The Parliament of the Commonwealth of Australia

Science Overcoming Salinity:

Coordinating and extending the science to address the nation's salinity problem

House of Representatives
Standing Committee on Science and Innovation

May 2004
Canberra

ISBN 0 642 78468 X

Cover photograph: Salt crystals build up on the remnants of tree trunks at Quairading, in Western Australia's Wheat Belt.

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Foreword

There is a public perception that salinity is overwhelmingly the result of poor agricultural practices over many decades. While some of those practices have clearly caused and/or added to the problem in some instances, the occurrence of salt in our landscape is both natural and historical. Captain Charles Sturt finding the Darling River too salty to drink in 1829 is a good demonstration.

The House of Representatives Standing Committee on Science and Innovation, in conducting this Inquiry, did not focus on the causes of salinity as such, other than to outline some of the history of salinity. The Committee's main goal was to determine whether the best and most up-to-date science was being applied to individual problems, and whether effective coordination was in place so that the science made it 'down to the ground'.

Governments at both the national and state level are and will continue to invest substantial amounts of money in addressing salinity throughout many parts of Australia. It is crucial for that investment not to be wasted. However, if there are not strong and easily followed links between the science and those working at the catchment or farm level, that investment may be ill directed.

In the report that follows, the Committee makes twenty-four recommendations designed to ensure the science base remains current and relevant and that processes give land managers confidence that their work will have maximum impact on salinity problems.

The Inquiry was greatly assisted by the quality of the submissions, the wonderful cooperation during inspections and the excellent witnesses. The input came from government, academe and the private sector and the Committee is grateful to everyone who contributed.

My thanks go to my colleagues on the Committee who participated with enthusiasm throughout the Inquiry. Thanks also go to the dedicated staff of the Secretariat for their diligence and support.

Gary Nairn MP
Chair

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Terms of reference

On 18 August 2003, the Minister for Science, the Hon Peter McGauran MP, asked the House of Representatives Standing Committee on Science and Innovation to inquire into and report on the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity programs.

In conducting its inquiry, the Committee was asked to give particular consideration to the:

a) use of the salinity science base and research data (including the development of new scientific, technical and engineering knowledge) in the management, coordination and implementation of salinity programs;

b) linkages between those conducting research and those implementing salinity solutions, including the coordination and dissemination of research and data across jurisdictions and agencies, and to all relevant decision makers (including catchment management bodies and land holders); and

c) adequacy of technical and scientific support in applying salinity management options.

List of abbreviations and glossary of terms[1]

AAS

Australian Academy of Science

ABS

Australian Bureau of Statistics

Accreditation

A formal process for assessing the appropriateness of a strategy or plan for implementation

ACF

Australian Conservation Foundation

AEM

airborne electromagnetic (induction techniques for salinity mapping)

Agroforestry

A collective name for land-use systems in which woody perennials (trees,

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1 The glossary has been compiled from the following sources: Murray-Darling Basin Commission, *Annual Report 2001 – 2002*, MDBC, Canberra, 2002, pp. 144-48; Murray-Darling Basin Commission, *Integrated Catchment Management in the Murray-Darling Basin 2001 – 2010*, MDB Ministerial Council, Canberra, 2001, pp. 26-29; Parliamentary Research Service, *Murray-Darling Basin: Ecologically Sustainable Irrigation?*, Research Paper No. 30 1994/95, Canberra, Department of the Parliamentary Library, 1995, pp. 3-4; Industry Commission, *A Full Repairing Lease*, IC, Report No. 60, Canberra, 1998, pp. xix–xx; M. Sexton, *Silent Flood: Australia's Salinity Crisis*, ABC Books, Sydney, 2003, pp. 195-8; F. Ghassemi et. al., *Salinisation of Land and Water Resources*, UNSW Press, Sydney, 1995, pp. 513-17; A. Young, 'The potential of agroforestry as a practical means of sustaining soil fertility', in R. T. Prinsley and M. J. Swift (eds), *Amelioration of soils by trees*, Commonwealth Science Council, London, 1986. ANZLIC – The Spatial Information Council, *Policy Statement on Spatial Data Management*, 1999, viewed 8 June 2004, <www.anzlic.org.au/publications.html>.
Government program titles are italicised.

shrubs) are grown in association with herbaceous plants (crops, pastures) and / or livestock in a spatial arrangement, a rotation, or both, and in which there are ecological and economic interactions between the tree and the non-tree components of the system

Aquifer
: A porous soil or rock formation, below the surface of the ground, that holds water and through which water can move to reach bores and springs

ASAN
: Australian Salinity Action Network

ANZLIC
: Australia New Zealand Land Information Council. The peak council for the coordination of spatial data management in Australia and New Zealand.

ASDD
: The Australian Spatial Data Directory. A key component of the ASDI which provides information about the availability, characteristics and quality of spatial data held by governments and the private sector and how that information may be obtained.

ASDI
: The Australian Spatial Data Infrastructure. A network of fundamental spatial databases maintained by custodians and linked through the adoption of consistent standards, policies and administrative arrangements.

Biodiversity
: The variety of life forms, plants, animals and micro-organisms, the genes they contain, the ecosystems they form, and ecosystem processes

BRS
: Bureau of Rural Sciences

Catchment
: An area of land supplying water to a watercourse bounded by hills or ridges that direct the flow of water

CMO
: Catchment management organisation. A generic name for organisations

comprising members of the catchment community, government and other interested parties established by state governments for the specific purpose of overseeing the management of a catchment's natural resources.

CCRC
: Cotton Cooperative Research Centre

CMA
: catchment management authority

CMB
: catchment management board

COAG
: Council of Australian Governments

CRC
: Cooperative Research Centre

CRC LEME
: Cooperative Research Centre for Landscape Environments and Mineral Exploration

CRC PBMDS
: Cooperative Research Centre for Plant-based Management of Dryland Salinity

CRDC
: Cotton Research and Development Corporation

CSIRO
: Commonwealth Scientific and Industrial Research Organisation

Cyclic salt
: The salt derived from oceanic spray transported inland by winds and deposited by rain

DAFF
: (Australian Government) Department of Agriculture, Fisheries and Forestry

DEST

(Australian Government) Department of Education, Science and Training

Discharge

Groundwater that escapes into a stream bed, lake or ocean, or through the land surface

Discharge zone

Areas of catchments where groundwater emerges at low points in the landscape

DRDC

Dairy Research and Development Corporation

Dryland salinity

Saline seepages or salt scalds occurring in rain-fed (non-irrigated) areas caused by changes in land use that affect the groundwater balance throughout the landscapes. A typical situation occurs following the tree clearing from hillslopes, which reduces transpiration and allows an increase in rainfall intake beyond the root zone and a rise in watertables lower down the slope. Increased subsurface seepage dissolves salts in the soil and, with lateral flow through the landscape, moves from hillslopes to valley floors. Salty water then surfaces in patches depending on the geomorphology and topography of the site. The salt becomes concentrated by evaporation at these locations and the normal vegetation is killed.

DEH

(Australian Government) Department of the Environment and Heritage

EC units

The electrical conductivity (EC) of water provides a measure of the amount of salt dissolved in the water—the higher the EC value, the more saline the water. One EC equals one micro-Siemen per centimetre measured at 25 degrees Celsius, or approximately 0.6 milligrams of salt per litre. 800 EC units is the World Health Organization recommended desirable upper limit for salinity in drinking water.

End-of-valley target

A target for the quality and quantity of water at the point where a river leaves a catchment

EMS
: environmental management systems

Evapotranspiration
: Water returned to the atmosphere by evaporation (by the sun) and by plants emitting water vapour from their leaves

FWPRDC
: Forest and Wood Products Research and Development Corporation

GRDC
: Grains Research and Development Corporation

Groundwater
: The water in the saturated pores of soil or rock below the watertable

ICM
: Integrated catchment management. The integration of water and land management activities and the government agencies involved in these activities within a catchment.

Irrigation salinity
: A form of salinity that is caused by the increasing build-up of salts in soils used for irrigation. It results from raised watertable levels that bring soil salts into the upper levels of the soil profile, as well as the repeated use of saline river water for irrigation.

Landcare
: Landcare is a community-based approach to fixing environmental problems and protecting the future of our natural resources. There are now more than 4250 Landcare groups across Australia. About one in every three rural landholders is a member of a Landcare Group.

Land holders
: Those who own or lease land

Land managers
: Those who manage land, including farmers, graziers, irrigators, cultural and environmental land holders, councils and government agencies

LWA

Land and Water Australia. LWA is an Australian Government research and development corporation within the Agriculture, Fisheries and Forestry portfolio. Established in 1990 as the Land and Water Resources Research and Development Corporation under the *Primary Industries and Energy Research and Development Act 1989*, LWA invests in research and development for the productive and sustainable management of Australia's land, water and vegetation resources.

Market mechanisms

Mechanisms that change the market forces for particular commodities to help achieve the desired natural resource management outcome

MDBC

Murray-Darling Basin Commission

NAP

National Action Plan for Salinity and Water Quality
Established by the Australian, state and territory governments in November 2000, the objectives of the NAP are to enable regional communities and landholders to use coordinated and targeted action to prevent, stabilise and reverse trends in dryland salinity, and to improve water quality. Under the NAP, the Commonwealth funds communities to implement accredited integrated catchment/region management plans through block funding, on a matching basis with the States and Territories. Twenty-one priority regions have been identified under the Plan. Governments have jointly committed a total of $1.4 billion for the NAP over seven years to 2007-08.

NDSP

National Dryland Salinity Program
The NDSP was established in 1993 to address the lack of opportunity for the research community to cooperate across disciplines, organisational boundaries and state borders to address the management of dryland salinity. The Program's goal is to research, develop and extend practical approaches to effectively manage dryland salinity. The Program, which completed a second phase in 2003, is managed by Land and Water Australia on behalf of a consortium of organisations. In 2003-04 the NDSP will focus on four key areas: policy, production, catchments and networks as part of an accelerated communication and regional consultation process.

NHT

Natural Heritage Trust

The Australian Government established the NHT in May 1997 to fund environmental protection, sustainable agriculture and natural resource management. Trust funding totalling $1.4 billion supported some 12 000 projects and related programs over the six years to 2001-02. More than 400 000 Australians were involved in these projects. In the May 2001 Budget, the NHT was extended with the allocation of an additional $1 billion for a further five years to 2006-07. Trust funds are delivered at three levels: national investments, regional investments and a local component to directly fund some community groups. Under the *NHT Extension*, states and territories have agreed to provide matching funding for investments at the regional level. Funding for projects is delivered under four Trust programs: Landcare, Bushcare, Rivercare and Coastcare. The 2004 Budget provided an additional $300 million for the NHT to 2007-08, bringing total investment in the Trust to $3.0 billion.

NLP

National Landcare Program

The objective of the NLP is to increase the engagement of industry and resource users in Landcare and NRM activities. The NLP has a focus on sustainable farming and sustainable land management. NLP investments currently consist of a community support and a national component. There are currently some 4 000 Landcare groups, involving some 40 per cent of the nation's farmers. In 2003, the NLP received an additional $122 million in funding for the three years to 2005-06. The 2004 Budget extended the Program by providing an additional $80 million ($40 million in both 2006-07 and 2007-08).

NLWRA

National Land and Water Resources Audit

Established in 1997, the NLWRA is a $30 million research program funded under the NHT, the objective of which is to facilitate improved decision making on land and water resource management issues, particularly by the Australian and state governments. Now in its second phase, June 2002–June 2007, the Audit will provide data, information and assessments of Australia's land, water and biological resources to support sustainable development. A core function will be to collate natural resource information to support the monitoring and evaluation of the NAP and the NHT. Two key audit information products are the Australian Natural Resources Atlas and the Australian Natural Resources Data Library. One of the Audit's principal pieces of research has been the Australian Dryland Salinity Assessment 2000.

NRM
: natural resource management

NRMMC
: Natural Resource Management Ministerial Council. The NRMMC consists of Australian, state and territory government ministers responsible for primary industries, natural resources, environment and water policy. The Council is the peak government forum for consultation, coordination and, where appropriate, integration of action by governments on natural resource management issues. Among its other roles, the Council oversees the development and implementation of national natural resource management programs, including the *National Action Plan for Salinity and Water Quality* and the *Natural Heritage Trust*. The Council is supported by one permanent standing committee, the Natural Resource Management Standing Committee, membership of which comprises departmental heads of relevant government agencies.

Public good
: A benefit accruing to the community as a whole

Private good
: A benefit accruing to an individual or individual organisations

PUR$L
: Productive Use and Rehabilitation of Saline Land

RDC
: Research and Development Corporation

Recharge
: Water that has drained below the root zone of any local vegetation and which is then able to drain downward to add to the underlying layer of saturated soil, or groundwater

Recharge area
: An area where water enters the soil and contributes to the groundwater store. Upper slopes and areas with shallow soils are common recharge areas. Recharge is maximised where soils overlie fractured rocks, where

soils are highly permeable, where vegetation is shallow-rooted or absent, and when rainfall exceeds evapotranspiration.

Regolith

A general term for the entire layer of fragmental and loose, incoherent or unconsolidated rock material of whatever origin (residual or transported) and of very varied character, that nearly everywhere forms the surface of the land and overlies or covers the bedrock

Riparian

Of, inhabiting, or situated on the bank and floodplain of a river

RIRDC

Rural Industries Research and Development Corporation

River salinity

River salinity is caused by saline discharges from dryland, irrigation and urban salinity, and aquifers into creeks and rivers

Salinisation

Degradation of the soil or water through the accumulation of salts. Land salinisation occurs following the accumulation of soluble salts (usually sodium chloride) at or near the soil surface, to a level that causes degradation. This usually occurs through the evaporation of groundwater that discharges through the soil surface. Water salinisation usually results from increasing salinity of run-off and groundwater.

Salinity

The concentration of dissolved salts in groundwater or river water, usually expressed in EC units

Salt scald

An area where salt crystals accumulate on the soil surface, suppressing plant growth and often leading to surface soil erosion which can expose saline subsoils

Surface water

Water on the surface of the land, for example, rivers, creeks, lakes, dams and overland flows

Urban salinity

Salinity that occurs as a result of urban activities

Waterlogging

Saturation of soil with water, resulting from over irrigation, seepage or inadequate drainage

Watertable

The upper surface of a layer of soil or rock material that is saturated with water

List of recommendations

2 The nation's programs to combat salinity

Recommendation 1

The Committee recommends that mechanisms be developed to ensure that validated salinity research findings are considered in regional planning processes, and specifically that Australian Government agencies in cooperation with state and territory governments:

(a) develop systems to ensure that the best science is made available to state government agencies, catchment management organisations (CMOs) and land managers on an on-going basis;

(b) provide CMOs and land managers with adequate support and resources to use and incorporate science into their regional plans, investment strategies and on-ground works; and

(c) provide guidelines for CMOs and land managers, making them aware of pertinent salinity research findings, detailing their implications for the broad types of investments that may be undertaken, and enforcing the guidelines through the accreditation process for regional plans.

For implementation, this recommendation should be read in conjunction with recommendations 3 and 15.

4 The salinity science base

Recommendation 2

(a) The Committee recommends that the Australian Government, in cooperation with state agencies, conduct an audit of the totality of salinity research and development activities undertaken by all agencies and programs in which the Australian Government invests, including:

(i) national programs that address salinity, such as the *National Action Plan for Salinity and Water Quality* and *Natural Heritage Trust*;

(ii) programs such as the *National Dryland Salinity Program* and National Land and Water Resources Audit;

(iii) agencies within Australian Government departments, including the Bureau of Rural Sciences;

(iv) Cooperative Research Centres;

(v) Research and Development Corporations;

(vi) national science agencies, including the Commonwealth Scientific and Industrial Research Organisation;

(vii) universities; and

(viii) where possible, the private sector.

