office of the Auditor General (OAG) published an audit into the Management of Salinity and recommended that the Department of Primary Industries and Regional Development (DPIRD), in consultation with the Department of Biodiversity, Conservation and Attractions (DBCA) and the Department of Water and Environmental Regulation (DWER), set a strategic direction for salinity management for WA and improve monitoring, cooperation, coordination, promotion of soil conservation, and compliance of salinity impacts and its management.

The OAG's audit focused on two key questions,

1. Do agencies know the extent and impact of dryland salinity in the South West agricultural regions?
2. Are efforts to reduce the impacts of dryland salinity in the South West regions working?

To respond to these questions, DPIRD commissioned an independent review of state and federal government salinity policies and programmes and their effectiveness in addressing salinity. This review included consultation with key agencies on the effectiveness of a range of government programmes that had investment in salinity management and research and a workshop that involved more than 35 stakeholder groups, each representing ranging perspectives on salinity extent and management.

The overall conclusion of this review is that salinisation of land and water remains a significant problem. The review found that since 2006, there has been limited investment into the economic and environmental impacts of salinity and that studies of feasible and cost effective management options have not been updated in recent times.

To answer the two questions posed by the OAG, this review finds that:

- Agencies do not know, accurately, the changes in extent and impacts of secondary dryland salinity since the last quantitative measure in 2000.
- There has been successful reduction of the impacts of secondary dryland salinity in discrete areas, but at the gross level, reduction of impacts has been very limited.

In response to these findings, two key actions are recommended:

1. Update data on the extent and impacts of dryland salinity
2. Target investment of public and private funds in four key areas: Information, Governance, Innovation and Investment (described below)

These key areas are presented as the 'Pillars' for the New Direction in Salinity.

Information

The Information Pillar focusses on effective monitoring and evaluation on the extent and trend in salinity and improving knowledge on tools to manage salinity. These tools include land management practices, for example the productive use of saline land, native vegetation management and engineering options. This information provides both the quantitative and qualitative data required to inform investment decisions by Government and the private sector in salinity research, management and communication.

Governance

The Governance Pillar supports the coordination of Government action and engagement with industry and communities. Renewed emphasis on coordination of actions by government departments with regional NRM groups, industry groups and landcare network will provide a more effective response to the environmental, economic and social impacts of salinity. This Pillar considers the opportunity for a new Soil and Land Conservation Council (SLCC) whose role would include providing strategic advice to Government as well maintaining a commitment to genuine community involvement at State and regional levels.

Innovation

The Innovation Pillar invests in new ways of thinking and approaches in not only managing the impact of salinity but developing profitable solutions for saline land, for example, grazing systems, drainage and innovative water use. This Pillar maintains the important role Government has in setting research priorities in dryland salinity where this is undertaken in consultation with research leaders from both the public and private sector. Research priorities in this new direction for salinity includes innovative approaches to integrated valley floor farming, carbon farming, conservation plantings and sustainable agriculture systems that improve salinity management. Enabling information flow and mechanisms for private industry to develop opportunities for investment in these areas is an important change.

Investment

The Investment Pillar acknowledges three primary sources of investment in salinity management: state government investment for the protection of public assets, federal government investment priorities as identified in various natural resource management programmes and private investment in salinity research and management. Each of these sources of investment has an important role in salinity's new direction. While an important action for government is to identify and invest in important public assets, government has an equally important role in influencing the national agenda in NRM investment as well as stimulating and supporting private investment.

A summary of the key actions and intended outcomes for each Pillar is shown in Table 1.

Limitations

This report has been prepared by GHD for the Department of Primary Industries and Regional Development. GHD otherwise disclaims responsibility to any person other than the Department of Primary Industries and Regional Development arising in connection with this report.

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Table 1 Summary objectives and actions for the four Pillars for salinity management

Pillar	Objective	Actions
Information	To provide up-to-date and relevant information on the status of salinity and tools to manage salinity to inform decision-making by government and other stakeholders.	- DPIRD to undertake an assessment of the current area of salt-affected land and salinity hazard areas as a priority and determine an appropriate review period or ongoing assessment, e.g. five years, ten years. - DWER to prepare a status of stream salinity report by 2020. - DPIRD, with DBCA and DWER to prepare a Salinity Situation Statement 2020, in consultation with government, industry and community, on status and response to dryland salinity in Western Australia. - Information on salinity management options to be revised in consultation with key knowledge providers with effective knowledge transfer to land managers and decision-makers.
Governance	To provide strategic advice and coordination to government, industry and community	- WA Government to establish the Soil and Land Conservation Council (SLCC) to provide strategic advice on salinity and other land degradation as a priority. - DPIRD to facilitate improved integration of government actions across salinity management and broader land degradation issues. - DPIRD to facilitate increased engagement, coordination and collaboration with regional NRM, catchment, grower, and Landcare groups. - The SLCC, with the Soil and Land Commissioner, to assess options to streamline compliance and mitigate disputes and offsite impacts by 2019.
Innovation	To enable and facilitate the development and delivery of innovation to enhance the management of salinity and adaptation to its impacts.	- DPIRD to coordinate the development of a plan for salinity management and mitigation research with key RDCs, research providers, government and grower groups by 2020. - DPIRD to assess land tenure options such as leases and covenants to enable viable and marketable areas for grazing, carbon and conservation in salt-affected and other low productivity areas that impact salinity by 2019. - DPIRD to develop and provide up-to-date information on opportunities and issues with carbon farming and sustainable agriculture in salt-affected areas from 2019 to enable private public partnerships.
Investment	To provide effective investment by government and private to recover or manage salinity assets at risk	- DBCA to review biodiversity priorities in the context of a revised salt-affected land assessment by 2020. - DWER to review Water Resource Recovery Catchment approach and catchments in the context of a revised salt-affected land assessment and stream salinity analysis by 2019. - DPIRD, in consultation with MRWA and local government, to review critical infrastructure at risk from revised assessment of salinity risk by 2019. - DPIRD, in consultation with DBCA and key stakeholders, to assess role for government in creating opportunities for private investment from perspectives of carbon, biodiversity and sustainable agriculture by 2019. - DPIRD and DBCA to engage with Commonwealth government departments on priorities for salinity management for NRM programs. - Prepare a Salinity Investment Framework Phase III

Acronyms

ABS	Australian Bureau of Statistics
CALM Act 1984	*Conservation and Land Management Act 1984*
CAR	Comprehensive, Adequate and Representative
CAWS Act 1947	*Country Areas Water Supply Act 1947*
CDI	Catchment Demonstration Initiative
CRC	Cooperative Research Centre
CRID	Collie River Irrigation District
DAFWA	Department of Agriculture and Food Western Australia
DAWR	Department of Agriculture and Water Resources
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DoEE	Department of the Environment and Energy
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
EEI	Engineering Evaluation Initiative
EPBC Act 1999	*Environment Protection and Biodiversity Conservation Act 1999*
FPC	Forest Products Commission
GRDC	Grains Research and Development Corporation
ha	Hectares
mgL^{-1}	Milligrams per litre
Mha	Million hectares
MIDAS	Model of Integrated Dryland Agriculture System
MLA	Meat and Livestock Australia
MRWA	Main Roads Western Australia
NAP	National Action Plan for Salinity and Water Quality
NDSP	National Dryland Salinity Program
NHTA Act 1997	*National Heritage Trust of Australia Act 1997 (Cth)*
NRM Act 1992	*Natural Resources Management (Financial Assistance) Act 1992 (Cth)*
NRM	Natural Resource Management
OAG	Office of the Auditor General
RCA	Rapid Catchment Appraisal
RDC	Rural Research and Development Corporations
RD&E	Research Development and Extension

RT-LA	Rural Towns – Liquid Assets
R&D	Research and Development
SGSL	Sustainable Grazing on Saline Land
SIF	Salinity Investment Framework
SLC Act 1945	*Soil and Land Conservation Act 1945*
SLCC	Soil and Land Conservation Council
STF	Strategic Tree Farms
TDS	Total Dissolved Solids
UWA	University of Western Australia
WA	Western Australia
WA SAP	West Australian Salinity Action Plan
WDE	Wheatbelt Drainage Evaluation
WRRC	Water Resource Recovery Catchments (Controlled Catchments)

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1. Introduction

1.1 Extent of salinity

The WA Wheatbelt is approximately 18 million hectares (ha) with grains, wool and livestock the dominant industries. Agricultural production from these broadacre industries generates an average annual income of $6 billion increasing to $13.2 billion as an overall contribution to the WA economy based on a multiplier of 2.2. The most recent calculation of salt-affected land estimates that 1 million ha of land is affected, of which 821,000 ha is agricultural land (George et al 2005) with an annual average opportunity cost of $519 million (OAG 2018). Historical estimates indicate that another 1.8 to 3.5 million ha is within salinity hazard areas.

Agricultural production is not the only asset impacted by salinity. Biodiversity on public and private land, rural towns, water quality (and therefore supply), road and rail infrastructure are the public assets at risk of loss or damage due to rising groundwater and salinity. In 1998, an estimated 450 plant species were identified as only occurring in salinity hazard areas and therefore at risk of extinction (State Salinity Council 2000; Keighery 2000). In 2010, the Department of Environment and Conservation (DEC) estimated that 850 endemic flora and fauna species were at threat of extinction as a result of dryland salinity.

In 1999, salinity was found to be rising in most rivers, including those used for potable water supplies (Hatton and Salama 1999). Stream salinity remains a major issue in many rivers of the south-west of WA (Mayer *et al* 2005). Estimates from 2006 and based on large-scale data, found that approximately 252 km of highways and main roads and 3850 km of local and unclassified roads are within salt affected areas, with a further 1194 km of highways and main roads and 22 960 km of local and unclassified roads potentially a high salinity hazard. The estimated present value of costs associated with increased repair and maintenance of roads if areas with a high salinity hazard become impacted was over $1900 million (Sparks *et al* 2006).

While previous studies estimate increases in the area impacted by salinity, the impact that the drying climate may have on salinity is less certain. With the extent of dryland salinity driven by excess water in the landscape, the decrease in winter rainfall has been thought to cause a slowing in the process of salinisation in many areas. Groundwater levels in parts of the Wheatbelt however have continued to rise, as shown in Figure 2. Stream salinities have also continued to increase, a trend largely attributable to the reduced volumes of fresh runoff diluting high salt concentrations in rivers flowing through saline landscapes. Conversely, in forested catchments where groundwater no longer intersects the valley, the salinity of the streamflow may have freshened.

Improving and protecting the condition of natural resources and infrastructure from dryland salinity is a slow process and requires long-term focus and investment. While significant investments were made in salinity research and management between 1980 and 2006, this investment has significantly reduced in recent years from both the Commonwealth and State governments with the exception being in 2017/18 with funding for the Myalup-Wellington project.

Given this context of reduced investment into salinity management and that salinity remains a significant NRM issue, the Office of the Auditor General (OAG) undertook an audit into the management of salinity in agricultural regions of the South West of Western Australia. In May 2018, the OAG recommended that:

To improve the effectiveness and efficiency of the management of dryland salinity DPIRD (in consultation with DBCA and DWER) should by December 2018:

a. set the strategic direction for the management of salinity

b. establish regular monitoring and reporting of the spread, impact and cost of dryland salinity

c. make better use of established mechanisms to ensure there is better cooperation and coordination at the government and local level

d. consider whether there should be targets to reduce water tables and re-plant deep rooted trees on a catchment wide or localised level

e. continue to promote soil conservation, and educate landholders and the public

f. where necessary, make greater use of compliance and enforcement mechanisms under the *Soil and Land Conservation Act 1945* (*SLC Act 1945*) to ensure that landholders prevent and/or mitigate land degradation.

To meet this recommendation, DPIRD commissioned an independent review of the history of government policies and programmes in salinity investment and management in Western Australia. This Report presents the findings of this Review. This Report assesses the OAG recommendations and findings of an independent review of current and past salinity programs and provides a new direction for salinity management in WA.

1.2 History of salinity

Salinity is not a new problem in WA and not entirely as a result of European settlement (Schofield *et al*. 1988). Before large-scale colonisation, the south-west region, especially in the inland areas had many brackish streams, saline lakes and abandoned landforms reflecting periods of high watertables (George *et al.* 2008a; Schofield *et al.* 1988). For example, Mr E.H. Hargraves (1863a, b) noted high stream salinities when he travelled from Jerramungup to the Murchison in search of gold. He reported that WA rivers were *'beds of salt, pools of brine and brackish water'* with the exception of the rivers flowing west from the Darling Range.

European settlement did however result in rising stream salinities. Salinity in the Mundaring Reservoir rose over the period 1904–08 (Reynoldson 1909). Reynoldson concluded that this was caused by ring-barking trees and cultivation in the catchment. Ring-barking stopped and stream salinity dropped. In 1912, Wood (1924) found that the Blackwood River near Bridgetown had become too salty for use in steam engines. Since then, salinity in the Blackwood River at Bridgetown has risen from 300 mg/L and increased by more than 300%.

Bleazby (1917) noted the rising stream salinity with salinisation of railway reservoirs. When investigating the problem, he found that nearly all the reservoir catchments where ring-barked trees had been cleared, produced unsuitably highly saline water (430 mg/L), whereas in vegetated catchments, salinity remained very low (86–143 mg/L). Wood (1924) put forward the conceptual model as to how stream salinity develops, a model that still applies today. He proposed that the high concentration of salt in the soil and groundwater was due to oceanic salt continuously brought inland and deposited via rain and dry fallout, and that the removal of trees allowed much more water to percolate to the salty groundwater, which then rose bringing salts to the surface.

Through the 1960s, there was a growing awareness that control of alienation of Crown Land would not be sufficient to maintain satisfactory salinity levels in a number of major water resources. Action would be required to halt clearing on land already alienated. In 1976, amendments to the *Country Areas Water Supply Act 1947* (*CAWS Act)* were passed by both Houses of Parliament.

The legislation made it an offence to clear or destroy native vegetation without a licence. The legislation was applied initially to the catchment of Wellington Dam. In 1978, the legislation

was extended to four other critically important water resource catchments: the Mundaring reservoir catchment and the Denmark, Warren and Kent River catchments. The catchments were carefully selected to represent those most sensitive to further agricultural expansion.

Catchments which had brackish or saline streams that could not be easily returned to potable levels were not included under this legislation. Also not included were catchments that drained predominantly through State Forest with freshwater streams and unlikely to become saline if small areas of private land in their catchments were cleared.

1.2.1 Agricultural development

Wheat farming in the south-west of the State commenced in the 500-600 mm rainfall region and subsequently moved eastwards into lower rainfall regions. In 1900, there were 30 000 ha sown to wheat in the whole of the State. In 2018/19, Western Australia harvested approximately 8 million ha of dryland agricultural crops, predominately comprising wheat, barley, canola and lupins. The most rapid periods of development were 1900-1930 and 1955-1985. Land salinisation emerged as a problem to agriculture during the early period of expansion. The first record appeared in 1907 as a reply printed in the Journal of Agriculture under the heading *`Does clearing increase salt in ground?'* The reply indicated that a farmer's query had been referred to the Government Analyst for attention. The response suggested that it had been *'pretty conclusively proved'* that the removal of trees affected water supplies and that to prevent salting it would be necessary to replant a very high proportion of the trees that had been removed.

In 1917, the Royal Commission on the Mallee Belt and Esperance Lands made reference to soil salt concentrations in the Esperance region. J. W. Paterson (1917), Foundation Professor of Agriculture at the University of Western Australia (UWA), outlined in considerable detail the manner in which salts accumulated in the soil and the factors influencing salt concentrations significant to crop establishment and production. He concluded on the basis of soil analyses, that about half of the Salmon Gums area had too much salt to be of profitable use. However, the Royal Commission criticised his report and advocated land release. Soil surveys conducted in the 1930s and 1940s showed salt problems developing in the Salmon Gums area.

As more and more land was released for agriculture, salinity concerns continued to be raised. However, the demand for new land was so great that concern for the adverse effects were overridden, resulting in the release of large contiguous blocks of land on which native vegetation was totally cleared over extensive areas.

Following its rapid expansion in the 1920s, agriculture went through a period of decline to the late 1940s and salinity was considered to be essentially an agricultural problem. Little concern for water supplies was apparent as adequate sources of boiler water could always be found for railway locomotives and the problem of increasing salinity in Mundaring Weir was thought to be solved. In the 1930s and 1940s, extensive soil surveys were carried out (Burvill 1947; 1950; Teakle and Burvill 1938; 1945). These surveys quantified and described the extent and nature of the salt problem in WA soils. The second major period of agricultural expansion occurred from the mid-1950s to the 1980s. The consequent increase in land salinisation continued to affect agriculture and further studies were carried out. Notable contributions to the understanding of the salt problem were made by Pennefather (1950) and Smith (1962). Further soil and landform analyses were carried out in the late 1950s and early 1960s drawing attention to the role of these landscape features in land salinisation (for example Bettenay *et al.,* 1962).

Australian Bureau of Statistics (ABS) agricultural census surveys to gauge the extent of agricultural land affected by salinity were carried out in 1955, 1962, 1974, 1979, 1984, 1989,

1993, 1994, 1998, 2000 and 2002, Figure 1. By the late 1990s to early 2000s, the estimates of salt affected land ranged between 932,000 ha to 1,047,000 ha.

The area mapped as severely affected by dryland salinity, using Landsat TM was about 1 million ha in 1998 and the annual rate of increase between 1988 and 1998 was about 14 000 ha (Furby *et al.* 2010).

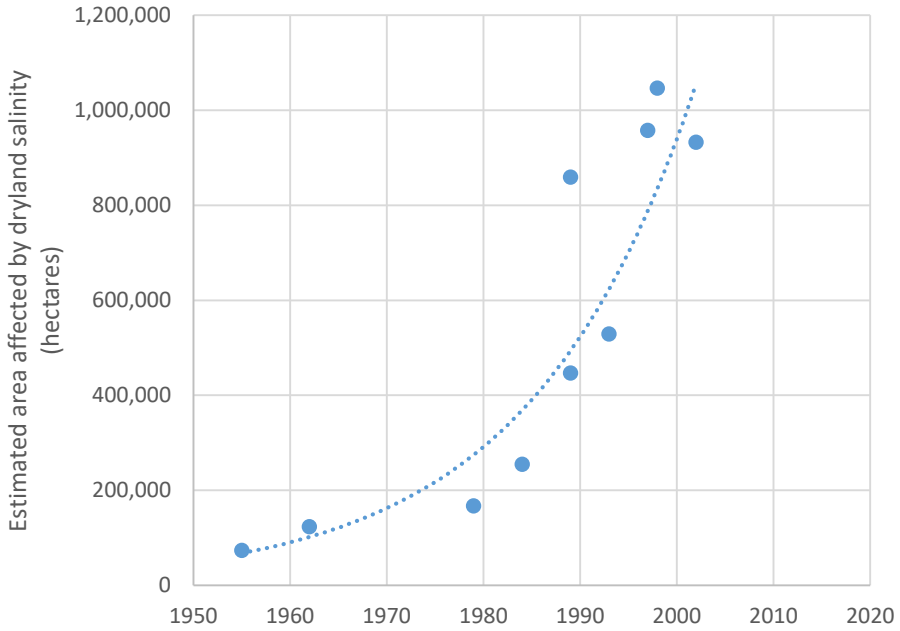

Figure 1 ABS survey results of estimated area affected by dryland salinity from 1955 to 2001.

To date, climate change has neither allowed farmers to significantly reclaim salt-affected land nor prevented the spread of salinity. The rapid rise in the estimated area affected by salinity between 1975 and 2000 relates to the timing of clearing across the Wheatbelt. There is uncertainty in the response of salt affected area to the drying climate recorded in many parts of the Wheatbelt and how that relates to the delayed impact of land clearing. However further increases in salt-affected land is considered highly likely in years and decades to come.

1.2.2 Policy response to salinity

Although there was a Salinity Strategy published jointly by the WA Water Resources Council and the Soil and Land Conservation Council (SLCC) in 1995, the first comprehensive whole of government approach to salinity management is considered to be the WA Salinity Action Plan (WA SAP), published in late 1996. The WA SAP brought together actions for four state agencies: Agriculture WA; Conservation and Land Management; Environmental Protection and Water and Rivers Commission. Some of the key actions in the WA SAP were a focus on Water Resource Recovery (five catchments), Natural Diversity Recovery (six catchments), Focus Catchments (all catchments in the SW and 12 catchment support teams), and a Rural Towns Program. The WA SAP also recommended the establishment of a State Salinity Council to report to a Cabinet Committee who had overall accountability for the Action Plan achievements.

Although the WA SAP outlined the roles of various agencies, coordination of agencies, and the scale of intervention required it was not seen as a being sufficiently consultative. An update of the WA SAP was prepared in 1998. The Plan, whilst maintaining its strategic focus, addressed concerns that it was not inclusive of responses to salinity by industry and catchment groups. The updated document was not formally released.

The 2000 State Salinity Strategy incorporated some up-to-date science on the scale of intervention needed to address salinity and was much more sympathetic to concerns regarding a lack of engagement with and acknowledgement of the role the farming community can and do play in salinity management. This Strategy was however considered to be less targeted.

A Salinity Taskforce was established in 2001 to provide a more targeted and cohesive approach to salinity. A Report from the taskforce, "Salinity: A New Balance" was released in September 2001. A Government response to the report was prepared and although it is 17 years old, the majority of recommendations remain relevant to this day. The taskforce identified three main actions that Government should be leading:

- The protection of public assets at risk from the consequences of salinity.
- Investment in and support for major actions on private land through innovation and new approaches.
- Support and incentives for planning, coordination and implementation of smaller on-ground works on private land.

A summary of the state level plans for salinity is presented in Table 2.

As the Commonwealth programs changed into Caring for our Country with a broader focus on NRM, so too did the arrangements in WA. A NRM Council was established in 2003 and reconstituted in 2007 to include representation from indigenous, conservation, state and local government, regional groups, industry and grower groups and the peak NRM regional bodies. Since 2009 when the NRM Council was terminated, the seven state regional NRM groups together with agencies and some issue-specific groups have been the primary means of providing community views to the Government.

Table 2 Summary of state level plans for salinity

Plan	Aims and Objectives
Salinity – A Recommended Strategy for WA - 1995	A report jointly published by WA Water Resources Council and Soil and Land Conservation Council. The Strategy involved: - developing catchment plans - community and Government agreeing who does what and where and who pays how much; - achieving long term commitment by stakeholders, ensuring that all stakeholders in catchments *"do their bit"*
Salinity Action Plan - 1996	The Action Plan aimed to: - Reduce further deterioration of agricultural land and where possible recover or rehabilitate existing salt-affected land - Protect and restore key water resources to ensure salinity levels are kept at a level that permits safe, potable water supplies in perpetuity - Protect and restore high value wetlands and maintain natural (biological and physical) diversity within the agricultural areas of WA; and - Protect designated infrastructure affected by salinity
State Salinity Strategy - 2000	This Strategy aimed to reduce the impact of salinity in the south-west agricultural region of WA. It had as its goals: - To reduce the rate of degradation of agricultural and public land, and where practical recover, rehabilitate or manage salt-affected land; - To protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity; - To protect and restore high value wetlands and natural vegetation, and maintain natural (biological and physical) diversity with the south-west region of WA - To provide communities with the capacity to address salinity issues and manage the changes brought about by salinity - To protect infrastructure affected by salinity
Government Response to Salinity Taskforce - 2002	The response committed the Government to lead action in three key areas which build on the 1996 Salinity Action Plan and the 2000 Salinity Strategy: – direct support to protect assets of high public value (e.g. biodiversity, water resources, infrastructure), – indirect support through investing in new industries and technologies (e.g. new perennial plants, commercial farm forestry, engineering solutions) and; – providing support and incentives for planning, coordination and implementation of smaller on ground works on private land, especially where these will lead to public benefits.

2. Status of Salinity in Western Australia

2.1 Causes and processes

Secondary - dryland salinity refers to all soils in non-irrigated areas that have become saline since being cleared for agriculture. There are three basic requirements for dryland salinity to develop: a store of salt; a supply of water; and a mechanism to bring both of these into contact with the ground surface (Williamson 1998). Clearing for agriculture over the last one hundred years and the replacement of perennial, deep-rooted native vegetation with the shallower rooted annual crops and pastures has increased groundwater recharge. This recharge results in rising watertables, bringing naturally stored salts from depth to the surface. George *et al.* 1997; Hatton *et al.* 2003; Peck and Williamson 1987; Ruprecht and Schofield 1991; and Schofield and Ruprecht 1989 have documented the fundamental process, impacts and relationships between current and pre-clearing hydrology, in relation to salinisation.

Dryland salinity occurs when the concentration of soluble salts near the soil surface is sufficient to reduce plant establishment and growth. In WA, dryland salinity is caused by an altered water balance, which, at some time after clearing (decades to centuries) will reach a new equilibrium and the area of land affected by salinity will cease to expand. Although the extent of salinity changes naturally over geological scales (George *et al.* 2008a), the process has been accelerated and enlarged by widespread clearing and land use change. Dryland salinity is a form of land degradation currently affecting both agricultural and public land in the south-west of WA. It also affects water resources, natural biodiversity and damage to buildings, roads and other infrastructure.

In addition to the dryland salinity due to saline groundwater, transient salinity has become more widely acknowledged as an emerging NRM issue. Transient salinity is the seasonal and spatial variation of salt accumulation in the root zone not influenced by groundwater processes and rising water table (Rengasamy 2002). Transient salinity fluctuates in depth, due mainly to seasonal rainfall patterns and is extensive in many landscapes dominated by subsoil sodicity. Preliminary estimates are that probably two thirds of the agricultural area of Australia has the potential for transient salinity not associated with groundwater (Rengasamy 2002). Preliminary estimates at a regional scale have estimated that approximately 11% of croppable land in south-WA could potentially be affected by transient salinity (two million ha) based on scaling up broad landform analysis. Yield penalties can range significantly from negligible up to 65% depending on the severity of susceptibility and crop type, with an average currently estimated yield penalty of approximately 15%.

2.2 Extent and trends

The area of land considered salt-affected, based on ABS surveys has increased from 73,500ha in 1955 to 932,500 ha in 2002. The assessment from Land Monitor, 1998 ranged from 937,500 ha to 1,047,000 ha (Caccetta *et al.* 2010; George *et al.* 2005,). Given the last calculated assessment of extent was nearly 20 years ago, estimates of the current extent of salt-affected land are uncertain.

Up until 2000, the rates for groundwater rise were high with almost no falling trends across the Wheatbelt despite below long-term average rainfall for 1975 to 2000 being recorded for most areas. The 2000 – 07 dry period (approximately 30% reduction in long-term average winter rainfall) resulted in a reduction in the rate of groundwater level rise and a small downward trend in the depth to watertables beneath some valley floors. Although there have been regional variations since 2008, this trend has largely been reversed. In areas with groundwater systems still actively filling (not near equilibrium), reduced rainfall recharge

appears to have had little discernible impact on rising trends. Later, as these areas approach a 'new' hydrological equilibrium, climate impacts will become the dominant controller of groundwater level trends and the extent of dryland salinity.

Recent trends in groundwater levels have been attributed to the interaction of three factors: clearing of native vegetation, below long-term average rainfall, and the onset of a hydrological equilibrium (George *et al.* 2008b). Dryland salinity is considered to remain a potential hazard to an additional 1.8 to 3.5 million ha of productive agricultural land (George *et al*. 2005) and depending on future climate, the area actually affected will increase from the 1 million (Mha) currently considered salt-affected. The long-term extent of salinity may take decades to centuries to develop, especially in areas where clearing was staggered, the area cleared is small (< 50%), or where watertables are deep (George *et al*. 2008b). However, there remain critical areas in the Wheatbelt where the risk of expansion is high, Figure 2. The areas with the highest dryland salinity risk occur mostly in the highly productive, medium to high rainfall, dryland agricultural areas.