(b) The Committee further recommends that the audit:

(i) map the state of salinity research findings and the tools currently available for salinity management;

(ii) identify all critical research gaps;

(iii) suggest directions for future salinity research and development activities; and

(iv) identify steps that might be taken to bring greater coherence to salinity research efforts across all Australian Government funded agencies and programs, and to improve coordination with state and regional research activities.

5 The coordination of salinity research

Recommendation 3

The Committee recommends that the Australian Government ensure the continuation of the *National Dryland Salinity Program* (NDSP) as a matter of urgency, and that:

(a) the role of the NDSP be expanded to address irrigation and urban salinity, with the Program renamed the *National Salinity Program* (NSP) or similar;

(b) the NSP be managed within Land and Water Australia (LWA);

(c) the NSP adopt research, coordination and communication strategies that assist the regional delivery of natural resource management programs and the requirements of the *National Action Plan for Salinity and Water Quality* specifically;

(d) the functions of the NSP have regard for those identified in this report;

(e) the NSP/LWA be adequately resourced to perform its functions by the Australian and state governments;

(f) relevant Research and Development Corporations, Cooperative Research Centres, national science agencies, universities, state agencies and the private sector be strongly encouraged to partner the NSP; and

(g) there be a continuing role for an Operations Committee, or equivalent, in providing independent scientific advice with that advice coming from a broad cross-section of scientific personnel from both the government and non-government sectors.

This recommendation should be read in conjunction with recommendations 1 and 15.

6 The adequacy of the science base, research needs and funding

Recommendation 4

The Committee recommends that the Australian Government give greater emphasis through its investments in salinity science to develop new, economically viable land and water use systems.

Recommendation 5

The Committee recommends that the Australian Government encourage catchment management organisations to introduce industry development planning into their natural resource management planning and funding prioritisation process.

Recommendation 6

The Committee recommends that the Australian Government emphasise, though its investments in salinity science, the development of technologies to address urban salinity, including:

(a) salinity assessment and risk evaluation methods; and

(b) options for treatment and management.

Recommendation 7

The Committee recommends that the Australian Government:

(a) foster greater cooperation amongst scientists addressing salinity and, specifically, sponsor an annual multidisciplinary salinity conference, research showcase or science roundtable; and

(b) examine ways to foster interdisciplinary research in natural resource management more generally.

Recommendation 8

(a) The Committee recommends that the Australian and state governments make provision within the *National Action Plan for Salinity and Water Quality* for the establishment of a salinity research and development fund, to finance research that:

(i) is of national or statewide significance, and beyond the scope of individual catchment management organisations (CMOs);

(ii) pertains to the development of new technologies and industries for salinity management; and

(iii) is otherwise of a long-term, strategic or generic nature.

(b) The Committee further recommends that the allocation of the pooled research funds:

(i) be as agreed between the Australian and state governments, but that CMOs be consulted for research needs; and

(ii) have regard for the research priorities identified in this report.

Recommendation 9

The Committee recommends that the Australian Government encourage Research and Development Corporations to:

(a) invest more substantially in research for sustainable land use systems and in the development of new salinity technologies; and

(b) conduct projects that forge links across commodities in farming systems.

Recommendation 10

The Committee recommends that, in cooperation with the states, the Australian Government:

(a) identify and remove impediments for catchment management organisations (CMOs) to undertake or commission research, and encourage CMOs to support research activity as part of their investment strategies;

(b) provide incentives for greater collaboration between CMOs to support research of cross-catchment benefit; and

(c) provide an appropriate degree of support to evaluate tenders and contracts let at the regional level.

Recommendation 11

The Committee recommends that the Australian Government examine ways to encourage private sector investment in research and development for commercial measures to arrest salinity and other forms of natural resource degradation.

Recommendation 12

The Committee recommends that the Australian Government, in cooperation with state governments, encourage development of industry capacity in salinity research and development, by adopting measures that include:

(a) ensuring tender specifications provide genuine opportunities for industry to compete for public research funds, particularly for small to medium sized enterprises at the regional level; and

(b) ensuring tendering processes are transparent, so that industry can compete effectively against publicly funded organisations.

7 Data management and mapping technologies

Recommendation 13

The Committee recommends that the Australian and state government agencies holding natural resource management datasets, accelerate the development of data collection, management and retrieval systems that are standardised, integrated and accessible.

Recommendation 14

The Committee recommends that ANZLIC – the Spatial Information Council, in collaboration with the National Land and Water Resources Audit, be resourced to support managers of regional projects to develop and implement best practice data management policies. Emphasis should be placed on developing:

(a) consistent data collection, management and retrieval systems;

(b) mechanisms to encourage data sharing between catchment management organisations, research institutions, industry bodies and government agencies; and

(c) quality assurance processes to ensure standards are attained.

8 Support for implementers: extending the science

Recommendation 15

The Committee recommends that the Australian Government in cooperation with the states and territories build on existing initiatives to establish a database of interpretive material, scientific research and data, related to salinity and its management. The three levels of the database should be:

(a) a ready reference salinity component, containing concise, integrated, accurate, and easy to understand information to assist land managers, particular farmers, catchment management organisation staff and natural resource management extension officers;

(b) links to salinity related research papers, endorsed by the *National Dryland Salinity Program* or its successor body;

(c) a meta-data component identifying the location of available salinity data and, where possible, the capacity for a storage and retrieval system for salinity related data particularly that collected for the *National Action Plan for Salinity and Water Quality*.

For implementation, this recommendation should be read in conjunction with recommendations 1 and 3.

Recommendation 16

The Committee urges relevant Australian, state and territory government agencies and industry groups to enhance their support for face-to-face extension services by ensuring that there are adequate numbers of qualified extension staff available to assist land managers, particularly farmers.

Recommendation 17

The Committee recommends that the Australian Government, in partnership with the relevant state agencies, compile and publish a state by state manual of viable salinity management options, to assist extension staff and land managers. This manual should be updated regularly, and survey current best practice approaches to salinity management. It should also be available free of charge in both hard copy and on the internet to extension staff and land managers dealing with salinity problems.

Recommendation 18

The Committee recommends that the relevant Australian Government agencies in consultation with state and territory governments review the issue of diminishing state extension services, with a particular focus on:

(a) the employment conditions of extension staff;

(b) the potential career pathways of extension staff; and

(c) the adequacy of the training provided for extension staff to ensure their knowledge of technical, scientific and policy issues, relating to natural resource management and in particular salinity, is both current and comprehensive.

Recommendation 19

The Committee recommends that the Australian Government, in cooperation with the states, undertake an audit of the national, state and regional extension services available for salinity management, and natural resource management more generally.

Recommendation 20

The Committee recommends that the Australian Government review the effectiveness of the *National Landcare Program's* state and regional natural resource management facilitators, with a particular focus on ensuring that:

(a) their roles and responsibilities are delineated clearly to avoid duplication with other extension services and are consistent with other national programs designed to address salinity issues; and

(b) they receive the training and access to current information, necessary to perform their duties.

Recommendation 21

The Committee recommends that the extension services provided by the Australian Government, and participating states and territories, through the *National Action Plan for Salinity and Water Quality* and the *Natural Heritage Trust* be reviewed in due course, with a particular focus on:

(a) the employment conditions of extension staff;

(b) the potential career pathways of extension staff; and

(c) the adequacy of the training provided for extension staff to ensure their knowledge of technical, scientific and policy issues, relating to natural resource management and in particular salinity, is both current and comprehensive.

Recommendation 22

The Committee recommends that the Australian, state and territory governments increase their support of catchment management organisations by:

(a) undertaking a review to assess the effectiveness of providing groups of mobile knowledge brokers, directed to advise on national natural resource management policies and provide integrated, current and relevant scientific and technical support on salinity issues to individuals and organisations managing salinity;

(b) providing funding for the operations of any such groups as are recommended to be formed;

(c) enabling the secondment of such knowledge brokers from relevant research agencies, such as the *National Dryland Salinity Program*, the Cooperative Research Centre for Plant-Based Management of Dryland Salinity and the Commonwealth Scientific and Industrial Research Organisation's Land and Water Division.

Recommendation 23

The Committee recommends that the Australian Government support the establishment of a national annual forum on salinity policy, research and management, associated with the *National Action Plan for Salinity and Water Quality*, for government agency staff, catchment management organisations, private consultants, farmers, and other land managers.

Recommendation 24

The Committee recommends the Australian Government:

(a) examine and remove any impediments to the further development of an industry in technical and support services for environmental management; and

(b) establish and coordinate, with the cooperation of the states and territories, a national accreditation process for private sector salinity advisors to ensure that salinity advice and implementation services meet best practice standards.

Executive summary

Introduction

The terms of reference for the inquiry were to examine and report on the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity programs. The Committee was asked to give particular consideration to: the use of the salinity science base and research data in salinity programs; linkages between researchers and those implementing solutions, including the coordination and dissemination of research; and the adequacy of technical and scientific support in applying management options.

These matters are addressed in the Committee's report, which consists of eight chapters. The contents, findings and recommendations of each chapter are summarised as follows.

Chapter one Introduction

The chapter outlines the referral of the inquiry to the Committee, the conduct of the inquiry, and the structure of the report and its principal findings.

Chapter two The nation's programs to address salinity

The chapter discusses the major national natural resource management (NRM) programs that address salinity, strategies to address salinity in the Murray-Darling Basin and the states, and local government initiatives. The Committee notes the role of regional planning and delivery of NRM programs (particularly *A National Action Plan for Salinity and Water Quality* (NAP) and the *Natural Heritage Trust*) through catchment management organisations (CMOs), and the evidence in response to the national programs.

The responses to the NRM programs relate to the implications for salinity research, research coordination and extension of research findings that emerge from:

- the architecture of the NAP;
- the alleged failure to incorporate key research findings into salinity programs and the mistaken presumption that economically viable solutions are available for widespread adoption;
- the claim that the Australian Government's science investments neglect research into new salinity management methods and technologies; and
- the implications of region-based planning and delivery of NRM programs.

Several of these matters are further developed in subsequent chapters.

The Committee welcomes the commitment by the Australian and state governments to address salinity. The NAP involves a funding commitment of $1.4 billion over seven years, which represents a significant increase in aggregate funding for works to address salinity.

Primary responsibility for NRM rests with the states and several state governments have developed salinity strategies which incorporate research findings. Efforts to address salinity in the Murray-Darling Basin commenced in 1988 with the adoption of the *Basin Salinity and Drainage Strategy*. Over the ten years to 1999, the Murray-Darling Basin Commission invested some $70 million in on-ground works, which were successful in achieving salinity reduction targets. The Commission has now developed a new *Basin Salinity Management Strategy* for the period to 2015.

The Committee concludes that the NAP-related research activities of national agencies should be better coordinated with state and regional activities.

The Committee supports the NAP's focus on immediate on-ground actions to address salinity, noting evidence suggesting there is sufficient knowledge to support some positive landscape change. However, the Committee is also persuaded that a sufficient number of economically viable management options to address salinity are not yet available. Consequently, the Committee concludes there is a need to support further research and development (R&D) if salinity is to be addressed at the scales required.

The establishment of CMOs has assisted the integrated management of natural resource degradation issues, ensuring that salinity is not addressed in isolation. The Committee is also aware that many CMOs are currently being established or have not been operating long. However, arrangements for CMOs (for example, their organisational structure and legislative basis) vary considerably across the states. The Committee concludes that, to facilitate delivery of NRM programs, there may be value in establishing all CMOs on a consistent basis, perhaps through the Council of Australian Governments.

The Committee notes the risks attendant upon the devolution of NRM to regional bodies, particularly for the adequate use of science in regional plans, coordinated research activity and the extension of salinity science.

While the Committee supports regional-level investment, it notes that there is likely to be a focus on funding immediate on-ground works and a tendency to give investment in longer-term and generic research (that transcend regional boundaries) a low priority. Generic research may be beyond the resources, charter and scale of individual CMOs. Consequently, the Committee is concerned that the regional delivery focus under NRM programs not detract from coordinated research of a type that will benefit multiple regions, and that should properly be conducted at the state or national levels.

Evidence pointed to considerable variation across CMOs in the uptake of science. The Committee urges that regional planning, investment strategies and on-ground works be informed by the best available science and recommends that CMOs and land managers be adequately supported to use and incorporate science into their planning and investment activities **[Recommendation 1]**.

The Committee also urges that adequate scientific and technical support be given to those non-NAP regions that are also threatened by salinity. The matters of regional capacity and support for the implementation of salinity programs are addressed further in chapter eight.

Chapter three The nature of the salinity problem

The chapter presents the dominant explanation of the salinity problem and provides an overview of salinisation processes, types of salinity, management options, and the extent, impacts and costs of salinisation. Alternative scientific perspectives for the sources of salt in the landscape, salinity processes, the extent of the salinity problem, and the veracity of some public sector research and audit findings are considered.

A consensus explanation of the salinity problem has developed which explains secondary, or human-induced, salinity as having resulted from changes to the hydrology of the Australian landscape caused by changed land use following European settlement. However, this explanation has been criticised and alternative models proposed. Although the Committee does not wish to definitively adjudicate on these debates, it urges that all contributors to the scientific understanding of salinity have adequate opportunity for their perspectives to be presented and examined.

The Committee is profoundly concerned that while the precise extent of salinisation is unclear, 5.7 million hectares of agricultural and pastoral land are currently estimated to have a high potential for developing salinity. It is estimated that two million hectares of agricultural land are currently showing signs of salinity. More than 70 per cent of the nation’s salinity problem occurs in one state—Western Australia. The Committee observed first-hand the impacts of salinity during its inspections in New South Wales, Victoria and Western Australia. Vast tracts of farming land have succumbed to salinity. The effect of salinity in urban areas was just as striking.

The current and predicted impact of salinity on infrastructure, water quality, productive land, bio-diversity, remnant vegetation and conservation reserves is significant. The costs imposed on landholders, governments and residents of rural towns are considerable. The loss in profits for the agricultural sector in Western Australia has been estimated at between $80 and $260 million per year, while in the Murray-Darling Basin, the cost of dryland salinity in eight tributary valleys of the Basin is approximately $247 million per year. The cost of salinity to consumptive users of River Murray water totals $47 million per year. In Wagga Wagga, the Council reported that the damage to infrastructure in the town would amount to $180 million over 30 years, with some residents already spending up to $20 000 to repair their homes.

Chapter four The salinity science base

The chapter reviews the agencies and programs whose research efforts constitute the ‘science base and research data’ to address salinity at the national level. The chapter summarises key research findings and products of these agencies and programs. The chapter also summarises the salinity science and technologies developed by private sector contributors to the inquiry, and notes the significant ‘applied science’ contribution of many individual landholders.

A wealth of salinity research has been undertaken by a range of Australian Government funded agencies and programs, including: national science agencies, Cooperative Research Centres, Research and Development Corporations (RDCs), the *National Dryland Salinity Program* (NDSP), the National Land and Water Resources Audit, and universities. An array of research products and management tools have been developed.

The Committee concludes that a comprehensive audit of the Australian Government investment in salinity research may help to: map the salinity science base and management tools currently available; identify critical research gaps; and assist in bringing greater coherence to the range of science investments for salinity and, potentially, improve their effectiveness **[Recommendation 2]**. The audit may also assist in improving coordination with state and regional research efforts.

Chapter five The coordination of salinity research

The chapter describes the coordination of salinity research at national and state levels, the challenges for research coordination in the new NRM environment and institutional proposals for improved coordination.