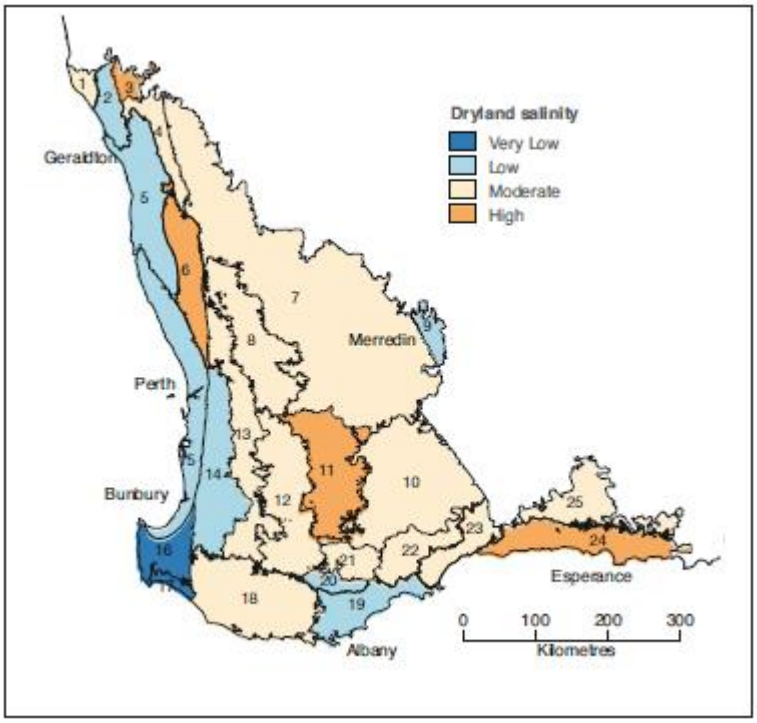

Figure 2 Resource risk summary for risk of expansion of dryland salinity within hydrozones (Simons *et al.* 2013).

The annual cost of lost production of currently saline agricultural land is estimated at $519 million (Anne Bennett pers. comm, 2017). While the total state level benefit of successfully managing salinity is estimated at $667 million (George *et al.* 2005), the estimated average annual value of lost production to transient salinity is $92 million.

Dryland salinity does not affect all farmers equally and in the late 1990s, one-third (35%) of the salt-affected land mapped was managed by less than 10% (280) of farmers, including:

- 12 landholders with more than 2000 ha of salt affected land
- 267 landholders with 500 to 2000 ha of salt affected land
- 1377 landholders with 100 to 500 ha of salt affected land.

2.2.1 Estimated state level annual off-site costs

The total off-site costs of salinity are estimated to exceed on-farm costs (Simons *et al*, 2013). Salinity affects rural infrastructure relied upon by the agricultural industry. About 250 km of main roads and 3850 km of local roads were estimated to be affected by dryland salinity (Sparks *et al*. 2006) with the total cost of maintenance of salt-damaged rail and roads alone estimated at $175 million annually.

Rising watertables that accompany dryland salinity also increase discharge into waterways. Such watertables often have a low pH resulting in the acidification of some waterways. This process has a high off-farm environmental cost, especially when combined with discharge from engineering management options if water from drains is disposed of inappropriately.

There are other high environmental costs of dryland salinity that have not been quantified but are significant. The impacts of salinity in Western Australia are not confined to economics and the environment, there are also social impacts. These can include impacts on human values such as 'sense of community' and 'sense of place' as well as quantifiable impacts on population, prosperity, land prices, tourism potential, and recreational resources.

3. Salinity reviews

There have been a number of reviews of salinity extent and impact for both Western Australia and Australia. These reviews include the:

- 1917 Royal Commission into land expansion into the Mallee belt and Esperance Area
- review by Pennefather into the salinity problem in WA in 1950
- Parliamentary Committee established in 1964 that proposed clearing controls in response to rising stream salinity in water supply and irrigation reservoirs.

A list of the more recent reviews is presented in Table 3 and the terms of reference and findings for each of these reviews are summarised in Appendix 2.

Some of the common recommendations and findings were:

- monitoring of the extent of salinity
- targeted investment of public funds
- integration of government actions
- clear roles and responsibilities
- structured research and development.

It is reasonable to consider that these recommendations remain relevant in 2018.

Table 3 Reviews of salinity since 1983

Review	Author	Year
GENERAL		
Wheatbelt salinity : a review of the salt land problem in South WA	Department of Agriculture	1983
Select Committee on Salinity	WA Government	1988
Salinity : A New Balance	Salinity Taskforce	2001
Inquiry into the extent and economic impact of salinity –	Australian Senate Committee	2006
Australia's National Action Plan For Salinity And Water Quality: A Retrospective Assessment	David Pannell and Anna Roberts	2010
WA Salinity Review	Roy Green and Colin Creighton	2010
Management of Salinity	OAG	2018
SPECIFIC ASPECT		
Review of Strategic Tree Farm project	URS	2008
Review Of The State NAP And NHT2 Monitoring And Evaluation Plan	Department of Agriculture and Food Western Australia (DAFWA)	2010
SAP - Evaluation Of The Catchment Demonstration Initiative	URS	2010

Review	Author	Year
SAP - Review of Rural Towns Program	URS	2001
Natural Diversity Recovery Catchment Program: Review	Department of Environment and Conservation	2010
Salinity And Land Use Impacts Program Review	Department of Water	2012
Salinity Management In The South West Of WA	Conservation Commission	2013
Review of Inland Drainage Research	GHD	2017

As the focus expanded from salinity to broader NRM, the focus of reviews similarly expanded, Table 4. From 2006 to 2009 there were at least six reviews into NRM governance and programs.

Table 4 Review of Natural Resource Management programs and governance

Review	Scope and Recommendations
Keogh Review (2006)	Identified the significant investments in human, time and financial resources needed to establish the regional delivery model nationally. It also identified the importance of communication and gaps in engagement
Hicks Review (2006)	Focused on WA governance frameworks and structures.
Read (2007)	Reviewed the capabilities of government agencies and community in the delivery of NAP/NHT. Read concluded that the deficiencies related primarily to engagement, project planning and management; administration and outcomes-based reporting
Griffith *et al* (2007)	Identified key attributes and standards that could be applied for future quality assured regional NRM.
URS (2008)	Undertook an evaluation of the effectiveness of the regional investment planning, approval and review process. The evaluation focused on areas for improvement and recommendations for a future NRM program including: – more clarity around roles and responsibilities; – allowing more time to develop the whole process and subsequent documentation; – consistency in agency assessment and feedback; – improved communications on the steps of the process; and valuing of people's efforts within the process.
English *et al* (2009)	– There is strong support for the continuation of a State NRM Program. However, the State NRM effort needs to better reflect the community's values and priorities. – Extensive activity has occurred during the last five years and some excellent outcomes achieved by State agency and Regional NRM Group programs. However improvements in program implementation (i.e. planning; service delivery; and monitoring, evaluation and reporting) are needed so that the State's investment better targets the outcomes sought by the community.

Review	Scope and Recommendations
	The panel concluded that for the government to successfully implement a State NRM Program that reflects these values and priorities, a strong community engagement component must be an integral part.

With respect to research into dryland salinity, the first national program was the National Dryland Salinity Programme (NDSP). Between 1993 and 2004, the NDSP provided a national forum for exchange of knowledge, building links and providing government, communities and individuals with the information and technology required to manage dryland salinity in Australia.

The key messages to emerge from the NDSP, which are still relevant today, were:

- Salinity costs are significant and rising, hence responses must be strategic.
- Profitable options for reversing the trend are lacking, but under development.
- There is no one salinity problem: It challenges us to look beyond traditional policy instruments.
- Integrated catchment management must be seen as only one approach to deal with dryland salinity.
- Vegetation management remains the key to managing water resources, although the benefit:cost ratio of re-vegetating catchments requires careful analysis.
- Lack of capacity is an important, but secondary constraint to managing salinity.

From 2001 – 2007, the CRC for Plant-based Management of Dryland Salinity aimed to develop plant-based methods of reducing environmental, economic and social impacts of dryland salinity. While the CRC for Future Farm Industries operated from 2007-2014 with the objective to contribute substantially to Australia's growth through the transformation of agricultural production across southern Australia using perennial plant based farming systems.

Since 2014, dryland salinity research has been funded through research development corporations such as Grains Research and Development Corporation (GRDC), Meat and Livestock Australia (MLA) and AgriFutures, but at a much lower level and with little coordination across programs.

4. Past Strategic State Government Salinity Programs

The state level plans for salinity management in the 1990s and 2000s implemented a number of WA Government programs, particularly as part of the National Action Plan for Salinity and Water Quality. These strategic salinity programs included:

- Engineering Evaluation Initiative (EEI)
- Wheatbelt Drainage Evaluation (WDE)
- Catchment Demonstration Initiative (CDI)
- Rapid Catchment Appraisal (RCA)
- Strategic Tree Farms (STF)
- Rural Towns – Liquid Assets (RT-LA**)**
- Sustainable Grazing on Saline Land (SGSL)
- Salinity Investment Framework (SIF)

Each of these programs was time-bound with specific objectives in contrast to the longer term programs of Water Resource Recovery Catchments **(**WRRC) or Natural Diversity Catchments. Whilst this can be an advantage, it can also mean that the programs may not leave a legacy and the outputs and outcomes possibly forgotten. A summary of the objective, status and a short assessment is provided in Table 5.

There would be benefit in reviewing these programs in detail some years after the programs have ceased. This could include:

- sites which were well monitored and documented,
- sites where trees were planted as part of the STF,
- the four CDI catchments, and
- the sites implemented as part of the EEI.

This list does not include State Government programs related to oil mallee and bluegum investments nor does it include the programs funded by the Commonwealth government or industry given that the focus of this review is on the initiatives and programs of the WA government. As such, there are many valuable programs that were implemented by Regional NRM groups, catchment groups and landcare networks that were not, nor are being assessed.

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Table 5 Summary of past strategic State Government salinity programs

Programme	Objective	Status	Assessment
Engineering Evaluation Initiative / Wheatbelt Drainage Evaluation $4m / $2.4m	• To review the current knowledge on engineering options to mitigate dryland salinity and to clarify 'best practice' by establishing demonstration sites for a range of engineering options. • Test and evaluate current engineering approaches to salinity remediation. • Understand impacts at local and regional scales. Develop and test improved engineering for salinity management.	The Review of Engineering and Safe Disposal Options (Dogramaci and Degens 2003) identified gaps to guide investment under the EEI. In reviewing the achievements against the gaps identified in Dogramaci and Degens (2003) GHD identified that five out of the eight high priority recommendations were achieved. The three not achieved related to monitoring criteria, transmission losses and sodicity. The financial recommendations were achieved and 8 out of the 9 lower priority recommendations were achieved. Regional drainage evaluation of Avon River, Yarra Yarra catchment, and Blackwood Basin completed and development of governance including Wheatbelt Drainage Committee, defining roles and responsibilities for inland drainage and a policy framework for inland drainage. The Review of Inland Drainage Research (GHD, 2017) assessed 18 key reports delivered under the the EEI and Wheatbelt Drainage Evaluation and provided a summary of key findings and recommendations.	There is informal advice that ad hoc deep drainage is occurring for salinity mitigation. There is a continuing need to monitor and evaluate the impacts and benefits of engineering options for salinity mitigation. This should build on rather than replicate the significant investigations that have occurred to date. There needs to be renewed strategic engagement on this issue. Drainage governance should be a priority area for a reformed SLCC, rather than re-establishing the Wheatbelt Drainage Council.
Catchment Demonstration Initiative $6m	The initiative aimed to demonstrate viable *salinity management systems* in the agricultural area of WA. The CDI sought to deliver its outcomes in partnership with NRM Regions by co-investment in targeted, large-scaled, catchment-based demonstrations of integrated salinity management practices The four CDI projects were: • Gillingarra-West Koojan ('Gillingarra') Catchment Demonstration; • Wallatin-O'Brien ('Wallatin Creek') Catchment Demonstration; • Upper Coblinine ('Upper Coblinine') Catchment Demonstration. • Fitzgerald River ('Fitzgerald') Catchment Demonstration.	URS in the review of the program considered that the CDI Program had delivered on its objectives and served its purpose to demonstrate this catchment-level intervention approach, and that accelerated adoption of desired practices has occurred URS also state that it was clear that there were difficulties and frustrations in implementation at all levels, and concerns about the universality of the approach. Given these difficulties, and the impracticality of implementing this approach over the wider dryland agricultural areas, the approach need not be repeated, nor implemented more widely in addressing land and water management issues in the agricultural areas.	The CDI delivered on the objectives of the program and commitments made. However the benefits of a CDI program outside of the catchments selected are not considered significant. With respect to the objective of achieving integrated salinity management across the Wheatbelt approaches such as developing economic drivers for change and targeted investment in priority areas are more attractive.
Rapid Catchment Appraisal	To ensure that all farmers receive technical information to ensure informed decisions are made in managing salinity. The RCA approach is to provide landholders in agricultural areas with: • An assessment of current salinity • Risk of further spread • Options for managing those risks and their likely impacts; Help in accessing further assistance	The RCA program assessments were competed in 2007 (DAFWA Annual report 2007) with the last RCA report being published in 2009.	There is a role for catchment planning and action when one landholder's management of water affects others such as in dryland salinity. However the need for sustained effort to maintain the focus means that a targeted approach is clearly required. Identifying catchments for targeted response with scarce resources needs to be based on SIF principles.
Strategic Tree Farms $64m	The aim was to produce two main outcomes: environmental benefits, such as improved land and	URS Conclusions - Performance Story Report for the contribution of Strategic Tree Farming to Regional NRM outcomes – 2008 included:	