A strong case is made in the evidence for salinity R&D to be nationally coordinated. The reasons for this include:

- the structural changes ushered in with the NAP, notably the devolution of NRM responsibilities to regions and the fragmentation of efforts at the national level;
- the perhaps unavoidable complexity of salinity research efforts across a large number of agencies and programs, which need to be effectively coordinated—now more than ever;
- to link research providers and their products with CMOs, land managers and others undertaking on-ground works;
- to identify the R&D issues of national significance, ensure they are adequately addressed and avoid duplication;
- to maintain the momentum developed through the NDSP in R&D and extension; and
- to better coordinate research programs with state and territory salinity strategies, so as to avoid overlap between governments at different levels.

Strong support was expressed for the NDSP, which has effectively brokered R&D priorities at the national level since its establishment in 1993. The Committee believes that the NDSP ought to be continued and its functions expanded to address irrigation and urban salinity. The Program could be renamed the *National Salinity Program*, or similar **[Recommendation 3]**. With the imminent closure of the NDSP, the Committee recommends that the Australian and state governments, as a matter of urgency, provide funding for the Program's continuation and expansion.

Salinity ought to be addressed within the context of integrated responses to natural resource degradation issues. Institutional structures for salinity science should be integrated with other NRM science programs. In this way, the single issue focus will not undermine the development of integrated responses to the range of NRM issues required by CMOs and land managers. For this reason, continuing to locate a national research coordination function within Land and Water Australia (LWA) seems appropriate.

Chapter six The adequacy of the science base, research needs and funding

The chapter addresses the adequacy of the Australian Government's investments in salinity science, and the need for further research. The chapter canvasses an array of research needs proposed in the evidence and makes proposals for funding research to address knowledge gaps.

Despite the knowledge and management tools developed to date, the Committee is persuaded that governments need to provide on-going support for salinity R&D.

Evidence suggested there is an imbalance in the Australian Government's salinity science investments towards mapping, at the expense of developing new land and water use systems, including engineering systems and new industries for saline resources.

There were strongly divergent views in the evidence: between national NRM agencies, which argued for the efficacy of highly targeted interventions (at least in eastern Australia) aided by mapping technologies, versus a range of submitters who argued that research findings point to the need for large scale land use change and, hence, the need for profitable land use options that can be widely adopted by landholders.

The Committee notes that differences in geology and landscape characteristics between the east and west of the continent may have contributed to diverging perspectives on appropriate management interventions and R&D priorities. Nonetheless, the national NRM agencies conceded that, while the prospects for targeted interventions in eastern Australia may be positive, the situation in Western Australia is characterised by much larger, homogenous systems and landscape salt.

The Committee welcomes the potential for targeted salinity management in some locations assisted by mapping technologies, but notes that 70 per cent of the nation's salinity problem occurs in Western Australia. Calls from this state, and a range of other submitters, are for new land and water use systems and strategic interventions to protect high value assets. Consequently, the Committee recommends that the Australian Government give greater emphasis through its science investments to the development of new, economically viable land and water use systems **[Recommendation 4]**.

Although the Committee's inquiry was concerned with national salinity science coordination and the terms of reference did not seek comment on research priorities, approximately 70 submitters identified specific research needs.

Prioritising research needs for future R&D investment is properly the responsibility of CMOs and technical committees at state and national levels. However, the Committee recommends that, in addition to new land and water use systems, greater research emphasis be given to address urban salinity **[Recommendation 6]**. CMOs should also be encouraged to introduce industry development planning into their NRM planning and funding prioritisation process **[Recommendation 5]**.

The Committee also urges that multidisciplinary research be encouraged **[Recommendation 7]**.

The new NRM context has altered the research supply-demand relationship, with CMOs now having greater power to determine research priorities. While this situation is welcomed, the Committee urges that a 'bottom-up' approach to the identification of research priorities be effectively combined with a 'top-down' analysis to ensure that national perspectives and new scientific knowledge or techniques are incorporated into regional management practice.

Notwithstanding the overall increase in salinity funding, the Committee is concerned that the NAP does not have a charter to fund salinity R&D, at least not beyond that required for regional level implementation. The Committee is persuaded that adequate funding should be available to support salinity R&D, particularly into generic issues that are of national relevance or for research that is beyond the scope of individual CMOs. The Committee recommends that provision be made within the NAP for the establishment of a salinity R&D fund to finance research of this nature **[Recommendation 8]**.

In view of the significance of their research investments and their relationship with primary producers, the role of RDCs is of particular importance. The Committee supports calls for RDCs to invest more substantially in researching sustainable land use systems, and in the development of new salinity technologies **[Recommendation 9]**.

Although the Committee identifies the need for generic research activities to be supported at state and national levels, the Committee believes that individual CMOs ought to be encouraged to undertake or commission salinity R&D, where this is relevant **[Recommendation 10]**. CMOs should also be provided with an appropriate degree of support, particularly in regard to evaluation of tenders and contracts let at the regional level.

The Committee wishes to encourage greater opportunity for small to medium sized enterprises to tender for research work, particularly at the regional level, and to encourage private sector investment in salinity research activities **[Recommendations 11 and 12]**.

The Committee notes the need for long-term funding for data collection to monitor the effects of salinity management actions at the regional level. The Committee urges government agencies to provide this on-going support.

Chapter seven Data management and mapping technologies

The chapter reviews the evidence relating to the Australian Government's data collection, management and retrieval arrangements, canvasses options for improving coordination to address submitters' concerns and describes the Australian Government's initiatives to reduce problems associated with data management. The chapter then continues the discussion, from chapter six, of the place of mapping technologies in the NAP, and outlines the views of submitters' in relation to the appropriate use of these technologies.

A range of Federal and state government initiatives is in place to facilitate best practice data collection, management and retrieval practices. However, the Committee is concerned that problems in this area persist and recommends that governments expedite the development of data management systems that are standardised, integrated and accessible **[Recommendation 13]**. With the increased involvement of CMOs in data collection, the Committee recommends that the Australian Government increase efforts to equip managers of regional projects with the requisite skills for data management **[Recommendations 14]**.

The Committee notes the importance accorded to mapping technologies, particularly airborne geophysical techniques, in the NAP. The Committee contends that mapping technologies may perform an important role in salinity management, for example: surveying large areas of land (greater than 50 000 hectares); in prioritising on-ground works; and in protecting high value assets (such as towns).

The Committee notes a range of concerns about the use of airborne geophysical techniques, specifically the observation that airborne electromagnetics (AEM) may have been 'over sold' by relevant Australian Government agencies. The Committee believes that the Australian Government should take note of the concerns raised by submitters. Following the discussion in chapter six, the Committee concludes that while AEM is a useful enabling technology, the utilisation of the technology should not detract from efforts to develop new land and water use systems that can be adopted on-ground by land managers, particularly in Western Australia.

The Committee was disappointed to hear that some companies felt they were being discouraged from participating in salinity mapping surveys. The Committee believes that the private sector has an important role in developing innovative technologies, and providing on-ground services to land managers, which is an issue explored further in chapter eight.

Chapter eight Support for implementers: extending the science

The final chapter of the report addresses the adequacy of technical and scientific support for land managers and CMOs in applying salinity management options.

In the absence of economically viable management options, better means of information transfer will not solve the problem of salinity. Evidence suggests that for land managers to adopt research products, they require management options that are as profitable as current systems, complimentary to efforts to address other natural resource degradation issues, are low risk and simple to implement.

The Committee concludes that the Australian and state governments should publish, and regularly update, a manual of viable salinity management options. This should be available both in hard copy and on the internet **[Recommendation 17]**. The Committee notes calls from a number of submitters for the establishment of a national salinity database or 'one-stop-shop' of salinity information. The Committee recommends that the Australian Government build on the efforts of the NDSP in developing a database of interpretive material and scientific research, including raw data, related to salinity and its management **[Recommendation 15]**.

Information is delivered to implementers in a variety of forms and through a range of delivery methods, of which traditional face-to-face extension by state agencies remains widely preferred. The Committee recognises that land managers and CMOs consult a range of sources for advice and support and that these various means ought to be supported in their diversity.

The Committee observed the excellent work of services that continue to be provided by some states. However, the Committee is concerned at the decline in the numbers of state extension officers and evidence of depletion in the skill base among extension personnel. The Committee urges the Australian and state governments to increase their face-to-face extension services and to review the employment conditions, career pathways and training for extension personnel **[Recommendations 16 and 18]**.

Funding provided under the NAP and NHT will significantly boost extension services nationally. However, there is a lack of clarity about the extent of extension services funded by the Australian Government and the Committee believes that an audit ought to be conducted to assess the adequacy of the Government's efforts in this regard **[Recommendation 19]**. While insufficient time has elapsed to review progress, the Committee recommends that, in due course, a review of the training and employment conditions be conducted for the Australian Government-funded NRM facilitators **[Recommendations 20 and 21]**.

Under the regional delivery arrangements of the NAP, CMOs will increasingly provide support services. However, there is considerable variation in the capacity of CMOs to access, comprehend and extend salinity science findings. A range of options to increase the capacity of CMOs was proposed. The Committee recommends that the Australian Government consider establishing groups of mobile knowledge brokers to advise on NRM policy and provide integrated scientific and technical support to land managers and CMOs **[Recommendation 22]**. Furthermore, the Committee acknowledges the key role of the NDSP as a communicator of research findings on dryland salinity, particularly through its Communications Team.

Accompanying the decline in traditional state extension, services have increasingly been provided by others organisations and individuals, including: science agencies, industry bodies, individual scientists, agribusinesses, landholder groups and local governments. A private consulting industry has now also emerged. The Committee considers the support for landholders provided through these various means.

While encouraging direct interaction between scientists and land managers, and supporting the co-location of researchers and implementers, the direct extension of research by individual scientist may not be the most efficient means of extending research findings. The Committee recommends the establishment of a national annual forum on salinity policy, research and management, to bring together government agency staff, CMOs, land managers, scientists and private consultants **[Recommendation 23]**.

While wishing to encourage private sector provision of technical and support services, the Committee recognises that there are limits to their role, especially when dealing with an issue like salinity that crosses farm and state boundaries and has a strong public good dimension. Nonetheless, the Committee recommends that impediments to the future development of this industry be removed **[Recommendation 24]**. To ensure that CMOs and landholders are given appropriate and credible advice by private consultants, the Committee further recommends an accreditation process be developed to ensure salinity advice meets best practice standards.

1

Introduction

Referral of the inquiry

1.1 On 18 August 2003, the Minister for Science, the Hon. Peter McGauran MP, wrote to the House of Representatives Standing Committee on Science and Innovation (the Committee) asking it to inquire into and report on the Commonwealth's role in managing and coordinating the best science in relation to Australia's salinity programs. The terms of reference for the inquiry are provided on page *xii* of the report.

Conduct of the inquiry

1.2 A media release announcing the inquiry was issued on 25 August 2003. The Committee's terms of reference were advertised and written submissions invited in *The Land* on 28 August 2003 and *The Australian* on 3 September 2003. The inquiry was also advertised electronically, including through SALTLIST, a listserv managed by the *National Dryland Salinity Program*.

1.3 The Committee issued an inquiry information paper and brochure, which were made available on the Committee's web site.

1.4 The Committee wrote to more than 250 stakeholders inviting them to make submissions to the inquiry. These included regional/catchment management organisations (CMOs) in all states and territories, science organisations, regional universities, Research and Development Corporations, Cooperative Research Centres and industry associations.

1.5 The Committee received 81 written submissions, listed at Appendix A. The Committee also received 134 exhibits, which included ancillary material such as technical documents detailing salinity research findings. A list of the exhibits is at Appendix B.

1.6 The written evidence received by the Committee was a balanced reflection of the range of salinity interests. Approximately equal numbers of submissions were received from CMOs, governments and their agencies, science organisations, industry bodies and individuals. The Committee received submissions from the state governments of Western Australia, South Australia and New South Wales. Tables indicating the source of submissions by state and territory, and by type of submitter are provided at Appendix D.

1.7 Public hearings were conducted by the Committee in Sydney, Wagga Wagga, Shepparton, Perth and Canberra from October to December 2003. In total, 60 witnesses were examined. The dates and locations of the hearings, together with the names of witnesses who appeared before the Committee is at Appendix C.

1.8 Inspections were held by the Committee in areas of New South Wales (Wagga Wagga and the Kyeamba Valley), Victoria (Shepparton Irrigation Region) and Western Australia (the south western region of the Wheat Belt, including Katanning).

1.9 Access to the published submissions to the inquiry, transcripts of evidence taken at the public hearings and an electronic copy of the report is available on the internet from the Committee's web site:

www.aph.gov.au/house/committee/scin/salinity

Structure of the report and principal findings

1.10 In addition to this introductory chapter, the report comprises seven chapters. The contents and principal findings of the chapters are summarised as follows.

Chapter two: The nation's programs to combat salinity

1.11 The chapter discusses the major national natural resource management (NRM) programs that address salinity, strategies to address salinity in the Murray-Darling Basin and the states, and local government initiatives. The Committee notes the role of regional planning and delivery of NRM programs through CMOs, and the evidence in response to the national programs that relate to salinity research, research coordination and extension.

1.12 The Committee welcomes the commitment by the Australian and state governments to address salinity and notes the significant increase in funding for on-ground works through the *National Action Plan for Salinity and Water Quality*. The Committee discusses the implications for research activities and research coordination due to the regional delivery approach of NRM programs, and the alleged failure to incorporate key research findings into salinity programs. The Committee recommends that mechanisms be developed to ensure that salinity research findings are adequately considered in regional planning processes.

Chapter three: The nature of the salinity problem

1.13 The chapter presents the dominant explanation of the salinity problem—salinisation processes, types of salinity, management options, and the extent, impacts and costs of salinisation. Alternative scientific perspectives for the sources of salt in the landscape, salinity processes, the extent of the salinity problem, and the veracity of some public sector research and audit findings are considered.

1.14 A consensus explanation of the salinity problem has developed which explains secondary, or human-induced, salinity as having resulted from changes to the hydrology of the Australian landscape caused by changed land use following European settlement. However, the consensus explanation of the basic salinisation process and sources of salt have been criticised and alternative models proposed. Although the Committee does not wish to definitively adjudicate on these debates, it urges that all contributors to the scientific understanding of salinity have adequate opportunity for their perspectives to be presented and examined.

Chapter four: The salinity science base

1.15 The chapter reviews the agencies and programs whose research efforts constitute the ‘science base and research data’ to address salinity at the national level. The chapter summarises research findings and products of these initiatives.

1.16 The Committee concludes that a wealth of salinity research has been undertaken by a range of Australian Government funded agencies and programs. An array of research products and management tools has been developed. The Committee concludes that a comprehensive audit of the Australian Government investment in salinity research may be timely. The aims of such an audit would be to: map the salinity science base and management tools currently available; identify critical research gaps; and assist in bringing greater coherence to the range of science investments for salinity and, potentially, improve their effectiveness. The audit may also assist in improving coordination with state and regional research efforts.

Chapter five: The coordination of salinity research

1.17 The chapter describes the coordination of salinity research at national and state levels, the challenges for research coordination in the new NRM environment and proposals for improved coordination.

1.18 The Committee finds that there is a clear need for an on-going national coordination role for salinity research efforts, and recommends that the *National Dryland Salinity Program* be retained. The Committee further recommends that the Program be expanded to address irrigation and urban salinity issues. The Program's coordination and communication strategies should evolve to meet the requirements of the new NRM environment and the *National Action Plan for Salinity and Water Quality* (NAP) more specifically.

Chapter six: The adequacy of the science base, research needs and funding

1.19 The chapter addresses the adequacy of the Australian Government's investments in salinity science, and the need for further research. The chapter then canvasses the array of research needs and makes proposals for funding research to address critical knowledge gaps.

1.20 The Committee welcomes the Australian Government's investments in mapping technologies, but recommends that there be greater emphasis through its science investments on the development of profitable land and water use systems that can be widely adopted by landholders. The Committee further recommends that the Australian and state governments make provision within the NAP for the establishment of a salinity research and development fund, to finance research that is beyond the scope of individual CMOs, or of statewide/national significance.

Chapter seven: Data management and mapping technologies

1.21 The chapter reviews the evidence relating to the data collection, management and retrieval arrangements, canvasses options for improving coordination to address submitters' concerns and describes the Australian Government's initiatives to reduce problems associated with data management. The chapter then continues the discussion, from chapter six, of the place of mapping technologies in the NAP, and outlines the views of submitters' in relation to the appropriate use of these technologies.

1.22 The Committee is concerned that, despite the Australian Government's substantial efforts to improve access to spatial and temporal datasets and standardise measurement and lodgement procedures, problems persist. The Committee recommends the Australian and state governments accelerate the development of data collection, management and retrieval systems that are standardised, integrated and accessible. Greater support should also be provided to assist CMOs implement best practice data management policies.

Chapter eight: Support for implementers: extending the science

1.23 The final chapter of the report addresses the adequacy of technical and scientific support for land managers and CMOs in applying salinity management options. The issues addressed include the role of extension services and other methods of delivering information to users, and the effectiveness of current arrangements for the transfer of information.

1.24 The Committee concludes that the adequacy of technical and scientific support for salinity management is variable across the nation. The withdrawal and deskilling of state/territory extension services continues to be a matter of concern. However, the Committee notes that this issue is being addressed by some states in their salinity strategies, and via involvement in national programs (for example the NAP facilitators). In addition, the Committee notes the increased involvement of researchers, industry groups, private consultants, and the Federal and local governments, in the provision of extension services. The future task will be to ensure that the capacity of CMOs is sufficient to undertake their responsibilities with regard to the provision of extension services. The Committee views the increasing involvement by agribusiness and non-government extension providers as offering a promising avenue to consolidate efforts in this regard.

Appreciation

1.25 The Committee wishes to thank those who contributed to the inquiry, particularly the officers from state agencies, CMOs and landholders who facilitated its inspections in New South Wales, Victoria and Western Australia.

2

The nation’s programs to combat salinity

Introduction

2.1 This chapter provides an overview of the:

- national programs that address salinity:

  A National Action Plan for Salinity and Water Quality (paragraphs 2.24-2.32); *Natural Heritage Trust* (paragraphs 2.33-2.40); and *National Landcare Program* (paragraphs 2.41-2.47);

- strategies to address salinity in the Murray-Darling Basin, the states and local government initiatives (paragraphs 2.48-2.113);

- responses to the national salinity programs:

  A National Action Plan (paragraphs 2.114-2.131); incorporating key research findings into salinity programs (paragraphs 2.132-2.140); the Australian Government’s science investments into new salinity management methods and technologies (paragraphs 2.141-2.148; and region-based planning and delivery of NRM programs (paragraphs 2.149-2.183).

History gives us lessons on the consequences of not addressing problems of salinity. Salinisation of the soil was a major contributor to the downfall of ancient civilizations in Mesopotamia in 4000 BC and again in 500 AD. Salt from sedimentary rocks was deposited in the Tigris-Euphrates Delta by flooding and irrigation. As salinity increased, soil fertility diminished, as did the ability of agricultural systems to respond to natural environmental disturbances. Crop production shifted to more salt-tolerant crops (eg, wheat to barley) and control of water rights became a cause of conflict. We will travel down the same path unless scientists from a variety of backgrounds are encouraged to explore new and innovative ways of managing our land and water resources to control salinity.[1]

2.2 Prior to European settlement, much of the Australian landscape was naturally saline.[2] In 1829 Captain Charles Sturt found the water of the Darling River near Bourke too salty to drink. The start of irrigation in the Murray-Darling Basin during the 1870s was accompanied by significant increases in the areas affected by salinity:

> Irrigated land salinisation began to emerge as a problem soon after irrigation commenced. In the Kerang region salt problems were first noticed in the 1890s, less than 20 years after the commencement of irrigation … By the early 1930s, salinisation had extended over much of the Kerang region. Drains were then constructed to remove saline groundwater and the saline drainage water was carried into the River Murray via Barr Creek.[3]

2.3 The link between land clearing and salinity was identified in the Western Australian Wheat Belt by the turn of the twentieth century.[4] Two engineers, Mr W.E. Wood and Mr N.C. Reynoldson, are credited with first describing the dryland salinity processes. In 1917, a Royal Commission on the Mallee Belt and Esperance Lands aimed ‘to create the case for an extension of the railway so as to facilitate the expansion of the wheat industry’.[5] However, to the Commissioners’ dismay, compelling evidence was presented that ‘salinity was a major obstacle to the opening up of this

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1 Centre for Salinity Assessment and Management, *Submission no. 19*, p. 3.

2 F. Ghassemi, A.J. Jakeman and H.A. Nix, *Salinisation of Land and Water Resources: human cases, extent, management and case studies*, Centre for Resource and Environmental Studies, Canberra, 2000, p. 181.

3 *ibid.*, pp. 181-182.

4 Q. Beresford, H. Bekle, H. Phillips and J. Mulcock, *The Salinity Crisis: landscapes, communities and politics*, University of Western Australia Press, 2001, pp. 45-50.

5 *ibid.*, p. 46.

region'. The Commissioners rejected the scientific evidence presented as 'prejudice'.[6]

2.4 After the Second World War returned soldiers were supported, through the War Service Land Settlement Scheme and later the New Farm Lands Scheme, to settle and clear the land for agricultural production in Western Australia.[7] According to Beresford et. al. the authorities were by this time aware that the 'frenzy of land clearing' could be linked to land salinisation:

> … government was in receipt of explicit scientific information which it chose to ignore in favour of rapid development.[8]

2.5 During the 1970s there was a shift within the Federal and state governments to acknowledge the importance of protecting the natural environment.[9] In 1989 Mr Ric Farley (former Director, National Farmers Federation) and Mr Phillip Toyne (former Director, Australian Conservation Foundation) approached the then Prime Minister, the Hon. R.J.C. Hawke, for funds to address land degradation issues.[10] The result was the creation of the *National Landcare Program*.

National programs that address salinity

2.6 The following section provides an overview of the national programs to address salinity. The importance of regional level planning and delivery in the implementation of these initiatives is described.

2.7 The Australian Government's strategies for salinity management are placed within the broader context of managing all of Australia's natural resources. The national natural resource management (NRM) model incorporates:

- policy, institutional and legislative reform;
- regional delivery and action;
- standards and targets;

6 *ibid*.
7 *ibid*., p. 63.
8 *ibid*., p. 70.
9 *ibid*., p. 85.
10 P. Toyne and R. Farley, *The Decade of Landcare: looking backward – looking forward*, 2000, viewed 14 May 2004, <www.tai.org.au/Publications_Files/DP_Files/DP30SUM.PDF>.

- good science and information;
- strategic investment;
- monitoring and evaluation;
- community engagement; and
- focus on causes not symptoms.[11]

2.8 National NRM is supported by three major initiatives:

- *A National Action Plan for Salinity and Water Quality* (NAP);
- *Natural Heritage Trust* (NHT); and the
- *National Landcare Program* (NLP).[12]

2.9 The development and implementation of these and other initiatives for NRM are overseen by the Natural Resource Management Ministerial Council (NRMMC), which is comprised of all the Australian and state/territory government ministers responsible for NRM matters. The NRMMC is supported by the NRM Standing Committee and its working groups.[13]

2.10 The NAP and NHT programs are administered at the national level by the Australian Government Regional Natural Resource Management Team, which is staffed by the Departments of Agriculture, Fisheries and Forestry (DAFF), and the Environment and Heritage (DEH).

2.11 A significant development in the NRM policy environment over the past 15 years has been the creation of regional NRM groups and regional strategic planning.[14] In 1999, the Agriculture and Resource Management Council of Australia and New Zealand agreed to develop a policy statement on the management of rural resources for the next 10 to 15 years.[15] A national discussion paper was produced and public comment was invited.[16] Five hundred written submissions and over 100 verbal

11 Australian Government Departments of the Environment and Heritage (DEH), and Agriculture, Fisheries and Forestry (DAFF), *Submission no. 72*, p. 2.

12 *ibid.*, p. 7.

13 Information on the Natural Resource Management Ministerial Council and its Standing Committee is available from the Ministerial council's web site, viewed 21 January 2004, <www.mincos.gov.au>.

14 Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Submission no. 42*, p. 3.

15 In 2001, the Council was subsumed by the Natural Resource Management Ministerial Council (NRMMC) and the Primary Industries Ministerial Council (PIMC).

16 Also see *Managing Natural Resources in Rural Australia for a Sustainable Future: a discussion paper for developing a national policy*, 1999, available the National Action Plan for Salinity and Water

comments were submitted. The public submissions were supportive of the seven policy directives outlined in the paper, notably 'devolving authority and empowering regions':

> Appropriate institutional arrangements for decision making at the regional level should be established, in the form of regional management bodies with clearly defined responsibilities for natural resource management.[17]

2.12 The role of region-based planning for NRM and its implications for salinity programs are described in the following section.

Region-based planning and delivery under the national natural resource management framework

2.13 Major components of both the NAP and NHT have been designed around regional or catchment level planning and implementation. DAFF stated that effective management of natural resources requires regional level understanding and action, and argued that 'the regional level is the most effective level to engage communities and to effect the necessary landscape-scale changes to manage Australia's natural resources.'[18] This is because sustainable landscape-level change 'needs to be driven from the ground up and must be responsive to regional priorities.'[19]

2.14 Fifty-six regions, covering Australia, have been identified to address natural resource issues under the national NRM framework. Each region is to have at least one regional NRM body, referred to generically throughout this report as catchment management organisations (CMOs), formed to manage their region's natural resources and to develop a single integrated catchment/regional NRM plan. At present it is difficult to make generalisations about CMOs in Australia.[20] This is due to the rapidity and frequency of the changes to CMOs' 'structural arrangements, legislative

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Quality website, viewed 13 May 2004, <www.napswq.gov.au/publications/nrm-discussion.html>.

17 Steering Committee's report to Australian governments on the public response to *Managing Natural Resources in Rural Australia for a Sustainable Future: a discussion paper for developing a national policy*, 2000, p. 33, available the National Action Plan for Salinity and Water Quality website, viewed 14 May 2004, <www.napswq.gov.au/publications/steering-committee/index.html>.

18 DAFF and DEH, *loc. cit.*

19 *ibid.*, p. 8.

20 D. Pannell, A. Ridley, P. Regan and G. Gale, *Catchment Management Bodies in Four Australian States: structures, legislation, and relationships to government agencies*, 2004, pp. 1-7, viewed 13 May 2004, <www.general.uwa.edu.au/u/dpannell/cmbs2.pdf>.

basis and relationships to government agencies', and the variations in the organisational arrangements that exist between states and territories.[21]

2.15 These plans are to be:

- based on a 'whole of region' approach, and address significant natural resource management issues incorporating environmental, social and economic aspects;
- developed by an organised catchment or regional body representing the local community and accountable for expenditure of public monies;
- based on meeting agreed targets and outcomes that reflect good science; and
- based on meeting a firm timetable agreed by all parties.[22]

2.16 Following the signing of a bilateral agreement between the Australian Government and the particular state or territory, regional plans (or 'regional catchment strategies') are then jointly accredited by the Australian and the respective state or territory government using criteria agreed to through the NRMMC in May 2002. Key elements of the accreditation criteria include:

- addressing all local NRM issues;
- scientific analysis of natural resource conditions, problems and priorities;
- involvement of key stakeholders in planning and delivery;
- focus on the causes of problems rather than symptoms;
- development of practical strategies to manage issues;
- consistency with all other planning processes and legislative requirements applicable to the region;
- targets set at the regional scale which are consistent with the national framework for NRM standards and targets; and

21 The titles, functions, composition and legislative basis of the catchment management organisations vary across the states. Victoria and New South Wales have established their regional bodies as statutory authorities: Victoria has 10 catchment management authorities (CMAs) and New South Wales has 13 CMAs. Subject to the passage of NRM legislation, the South Australian Government proposes to establish eight NRM regions, each directed by an NRM Board. Western Australia has established six regional NRM groups and Queensland will establish 14 regional bodies. Further information on NRM regions and bodies is available on the Australian Government's NRM website, viewed 17 April 2004, <www.nrm.gov.au/about-regions/index.html#orgs>.

22 DAFF and DEH, *Exhibit no. 64*, *Overview of the NAP, NHT and NLP*, p. 3.

- continuous development, monitoring, review and improvement of the plan.[23]

2.17 In addition to accreditation criteria, nationally agreed frameworks have also been developed through the NRMMC to assist CMOs develop and implement plans for standards and targets, monitoring and evaluation, and capacity building.[24]

2.18 Once regional plans have been accredited, CMOs must develop investment strategies with specific actions, costs and timeframes required to implement the plan and achieve regional targets. These strategies form the basis for investment from both the NAP and NHT, which are described below.

2.19 Once investment strategies are decided, partnership agreements between the Australian Government, the CMO and the relevant state or territory government are signed, formally releasing investment funds. Partnership agreements define:

- funding amounts for salinity and water quality actions identified in the investment strategy flowing from each accredited regional plan;
- responsibilities for undertaking the activities and cost-sharing arrangements;
- agreed outcomes to be achieved; and
- targets and milestones, performance measures and a comprehensive monitoring and evaluation process.[25]

2.20 Several CMOs provided examples of their catchment blueprints and the salinity plans developed under these catchment strategies.[26]

2.21 The importance of addressing salinity in the wider NRM context was emphasised to the Committee. Salinity is one of a range of natural resource degradation issues that land managers and CMOs must address:

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23 *ibid.*, pp. 3-4.

24 *ibid.*, p. 2

25 Natural Resource Management Communications Team, *A natural resource management overview*, DAFF and DEH, Canberra, 2004, viewed 20 January 2004, <www.napswq.gov.au>.

26 Murrumbidgee Catchment Management Board, *Exhibit no. 53, Murrumbidgee Catchment Blueprint*; Glenelg Hopkins Catchment Management Authority (GHCMA), *Exhibit no. 22, Regional Catchment Strategy 2003–2004*; GHCMA, *Exhibit no. 20, Salinity Plan: Final Draft*; Eyre Peninsula Catchment Water Management Board, *Exhibit no. 117, Eyre Peninsula Salinity Strategy*; and Goulburn Broken Catchment Management Authority, *Exhibit no. 56, Goulburn Broken Draft Regional Catchment Strategy*.

> The natural resource system is complex. Diverse linkages occur between soil, water, plant and animal communities. It is not possible to change one aspect without expecting resultant change in linked areas. As such, salinity planning and implementation cannot occur in isolation. Regional, state and national frameworks provide the mechanism through which due consideration of these other elements are taken into account.[27]

2.22 Murrumbidgee Irrigation noted that 'salinity should not be considered in isolation, so knowledge transfer mechanisms need to be able to integrate all natural resource management issues for the landholder.'[28]

2.23 These perspectives accord with the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), which observed in its *Moving Forward in NRM* report that factors causing natural resource degradation are interrelated and degradation problems should not be viewed in isolation, but from a 'whole-of-landscape' perspective.[29] The PMSEIC also concluded that the causes of dryland salinity can be most effectively addressed at the catchment or regional scale, rather than the farm level.[30]

National Action Plan for Salinity and Water Quality

2.24 Agreed to by the Australian, state and territory governments at the Council of Australian Governments (COAG) meeting in November 2000, the NAP:

> identifies high priority, immediate actions to address salinity … and deteriorating water quality in key catchments and regions across Australia.
>
> It is a plan for decisive salinity and water quality related action to ensure that our land and water management practices will sustain

27 GHCMA, *Exhibit no. 20, Salinity Plan: Final Draft*, p. 21. See also: Dr Baden Williams, *Submission no. 1*, p. 1; Mr John Ive, *Submission no. 74.1*, p. 2; Land and Water Australia, *Submission no. 59*, p. 4; Murrumbidgee Irrigation, *Submission no. 52*, p. 4; CSIRO, *Submission no. 42*, p. 4; Mr Warwick McDonald (Murray-Darling Basin Commission), *Transcript of Evidence*, 7 November 2003, p. 27. Other forms of natural resource degradation include: waterlogging; sodicity; soil nutrient decline and acidification; acid sulphate soils; water and wind erosion; soil structure decline; declining river, wetland and estuary health; land and water contamination; loss of ecosystem function and biodiversity; weeds; and pests.