Programme	Objective	Status	Assessment
	water quality; and economic benefits through the creation of new industries based on wood. Funds were allocated to four NRM regions – Northern Agricultural, Avon, South West and South Coast. Each region has a planting program that aligns with its NRM goals and Forest Products Commission's (FPC) Industry Development Plans covering the area from Moora to Esperance.	The target for the area established to medium rainfall forestry (18,000 ha) at project commencement will be achieved by the end of 2009. This estate will yield useful information on the environmental and economic benefits of these trees through coming years. Without further investment, the STF plantings in pines and sawlogs (higher volume, lower value product), which are distributed widely across the medium rainfall areas are at the risk of being a 'stranded asset' without access to nearby processing facilities. However, the sandalwood plantings which generate a lower volume, higher value product are safer in this respect, and critical mass is more easily achieved. The full range of benefits provided by medium rainfall forestry (e.g. timber, carbon, salinity mitigation, amenity, biodiversity, shelter for stock) need to have a market value for the industry to be economically viable. The on-going challenge for FPC and its partners will be in developing market values for all of these benefits in a manner that encourages adequate public and private investment.	The lack of an industry focus has meant that the long-term benefit of the STF is difficult to see being realised. The lack of scale around specific centres which could create an environment for small scale timber processing centres has meant many trees have not created any commercial value. Information on the number of trees harvested, value created, and salinity benefit would assist in an evaluation
Rural Towns –Liquid Assets $4m (initially)	Aim of developing integrated water management plans for a number of WA towns at risk from salinity (16 high priority towns) Specific objectives included: • Protection of townsite infrastructure from salinity • A model of integrated town water management • Development of alternative new supplies plus recycled water schemes • Reduced reliance on scheme water in towns • Promotion of high value industries using new water supplies	Water Management Plans prepared for 15 priority towns that demonstrated how to control town-site salinity and potentially produce returns from the water issue. .	There needs to be an assessment of the current status of watertables and impacts across the identified priority towns. Based on this management plans need to be revised and funding secured for priority and urgent infrastructure. Case studies of town like Wagin where impacts have been substantial, and Katanning where opportunities for desalinisation remain would be of value.
Sustainable Grazing on Saline Land $12m	The focus of *Profitable and sustainable grazing on saline land in WA* is to evaluate the gains in animal production, water management and biodiversity in saltbush-based pastures as a result of the introduction of new plant species and better management systems. *Optimising the saltland pasture system for practical and profitable use* concentrates on the practical implementation and optimisation of saltbush and understorey systems to provide the most effective inputs into livestock production systems.	Key new knowledge outcomes from the project have included: • a greater awareness and integration of options for salt-affected land; • improved understanding of how to establish and manage saltland pasture systems; • greater confidence by many farmers to tackle salt-affected land, with their subsequent attitudes toward saltland having changed from wasteland to potential profitability; and • an increased desire to improve salt-affected areas and show others that it can be profitable. Land Wool & Water provided a total budget of $12,017,903, including a proportion of program	There needs to be continued engagement and investment in developing new opportunities in saltland grazing systems with a focus on profitability and sustainability. There also needs to be re-engagement with the network of engaged and informed farmers involved with saltand pastures.

Programme	Objective	Status	Assessment
		overheads for SGSL. Based on a conservative estimate of the profitability gains likely and the area that may be planted to saltland pastures over the next 10 years, the investment in SGSL is considered to have provided benefits with a present value of $24.6 million. The investment is estimated to provide a benefit-cost ratio of 2.1 to 1 and an internal rate of return of about 11.8%. (Agtrans, 2007)	
Salinity Investment Framework	A framework to improve cost effectiveness of public investment in salinity management by directing funds to projects with the potential to protect or recover high value public assets and consider strategies for supporting work where direct investment in on-ground works cannot be justified.	The SIF is applied in principle to the salinity program across Government but only informally. The principles of SIF have been extended by UWA to SIF3 and to a project appraisal framework INFFER.	The principles of SIF were beneficial in clarifying the role of Government in investing in salinity. However the application at a project level has not been as consistent.

5. Status of Salinity Programs

The WA government departments with direct roles in salinity management include DPIRD, DWER and DBCA, Table 6. DPIRD also has a role in managing the NRM Program which provides funding for community grants for on-ground works as well as planning, training and resource assessment activities that help to conserve, restore, rehabilitate or enhance a local natural area or conserve biodiversity.

DPIRD recently completed a WA NRM Framework 2018 which has six strategies:

- Sustainable management of land resources
- Maintain and enhance water assets
- Protect and enhance the marine and coastal environment
- Conserve and recover biodiversity
- Enhance skills, capacity and engagement
- Deliver high quality planning that leads to effective action

Although dryland salinity is not explicitly mentioned in the framework, it is considered that the sustainable management of land resources would require that salinity is a priority area.

Table 6 Salinity management roles and responsibilities (adapted from OAG 2018)

Managing salinity – general responsibilities		***Soil and Land Conservation Act 1945* (Administered by DPIRD)**	
DPIRD	Administers legislation that is related to food production, environmental conservation, and sound agricultural management in WA	Commissioner of Soil and Land Conservation (within DPIRD)	General functions include the prevention and mitigation of land degradation, promotion of soil conservation, and education of landholders and the public
DWER	Manages water resources; its availability, quality and sustainability. Primary focus on high rainfall catchments and the Perth Basin.	Soil and Land Conservation Council	Functions of the Council are: Advise on the condition of soils and land resources Make recommendations on land use, soil and land conservation policy Coordinate, monitor and review the soil and land conservation programs and activities
DBCA	Has responsibilities for the State's biodiverse environment with a focus on lands and species managed under the		

Managing salinity – general responsibilities		*Soil and Land Conservation Act 1945* (Administered by DPIRD)
	Conservation and Land Management Act 1984 and the *Biodiversity and Conservation Act 1999*. Indirectly, cooperative working arrangements are established with other land managers to conserve important biota on lands not managed under the *CALM Act 1984*.	
Other responsibilities		
Landholders (includes government agencies, local government, and private landholders)	Have responsibility to manage their land Require approval to clear native vegetation Require approval to construct drainage systems	

With respect to legislation related to salinity management the *SLC Act 1945,* Table 7 is the principal legislation relating to the conservation of soil and land resources and the mitigation of the effects of erosion, salinity and flooding (DPIRD responsible). The *CAWS Act 1947* (DWER responsible) relates to the clearing controls that are still in place in the controlled catchment areas. Three of the Natural Diversity Recovery Catchments managed by DBCA (Lake Toolibin, Lake Warden and Muir-Unicup) are referenced as Ramsar wetlands under the Commonwealth legislation (*Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*).

In December 2017, the Minister for Agriculture and Food announced the formation of a Ministerial Advisory Committee to guide the re-establishment of the SLCC, acknowledging that greater understanding is needed as to how to manage WA's fragile soils. The Advisory Committee will develop recommendations on the modern functions for the SLCC while working on strategies to address soil health issues in WA.

Table 7 Summary of legislation related to salinity management

Legislation related to salinity	Department
SLC Act 1945	Primary Industries and Regional Development
CAWS Act 1947 – Control of Catchment Areas • Wellington Dam Catchment Area; • Mundaring Weir Catchment Area • Denmark River Catchment Area; • Kent River Water Reserve • Warren River Water Reserve • Harris River Dam Catchment Area	Department of Water and Environmental Regulation
Ramsar wetlands are protected under the Commonwealth *EPBC Act 1999* (Lake Toolibin, Lake Warden)	Department of Biodiversity, Conservation and Attractions

5.1 Agriculture

DPIRD through the agriculture component of the department, contributes to salinity management through:

- Functions of the Soil and Land Commissioner
- Salinity and risk monitoring
- Salinity management advice
- Research and development of salinity management options

The functions of the Soil and Land Commissioner as per the *SLC Act 1945* include:

a. the prevention and mitigation of land degradation[1]

b. the promotion of soil conservation

c. the encouragement of landholders and the public generally to utilise land in such a manner as will tend towards the prevention and mitigation of land degradation and the promotion of soil conservation, and

d. the education of landholders and the public generally in the objects and practice of soil conservation

e. compliance and enforcement when required.

Currently the Soil and Land Commissioner focuses on investigating land degradation complaints when received, reporting on land condition for the annual report by the DPIRD and an annual report to the Pastoral Lands Board.

DPIRD provides surveillance, groundwater monitoring and salinity management advice, see Table 8 and continues to work in research into areas such as transient salinity and of new non-salt tolerant plants for cropping or for grazing by livestock. An example of the dryland salinity research is the development of a matrix of species suitability versus site conditions, Figure 4. The matrix, in conjunction with professional agronomic advice, can help provide a high level of

[1] land degradation is defined as not only salinity but soil erosion, eutrophication, flooding; and the removal or deterioration of natural or introduced vegetation

success for much of the salt-affected land in Australia. In some cases, such as for messina and balansa clover (an important legume for low salinity sites) specific levels of salt tolerance in relation to germination have been determined. For recharge control, new species such as Lanza tedera are being developed for grazing management and use of areas for recharge management.

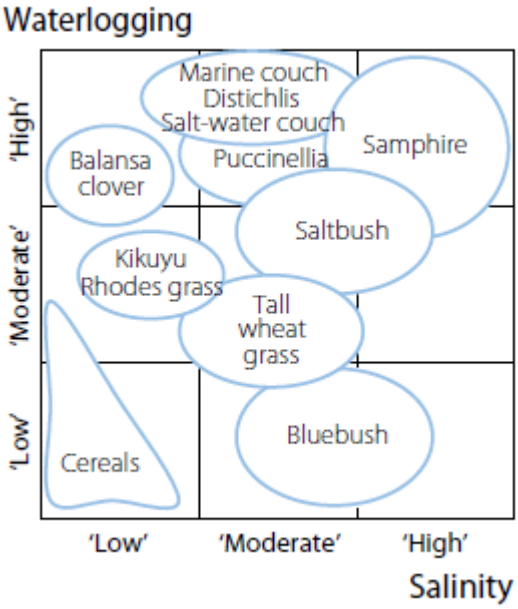

Figure 3 Indicative chart of species suitability for salinity and waterlogging

5.2 Water

The Salinity Action Plan re-affirmed the five clearing control catchments as priorities for recovery and the State Salinity Strategy badged them as WRRCs with specific targets:

- Collie River (including Harris River catchment) – potable water by 2015
- Kent River – potable water by 2030
- Warren River – potable water by 2030
- Denmark River – potable water by 2020
- Helena River – regular monitoring and establish target

In 2018, the Collie River and Wellington Dam project was awarded a major new investment of $396 million (Myalup-Wellington Project) funded by the State and Commonwealth governments and Collie Water. The project involves diverting the most highly saline flows from the Collie River East Branch and pumped to a mine void, with that water then treated in a new desalination plant located near Collie. A new, smaller Burekup Weir is proposed to be built onsite or upstream to enable gravity-fed water delivery in the Collie River Irrigation District (CRID). Increased revegetation of cleared land in the Wellington Dam catchment, through establishment of pine plantations, will also assist in reducing saline run off into the Collie River that feeds into the reservoir.

The Denmark River catchment has experienced significant reforestation with the cleared area reducing from 20 to 5.5% by 2009. This reforestation has resulted in reductions in stream salinity to an average of 546 milligrams per litre (mgL^{-1}) total dissolved solids (TDS) from 2012 to 2017. Given this reduction, the Denmark River has now returned to being a contingency water supply to the town of Denmark. The security of this salinity reduction will need to be

monitored if the commercial tree plantings are not renewed when harvesting occurs. The status of each of the WRRCs is outlined in Table 8.

Table 8 Status of Water Resource Recovery Catchments

Catchment	Status
Collie	Salinity Situation Statement completed River Recovery Plan completed (not published) Major investment reducing salinity but is not forecast to achieve 500 mgL^{-1} TDS
Kent	Salinity Situation Statement completed Salinity averaging 1525 mgL^{-1} TDS Not going to achieve target Review of status as WRRC required
Warren	Salinity Situation Statement completed Salinity averaging 960 mgL^{-1} TDS but forecast to reduce to 700 mgL^{-1} TDS with current land-use
Denmark	Salinity Situation Statement completed River Recovery Plan completed Close to achieving target of 500 mgL^{-1} TDS
Helena	Salinity Situation Statement completed

DWER continue to monitoring stream salinity in rivers across the south-west, however the last report on the status of stream salinity was 2005. Advice is also provided into the impact of land use changes such as bauxite mining and forest management on stream salinity, including auditing water related KPI's in the current Conservation Commission *Forest Management Plan.*

5.3 Biodiversity

The Natural Diversity Recovery Catchment program focused on six critical wetlands/catchments at risk from salinisation:

- Toolibin Lake
- Lake Warden System
- Muir-Unicup
- Lake Bryde System
- Buntine-Marchagee
- Drummond

The key biodiversity assets at each of the six Natural Diversity Recovery Catchments are outlined in Table 9.

Table 9 Summary of six Natural Diversity Catchments

Name	Catchment area (ha)	Year established	Key biodiversity assets
Toolibin Lake	48,000	1996	Listed as Ramsar Wetland of International Importance. Contains a threatened ecological community (listed at State and Commonwealth levels)

Lake Warden System	212,000	1996	Listed as a Ramsar Wetland of International Importance. Priority ecological communities and wetlands, used by migratory species and has a wide range of wetland and riparian assemblages.
Muir-Unicup	70,000	1996	Listed as Ramsar Wetland of International Importance. Priority ecological community and threatened species and has a wide range of wetland and riparian assemblages.
Lake Bryde System	140,000	1999	Threatened ecological community, threatened species, and wide range of wetland and riparian assemblages
Buntine-Marchagee	181,000	2001	Threatened ecological community, threatened species and wide range of wetland and riparian assemblages.
Drummond	39,500	2001	Freshwater clay-pans, priority ecological communities and threatened species.

Toolibin Lake, Muir-Unicup and Lake Warden System are included on the List of Wetlands of International Importance under the Ramsar Convention.