28 Murrumbidgee Irrigation, *Submission no. 52*, p. 4.

29 PMSEIC, *Moving Forward in Natural Resource Management: The contribution that science, engineering and innovation can make*, Australian Government Department of Education, Science and Training (DEST), Canberra, 1999, p. 34, viewed 29 January 2004, <www.dest.gov.au/science/pmseic/documents/nrm2.pdf>.

30 *ibid.*, p. 21.

productive and profitable land and water uses as well as our natural environments.[31]

2.25 The NAP aims to enable regional communities and landholders 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 infrastructure; and
- improve water quality and secure reliable allocations for human uses, industry and the environment.[32]

2.26 The NAP proposes that 21 highly affected catchments and regions be addressed. These 'priority regions' were determined by the Australian Government following consultation with the states and territories, and were based on data from the National Land and Water Resources Audit (NLWRA).[33]

2.27 The NAP comprises six key components:

- setting standards and regional targets for salinity, water quality and stream and terrestrial biodiversity. These are to be based on good science and economics, established bilaterally or multilaterally with the states;
- integrated catchment/regional NRM plans developed by the local community in all highly affected catchments/regions, which will be jointly accredited by the Australian and relevant state and territory governments, and include proposed targets and outcomes, accountability and performance monitoring and reporting measures;
- capacity building activities to assist communities and landholders to develop and implement integrated regional plans, together with technical and scientific support and engineering innovations;
- an improved governance framework, covering property rights, pricing and regulatory reforms for water and land use;
- clearly articulated roles for each level of government and the community to replace current frameworks for natural resource management; and

31 COAG, *A National Action Plan for Salinity and Water Quality*, DAFF and DEH, Canberra, 2000, p. 5.

32 DAFF and DEH, *Exhibit no. 64*, *op. cit.*, p. 1.

33 The locations of the priority regions are available on the web site of the National Action Plan, viewed 20 January 2004, <www.napswq.gov.au/publications/priority_regions>.

- a public communication program to support understanding of the NAP.[34]

2.28 The capacity building component is intended to assist communities and landholders by:

- reorienting the facilitator and coordinator support network to support integrated catchment/region management planning and implementation;
- developing the management and technical skills of land managers and other stakeholders to ensure wider adoption of sustainable land and water use, and to enhance the capacity of communities to prepare, evaluate and monitor the progress of integrated catchment/region management plans;
- extending information to communities, including NLWRA data, so that they can effectively develop and implement their plans; and
- developing (where they do not exist) appropriate catchment/regional delivery bodies/arrangements to implement the plans.[35]

2.29 The NAP notes that 'new scientific developments allow localised salt to be identified and investment to be targeted'.[36] The application of new scientific, technical and engineering knowledge is said to require:

- 'ultrasound' (that is, airborne geophysics, incorporating electromagnetic, airborne magnetic, radiometric and digital elevation techniques) salinity mapping and related technologies in priority catchments/regions to identify salinity deposits and flows as a basis for focused regional management action;
- salinity response teams to provide specific technical expertise to assist communities to develop integrated regional plans;
- development of production systems attuned to Australian conditions that facilitate sustainable production in rural and regional Australia; and
- salt interception/engineering schemes in areas that are exporting salt into waterways and where resulting downstream impacts are positive.[37]

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34 COAG, *op. cit.*, p. 6. See also: National Capacity Building Team for the National Action Plan for Salinity and Water Quality, *Natural Resource Management Capacity Building Framework*, DAFF, Canberra, 2002, pp. 2-6, viewed 20 January 2004, <www.affa.gov.au>.

35 *ibid.*, p. 8.

36 *ibid.*

37 *ibid.*

2.30 The Australian Government will contribute $700 million to the NAP over the seven years to 2007–08. CMOs will be funded to implement accredited regional plans on a matching basis with the states and territories. State allocations for the NAP are listed in Table 2.1.

2.31 Funding under the NAP is to be delivered primarily by:

- foundation funding to assist CMOs in priority regions to develop accredited regional plans to support future investment, which can include activities such as a research and development (R&D) needs analysis and preparing a strategy for monitoring and evaluation;
- priority funding is for actions, agreed between the Australian Government, state and CMO, prior to accreditation of the regional plan and include high priority works; and
- capacity building funding to provide the information, tools or skills to support the NAP.

Table 2.1: Indicative allocations for the $700 million *National Action Plan for Salinity and Water Quality* matching funding to be contributed by state and territory governments— agreed at the Council of Australian Governments meeting, November 2000

State	$ Million
New South Wales	**198**
Victoria	**152**
Queensland	**81**
Western Australia	**158**
South Australia	**93**
Tasmania	**12**
Northern Territory	**6**
Total	**700**

Source Natural Resource Management Communications Team, *A natural resource management overview*, Australian Government Departments of Agriculture, Fisheries and Forestry and the Environment and Heritage, Canberra, 2004, viewed 20 January 2004, <www.napswq.gov.au/publications/index>.

2.32 Following adoption of the initial in-principle intergovernmental agreement, each state and territory government has now entered into bilateral agreements with the Australian Government. The bilateral agreements established state / territory-specific arrangements for the CMOs, the process for accrediting regional plans within that jurisdiction and other administrative arrangements.

Natural Heritage Trust

2.33 The NHT was established by the Australian Government in 1997 to fund environmental protection, sustainable agriculture and natural resource management directed towards:

- biodiversity conservation;
- sustainable use of natural resources; and
- community capacity building and institutional change.[38]

2.34 Trust funding totalling $1.4 billion supported over 12 000 projects and related programs over the six years to 2001–02. More than 400 000 volunteers were involved in these projects, which included erecting more than 36 000 kilometres of fencing to protect areas of remnant vegetation, and planting some 27 million seedlings.[39]

2.35 During its first phase, the Trust funded key research programs that produced valuable information to aid understanding of the salinity problem, notably the NLWRA, which was established in 1997 and allocated $30 million of Trust funds.

2.36 In the 2001 Budget, the Trust was allocated an additional $1 billion to extend the program for a further five years to 2006–07. Of the extension budget, an estimated $350 million has been allocated for measures to improve water quality.[40] The 2004 Budget provided an additional $300 million for the NHT to 2007-08, bringing total investment in the Trust to $3.0 billion.[41]

2.37 Trust funds are delivered at three levels:

- national investments, which may be funded solely by the Australian Government or matched by the relevant states and territories;
- regional investments, for which the states and territories have agreed to match the Australian Government's investments in delivering the NHT extension; and

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38 DAFF and DEH, *Exhibit no. 64*, *op. cit.*, p. 2.

39 *ibid.*

40 Information on the NHT obtained from the Trust web site, viewed 21 January 2004, <www.nht.gov.au/overview.html>.

41 The Hon. Dr David Kemp MP (Australian Government Minister for the Environment and Heritage), *A Sustainability Strategy for the Australian Continent: Environment Budget Statement 2004-05*, p. 23, viewed 12 May 2004, <www.budget.gov.au/2004-05/ministerial/download/environment.pdf>.

- local investments, which are funded solely by the Commonwealth through the Australian Government Envirofund.[42]

2.38 During the first phase of the NHT, approximately 60 per cent of approved funding was allocated to community organisations and local governments, with numerous grants provided directly for salinity projects. In phase two, regional investments will become the principal delivery mechanism for Trust funds and will follow the model developed under the NAP. That is, investments are to be made on the basis of accredited, integrated catchment or regional NRM plans, incorporating the major natural resource management issues in the particular region or catchment.[43]

2.39 As with the NAP, regional plans accredited under the NHT are to be 'based on rigorous scientific and technical information' and 'set achievable natural resource condition targets'. This requires investment in research.[44]

2.40 With the second phase of the Trust, programs have been consolidated and funding for projects is now delivered under four programs:

- Landcare invests in contributions to reverse land degradation and promote sustainable agriculture;
- Bushcare invests in contributions to conserve and restore habitat for Australia's native flora and fauna;
- Rivercare invests in contributions to improve water quality and environmental conditions in river systems and wetlands; and
- Coastcare invests in contributions to protecting coastal catchments, ecosystems and the marine environment.[45]

National Landcare Program

2.41 Australian Government efforts to address salinity began with the NLP in 1989.[46] The NLP aims to 'increase engagement by industry and resource

42 DAFF and DEH, *Exhibit no. 64*, *op. cit*., pp. 2-3.

43 DAFF and DEH, *Framework for the Extension of the Natural Heritage Trust*, Canberra, 2002, p. 4, viewed 21 January 2004, <www.nht.gov.au/extension/framework/index.html#framework>.

44 *ibid*.

45 *ibid*., p. 2.

46 D. J. Pannell, 'Dryland salinity: economic, scientific, social and policy dimensions,' *Australian Journal of Agricultural and Resource Economics*, vol. 45, no. 2, December 2001, pp. 536-537.

users in landcare and NRM activities, with a focus on developing partnerships in sustainable primary industries.'[47]

2.42 The NLP primarily provides facilitators and organisers for Landcare groups (comprised of volunteers), and partial funding of relatively small on-ground works. There are currently 4 000 Landcare groups nationally, which operate largely in rural Australia, and some 40 per cent of Australian farmers belong to Landcare groups.[48]

2.43 Activities of the Program have included: raising awareness and improving information flows, with a focus on the communication of information on improved management practices; facilitating engagement of industry and the wider community in NRM at regional and national levels; and assisting on-ground implementation of projects that contribute to NLP outcomes.

2.44 In 2003 the NLP received additional funding of $122 million for the three years to 2005–06. Investment in Landcare is also provided by the NHT to complement investment in sustainable NRM practices.

2.45 The NLP Investment Framework for 2003–04 states that the Program will consist of community support and a national component:

- Community support will fund Landcare investments principally identified in accredited regional NRM plans and investment strategies. In this regard, the NLP complements the NHT and NAP programs. Investment under the Community Support component will fund community and industry on-ground works where they increase uptake of sustainable NRM practices, enhance the skills of NRM managers, promote the implementation of best management practice and improve integration of NRM into business and property management plans at the enterprise level.
- The national component will fund projects that have a broad scale national outcome rather than regional or local outcomes, and are therefore most effectively addressed at the national level. The National Component has the following elements:
  - ⇒ Landcare Support funds the Australian Landcare Council (which advises the Federal Ministers for the Environment and Heritage and Agriculture, Fisheries and Forestry), Landcare Australia Limited (which promotes the landcare ethic and raises corporate

47 Landcare and Sustainable Industries, Natural Resource Management Business Unit, *National Landcare Program – Investment Framework for 2003–04*, DAFF, Canberra, 2003, p. 1, viewed 21 January 2004, <www.affa.gov.au>.

48 *ibid.*

sponsorship for landcare activities), and the National Landcare Facilitator.

- ⇒ Natural Resource Innovation Grants: one-off grants to groups or individuals to adopt, implement and deliver innovations that will contribute to improved NRM in primary production or processing. Such innovations might include, for example, testing of cultivars of salt-tolerant plants in a region.
- ⇒ Industry Partnerships: investments in projects to assist industry in identifying the NRM issues facing them nationally and to assist in addressing these issues.
- ⇒ Priority National Projects: funds projects in areas of high priority identified by the Australian Government.
- ⇒ Monitoring and evaluation: funds program evaluations and assessments.[49]

2.46 A review of the Program's effectiveness and appropriateness, which was submitted to the relevant Ministers in October 2003, concluded that the NLP:

> has been highly effective in increasing awareness of natural resource management issues, in generating and transferring knowledge among participants on sustainable farming and natural resource management practices, and in building skills, capacity and social cohesion.[50]

2.47 The 2004 Budget extended the Program for two years, providing an additional $80 million ($40 million in both 2006-07 and 2007-08).[51]

Multilateral, state and local government initiatives to address salinity

2.48 In addition to the three national programs described in the preceding section, salinity is also being addressed through strategies developed by

49 *ibid.*, pp. 2-3.

50 Australian Government Department of Agriculture, Fisheries and Forestry, *Review of the National Landcare Program*, DAFF, Canberra, October 2003, p. 9, viewed 19 April 2004, <www.daff.gov.au/corporate_docs/publications/pdf/nrm/landcare/nlp_review_report_final.pdf>.

51 The Hon. Dr David Kemp MP (Australian Government Minister for the Environment and Heritage), *A Sustainability Strategy for the Australian Continent: Environment Budget Statement 2004-05*, p. 27, viewed 12 May 2004, <www.budget.gov.au/2004-05/ministerial/download/environment.pdf>.

the states and the Murray-Darling Basin Commission (MDBC). Recognising the threat posed by salinity to rural towns and urban areas, some local governments have also taken action to address salinity. The following section surveys the salinity strategies adopted by the MDBC and those state and local governments that submitted to the inquiry, and describes the place of science in these initiatives.

The Murray-Darling Basin Initiative and salinity strategies

2.49 The *Murray-Darling Basin Initiative,* which was established to give effect to the Murray-Darling Basin Agreement, is:

> the largest integrated catchment management program in the world, covering the watersheds of the Murray and Darling rivers, an area of over one million square kilometres.[52]

2.50 The Murray-Darling Basin Agreement was adopted in 1992 and followed the establishment in 1985 of the Murray-Darling Basin Ministerial Council. The Council is comprised of ministers from the Australian Government, New South Wales, Victoria, South Australia and Queensland governments holding land, water and environment portfolios. It aims:

> to promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin.[53]

2.51 The key institutional elements specified in the Agreement are the:

- Murray-Darling Basin Ministerial Council (MDBMC), the decision-making forum;
- MDBC, the executive arm of the Ministerial Council which advises the Council and implements its decisions; and the
- Community Advisory Committee, which provides the Ministerial Council with advice and provides a means of communication between the Council and the community.[54]

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52 MDBC, *The Murray-Darling Basin Initiative – Overview*, Canberra, 2004, viewed 22 January 2004, <www.mdbc.gov.au/about/governance/overview.htm>.

53 Murray-Darling Basin Ministerial Council, *Murray-Darling Basin Agreement*, MDBC, Canberra, 1992, p. 8, viewed 22 January 2003, <www.mdbc.gov.au/about/governance/agreement.htm>. Queensland became a signatory to the Agreement in 1996 and the ACT Government formalised its involvement through a memorandum of understanding in 1998.

54 MDBC, *The Murray-Darling Basin Initiative–Overview, loc. cit.*

The role of the Murray-Darling Basin Commission

2.52 The MDBC, comprising an independent President, two Commissioners from each contracting government and a representative of the ACT Government, is responsible for:

- managing the River Murray and the Menindee Lakes system of the lower Darling River; and
- advising the Ministerial Council in relation to the use of the water, land and other environmental resources of the Basin.[55]

2.53 In performing its functions, which are specified in the Agreement, the Commission has a role in coordinating the efforts of government partners to the Initiative and has a 'mandate to initiate, support and evaluate integrated NRM across the Murray-Darling Basin.'[56] In this way the Commission:

> works cooperatively with the partner governments, committees and community groups to develop and implement policies and programs aimed at the integrated management of the Murray-Darling catchment and managing and distributing the water of the River Murray in accordance with the Murray-Darling Basin Agreement.[57]

2.54 The Commission is an autonomous organisation equally responsible to the governments represented on the Ministerial Council. The Commission is not a government department, nor a statutory body of any individual government.[58]

Salinity strategies for the Murray-Darling Basin

2.55 In response to the threat posed by salinity to the irrigation industry, the residents of Adelaide and many regional towns in the Basin, in 1988 the MDBMC adopted a *Salinity and Drainage Strategy* (S&DS). From 1988 until it was superseded in 2001, the Strategy provided a framework for New South Wales, Victoria, South Australia and the Commonwealth to manage salinisation in the shared rivers of the Basin.