DBCA continues to focus recovery work at:

- Toolibin Lake
- Lake Bryde System

At a reduced scale, the Lake Warden system is monitored for wetland depth, pH and salinity of the major wetlands; and the maintenance and operation of hydrologic infrastructure to manage lake water depths. While at Muir-Unicup, a hydrogeology project is examining the mechanisms and risks of further acidification in those wetlands in a drying climate.

There is also investment through the Commonwealth Government's National Landcare Program by the South Coast NRM in fencing and revegetation in the Lake Warden Catchment.

DBCA now focuses monitoring within Ramsar wetlands and some critical sites within wetlands in national parks and nature reserves.

5.4 Summary of salinity programs

A summary of the current status of the WA Government salinity programs, as outlined in Table 10, highlights the reduction in resources focused on salinity. Participants at the workshop convened as part of this review did however make the point that there does remain a significant level of interest in salinity impact and extent across the Wheatbelt.

Table 10 Summary of current salinity programmes

Program	Objective	Status	Assessment
Soil and Land Commissioner	The functions of the Soil and Land Commissioner include: (a) the prevention and mitigation of land degradation; (b) the promotion of soil conservation; (c) the encouragement of landholders and the public generally to utilise land in such a manner as will tend towards the prevention and mitigation of land degradation and the promotion of soil conservation; (d) the education of landholders and the public generally in the objects and practice of soil conservation.	Soil and Land Commissioner investigates land degradation complaints when received. Only two complaints received directly for salinity and 33 related to drainage since 2008. Produces Statement of the Soil and Land Commissioner for the DPIRD annual report, and an annual statement for the Pastoral Lands Board.	The current focus of the Soil and Land Commissioner is considered reactive to complaints. The role as defined in the *SLC Act 1945* is for a proactive role in prevention, promotion encouragement and education. Currently these roles are not undertaken in any significant approach.
Salinity and risk monitoring	To develop an understanding of groundwater systems in the agricultural areas, and to support intervention activities, groundwater bores were established to investigate and monitor the groundwater depth, quality and trends.	Surveillance groundwater monitoring to support Soil and Land Commissioner's annual report and the Sustainable Agriculture Report Card.	Important that a targeted program of monitoring of groundwater level is maintained. Need to assess the opportunity of integrating with monitoring undertaken by Regional NRM groups. However evaluation and communication of relevant information is important.
Salinity Management Advice	To advise on hydrologic land degradation problems and on agriculture-based groundwater resource management and protection issues.	Regional hydrologists continue to receive requests for salinity information. Monitoring of groundwater keeps staff engaged with and in contact with farmers across Wheatbelt. Ad hoc requests for advice and salinity information by local governments (including Merredin, Wagin and Katanning) regarding town salinity issues and opportunities Salinity remains as the most searched area on the DAFWA NRM component of the DPIRD website	Currently resources are limited to reacting to requests. There is little proactive work on land degradation issues, particularly salinity.
Research and development of salinity management options	No specific objective related to research into salinity management options but informally to develop new approaches to managing salinity is the focus.	Current research is focused on transient salinity, saltland pastures and new saltbush varieties.	There is valuable research being undertaken into salinity management by individuals in government and research agencies. However there is a lack of a coordinated and strategic approach to research and development into salinity management.
Water Resource Recovery (Controlled Catchments)	1996 Salinity Action Plan identified the following as WRRCs with the target to achieve 500 mgL^{-1} TDS: - Helena - Collie by 2015 - Warren by 2030 - Kent by 2030 - Denmark by 2020	Helena - Salinity Situation Statement Collie - Salinity Situation Statement - River Recovery Plan - Major investment reducing salinity but is not forecast to achieve 500 mgL^{-1} TDS Warren - Salinity Situation Statement - Salinity averaging 960 mgL-1 TDS but forecast to reduce to 700 mgL-1 TDS with current land-use Kent - Salinity Situation Statement - Salinity averaging 1525 mgL-1 TDS - Not going to achieve target - Review of status as WRRC required Denmark	By having clear objectives within WRRC has meant that targeted effort and investment has occurred. There have been investment priorities within the program with most effort and resources focused on the Collie River. The status and objective for the Warren and Kent WRRCs is due to be re-assessed and the potential to incorporate new WRRCs such as Preston River should be evaluated. The success of the program has been through both direct investment and facilitating investment through initial investment (plantations) or trialling engineering options (groundwater pumping).

Program	Objective	Status	Assessment
		- Salinity Situation Statement - River Recovery Plan - Close to achieving target of 500 mgL^{-1} TDS	
Land use impacts and catchment research	- Stream salinity monitoring and status reporting - Bauxite Hydrology – Impact of mining on water resources - Forest Management Plan - KPI reporting	The Stream Salinity Status report of 2005 was a good summary of current status but the report is now `3 years old and the data is becoming dated.	The reporting on stream salinity status is a valuable assessment that requires updating given the data from the last analysis are now 16 years old.
Biodiversity Recovery Previously Natural Diversity Recovery Catchments	*1996 Salinity Action Plan* - *To develop and implement a coordinated Wetlands and Natural Diversity Recovery Program targeting at least six key catchments over the next 10 years to ensure that critical and regionally significant natural areas, particularly wetlands, are protected in perpetuity* - *To develop knowledge and technologies to combat salinity throughout the agricultural region.* The Natural Diversity Recovery Catchment program focused on six critical wetlands/catchments at risk from salinisation: • Toolibin Lake • Lake Warden System • Muir-Unicup • Lake Bryde Systen • Buntine-Marchagee • Drummond • Toolibin Lake, Muir-Unicup and Lake Warden System are listed as a Wetland of International Importance under the Ramsar Convention.	2011 Review found that over the six natural diversity recovery catchments all 11 threatened species and three listed threatened ecological communities endangered by altered hydrology have persisted, but continue to be at risk. Of these biodiversity assets, one of the listed threatened ecological communities (at Toolibin Lake) would almost certainly have been degraded to the point of de-listing by 2009 without management intervention through the Recovery Program. *2011 Review recommended that* *The goal of the Natural Diversity Recovery Catchment Program becomes:* *To develop and implement works within the South West Land Division that protect, and where practicable recover, the biodiversity of significant, natural wetlands and associated valley biological communities from the adverse effects of altered hydrology.* DBCA continues to focus recovery work at: - Lake Toolibin - Lake Bryde - At a reduced scale the Lake Warden system is monitored for wetland depth, pH and salinity of major the wetlands; and the maintenance and operation of build infrastructure to manage water quality. - At Muir-Unicup a hydrogeology project is examining the mechanisms and risks of further acidification in those wetlands in a drying climate.	That a well targeted investment program continues for high value **Biodiversity Assets** building on the Natural Diversity Recovery Catchments Program and priorities for threatened species and the CAR reserve system. Activities should focus on: • maintenance of the high priority set of assets that are already being managed to reduce the impacts of salinity; • protective repair *insitu*, including engineering works; and • catchment rehabilitation, including the provision of stewardship payments to foster catchment scale biodiversity rehabilitation. The program should be assessed against a new assessment of the area of salt affected land, the biodiversity values at risk, the duration of less risk, the feasibility versus the cost, and of wetland and river salinity and related water quality parameters. A rigorous risk-based assessment is required with the new information on salinity area and hazard, and biodiversity values.
South-west Wetland monitoring program	To monitor a sample of wetlands, and their associated flora and fauna throughout the south-west to determine long-term trends in natural diversity and provide a sound basis for corrective action.”	105 wetlands monitored mostly in national parks and nature reserves Last published in 2015 Long-term trends are evident, particularly declining water levels and increasing salinity at many, but not all, wetlands. These and other changes are affecting fringing and emergent vegetation and the suitability of certain areas for waterbirds and other fauna (Lane, 2013).	Important that the salinity status of major wetland systems across the South-west land division is updated for both wetlands in public and private land tenure. Need to assess the opportunity of integrating with monitoring undertaken by Regional NRM groups. In a reducing financial and resource world it is important that monitoring is focused on strategic wetlands as the way forward.
Roads	SIF 2 identified based on large-scale data, about 252 km of highways and main roads and 3850 km of local and unclassified roads are currently estimated to be affected by salinity. The total combined current annual cost is around $21 million. However, 1194	MRWA currently reviewing maintenance costs over the last three years to determine if saline areas are costing more to maintain and if so by how much.	Based on the new assessment of extent, a benefit versus costs of a catchment approach compared to continuing with at-site repair is recommended.

Program	Objective	Status	Assessment
	km of highways and main roads and 22 960 km of local and unclassified roads have a high hazard (likely to be an overestimate). Allowing for the gradual increase in repair and maintenance of roads as salinity spreads, and assuming all affected roads are repaired, the present value of forecast road repair costs is $1938 million, of which $271 million is for highway and main road repairs.		

5.5 Compliance and targets

The OAG Report recommended greater use of compliance and enforcement mechanisms available under the *SLC Act 1945*. The Report concluded that DPIRD was not effectively using all its legislative powers to prevent land degradation. Measures to prevent land degradation are mostly reactive and reliant on applications for drainage or complaints from the public. The OAG went on to state that *"with up to 2 million ha affected by salinity, and the problem predicted to get worse, we would expect a more proactive approach to the prevention and mitigation of land degradation"*.

Historically the *CAWS Act 1947* was used to control clearing of private land in what are now termed the WRRCs (Controlled Catchments). A clearing control budget of $138 M (in 2010 dollars) was to acquire 38,962ha of land and pay compensation for about 252 000ha where there was a *CAWS Act* licence to clear refusal. This land and vegetation on it provide a significant benefit to the five WRRCs. However, the cost involved for such a small area relative to the 1 Mha salt-affected and the additional 1.8 to 3.5 Mha at potential threat meant that constraining current land use may mean the level of compensation is prohibitively high.

Appropriate land management is vital for the sustainable use of soil and land resources to meet the needs of current and future generations and maintain soil productivity and ecosystem services. Sustainable land management can be encouraged through promotion, encouragement, education and incentives.

Compliance and enforcement in relation to dryland salinity is complex due to aspects such as:

- the significant delays between clearing of native vegetation and expression of salinity
- the catchment scale rather than individual farmer, and
- historical encouragements by government to clear the land for development

Compliance can and is used where there are immediate problems such vegetation clearing without a permit.

With respect to targets, they are difficult to set based on groundwater levels without detailed analysis that takes into consideration hydrologic and economic realities. Where targets can be useful is when they are focused on priority biodiversity, water resource or infrastructure assets, and they can provide clear direction for implementation strategies. For example DBCA has implicit targets around no loss of species and communities and DBCA's performance in managing threatened species, and DWER has salinity targets for the WRRCs.

6. A new direction for salinity management in Western Australia

The Office of the Auditor General audit into the management of salinity focused on two key questions,

1. Do agencies know the extent and impact of dryland salinity in the South West agricultural regions?
2. Are efforts to reduce the impacts of dryland salinity in the South West regions working?

With respect to the two questions posed by the Office and the Audit General, this review has found that:

- The extent and impact of salinity needs to be updated as a priority
- The efforts to reduce the impacts of dryland salinity need to be refocused (based on the revised salinity extent and impact) by the targeted investment of both public and private funds in four key areas: Information, Governance, Innovation and Investment

These key areas are presented as the 'Pillars' for the New Direction in Salinity.

6.1 Information

A key role for Government is to provide information on current and future salinity risks. This role was emphasised in the reviews of the Salinity Taskforce, the Western Australia Salinity Review and the OAG. This review maintains this position. The Information Pillar has three main actions for government investment.

- Investment in effective monitoring and evaluation of salinity impact and extent
- Investment in the process of engagement and communication among individuals and organisations, and
- Investment in updating publications and training material on salinity, its history, extent and management

Monitoring and evaluation

The Information Pillar recommends effective monitoring and evaluation to inform the Government on status of salinity including the area currently impacted, areas at risk, water quality, economic loss and the condition of public assets. This information guides investment decisions by government, industry and farm businesses and informs research and development priorities.

A key plank of this pillar is an investment in the information required to update maps of areas currently affected and 'at risk' of dryland salinity. These maps would be prepared using the latest technologies in mapping and remote sensing and include current climate change scenarios. To further inform this map, spatial and time based trend assessments should be undertaken to reflect changing drivers for salinity such as climate change, land clearing and land use. This information would be used to inform stakeholders of the impact salinity at each landscape scale: property, catchment, regional extent and statewide and guide investment decisions in R&D, mitigation and management options. 'Land Monitor' is currently the most effective methodology available to complete this assessment.

In addition to the updating of Land Monitor, the preparation of a Salinity Situation Statement is recommended. This document would be prepared by DPIRD in conjunction with DBCA and

DWER and include assessments of areas at risk of salinity under a range of climate change and landuse scenario's in addition to a description of its current extent. Involvement of key stakeholder groups in the preparation of the Salinity Situation Statement, for example, peak body groups, NRM Councils and private industry would ensure that the Salinity Situation Statement presents a complete assessment of the status of salinity across the south west land division. The Salinity Situation Statement provides the objective information that is needed, and arguably is currently lacking, for government, industry and community to make informed management decisions. The Statement would ideally be updated every five years.

The process of communication and engagement

A second feature of this pillar is recognition of the importance of the *process* of effective communication and engagement among the diverse range of individuals and organisations involved in salinity research and management. A communicative environment where long-standing knowledge is shared with new ways of thinking will establish an environment conducive to innovation and informed investment in salinity management and is recommended as a feature of this Pillar.

An effective process of engagement across government can also ensure that relevant government agencies are aware of current priorities, new learnings and major difficulties thereby providing informed and consistent advice on salinity to government.

Publications and training material

The NRM component of the DPIRD website has salinity as the most searched keyword, after weather information. This suggests that there remains a demand for information that can reasonably be assumed is not being met with the most up-to-date information. This information would include best management practice in salinity management across recovery, mitigation, and adaptation and on land management practices (cropping, pasture, farm forestry and productive use of saline lands), native vegetation management and engineering options. The determination of 'best practice' is a process that DPIRD may manage in consultation with research providers, industry and grower groups. Fact sheets, a Sustainable Agriculture Report Card and summaries of salinity management would all provide accessible best practice benchmark information. The effective use of modern communication technologies, AgTech and 'Internet of Things' data systems should also be considered as part of the knowledge transfer process.