2.56 A key element of the Strategy was the commitment by governments to undertake a program of works to achieve a specific salinity reduction target of lowering average salinity in the Murray River at Morgan by 80

55 MDBC, *Submission no. 51*, p. 4.

56 *ibid.* p. 5.

57 *ibid.*

58 *ibid.*, p. 4

Electrical Conductivity Units (EC).[59] The Strategy also aimed to ensure that salinity levels at Morgan were less than 800 EC, 95 per cent of the time. A system of salinity credits and debits was adopted to manage the state accountabilities. Each state needed to ensure that it remained in credit by undertaking works which reduced average salinity levels at Morgan.[60]

2.57 The S&DS sought to balance the competing needs of land management and river protection through the use of a combination of engineering options, involving construction of salt interception and drainage schemes (for example, groundwater pumping), and non-engineering solutions, including the development of land and water management plans in irrigation regions.[61]

2.58 In the decade to 1998, approximately $70 million was invested in the on-ground works and plans, which now exist for most irrigation areas in the Basin.[62] Combined with state interception and drainage diversion schemes, the Strategy intercepted more than 400 000 tonnes of salt per year that would have otherwise entered the Murray. The S&DS successfully achieved its objectives.[63]

2.59 The MDBC estimated that over the period 1980 to 2003 salinity management in the Basin lowered average salinity levels in the river Murray at Morgan by 200 EC, relative to the levels that would have occurred without intervention.[64]

2.60 Under the S&DS the Commission's key roles, through inter-jurisdictional working groups, were to:

59 Electrical Conductivity Units (EC) is the standard measure of water salinity levels—the higher the EC value, the more saline the water. One EC equals one micro-Siemen per centimetre measured at 25 degrees Celsius, or approximately 0.6 milligrams of salt per litre. Morgan is located a short distance upstream of the pipeline off-takes for Adelaide's water supply and is used as an indicator site for impacts on the whole Murray-Darling Basin system.

60 MDBC, *Salinity and Drainage Strategy – Ten Years On*, Canberra, 1999, p. 3. 800 EC units is the World Health Organization's recommended desirable upper limit for salinity in drinking water.

61 MDBC, *Submission no. 51*, p. 5.

62 PMSEIC, *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, DEST, Canberra, 1998, p. 28, viewed 22 January 2004, <www.dest.gov.au/science/pmseic/documents/salinity.pdf>.

63 MDBC, *Submission no. 51*, p. 5; MDBC, *Salinity and Drainage Strategy – Ten Years On*, *op. cit.*, p. 9.

64 MDBC, *Exhibit no. 72*, *The Effect of Salinity Management in the Murray-Darling Basin – Average Salinity Levels in the River Murray at Morgan (South Australia).*

- coordinate the investigation, construction and ongoing operation of jointly funded salt interception schemes (Salt Interception Working Group);
- administer the accountability arrangements for the system of salinity credits and debits that operated under the Murray-Darling Basin Agreement (Salinity and Drainage Strategy Assessment Working Group);
- coordinate strategic investigations and education activities to develop and disseminate new knowledge in salinity related issues (Irrigation and Dryland Issues Working Groups); and
- participate in broader forums for salinity research and development, including the *National Dryland Salinity Program* (NDSP), Cooperative Research Centres (CRC) for Catchment Hydrology and Freshwater Ecology, and the NLWRA.[65]

2.61 In 1997 a process to review the Strategy was begun and a *Basin Salinity Audit* was issued in 1999.[66] The Audit concluded that under the then existing management systems and in the absence of major interventions:

- over five million tonnes of salt are mobilised to the land surface every year in the Basin and by 2050 that figure will increase to 8.4 million tonnes and more than 10.3 million tonnes in 2100;
- three to five million hectares of land will become salinised during the coming 100 years to the extent that there will be substantial effects on water quality, productivity, the environment and built infrastructure;
- salinity in the lower Murray will increase by approximately 50 per cent during the coming 50 years;
- damage to agricultural productivity and infrastructure in the Basin caused by salt will increase to an estimated $600 to $1 000 million a year during the next century; and
- there will be serious effects on major wetlands such as the Macquarie marshes, the Avoca marshes and the Chowilla wetlands.[67]

2.62 With these dire predictions the Audit concluded that the nation's efforts to combat salinity in the Basin needed to be significantly expanded.

65 MDBC, *Submission no. 51*, p. 5.

66 MDBMC, *The Salinity Audit of the Murray-Darling Basin: A 100-year perspective*, MDBC, Canberra, 1999, p. vii, viewed 21 January 2004, <www.mdbc.gov.au/naturalresources/pdf/Final_Salt_Audit.pdf>.

67 MDBMC, *Salinity Audit: Community Summary*, MDBC, Canberra, 1999.

2.63 It was concluded that if no additional salinity management measures were undertaken, the gains in river quality made under the Strategy would be overwhelmed by large increases in salinity contributions from the dryland farming areas and from drainage systems built prior to the Strategy. The Audit estimated that the reduction in lower River Murray salinity would be cancelled out in 20 to 30 years, and salinity levels would exceed the Australian Drinking Water Guidelines for good quality water within 50 to 100 years.[68] The Audit pointed to the need for a new Basin salinity strategy.

2.64 The new *Basin Salinity Management Strategy 2001—2015* (BSMS) was released in August 2001. The BSMS extends the life of the targets set under the Salinity and Drainage Strategy for the Murray River at Morgan until 2015. It also extends the accountability arrangements to South Australia and Queensland and introduces the use of end-of-valley salinity and salt-load targets in each state to help maintain the Morgan (Basin-wide) target.

2.65 The BSMS has four objectives:

- to maintain the water quality of the shared water resources of the Murray and Darling Rivers for all beneficial uses—river salinity at Morgan will be maintained at less than 800 EC for 95 per cent of the time;
- to control the rise in salt loads in all tributary rivers of the Basin and, through that control, protect their water resources and aquatic ecosystems at agreed levels—meeting the end-of-valley salinity and salt load targets;
- to control land degradation and protect important terrestrial ecosystems, productive farm land, cultural heritage and built infrastructure at agreed levels Basin-wide—expressed as within-valley targets; and
- to maximise net benefits from salinity control across the Basin.[69]

2.66 Under the BSMS partner governments committed to nine elements of strategic action which are to be implemented over the next 15 years:

- capacity building initiatives to implement the Strategy, including improving access to and use of the knowledge and decision tools generated by salinity research and development;

68 MDBC, *Exhibit no. 34*, *Salinity Update 2003*, p. 3.

69 MDBC, *Submission no. 51*, p. 6.

- identifying important values and assets throughout the Basin at risk of salinity, and the nature and timeframe of risk. This explicitly recognises the 'triple bottom line' approach, requiring a balance between economic, environmental and social values. It also recognises that living with salinity will be the only choice in some situations;
- setting salinity targets. The Council will adopt end-of-valley targets. States will empower CMOs to advise on end-of-valley targets and determine within-valley targets and monitoring arrangements, under salinity and catchment management plans;
- managing trade-offs with the available within-valley options. While meeting other catchment health targets and social and economic needs, states are to analyse the best mix of land management, engineering, river flow, and 'living with salt' options to achieve salinity targets;
- implementing salinity and catchment management plans;
- redesigning farm systems. The state governments are to coordinate and enhance research and development into new farming and forestry systems that deliver improved control of groundwater recharge. The Commission will enhance R&D into new industries, such as broadacre saltland agronomy, saline aquaculture, and salt harvesting;
- targeting reforestation and vegetation management;
- constructing new salt interception works to protect Basin-wide assets and values; and
- ensuring Basin-wide accountability through monitoring, evaluating and reporting. The states are to demonstrate accountability by reporting to the Commission and Council through state end-of-valley Report Cards and Commission Salinity Registers that record the salinity effects of actions, including salt interception schemes and catchment management plans.[70]

2.67 The BSMS was the first strategy to be developed under the over-arching *Integrated Catchment Management Policy* (ICM Policy) statement. Released by the MDBMC and the Community Advisory Committee in 2001, the ICM Policy provides the framework for NRM in the Basin over the decade 2001 until 2010 and sets out a program for the development of a package of issue-specific strategies, of which the BSMS is the first.[71]

70 MDBC, *Exhibit no. 37, Basin Salinity Management Strategy 2001-2015*, pp. iii, 3.

71 *ibid.*, p. 27.

2.68 The ICM Policy sets standards to be met by all new Basin strategies and seeks to ensure:

> various natural resources management issues affecting a river catchment or region, and the environmental, economic and social dimensions of the issues, are addressed in a coordinated way by everyone with an interest in the issues.[72]

2.69 Consequently, the MDBC is now supporting research activities that will contribute to an understanding of how to manage multiple issues at once, in addition to supporting the implementation of the BSMS. These investigations include targeting reforestation and vegetation management, and redesigning farming systems.[73]

2.70 The BSMS has been designed to be compatible with the NAP, state salinity strategies and regional plans. The Intergovernmental Agreement for the NAP requires that the implementation of the NAP will be consistent with the multilateral approach of the BSMS and regional plans accredited under the NAP are expected to meet the requirements of the BSMS.[74]

The use of science in the Murray-Darling Basin salinity strategies

2.71 The MDBC stated that its salinity strategies have been developed with the use of rigorous science and research, including:

- the use of objective targets and strong accountabilities based on monitoring and assessment of proposed actions. The end-of-valley salinity target approach emphasised in the BSMS gives a reference point for decisions about the most appropriate and effective management actions, and the science needed to achieve them;
- the effects of all management actions are assessed in terms of their downstream salinity impacts by using a biophysical reference point of salinity levels in the River Murray at Morgan in South Australia, combined with an economic assessment framework;
- actions are based on the best available, 'best bet' knowledge, managing risks and continually learning from the results;

72 MDBC, *Exhibit no. 41*, *Managing Dryland Salinity – Draft Report*, p. 20.

73 *ibid*., pp. 20-21.

74 COAG, *Intergovernmental Agreement on a National Action Plan for Salinity and Water Quality*, Canberra, 2000, p. 3, viewed 21 January 2004, <www.napswq.gov.au/publications/intergovernmental.html>.

- a coordinated multi-jurisdictional approach, because bilateral approaches will not provide sufficient coordination for Basin-wide salinity management. Accordingly, the Commission has developed multi-jurisdictional working groups. Of particular relevance to salinity management is the Basin Salinity Management Strategy Implementation Working Group which implements the BSMS and develops and extends knowledge in relation to the Strategy; and
- the MDBC provides funds for investment in knowledge generation and dissemination of information related to salinity and other NRM issues. The Commission also draws on and partners with national science and research agencies, including CSIRO, NDSP, NLWRA, and the CRC Program.[75]

2.72 The MDBC has contributed to knowledge generation for salinity management through investigations funded under its Irrigation and Rivers, and Dryland Programs.

2.73 Since 1990, the Dryland Program has contributed to knowledge about the causes of land, water and vegetation issues in dryland landscapes, the impacts of the issues and management options to address them:

> The extensive body of knowledge generated by salinity investigation during the 1990s was brought together (and supplemented by additional investigations) in developing the *Basin Salinity Management Strategy 2001 – 2015* in 2000.[76]

2.74 Knowledge generated by the Dryland Program has been synthesised into booklets to promote the sharing of information among Basin stakeholders. Of these, the *Managing Dryland* salinity booklet describes the key salinity management tools and understanding developed by 27 key projects within the Dryland Program from 1990 to 2000, across the following themes: the quantification of salinity impacts; understanding salinity processes; assessing management options; and implementing on-ground works.[77]

2.75 The tools developed from the research are primarily aimed at supporting regional to Basin scale salinity management, rather than farm scale activities. The latter are considered to be 'primarily the preserve of State natural resources and agricultural agencies and rural industry R&D corporations.'[78]

75 MDBC, *Submission no. 51*, pp. 7-8.

76 MDBC, *Exhibit no. 41, op cit.*, p. 19.

77 *ibid.*, p. 3.

78 *ibid.*, pp. 4-5.

2.76 The Commission also stressed that knowledge is required across all geographic scales (national, Basin, state, catchment, local and property scales). It was argued that there must be strong links between the knowledge generated at each scale and, in particular, how cumulative action at the property scale will change the health of the catchment and the Basin as a whole. Knowledge about the biophysical processes causing salinity and management options needs to be expanded and integrated with knowledge about the economic and social needs of communities affected by salinity.[79]

2.77 The MDBC noted that primary responsibility for NRM lies with the state and territory governments, but that the Australian Government has now taken a greater role through its contribution of funding for the NAP. The MDBC argued it is therefore essential that the Commonwealth ‘work in partnerships across the State, Territory, catchment and local government boundaries to take action to protect the health of the Basin.’[80] It urged that roles and responsibilities in relation to NRM be clearly defined.

2.78 The MDBC stated that, under the ICM Policy, the Australian Government’s responsibilities include the following:

- provide leadership on matters of national interest, including international obligations;
- coordinate policies across portfolios of the Australian Government;
- generate, coordinate and share knowledge;
- be involved in setting targets for priority national outcomes;
- act to achieve these outcomes using a range of government mechanisms, including providing information and investment;
- be accountable for investments and outcomes;
- ensure that Basin, State and catchment frameworks are adequate to deliver these outcomes;
- monitor progress toward achieving these outcomes;
- engage key partners; and
- review and evaluate Australian Government policies, legislation and mechanisms.[81]

79 MDBC, *Submission no. 51*, pp. 7-8.

80 *ibid.*, p. 9.

81 *ibid.*, pp. 9-10.

2.79 In the 2004 Budget, the Australian Government announced funding of $67 million for the MDBC over four years to 2007-08, to fund capital works, education activities and salinity mitigation works.[82] Total Australian Government investment in the Basin now approaches $1 billion across the NHT, NAP and financial support for the MDBC.[83]

State strategies

2.80 While the Australian Government's role in natural resource management is significant—through leadership, national coordination and financial assistance to the states / territories and regions—the division of Constitutional powers grants states and territories the power to legislate with respect to most NRM matters, including rural industries, land tenure, land use and water supply.[84]

2.81 Salinity strategies have been developed by most states, including all the Murray-Darling Basin states. Of those states with salinity programs, the Committee received submissions from the Governments of New South Wales, Western Australia and South Australia.

New South Wales

2.82 Developed following the State's Salinity Summit in March 2000, the New South Wales salinity strategy, *Taking on the Challenge: NSW Salinity Strategy*, was released in August 2000 and involved an initial State Government commitment of $52 million over four years. The Strategy's objective is to slow down the rate of increase in salinity in the State and it has eight components:

82 Australian Government, *2004-05 Budget Overview*, p. 22, viewed 12 May 2004, <www.budget.gov.au / 2004-05 / overview / download / budget_overview.pdf>.

83 The Hon. Dr David Kemp MP (Australian Government Minister for the Environment and Heritage), *A Sustainability Strategy for the Australian Continent: Environment Budget Statement 2004-05*, p. 9, viewed 12 May 2004, <www.budget.gov.au / 2004-05 / ministerial / download / environment.pdf>.