An unintended consequence of the reduced state and federal investment in salinity programmes has been the gradual loss of 'corporate' memory of salinity. This lack of investment in training material and salinity updates has resulted in the general knowledge of salinity and its research and NRM history in Western Australia being held by a small number of people, many of whom are likely to retire within the next ten years. Raising the profile of salinity as a NRM issue in Western Australia has the potential to introduce a new group of researchers and NRM advisers and researchers in salinity processes and management and therefore ensure that the knowledge gained during the decade of landcare and up to the early 2000's is not lost.

6.1.1 Summary

In summary, the key actions required for the Information pillar are:

- DPIRD to undertake an assessment of the current area of salt-affected land and salinity hazard areas as a priority
- DWER to prepare a status of stream salinity report by 2020

- DPIRD, with DBCA and DWER, prepare a Salinity Situation Statement 2020, in consultation with government, industry and community, on current status and response to dryland salinity in Western Australia
- Information on salinity management options to be revised in consultation with key knowledge providers with effective knowledge transfer to land managers and decision-makers

6.2 Governance

This Pillar focuses on good governance to ensure coordination of Government action, rigorous policy advice to Government and genuine community involvement and interface on salinity management at the State and regional levels.

A key tenet in the Governance pillar is the re-establishment of the Soil and Land Conservation Council. The primary functions of the Council, as defined in the *SLC Act 1945* are:

- advise the Minister as to the condition of soil and land resources
- present recommendations to the Minister on land use, soil and land conservation policy
- review soil and land conservation programmes and activities and determine if the investment has achieved their stated objectives
- promote awareness of land degradation and conservation

This review recommends that membership of the Council is skills-based rather than representing stakeholder groups, noting that the skills of members needs to be broad and inclusive. DPIRD has an important role in salinity Governance in that it can facilitate an improved integration of government actions across salinity management and broader land degradation issues in consultation with SLCC. The Council should not only be supported by the Soil and Land Commissioner but by relevant state government agencies. Effective and efficient engagement needs to continue with regional NRM, grower, catchment and Landcare groups.

Given that these functions are much broader than compliance, it is important that the WA Government considers the broader role of the Soil and Land Commissioner in salinity management.

The functions of the Soil and Land Commissioner include the:

- prevention and mitigation of land degradation
- promotion of soil conservation
- encouragement of landholders and the public generally to utilise land in such a manner as will tend towards the prevention and mitigation of land degradation and the promotion of soil conservation
- education of landholders and the public generally in the objects and practice of soil conservation

The value and impact of engineering options such as drainage continue to be raised by stakeholders and the SLCC with the Soil and Land Commissioner should assess options to streamline compliance and mitigate disputes and offsite impacts.

6.2.1 Summary

In summary the key actions required for the Governance pillar are:

- WA Government to establish the Soil and Land Conservation Council (SLCC) to provide strategic advice on salinity and other land degradation issues as a priority

- DPIRD to review the current role of the Soil and Land Commissioner to be consistent with the broader functions that are prescribed in the SLC Act
- DPIRD to facilitate improved integration of government actions across salinity management and broader land degradation issues
- DPIRD to facilitate increased engagement, coordination, and collaboration with regional NRM, catchment, grower, and Landcare groups
- The SLCC, with the Soil and Land Commissioner, to assess options to streamline compliance and mitigate disputes and offsite impacts by 2019

6.3 Innovation

A renewed policy and industry focus on dryland salinity creates the opportunity to introduce new, and re-establish, research and development priorities and introduce new concepts and systems for Western Australia. Advances in technology to provide real-time and increasingly sophisticated data, carbon farming, regenerative agriculture, innovative water use and land management systems are examples of the innovations that may be invested in as part of the salinity management solution. For example, notwithstanding the policy and pricing uncertainty with research into carbon farming initiatives, the barriers to the adoption of carbon farming include a lack of specific information on carbon farming opportunities and how to economically integrate with current farming practice. Research initiatives in carbon farming could therefore include quantifying the improved soil quality and reduced soil erosion which are both recognised as important potential co-benefits of carbon farming.

There is a strong foundation from which the Innovation Pillar can build on, including the work undertaken by the NDSP, the CRCs of Plant Based Management of Salinity, and Future Farm Industries. Re-establishing the research network, to include research providers such as GRDC, MLA and AgriFutures with state government departments, CSIRO and independent researchers would establish a collegiate research environment that would identify and prioritise contemporary research questions in salinity management and profitable farming systems on saline soils.

Increased active engagement at the national level regarding Commonwealth Government investment into salinity management is important particularly in light of the decision to shift the focus for NRM funding away from salinity in the Caring for our Country and now National Landcare Program. A long-term research plan, and one that fosters innovative partnerships and salinity management solutions requires that the Commonwealth Government invests in this NRM issue alongside the state government and private industry.

Research initiatives

Long-standing and emerging research gaps in salinity management include

- salt tolerant crops and pastures
- new technologies to assess and manage salinity
- new approaches to salinity management
    - including potential utilisation of the saline groundwater resources, and
    - cross-discipline aspects that integrate social processes, value creation and policy to influence behaviour at a grower level

To guide this direction a Research Plan for salinity, developed in consultation with the above listed research providers, is recommended.

This Plan would include but not be limited to:

- Solutions for the productive use of saline land
- Productive use of saline water
- Agricultural technology to enable timely and site specific information on salt affected soils including remote sensing, crop monitoring, robotics, digital agriculture and precision agriculture to enable better management and potentially reduced impact of salinity.
- Transient salinity: Cause and extent.

Innovative uses of saline and non-productive lands, particularly where farmers are focused on cropping, may require new approaches to land tenure.

6.3.1 Summary

In summary the key actions required for the Innovation pillar are:

- DPIRD to coordinate the development of a Research Plan for salinity management and mitigation research with key RDCs, research providers, government and grower groups by 2019
- DPIRD to assess land tenure options such as leases and covenants to enable viable and marketable areas for grazing, carbon and conservation in salt-affected valley floor and other low productivity areas that impact salinity by 2019
- DPIRD to develop and provide up-to-date information on opportunities and issues with carbon farming and sustainable agriculture in salt-affected areas from 2019 to enable private public partnerships.

6.4 Investment

The protection of high-value public assets such as water resource catchments, threatened high value conservation areas, and built infrastructure from the impacts of salinity and other forms of resource degradation has been a government priority action for many years. This review maintains that the protection of public assets should remain a government action. Targeted investment of public funds in public assets was informed by the State Salinity Investment Framework (SIF), Figure 4. The SIF remains relevant, guiding investment on agricultural land in three different but complementary ways:

- Public investment in changes in the use of land that directly contributes to the protection of priority assets
- Encouragement of private investment in recovering salt-affected land, containing the spread of salinity, and in adapting to salinity by changing land uses of saline land and
- Industry development, where public and private investment is used to develop new land uses, farming systems and salinity-related industries that can generate economic and environmental benefits for landholders and the WA community.

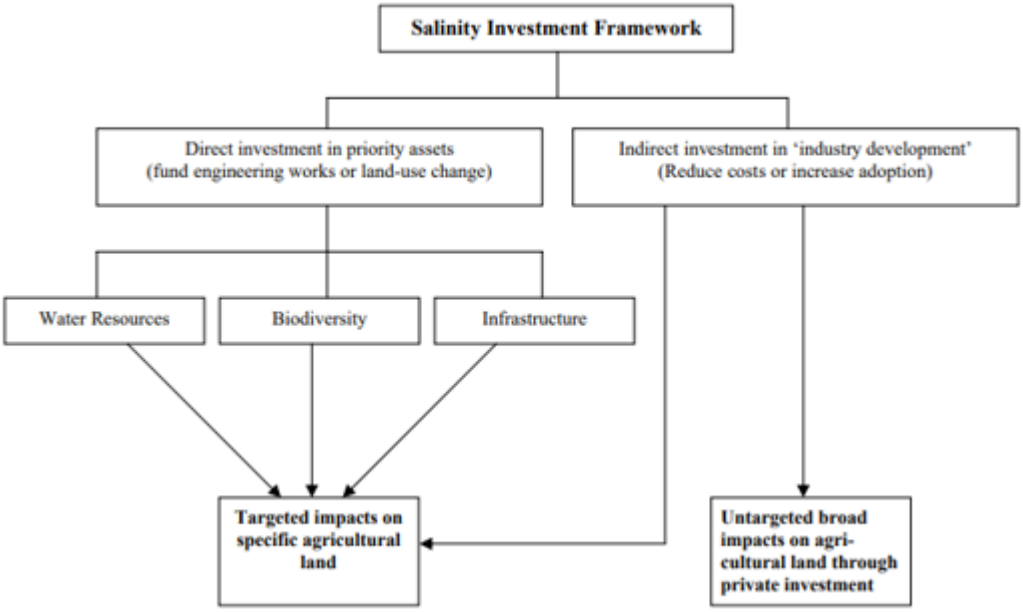

Figure 4 Salinity Investment Framework (Sparks *et al.* 2006)

Targeted investment is essential to ensure that high priority biodiversity, water resource, and infrastructure assets are protected from salinity, however the list of targeted assets has not been formally reviewed for a number of years. Based on the three targeted areas of investment, this Review recommends that a review of public assets is undertaken by 2020 to take into account risk, value of the asset and feasibility of protection or recovery. Examples of these reviews are presented below.

Biodiversity

Walshe *et al.* (2004), for example, identified 15 catchments where assemblages were highly valued for conserving biodiversity and at the time were at risk from salinisation. A review of these catchments against the revised assessment of salt-affected land is recommended to confirm the priority catchments from a biodiversity perspective for Government investment to prevent extinction of species.

Water Resources

Reviewing the status of the current five WRRCs is also recommended particularly in the context of a revised assessment of salt-affected land and the updated stream salinity status. There is the added opportunity to review whether the current WRRCs should remain as priority and/or if other rivers should be considered such as the Preston River particularly if the objective of the WRRC is broadened to include other parameters in addition to water supply.

Infrastructure

The Rural Towns Program involved 38 towns where salinity and water logging was identified as having significant current (and future) economic impacts on town infrastructure. Groundwater monitoring programmes were established in many of the towns and economic impacts to assess the costs of salinity and rising groundwater were completed. Reviewing longitudinal data for those towns still participating in the programme and reviewing the list of towns potentially at risk of infrastructure damage is recommended.

Agricultural land

Government has an important role to play in creating an environment where investing in conservation, restoration and better land management practices makes economic sense. A

good example is the investment in innovation in sustainable agricultural and landscape systems through initiatives such as carbon farming in order to sequester more carbon and reduce greenhouse gas emissions. An environment where private industry and community can invest for sustainable long-term outcomes to address a long-term land management issue has the potential to reduce the extent of financial investment often expected of government and establish new profitable farming system solutions.

Salinity Investment Framework

This Review recommends that following the review of the priorities for each of the public assets, a Salinity Investment Framework, Phase III is prepared to inform Government policy and public debate on the management of Western Australia's public assets at risk of salinity.

6.4.1 Summary

In summary the key actions required for the Investment pillar are:

- DBCA to review biodiversity priorities in the context of a revised salt-affected land assessment by 2020.
- DWER to review Water Resource Recovery Catchment approach and catchments in the context of a revised salt-affected land assessment and stream salinity analysis by 2019.
- DPIRD, in consultation with MRWA and local government, to review critical infrastructure at risk from revised assessment of salinity risk by 2019.
- DPIRD, in consultation with DBCA and other key stakeholders, to assess role for government in creating opportunities for private investment from perspectives of carbon, biodiversity and sustainable agriculture by 2019.
- A Salinity Investment Framework Phase III is prepared to inform public debate and public investment decisions.

7. Conclusion

This New Directions study reviewed a range of Western Australia's salinity programmes and, taking into consideration the views of the stakeholders consulted, considered emerging opportunities and potential issues. In undertaking this review two fundamental questions raised by the OAG in their May 2018 report were considered.

- Do agencies know the extent and impact of dryland salinity in the South West agricultural regions?
- Are efforts to reduce the impacts of dryland salinity in the South West regions working?

The overall findings of this Review were that:

- The extent and impact of salinity has not been reviewed for at least twenty years and needs to be updated as a priority
- The efforts to reduce the impacts of dryland salinity have not been reviewed for many years and therefore the impact of salinity management programmes on salinity is not well understood.

It is timely to re-set the agenda in salinity R&D and investment priorities. The policy vacuum salinity in Western Australia has experienced over the last 15-20 years, has not only meant that the extent of salinity and impact of salinity investment programmes is not clear, but opportunities to introduce innovative thinking to salinity programmes have not been created. However, despite salinity's low policy profile, important legacies of the many years of investment remain. These legacies include:

- The importance of consultation, collaboration and community engagement with government in developing and applying salinity management programmes remains strong. If government chooses to invest in the salinity management and R&D, there remains a firm commitment to *'work' together* to develop informed policy and programmes
- There was significant investment in salinity R&D during the 'salinity era' including, plant breeding, grazing systems, groundwater trends, deep drainage, water quality, economics and landuse and catchment management planning. Many of the researchers responsible for these research programmes remain involved in the industry and therefore available to provide informed advice on salinity research priorities for Western Australia.
- Salinity is a long-term NRM issue and because of this, many of the principles, objectives and recommendations of a number of the salinity programmes and reviews established in WA remain relevant and can be used as the basis for renewed investment in salinity. Good examples include, the Salinity Investment Framework, Phases I and II, the Report of the State Salinity Taskforce and the strategic salinity programmes such as the EEI, CDI and Rural Towns programme.
- The appreciation that salinity is considered in context of other NRM issues and socio-economic values remains well understood. The integrated approach to land management and the importance of the social environment in the adoption of recommended land management practices means that decisions in salinity investment will be in context of the natural and social environment.
- Governance arrangements established in the 'salinity era' remain active with the Soil and Land Conservation Commission provide to Government a foundation from which governance reforms may be established.