84 Information obtained from the web site of the Natural Resource Management Ministerial Council and the Primary Industries Ministerial Council, viewed 27 January 2004, <www.mincos.gov.au / background.htm>. See also: s. 100 and s. 96 of the Constitution; DAFF submission to the House of Representatives Standing Committee on Agriculture, Fisheries and Forestry *Inquiry into Future Water Supplies for Australia's Rural Industries and Communities*, p. 4, viewed 10 April 2004, <www.aph.gov.au / house / committee / primind / waterinq / sub160.pdf>; The Hon. John Anderson MP (Deputy Prime Minister, Minister for Transport and Regional Services), *National Salinity and Water Quality Action Plan is a Watershed for Farmers' Rights – Anderson*, media release, Canberra, 2 November 2000, viewed 5 April 2004, <www.ministers.dotars.gov.au / ja / releases / 2000 / november / a159_2000.htm>.

- development of end-of-valley salinity targets that the State can live with and afford;
- establishment of market-based mechanisms to provide land managers with incentives to reduce salinity;
- development of business opportunities for productive use of saline land and water resources;
- improved regulation;
- provision of salinity advice to land managers through extension staff and Salt Action Teams;
- provision of information, including data, analytical tools, decision support and dissemination;
- in collaboration with other agencies, conduct scientific research into the biophysical processes of salinity, land use systems that minimise recharge or allow for the use of saline land and water, the impact of salinity on natural ecosystems and the social and economic impacts of salinity management; and
- planning at the appropriate geographic scale, including the development of catchment management plans.[85]

2.83 As part of an NRM package announced by the New South Wales Government in October 2003, the State established a Natural Resources Commission and a Natural Resources Advisory Council. Among its responsibilities, the Commission will:

- set environmental targets and standards for New South Wales and report on progress towards their achievement;
- recommend to Government the approval of catchment plans developed by the State's 13 Catchment Management Authorities (CMAs); and
- audit the performance of CMAs and carry out inquiries.[86]

2.84 The New South Wales Government explained that management actions for salinity mitigation at the regional level, which flow from the catchment blueprints and their associated regional investment strategies, are based on the best available scientific knowledge.[87]

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85 New South Wales Department of Land and Water Conservation, *Taking on the Challenge: NSW Salinity Strategy*, Government of New South Wales, Sydney, 2000, viewed 27 January 2004, <www.dlwc.nsw.gov.au/care/salinity/index.html>.

86 *Land and Water News*, 2 December 2003, p. 14.

87 Government of New South Wales, *Submission no. 61*, p. 1.

2.85 It was submitted that detailed salinity assessment across the whole landscape is both impractical and financially prohibitive. However, the State argued that it is well advanced in developing techniques for salt and water balance modelling from a paddock to whole-of-catchment scale. These models also measure the impacts of various management actions.[88]

2.86 The New South Wales Government stated that it uses science to develop solutions for commercial agriculture and to support salinity management at three levels:

- At the Basin level, the key questions which require the use of science are:
  - ⇒ What is the current and expected future size and extent of the salt problem?
  - ⇒ How does salt generated in one catchment impact on downstream catchments and states?

  Audits have been undertaken to identify the magnitude of the salinity problem and its driving factors. These were peer reviewed by the CSIRO and used data on groundwater levels and river salinity as the basis for estimating future dryland salinity trends. The State's regional bodies used the audits as the primary source of information when setting end-of-valley salinity targets in their regional plans. At this level, the State utilises the river basin Integrated Water Quantity and Quality Model (IQQM) which is able to analyse how daily flows and salt loads from contributing tributaries travel through the main river systems of New South Wales. Combined with a sub-catchment scale salt and water balance model, referred to as CATSALT, land use change scenarios can be analysed at a Basin scale to evaluate contributions to achieving salinity targets.[89]

- At a sub-catchment level, New South Wales is undertaking new salinity hazard and risk assessments in order to answer four key questions:
  - ⇒ Where is the salt?
  - ⇒ Is it being mobilised?
  - ⇒ Where are management options best located to achieve required outcomes?
  - ⇒ What undesirable consequences, such as impacts on water yields, might there be?

88 *ibid.*

89 *ibid.*, pp. 1-2.

The Government is currently rolling out CATSALT in 150 sub-catchments across the State. The model provides a daily time series analysis of land use change impacts on groundwater and surface wash-off of salt from priority tributaries identified in the Murray-Darling Basin, Hunter and coastal audits.[90]

- At the property scale, science is being used to answer questions that include:
  - ⇒ Is salt a problem due to current or future land use and management?
  - ⇒ What options are available to mitigate it?
  - ⇒ Where are the options best located?
  - ⇒ How effective are the options?

  At this scale, the State has developed a Land Use Options Simulator (LUOS) to extrapolate CATSALT results to calculate the effectiveness or impacts of a land use option, down to the paddock scale, on the average annual river salinity.[91]

Western Australia

2.87 With more than 70 per cent of the nation's salinity affected land area, Western Australia has a major dryland salinity problem:

> Land, water, infrastructure and biodiversity assets are either affected, or at imminent risk. In this State, salinity is obvious, its consequences immediately apparent and the time to develop cost effective interventions is running out, both in terms of community expectations and the rate of salinity encroachment.[92]

2.88 A Western Australian *Salinity Strategy* was issued in 2000, following an earlier State Salinity Action Plan released in 1996.[93]

2.89 The Strategy aims to reduce the impact of salinity in the south-western agricultural region of the State and has five goals:

- to reduce the rate of degradation of agricultural and public land, and where practical recover, rehabilitate or manage salt-affected land;

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90 *ibid.*, pp. 2-3.

91 *ibid.*, p. 3.

92 Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, p. 3.

93 Western Australian State Salinity Council, *The Salinity Strategy*, Government of Western Australia, Perth, 2000, viewed 28 January 2004, <www.salinity.org.au/management/pdfs/salinity-strategy.pdf>.

- 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 diversity within the south-west region of Western Australia;
- 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.[94]

2.90 The proposed actions to achieve these goals are based on three principles: salinity needs to be addressed by treating the causes of the problem; developing practical and environmentally sound methods that mitigate the impact of salinity; and the strategy needs to be implemented in a partnership with stakeholders at the regional and catchment level. The strategy contains nine elements:

- working in partnerships that involve all stakeholders;
- analysing risk in different areas over time to allow appropriate priorities to be set;
- retaining native vegetation and protecting remaining biodiversity values;
- adopting an appropriate mix of the tools available to manage salinity;
- helping the farming community to make the transition to more sustainable production systems and building their capacity to do so;
- addressing the equity concerns that arise;
- promoting research and development to improve salinity management;
- planning to address shortfalls in actions where priority biodiversity and other public assets remain at an unacceptable risk, or are significantly affected; and
- developing continuous monitoring and evaluation of salinity management actions.[95]

2.91 A major investment in salinity management in Western Australia has been the Land Monitor Project, funded by the NHT and the State Government, 'to map and monitor the extent of salinity through satellite imagery at the

94 *ibid.*, p. 10.
95 *ibid.*, p. 11.

farm and catchment scale', particularly in the south-western agricultural region of the State.[96]

2.92 In May 2001 the Minister with Special Responsibility for Salinity formed a Salinity Taskforce to review the State's Salinity Strategy and Salinity Action Plan, and to recommend future strategies which would provide a more targeted and cohesive response to the State's salinity threat.

2.93 In September 2001 the Taskforce issued its report, *Salinity: A New Balance*, which encouraged a more focused approach to salinity management and recommended that governments conduct three main actions:

- protect outstanding public assets (for example, rural towns and threatened high-value conservation areas) from the consequences of salinity and other resource degradation;
- invest in and support major actions on private land by developing new technologies and industries (for example, new perennial plants, commercial farm forestry and engineering solutions); and
- support and provide incentives for planning, coordination and implementation of smaller on-ground works on private land (for example, for water management and protection of biodiversity).[97]

2.94 Specifically, the Taskforce recommended a 'new balance' of Government activity in favour of protecting high-value public assets and investment in major actions on private land by developing new technologies and industries.[98]

2.95 Among its responses to the Taskforce report, the Western Australian Government established a Natural Resource Management Council to provide a broader context for the integrated management of salinity and other natural resource issues in the State.[99]

2.96 The State's Salinity Council, the predecessor of the NRM Council, also initiated the development of a Salinity Investment Framework in 2002, to

96 Land and Water Australia (LWA), *Exhibit no. 71, Australian Dryland Salinity Assessment 2000*, p. 39; Mr Tim Sparks (Western Australian Department of Environment), *Exhibit no. 89, Land Monitor Salinity Mapping*.

97 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111, Salinity: A New Balance*, p. 15.

98 *ibid.*, pp. 15-17.

99 The Hon. Dr J. Edwards MLA (Western Australian Minister for the Environment and Heritage), *State Government outlines new initiatives to tackle salinity problem*, media release, Perth, 10 July 2002, viewed 27 January 2004, <www.salinity.org.au/news/latestnews.cfm>.

guide targeted public investment in salinity management initiatives at state and catchment levels.[100]

South Australia

2.97 In 1989 the Government of South Australia established a State Dryland Salinity Committee, which developed a 'Technical strategy to address Dryland Salinity in South Australia', issued in 1990.[101]

2.98 In 1999 the Soil Conservation Council of South Australia instigated the development of a new Strategy, the overarching objective of which is to reverse the trend of rising salinity and, where possible, reduce the impacts on resources and assets. The Strategy aims to protect:

- the quality of River Murray water, keeping salinity below the guideline level of 800 EC for drinking water at Morgan 95 per cent of the time;
- land resources from salinisation, minimising the area of land affected by dryland salinity beyond the currently affected (326 000 hectares) area;
- natural environment and biodiversity resources, keeping salinity impacts to current levels or where possible reducing them; and
- the State's economic resource base, developing productive uses for irreversibly saline land and water.[102]

2.99 The Strategy outlines support for its implementation under four themes: on-ground works; developing partnerships between various agencies and groups; improving knowledge; and arrangements for effective implementation.

2.100 The on-ground works to manage salinity under the Strategy include:

- reducing recharge, usually with the aid of deep-rooted perennial vegetation;
- utilising discharge with salt-tolerant plants or in other industries that can use saline water; and

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100 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 104, Salinity Investment Framework Interim Report – Phase I*, p. 6.

101 South Australian Department of Water, Land and Biodiversity Conservation, *Salt Control SA*, 'Salinity in SA: Overview' , viewed 23 February 2004, <www.saltcontrolsa.com/overviewsa.html#01>.

102 Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, Government of South Australia, Adelaide, 2001, p. 2, viewed 23 February 2004, <www.saltcontrolsa.com/pdfs/sadss_72.pdf>.

- disposing of surplus water, usually by drainage.[103]

2.101 The Strategy identifies several imperatives in relation to research and development for salinity management, including the need to provide farmers with profitable solutions, particularly perennial crops, and new ways to productively use saline land and water resources, including development of new industries.[104]

2.102 The Dryland Salinity Strategy is linked with the South Australian River Murray Salinity Strategy, released in 2001, which established actions to protect the River Murray and its floodplain from salinity impacts due to dryland farming practices.[105]

2.103 A new South Australian Dryland Salinity Committee (SADSC) has been established to:

> provide a broad community and technical forum to prioritise actions under the Strategy, to coordinate the activities of partners, to conduct special cross-agency projects and to measure progress.[106]

2.104 The SADSC aims to identify salinity research and development priorities for the State and facilitate communication between stakeholders.

2.105 Natural resource management programs in South Australia, including salinity, are delivered through a 'regional Integrated Natural Resource Management (INRM) framework.'[107] Eight regional INRM groups are in the process of being established and it is intended that these will operate on a statutory basis.

2.106 The existing regional groups are currently developing integrated NRM plans and investment strategies. The groups are being guided by the SADSC in the development, implementation and evaluation of salinity management plans. The regional groups will be responsible to a Ministerial Integrated Natural Resource Management Board, which will have ultimate responsibility for salinity management in South Australia.[108]

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103 *ibid.*, p. 17.

104 *ibid.*, pp. 30-32.

105 South Australian Department of Water, Land and Biodiversity Conservation, *Salt Control SA*, *loc. cit*.

106 Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, *op. cit.*, p. 3.

107 Government of South Australia, *Submission no. 81*, p. 4.

108 Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, *op. cit.*, p. 34.

Local government initiatives

2.107 The Committee received evidence from local governments that have implemented programs to address the issue of urban salinity. There are some 50 towns in the Murray-Darling Basin (28 in New South Wales and 22 in Victoria) and at least 34 towns in Western Australia affected by urban salinity. Parts of Western Sydney and areas of the Hunter Valley have also been affected.[109] Two examples of the impacts of urban salinity and measures to address it follow.

Wagga Wagga

2.108 The Wagga Wagga City Council first identified signs of rising saline groundwater in Wagga Wagga in 1993. This was apparent from damage to residences, sporting grounds, dying vegetation and premature deterioration of road surfaces.

2.109 Economic analysis estimated that if nothing were done, the costs to the town would be approximately $180 million over 30 years.[110] Costs to individual residents are substantial, with some people 'finding that they have to spend $10 000 to $20 000 on repair work for some of these houses.'[111]

2.110 In conjunction with CSIRO and state agencies, the Council undertook a four year investigation phase. This was followed by a further four year period trialling various initiatives to address the urban salinity threat. These were in large part supported by funding from the NHT program. The Council's programs include:

- education and demonstration to change water usage habits and to show residents how to live with salt—this has included the production of a number of brochures and booklets, including education packages for school and university groups, and provision of information through the Council's web site;[112]
- revegetation requirements in the Council's planning instruments to ensure more vegetation in future urban development;

109 Wagga Wagga City Council, *Exhibit no. 7, The One Stop Shop for Managing Urban Salinity*, p. 2.

110 Wagga Wagga City Council, *Submission no. 5*, p. 1.

111 Mr Bryan Short (Wagga Wagga City Council), *Transcript of Evidence*, 30 October 2003, p. 23.

112 See for example: Wagga Wagga City Council, *Exhibit no. 49, Halt the salt in our homes, buildings and farms*; and *Exhibit no. 51, Water Wise and Salt Tolerant Plants.*

- leakage reduction initiatives to reduce the volume of water entering the watertable; and
- installation of nine bores to lower the watertable under the worst affected area of the town, and the Council has installed a network of over 100 piezometers to monitor watertable levels.[113]

Western Sydney Regional Organisation of Councils

2.111 The Western Sydney Regional Organisation of Councils (WSROC) has recognised that urban salinity is an emerging issue for the residents in western Sydney.[114] A map of salinity potential in western Sydney, published by the New South Wales Government, has indicated that 'a vast area of Western Sydney is affected by or is susceptible to salinity.'[115]

2.112 Among its initiatives, and with Australian Government support, WSROC has published a *Western Sydney Salinity Code of Practice,* which attempts to:

> link National, State and local initiatives within a regional management framework to provide a coordinated response to urban salinity in Western Sydney.[116]

Combined, the Councils spent in excess of $197 000 and $205 000 on salinity projects in 2001–02 and 2002–03 respectively.[117]

2.113 As part of its broader State Salinity Strategy, the New South Wales Government has also initiated a *Local Government Salinity Initiative*. The Initiative has involved publication of a series of booklets on urban salinity.[118]

Responses to the national programs that address salinity

2.114 The preceding sections provided an overview of the three major national NRM programs which address salinity. Major components of the national NRM initiatives have been designed around catchment/regional level planning and implementation. The salinity strategies developed by three

113 Wagga Wagga City Council, *Exhibit no. 7*, *op cit*., pp. 5-8.

114 Mr Colin Kandan-Smith (WSROC), *Transcript of Evidenc*e, 29 October 2003, p. 15.

115 *ibid*.