The recommendations made by this Review centres around four themes:

- Information – Investment in updated and relevant information on the extent and impact of salinity is recommended. Similarly information on salinity management recommendations requires updating. There is scope in this Pillar to investigate the role of new technologies in salinity, for example, real time data. Importantly, the collaborative, consultative approach to gaining and sharing 'salinity information' should not be lost.
- Governance – Governance arrangements to formally involve a range of stakeholders and provide targeted advice to government and government agencies is recommended. Re-instating the Soil and Land Conservation Council is a key recommendation of this Pillar
- Innovation – Innovation in saline water-use, carbon farming, deep drainage solutions and other salinity management solutions has the potential to complement the long-standing research programmes in salinity management. A key recommendation in this Pillar is the establishment of a research plan for salinity for Western Australia. This Plan would be developed in consultation with a range of research providers each representing key areas of interest. The Plan would become the basis for partnerships with state and federal agencies, public and private investors.
- Investment – Investment in important public assets remains an important Government action. A review of the list of biodiversity, water resource and infrastructure assets is warranted to assess their status and confirm as to whether other assets should be included. This Pillar recommends that a Salinity Investment Framework Phase III is prepared once the key public assets are known.

Salinity has, and will, remain an NRM issue for the West Australian Wheatbelt. Renewed investment and governance in salinity will increase the capacity of both public and private investment to meet the challenges it presents to the social, economic and natural values of Western Australia.

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Appendices

Appendix A - Summary of Salinity Programs – Historical and Current

Table A1 Summary of Salinity Programs – Historical and Current

Program	Objective	Achievements / Current Status
Commonwealth		
NHT	The first phase, NHT 1 (1996–97 to 2001–02), allocated $1.5 billion to NRM and environmental activities, including: The National Landcare Program ($326.7m): "The goal of the National Landcare Program is to develop and implement resource management practices that enhance our soil, water and biological resources. These practices are to be efficient, sustainable, equitable and consistent with the principles of ecologically sustainable development.	
NHTII	NHT 2 (2002–03 to 2007–08), allocated $1.3 billion for NRM activities	
National Action Plan for Salinity and Water Quality	The stated goal of the program was 'to motivate and enable regional communities to use coordinated and targeted action to: - prevent, stabilise and reverse trends in dryland salinity affecting the sustainability of production, the conservation of biological diversity and the viability of our infrastructure - improve water quality and secure reliable allocations for human uses, industry and the environment	Caring for our Country replaced several national programs, including the NAP. CfC had a budget of $2.25 billion to deal with a wide range of environmental issues. Salinity was not a priority for investment in Caring for our Country Pannell and Roberts: In our judgment, based on the evidence in Sections 4.1–4.12, the net benefits of the majority of investments under the program were negative, and in some cases, the gross benefits were negative. Funds were often poorly targeted, or effectively untargeted, and the choice of policy mechanisms was very poor, particularly in the excessive reliance on extension. The Australian National Audit Office (ANAO) 2008 in its review of the Regional Delivery Model for the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality: commented that '*Overall, the ANAO considers the information reported in the Department of Agriculture Fisheries and Forestry and NHT annual reports has been insufficient to make an informed judgement as to the progress of the programs towards either outcomes or intermediate outcomes,*' and further added that '*There is little evidence as yet that the programs are adequately achieving the anticipated national outcomes … Where the impact [of NAP investment] on resource condition is identified by regional bodies, the expected results were often low (frequently less than one per cent of the longer-term resource condition target).*' (Auditor General, 2008, pp. 19-20)
National Landcare Program	Caring of our Country was superseded by National Landcare Program. From July 2014 to June 2018, the Australian Government invested $1 billion to deliver on-ground biodiversity and sustainable agriculture. The Australian Government is investing around $1 billion in the Phase Two of the National Landcare Program. This includes the $100 million previously agreed in the 2016-17 Mid-Year Economic and Fiscal Outlook.	The changing focus to broader objectives in biodiversity and sustainable agriculture meant that there was no focus on salinity. However some programs incorporated an objective which had secondary benefits in salinity mitigation.

Program	Objective	Achievements / Current Status
	The majority of the investment will be delivered over a period of five years—from July 2018 to June 2023—while some elements of the program began during the 2017-18 financial year, including the additional $100 million. The proposed Regional Land Partnerships outcomes are: a. By 2023, the ecological character of Ramsar sites is maintained or improved b. By 2023, the trajectory of Threatened Species Strategy priority species is improved c. By 2023, the outstanding universal values of natural and mixed World Heritage Areas are maintained or enhanced by a reduction in invasive species threats d. By 2023, the condition of nationally threatened ecological communities on private land is improved e. By 2023, there is an increase in the awareness and adoption of land management practices that improve and protect the condition of soil, biodiversity and vegetation f. By 2023, agriculture systems have a capacity to adapt to significant changes in climate, weather and markets.	
State Government		
Salinity Action Plan - 1996	The Action Plan aims to: - Reduce further deterioration of agricultural land and where possible recover or rehabilitate existing salt-affected land - Protect and restore key water resources to ensure salinity levels are kept at a level that permits safe, potable water supplies in perpetuity - Protect and restore high value wetlands and maintain natural (biological and physical) diversity within the agricultural areas of WA - Protect designated infrastructure affected by salinity	Majority of initiatives were funded and committed in the Action Plan. The actions in relation to woody perennials, increased water use by crops and pastures, drainage, and remnant vegetation protection and management have basically been delivered. However there were criticism that the plan was too government focused and did not engage with farmers, industry and community groups.
State Salinity Strategy - 2000	This strategy aims to reduce the impact of salinity in the south west agricultural region of WA. It has the goals: - To reduce the rate of degradation of agricultural and public land, and where practical recover, rehabilitate or manage salt-affected land; - To protect and restore key water resources to ensure salinity levels are kept to a level that permits safe, potable water supplies in perpetuity; - To protect and restore high value wetlands and natural vegetation, and maintain natural (biological and physical) diversity within the south-west region of WA; - To provide communities with the capacity to address salinity issues and to manage the changes brought about by salinity; and - To protect infrastructure affected by salinity.	The Salinity Strategy provided greater focus to community based programs and partnership between government, community and industry. The Salinity Council was given the task of preparing annual operating plans detailing current projects, budgets and monitoring and evaluation information. The Salinity Strategy was completed as the NAPSWQ and NHT2 were being implemented, particularly given the delays in WA signing the NAPSWQ. There is little documentation on the many commitments that are throughout the Salinity Strategy document. In response to the Salinity Strategy the Salinity Taskforce in 2001 recommended a renewed, clearly focused and targeted investment approach.
Government Response to Salinity Taskforce - 2002	Government will lead action in three key areas which build on the 1996 Salinity Action Plan and the 2000 Salinity Strategy: 1. 'direct support' to protect assets of high public value (eg biodiversity, water resources, infrastructure), 2. 'indirect support' through investing in new	The Government Response to the Salinity Taskforce provided a relative ranking for each Salinity Management Priority. The highest priorities were for; - Expansion of the Biodiversity Recovery Program' - Recovery of key WRRCs - Development of economically viable new salinity management - Core support for regional NRM groups

Program	Objective	Achievements / Current Status
	industries and technologies (eg new perennial plants, commercial farm forestry, engineering solutions) and; 3. providing support and incentives for planning, Co-ordination and implementation of smaller on-ground works on private land, especially where these will lead to public benefits.	With respect to these priorities the Biodiversity Recovery Program has reduced to only two catchments; the WRRC program has focused on the Collie and Denmark catchments; there is some continued research into productive use of saline lands, and core support for regional NRM groups is now not funded by the WA government.
River / Water Supply		
Water Resource Recovery	1996 Salinity Action Plan identified the following as WRRCs with the target to achieve 500 mgL^{-1} TDS: - Helena - Collie by 2015 - Warren by 2030 - Kent by 2030 - Denmark by 2020	Helena - Salinity Situation Statement Collie - Salinity Situation Statement - River Recovery Plan - Major investment reducing salinity but is not forecast to achieve 500 mgL^{-1} TDS Warren - Salinity Situation Statement - Salinity averaging 960 mgL-1 TDS but forecast to reduce to 700 mgL-1 TDS with current land-use Kent - Salinity Situation Statement - Salinity averaging 1525 mgL-1 TDS - Not going to achieve target - Review of status as WRRC required Denmark - Salinity Situation Statement - River Recovery Plan - Achieved target of 500 mgL^{-1} TDS
Land use impacts and catchment research	- Stream salinity monitoring and status reporting - Bauxite Hydrology – Impact of mining on water resources	The Stream Salinity Status report of 2005 was a good summary of current status but the report is now `3 years old and the data is becoming dated.
Engineering Evaluation Initiative / Wheatbelt Drainage Evaluation	- To review the current knowledge on engineering options to mitigate dryland salinity and to clarify 'best practice' by establishing demonstration sites for a range of engineering options. - Test and evaluate current engineering approaches to salinity remediation. - Understand impacts at local and regional scales. - Develop and test improved engineering for salinity management.	The Review of Engineering and Safe Disposal Options (Dogramaci and Degens 2003) identified gaps to guide investment under the EEI. In reviewing the achievements against the gaps identified in Dogramaci and Degens,(2003) 5 out of the 8 high priority recommendations were achieved. The 3 not achieved related to monitoring criteria, transmission losses and sodicity. The financial recommendations were achieved and 8 out of the 9 lower priority recommendations were achieved. Regional drainage evaluation of Avon River, Yarra Yarra catchment, and Blackwood Basin completed Development of governance including Wheatbelt Drainage Committee, defining roles and responsibilities for inland drainage and a policy framework for inland drainage.
Biodiversity		

Program	Objective	Achievements / Current Status
Natural Diversity Recovery Catchments	*1996 Salinity Action Plan* - *To develop and implement a coordinated Wetlands and Natural Diversity Recovery Program targeting at least six key catchments over the next 10 years to ensure that critical and regionally significant natural areas, particularly wetlands, are protected in perpetuity* - *To develop knowledge and technologies to combat salinity throughout the agricultural region.* The Natural Diversity Recovery Catchment program focused on six critical wetlands/catchments at risk from salinisation: - Toolibin Lake - Lake Warden System - Muir-Unicup - Lake Bryde System - Buntine-Marchagee - Drummond Toolibin Lake, Muir-Unicup and Lake Warden System are listed as a Wetland of International Importance under the Ramsar Convention.	*2011 Review recommended that* *The goal of the Natural Diversity Recovery Catchment Program becomes:* *To develop and implement works within the South West Land Division that protect, and where practicable recover, the biodiversity of significant, natural wetlands and associated valley biological communities from the adverse effects of altered hydrology.* *Primary values underpinning this goal will be specified for each catchment project.* The Natural Diversity Recovery Catchment program undertaken by DBCA now focuses on: - Lake Toolibin - Lake Bryde
South-west Wetland monitoring program	To monitor a sample of wetlands, and their associated flora and fauna throughout the south-west to determine long-term trends in natural diversity and provide a sound basis for corrective action."	105 wetlands monitored mostly in national parks and nature reserves Last published in 2015 Long-term trends are evident, particularly declining water levels and increasing salinity at many, but not all, wetlands. These and other changes are affecting fringing and emergent vegetation and the suitability of certain areas for waterbirds and other fauna (Lane, 2013).
Agriculture		
SGSL	The focus of *Profitable and sustainable grazing on saline land in WA* is to evaluate the gains in animal production, water management and biodiversity in saltbush-based pastures as a result of the introduction of new plant species and better management systems. *Optimising the saltland pasture system for practical and profitable use* concentrates on the practical implementation and optimisation of saltbush and understorey systems to provide the most effective inputs into livestock production systems.	Key new knowledge outcomes from the project have included: - a greater awareness and integration of options for salt-affected land; - improved understanding of how to establish and manage saltland pasture systems; - greater confidence by many farmers to tackle salt-affected land, with their subsequent attitudes toward saltland having changed from wasteland to potential profitability; and - an increased desire to improve salt-affected areas and show others that it can be profitable. Land Wool & Water provided a total budget of $12,017,903, including a proportion of program overheads for SGSL. Based on a conservative estimate of the profitability gains likely and the area that may be planted to saltland pastures over the next 10 years, the investment in SGSL is considered to have provided benefits with a present value of $24.6 million. The investment is estimated to provide a benefit-cost ratio of 2.1 to 1 and an internal rate of return of about 11.8%. (Agtrans, 2007)
Groundwater Monitoring	To develop an understanding of groundwater systems in the agricultural areas, and to support intervention activities, groundwater bores were established to investigate and monitor the groundwater depth, quality and trends.	Surveillance groundwater monitoring to support Soil and Land Commissioner's annual report and the Sustainable Agriculture Report Card.
Wheatbelt Salinity Investigations / Advice		Regional hydrologists continue to receive requests for salinity information. Monitoring of groundwater keeps staff engaged with and in contact with farmers across Wheatbelt.
Catchment Demonstration Initiative	The initiative aimed to demonstrate viable *salinity management systems* in the agricultural area of WA. The CDI sought to deliver its outcomes in partnership with NRM Regions by co-investment in targeted, large-scaled, catchment-based demonstrations of integrated salinity management practices The four CDI projects were: - Gillingarra-West Koojan ('Gillingarra') Catchment Demonstration;	The CDI Program has delivered on its objectives and served its purpose to demonstrate this catchment-level intervention approach. Accelerated adoption of desired practices has occurred However, it is clear that there were difficulties and frustrations in implementation at all levels, and concerns about the universality of the approach. Given these difficulties, and the impracticality of implementing this approach over the wider dryland agricultural areas, the approach need not be repeated, nor implemented more widely in addressing land and water management issues in the agricultural areas.

Program	Objective	Achievements / Current Status
	- Wallatin-O'Brien ('Wallatin Creek') Catchment Demonstration; - Upper Coblinine ('Upper Coblinine') Catchment Demonstration; and - Fitzgerald River ('Fitzgerald') Catchment Demonstration.	
Forestry		
Strategic Tree Farms	The aim was to produce two main outcomes: environmental benefits, such as improved land and water quality; and economic benefits through the creation of new industries based on wood. Funds were allocated to four NRM regions – Northern Agricultural, Avon, South West and South Coast. Each region has a planting program that aligns with its NRM goals and FPC's Industry Development Plans covering the area from Moora to Esperance.	URS Conclusions - Performance Story Report for the contribution of Strategic Tree Farming to Regional NRM outcomes - 2008 The target for the area established to medium rainfall forestry (18,000 ha) at project commencement will be achieved by the end of 2009. This estate will yield useful information on the environmental and economic benefits of these trees through coming years. The incentives payable through the STF project have been welcomed by farmers, and have encouraged significant additional interest and involvement in agro-forestry. There has been a degree of culture change within the agricultural community about the role of agro-forestry in these areas. The STF project has been an important catalyst in providing education and involvement in tree-farming, and has facilitated relationships between people and organisations across the value chain. It has enabled support industries (nurseries, contractors) to develop and grow. The project has stimulated R&D in silviculture, physical impacts of trees, and the economics of medium rainfall forestry. In particular, the active and healthy debate about the value of trees in combating the salinity threat has been encouraged by the project. Resolution of this debate would enable more certainty in determining the level of investment in trees planted for salinity management. Without further investment, the STF plantings in pines and sawlogs (higher volume, lower value product), which are distributed widely across the medium rainfall areas are at the risk of being a 'stranded asset' without access to nearby processing facilities. However, the sandalwood plantings which generate a lower volume, higher value product are safer in this respect, and critical mass is more easily achieved. The full range of benefits provided by medium rainfall forestry (e.g. timber, carbon, salinity mitigation, amenity, biodiversity, shelter for stock) need to have a market value for the industry to be economically viable. The on-going challenge for FPC and its partners will be in developing market values for all of these benefits in a manner that encourages adequate public and private investment.
Infrastructure		
Rural Towns –Liquid Assets	Aim of developing integrated water management plans for a number of WA towns at risk from salinity (16 high priority towns) Specific objectives included: - Protection of townsite infrastructure from salinity - A model of integrated town water management - Development of alternative new supplies plus recycled water schemes - Reduced reliance on scheme water in towns - Promotion of high value industries using new water supplies; and - Fostering of local ownership of water resources management issues	Water Management Plans prepared for 15 priority towns that demonstrated how to control town-site salinity and potentially produce returns from the water issue. .
Roads	SIF 2 identified based on large-scale data, about 252 km of highways and main roads and 3850 km of local and unclassified roads are currently estimated to be affected by salinity. The total combined current annual cost is around $21 million. However, 1194 km of highways and	MRWA has reviewed the information for main roads in the Wheatbelt and assessed the annual increase in maintenance cost due to salinity is $410,000 per year.

Program	Objective	Achievements / Current Status
	main roads and 22 960 km of local and unclassified roads have a high hazard (likely to be an overestimate). Allowing for the gradual increase in repair and maintenance of roads as salinity spreads, and assuming all affected roads are repaired, the present value of forecast road repair costs is $1938 million, of which $271 million is for highway and main road repairs.	
Policy		
Salinity Investment Framework	A framework to improve cost effectiveness of public investment in salinity management by directing funds to projects with the potential to protect or recover high value public assets and consider strategies for supporting work where direct investment in on-ground works cannot be justified.	

Appendix B - Summary of Review Recommendations Based on OAG Report

Table B1 Summary of Review Recommendations Based on OAG Report

Monitoring and Reporting – spread, impact and cost of dryland salinity
Salinity Taskforce The Salinity Taskforce recommends that the monitoring and evaluation program for salinity and NRM include two broad monitoring components: (a) Broadscale baseline monitoring of the impacts of salinity and the implementation of salinity management practices; and (b) Monitoring to support evaluation of specific programs. **Recommendation 5.2.7** The Salinity Taskforce recommends that substantial additional funds be allocated to continue the Land Monitor project in support of the statewide program of baseline monitoring. **Recommendation 5.2.8** The Salinity Taskforce recommends that the adequacy of existing baseline monitoring programs be reviewed by the proposed NRM Office, together with the Departments of Conservation, Agriculture and Environment, Water and Catchment Protection. Any gaps or inefficiencies should be reported to the proposed NRM Council for Land and Water and the Cabinet Standing Committee on Environmental Policy, with recommendations for improvement. In designing the monitoring activities for specific programs, the information collected needs to provide the inputs to a formal evaluation. **Recommendation 5.2.9** The Salinity Taskforce recommends that monitoring be built into each program of the Salinity Strategy (including measurable targets over time) as an intrinsic part of the work, with a requirement that it will provide information for use in regular evaluations. **Recommendation 5.2.10** The Salinity Taskforce recommends that the new monitoring and evaluation program include development of formal and rigorous evaluation processes for salinity programs and identification of data requirements for such evaluations.
Review of the State NAP and NHT2 Monitoring and Evaluation Plan As natural resource changes occur over a long time, RCM requires a long-term commitment. • Provide ongoing funding. • Develop a plan to coordinate effort across the State agencies.
WESTERN AUSTRALIAN SALINITY REVIEW Roy Green and Colin Creighton 2010 Recommendation 1: That Resource Condition Monitoring of Dryland Salinity [groundwater and stream sampling] continue to be resourced so that a detailed analysis of trends in both groundwater and stream conditions across South West WA can be reported on routinely as part of WA State of Environment Reporting every 5 years. Recommendation 2: That Land Monitor or other remote sensing technologies are selectively applied to those groundwater regions exhibiting significant increase in groundwater level and/or to those catchments where instream water quality is exhibiting significant change. This should be undertaken in the year before WA State of Environment Reporting so that the results can reported on and interventions recommended as part of the 5-yearly Environment Reporting process.

Salinity and Land Use Impacts Program Review – 2012

Recommendation 6
Continue to prepare Stream Salinity Trend and Status reporting. Apart from its value to State of Water Resource reporting and State of Environment reporting it is highly valued by community and industry and can be the vehicle for a watching brief on Water Resource Recovery and other priority catchments.

Recommendation 7
Continue the small but highly valuable monitoring program that delivers the above initiatives and significantly reduces the risks outlines in the review.

Salinity Management in the south west of Western Australia – Conservation Commission - 2013

Finding 1 Further information is required to understand the interactions between climate variability and saline groundwater levels, and the changing nature of the threat posed by salinity.

Finding 2 The total area at risk from salinity is now considered less than that estimated by the National Land and Water Resources Audit (2000).

Finding 3 It is 15 years since the salinity estimates which are currently in use were produced and these data sets require updating and review.

OAG – 2018 – Management of Salinity

(b) .establish regular monitoring and reporting of the spread, impact and cost of dryland salinity

Cooperation and Coordination

Salinity Taskforce

Recommendation 5.4.15

The Salinity Taskforce recommends that the Department of Agriculture establish a process to ensure integration and coordination of the delivery of salinity and NRM extension services to landowners and land managers in the agricultural area of WA.

OAG – 2018 – Management of Salinity

(b) .establish regular monitoring and reporting of the spread, impact and cost of dryland salinity

Targets – catchment wide or local scale

Salinity Taskforce

Recommendation 5.1.4

The Salinity Taskforce recommends that, over time, outcomes, targets and milestones be refined as the Framework for Investment in Salinity Management is applied with greater detail and rigour to the range of investment options for salinity management.

Recommendation 5.2.3

The Salinity Taskforce recommends that targets for the new State Salinity Strategy be developed as key outcomes of the application of the “Framework for Investment in Salinity Management”.

Recommendation 5.2.3

The Salinity Taskforce recommends that targets for the new State Salinity Strategy be developed as key outcomes of the application of the “Framework for Investment in Salinity Management”.

These targets should:

• specify the difference which will be made by the State Salinity Strategy in comparison to a scenario where there is no coordinated strategy and no additional funding;

• be expressed in terms of specific outcomes, including area of land protected from salinisation, area of saline land in productive use, value of infrastructure protected from salinity, number of species estimated to have been protected from extinction, area of native vegetation protected from salinisation and reduction in peak flood flows; and

• incorporate targets for community and social impacts such as increased employment in rural areas, prevention of rural population decline and increased wealth in rural areas.

Recommendation 5.2.5

The Salinity Taskforce recommends that targets be specified for research and development and industry development as a whole in terms of the potential levels of adoption of newly developed technologies and the actual aggregate levels of adoption of the technologies over time.

OAG – 2018 – Management of Salinity

consider whether there should be targets to reduce water tables and re-plant deep rooted trees on a catchment wide or localised level

Promotion of soil conservation

Salinity Taskforce

Recommendation 5.4.15

The Salinity Taskforce recommends that the Department of Agriculture establish a process to ensure integration and coordination of the delivery of salinity and NRM extension services to landowners and land managers in the agricultural area of WA.

Recommendation 5.4.7

The Salinity Taskforce recommends that additional funds be allocated to the Department of Agriculture to develop a new coordinated training and education program available to all extension officers, advisers and Community Support Officers involved in salinity and NRM. The training should improve technical expertise in areas such as hydrogeology, engineering options, farming systems, woody perennials, native vegetation management, biodiversity and farm economics evaluation of management options

OAG – 2018 – Management of Salinity

Continue to promote soil conservation, and educate landholders and the public

Compliance and regulation

Salinity Taskforce

Recommendation 5.6.9

The Salinity Taskforce recommends that the Government strengthen regulations against vegetation destruction where adverse environmental outcomes are likely to occur and that enforcement of existing and new regulations are strongly enforced.

OAG – 2018 – Management of Salinity

(f) where necessary, make greater use of compliance and enforcement mechanisms under the *SLC Act 1945* to ensure that landholders prevent and/or mitigate land degradation.

Strategic Direction

Salinity Taskforce

Recommendation 5.1.1

The Salinity Taskforce recommends that the proposed NRM Council for Land and Water develops a new State Salinity Strategy to reflect the new investment priorities of the Government and any outcomes of negotiations for the National Action Plan for Salinity and Water Quality. The Strategy will build on the 1996 and 2000 Strategies by incorporating the findings of the Salinity Taskforce, particularly the need for increased attention to:

• the completion and application of the Framework for Investment in Salinity Management;

• better systems for monitoring and evaluation;

• engineering methods for salinity management in suitable locations;

• commercial drivers and development of new technologies and farming systems for salinity management;

• new structures and institutional arrangements; and

• improved biodiversity management and protection.

Recommendation 5.1.2

The Salinity Taskforce recommends that its statement of 'A New Position on Salinity Management' (Section 2)

be endorsed and used as the basis for developing the new State Salinity Strategy as well as guiding the State's negotiations for the National Action Plan for Salinity and Water Quality and influencing negotiations for phase two of the Natural Heritage Trust.

Recommendation 5.1.3

The Salinity Taskforce recommends that the new Salinity Strategy incorporate interim outcomes, targets and milestones, based as far as possible on the proposed Framework for Investment in Salinity Management

Salinity Management in the south west of Western Australia – Conservation Commission - 2013

Finding 8 There has been no whole-of-state government review into the effectiveness of salinity mitigation under the State Salinity Strategy

OAG – 2018 – Management of Salinity

set the strategic direction for the management of salinity

Appendix C – Workshop attendees

Attendee	Organisation
Glenice Batchelor	SGSL CDI
Mark Batty	WALGA
David Beatty	MLA
Keith Bradby	WA Landcare Network
David Broadhurst	South Coast NRM
Ben Coles	Wide Open Agriculture
Simon Cook	Curtin University – Premiers Agriculture Fellow
Geoff Craggs	Future Directions International
Andrew DelMarco	Peel/Harvey Catchment Council
Matthew Gilfellon	Shire of Dumbleyung
Doug Hall	PGA
Richard Harper	Murdoch University
Tom Hatton	EPA
Tom Hughson	Conservation Commission
Ross Kingwell	DPIRD/AEGIC
Callum Love	Northern Agriculture Catchments Council
Prof Alan Lymbery	Murdoch University
Kevin Lyons	Drainage
Rowan Maddern	GRDC
Bruce Manning	Great Southern Development Commission
Craig Manton	Main Roads
Ray Marchetti	Office of Auditor General
Dustin McCreery	Nurseries
Rob McFerran	Minister's Office
Robert Nixon	Northern Agriculture Catchments Council
Hayley Norman	CSIRO
Gavin Partridge	Aquaculture - use of saline water
Keith Pekin	Perth NRM
Simon Taylor	South West Development Commission
Andrew Watson	Soil and Land Commissioner
Ray Wilson	Carbon Farming
Justin Wolfgang	Perth NRM
Don Woodcock	RegenWA
Natarsha Woods	Wheatbelt NRM
Tony York	WAFarmers
Apologies	
Jules Alvaro	Ministerial Advisory Committee
David Beatty	MLA
Annabelle Bushell	GGA

Attendee	Organisation
Tim Colmer	UWA
Vanessa Forward	SWALSC
Pip Kirby	Wheatbelt Development Commission
Simon Taylor	South West Development Commission
Supporting	
Graeme Blake	DWER
Jamie Bowyer	DPIRD
Kim Brooksbank	DPIRD
Greg Durell	DBCA
Richard George	DPIRD
Andy Lyon	FPC
Mike Lyons	DBCA
Adrian Pinder	DBCA
John Simons	DPIRD
Tim Sparks	DWER
Melanie Strawbridge	DPIRD
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Document Status

Revision	Author	Reviewer		Approved for Issue		
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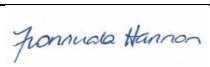
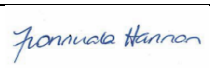
O	J .Ruprecht	F. Hannon		D. Horn		21 12 18
1	J. Ruprecht F. Hannon	F. Hannon		D. Horn		03.01.19
2	J. Ruprecht F. Hannon	D. Horn		D. Horn		17.01.2019

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