116 WSROC, *Submission no. 20*, p. 5.

117 WSROC, *Exhibit no. 133*, *Salinity Projects in Western Sydney*.

118 Hawkesbury-Nepean Catchment Management Board, *Exhibit no. 42*, *Salinity Potential in Western Sydney* (publications by the New South Wales Department of Infrastructure, Planning and Natural Resources).

states and for the Murray-Darling Basin were described. Initiatives of some local governments to address urban salinity were also outlined. The following section gathers evidence presented to the Committee in response to the national programs that address salinity.

2.115 The NAP and NHT have been welcomed:

> together these major national initiatives have considerably increased investment in work related to salinity at an Australian Government level.[119]

The Grains Research and Development Corporation (GRDC) congratulated 'the Commonwealth, State and Territory governments for agreeing to the National Action Plan and its matching funding arrangements', and observed that together with the NHT these programs 'have become the central pillars of Government support for the fight against salinity in Australia.'[120]

2.116 Similarly, the Australian Salinity Action Network (ASAN) stated:

> The current Federal and State government programs under the National Action Plan for Salinity and Water Quality to combat salinity are the most comprehensive and forward thinking that have ever been developed on the issue … The government is congratulated for the creation of the NAP including the provision of significant funds to execute it. It is difficult to fault the system and processes that have been put in place through the NAP in order to combat salinity.[121]

2.117 However, some concerns were raised in relation to the nation's salinity programs and the consequences of the regional approach to NRM. The principal concerns relate to the:

- architecture of the NAP, which:[122]
  - ⇒ inhibits national research coordination;
  - ⇒ does not have a charter to fund salinity research;
  - ⇒ has geographic gaps by focussing on only 21 regions;
  - ⇒ excludes industry participation and marginalises state agency involvement;

119 Land and Water Australia (LWA), *Submission no. 59*, p. 2.
120 GRDC, *Submission no. 29*, p. 3.
121 ASAN, *Submission no. 39*, p. 1.
122 See for example: LWA, *op. cit.*, p. 3.

- ⇒ renders achievement of targets under the Murray-Darling Basin Salinity Management Strategy vulnerable;
- ⇒ lacks a rigorous scientific basis for the allocation of funds to regions;

- failure to incorporate key research findings into salinity programs and the mistaken presumption that economically viable solutions are available;[123]
- Australian Government science investments neglect research into new salinity management methods and technologies;[124]
- region-based planning and delivery of NRM programs, which:[125]
  - ⇒ risk fragmenting the salinity research effort; and
  - ⇒ make the extension of science and linkages between researchers and CMOs more problematic.

2.118 These four themes are described in the sections which follow.

The architecture of the National Action Plan

Inhibits national research coordination

2.119 LWA argued that the bilateral architecture of the NAP and its use of regional investments does not facilitate a nationally coordinated approach to salinity research.[126]

Does not have a charter to fund salinity research

2.120 The NDSP argued that, while the NAP can fund research and development (R&D) where it is closely related to implementation at the regional level, the NAP:

> does not, however, have a charter to fund salinity R&D, nor has it given itself the leverage or buying power to strategically generate knowledge to address the gaps and priorities important to its sound investment in outcomes. As the NDSP has concluded, there

123 See for example: Associate Professor David Pannell, *Submission no. 13*, p. 2.

124 See for example: Cooperative Research Centre for Plant-based Management of Dryland Salinity (CRC PBMDS), *Submission no. 8*, p. 4.

125 See for example: Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), *Submission no. 64*, p. 5.

126 LWA, *loc. cit.*

> is a vital need to support further R&D if the problem is to be managed at the scales required.[127]

2.121 Mr Kevin Goss, in his capacity as Chair of the NDSP, stated:

> if we look at the central importance of R&D for the long term and we look at how things are unfolding at the moment under … the national action plan, it does not give us confidence that R&D will be effectively handled …[128]

Marginalisation of industry and state agency involvement

2.122 Several submitters noted that industry organisations, such as the research and development corporations, have been excluded from the NAP planning, management, monitoring and evaluation process. LWA stated that:

> As a result, a significant number of institutions involved in salinity management at a policy, R&D and on-ground level are distanced from the coordination efforts of what has been to date the most significant public investment in managing the salinity problem in Australia.[129]

2.123 The failure to include industry partners in the NAP has meant that the impetus for many primary producers to become involved in works funded by the Program has been absent. The WA SRDTC submitted that 'when industry has been involved', programs have been 'incredibly successful because they also bring in a lot of landholders that are not traditionally brought in under the landcare or conservation banner.'[130]

2.124 Some small to medium sized enterprises (SMEs) also commented critically that, 'as currently structured, the salinity industry does not offer the private sector opportunities that can be turned to account for profit.'[131] GecOz submitted that many SMEs have undertaken R&D 'at great expense and, in many cases, without government funding, yet government too often overlooks their potential contribution.'[132] Similarly, Orbtek and Natural Resource Intelligence submitted that the role of

127 NDSP, *Submission no. 35*, p. 6.

128 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 3.

129 LWA, *op. cit.*, p. 4; NDSP, *op. cit.*, p. 6; Dr Don McFarlane (Western Australian Salinity Research and Development Technical Committee), *Transcript of Evidence*, 12 November 2003, p. 42.

130 Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 42.

131 Mr Bill Henty, *Submission no. 4*, p. 3.

132 GecOz, *Submission no. 80*, p. 1.

industry has been stifled.[133] Mr Bill Henty argued that 'what is needed is a private sector attitude that applies business and entrepreneurial skills to develop new opportunities.'[134]

2.125 The WA SRDTC argued that, in contrast to other national programs such as the Regional Partnerships Program, the NAP has marginalised state agency involvement. It was suggested that the hallmark of successful national programs is a partnership of four parties: the Australian Government ('for instance, in new industry development and innovative research'); state agencies ('because they have been land and water managers for a long period of time' and have expertise in natural resource management); communities, particularly through regional groups; and industry ('for example, the rural industry research funds').[135] It was asserted that:

> we have never been able to renegotiate anything that was signed off at the early stage and, therefore, while it is called a partnership program, we feel [the NAP] was put together at federal level without involving us in perhaps better ways of carrying it out.[136]

2.126 Likewise, the NDSP argued that the NAP has 'not been effective in its role of Commonwealth, state and regional coordination.'[137] Engineers Australia also urged that links between state and Federal government agencies researching and managing salinity be strengthened.[138]

Geographic gaps by focussing on a limited number of regions

2.127 The NAP has also been criticised because it addresses salinity in only 21 priority regions and therefore excludes other areas affected by salinity.[139] Moreover, the scientific basis for the choice of regions that have been included in the NAP has also been questioned.[140]

Renders achievement of targets under the BSMS vulnerable

2.128 In contrast to arrangements under the NAP, the MDBI is multilateral. The MDBC expressed concern that the bilateral arrangements of the NAP may

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133 Orbtek, *Submission no. 3*, p. 1; NRI, *Submission no. 32*, pp. 8-12.

134 Mr Bill Henty, *op. cit.*, p. 2.

135 Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 42.

136 *ibid*.

137 NDSP, *op. cit.*, p. 20.

138 Engineers Australia, *Submission no. 73*, p. 1.

139 NDSP, *op. cit.*, pp. 6-7.

140 Associate Professor David Pannell, *op. cit.*, p. 4.

place achievement of the targets under the Basin Salinity Management Strategy at risk:

> It is vulnerable because we do not yet see the momentum under the [NAP] and its regional delivery so that it is moving from planning to investment and works happening with sufficient speed and precision to be able to deal with the rising need so that these catchment management actions will start to choke salt moving into the river.[141]

2.129 The MDBC is concerned that catchment plans developed by regional bodies do in fact maximise contributions to salinity credits for the Basin as a whole: 'This requires pretty tight coordination, and it is difficult when the investments go through bilateral arrangements.'[142]

Scientific basis for regional funding

2.130 The MDBC argued that regional investments need to be directed to specific catchments to achieve Basin salinity targets and funds ought not be spread evenly across regions:

> It is not about a popular notion of equity—that is, that everybody gets funds to do things … It is not necessarily equally or evenly spread across catchments and, in fact, there are some areas where you would hardly contemplate that investment at all in terms of living with salinity or managing it in certain ways.[143]

2.131 Similarly, Associate Professor David Pannell submitted that:

> a rigorous science-based allocation process would result in considerable diversity in funding levels between regions, but there is no sign that this will occur in practice, or if it does it will not be on the basis of scientific analysis of needs and opportunities.[144]

Murray Irrigation strongly concurred with this view and argued that there has been a distinct lack of science in prioritising funding for actions in the Murray Catchment Blueprint.[145]

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141 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 34.

142 *ibid*., p. 39.

143 *ibid*., p. 34.

144 Associate Professor David Pannell, *op. cit*., p. 4.

145 Murray Irrigation Ltd, *Submission no. 27*, p. 3; Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 14.

Failure to incorporate key research findings into salinity programs and the mistaken presumption that economically viable solutions are available

> *Science needs to be dealt with in a much more serious and sophisticated way in the design of national salinity policy.*[146]

2.132 Evidence suggested that key scientific insights and recent salinity research from several disciplines have not been reflected in the design of the NAP.

2.133 Hydrological research has concluded that to effectively manage watertables and contain salinity in most locations throughout Australia requires the establishment of perennial vegetation on at least 50 per cent (and perhaps more) of the landscape.[147] Corroborating this view, the WA SRDTC argued that:

> If our research has shown anything, it is that you have to apply a solution over a large part of the landscape. Applying it to five, 10 or even 20 per cent of the landscape does not have much of an impact. It might buy you a little bit more time, but it does not solve the problem. It just delays the onset of the problem.[148]

That is, the extent of land use change (adoption of perennial plants) needed to contain dryland salinity is much greater than previously believed.

2.134 Social research has determined that large-scale adoption by landholders of new land management systems depends substantially on the financial attractiveness of the proposed farming system—that is, 'farmers require new farming systems to be profitable if they are to be adopted on a large scale.'[149] This point was repeatedly made to the Committee during its inspections.

2.135 Research has also shown that some currently available perennials are economically attractive in some locations, 'but very rarely on a scale that

146 Associate Professor David Pannell, *loc. cit.*

147 *ibid.*, p. 2. Research cited includes: NLWRA, *Australian Dryland Salinity Assessment 2000*, NLWRA, Canberra, 2001; R. George, et. al., 'The effect of recharge management on the extent of dryland salinity, flood risk and biodiversity in Western Australia. Preliminary computer modelling, assessment and financial analysis, unpublished report to State Salinity Council of Western Australia, 1999; T. J. Hatton and R. A. Nulsen, 'Towards achieving functional ecosystem mimicry with respect to water cycling in southern Australian agriculture', *Agroforestry Systems*, vol. 45, 1999, pp. 203-14; M. Stauffacher et. al., 'Assessment of Salinity Management Options for Wanilla, Eyre Peninsula: Groundwater and Crop Water Balance Modelling', Technical Report 1/00, CSIRO Land and Water, BRS, Canberra, 2000.

148 Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 37.

149 CRC PBMDS, *op. cit.*, p. 3.

would be sufficient to fully manage rising watertables.'[150] This partly explains why landholders are not adopting plant-based systems on the required scale to effectively contain salinity.[151]

2.136 With the amount of funding currently available, Professor Pannell concluded that 'comprehensive establishment of perennials on a large scale will not be achieved by the NAP'.[152] The CRC for Plant-Based Management of Dryland Salinity (CRC PBMDS) also concluded that 'NAP funding alone is sufficient to achieve salinity containment in only a small minority of threatened locations.'[153]

2.137 The WA SRDTC stated that:

> We need to make major land use changes over that part of the land where the farmer's income is coming from. To do that you must have a very good farming system, you will have to be credible with those farmers and you have to show that it is an economic solution. Under the National Action Plan, I do not see that we have the ability to develop those broadacre solutions to make a real impact on salinity.[154]

2.138 It was argued that national salinity programs mistakenly presume that economically viable solutions to salinity are already available and that 'it is just a matter of widespread education of landholders and detailed planning of where these "solutions" need to be placed in the landscape.'[155] Similarly, the GRDC argued that '[c]ertainly in the NAPSWQ there seems to be the mistaken assumption that the solutions are known and simply need to be rolled out into the key catchments.'[156]

2.139 DAFF and DEH did indeed express this view, submitting that salinity solutions are generally well researched and that, with the use of salinity mapping technologies, effective interventions to address salinity can now be highly targeted—obviating the need for large scale land use change, at least in eastern Australia. DAFF argued that the key issue remains *where* to make targeted interventions in the landscape:

150 Associate Professor David Pannell, *op. cit.*, p. 2; GRDC, *Exhibit no. 79, Economic Evaluation of Salinity Management Options in Cropping Regions of Australia*.

151 CRC PBMDS, *op. cit.*, pp. 4, 6; CSIRO, *Submission no. 42*, p. 4; NDSP, *Submission no. 35*, p. 9.

152 Associate Professor David Pannell, *loc. cit*.

153 CRC PBMDS, *op. cit.*, p. 4.

154 Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 43.

155 WA SRDTC, *op. cit.*, p. 2.

156 GRDC, *op. cit.*, p. 10.

> In many cases the next step of tools is well researched. There has been a lot of research on different crop types, trees, deep percolation below crops, changes in land practice and all the rest of it. But it has been done in the absence of knowing where to do it. Now we have a much better picture of where to do it, the other science we can bring to bear in a useful way to intervene in relation to salt stores.[157]

2.140 This view was widely disputed. For example, the CRC PBMDS argued that:

> [W]e believe that the existing technology … is not readily available; it is not on the shelf. This is one of the areas where the CRC would probably disagree with the designers of the National Action Plan, who fundamentally believed that the science was in place.[158]

National science investments neglect research into new salinity management methods and technologies

2.141 Several submitters argued that the research findings (summarised in the preceding section), which suggested the need for large scale land use change and broadacre solutions to salinity, highlight the 'outstanding importance of R&D' into new salinity management methods and technologies, including:

- development of new types of perennial plants that are profitable (new trees, shrubs, pastures, crops). A range of these are needed to suit different climates and soil types, so that the total area of perennials is enough to make a difference to salinisation rates;
- development of profitable options for making productive use of salinised land and water; and
- testing and design of engineering methods, including assessment of downstream impacts.[159]

2.142 However, submitters argued that national salinity programs have not adequately supported this R&D activity. For example, the CRC PBMDS argued that 'research of this type has received minimal funding from the Commonwealth's NRM programs … and so far none at all from the NAP',

157 Mr Mike Lee (DAFF), *Transcript of Evidence*, 7 November 2003, p. 62.

158 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 15.

159 Associate Professor David Pannell, *op. cit.*, p. 4. See also: CRC PBMDS, *op. cit.*, pp. 3-4; WA SRDTC, *op. cit.*, pp. 1-2; CSIRO, *op. cit.*, pp. 4, 6; Murray Irrigation Ltd, *op. cit.*, p. 3.

and that this ‘reflects poorly on the capacity of certain Commonwealth agencies to assess the real needs for salinity management.’[160]

2.143 A similar argument was advanced by the WA SRDTC which asserted:

> The current Commonwealth provision of knowledge is focussed on mapping and monitoring groundwater systems and salinity hazards at the expense of … developing new technologies and systems, engineering systems and new industries for saline resources.[161]

2.144 In the priority research areas identified by these submitters, several of the national science agencies, such as the Bureau of Rural Sciences and GeoScience Australia, are said to be inactive.[162] CSIRO also observed that the NAP-related research of these agencies has been poorly coordinated with state and regional activities, and has lacked a strategic framework.[163] For instance, Australian Government involvement in salinity research in Western Australia is said to be limited to programs outside the core national agencies, and only involves the NLWRA, CSIRO, CRCs, and NDSP.[164]

2.145 The WA SRDTC urged a better balance be sought between the capacity building components emphasised in the NAP and NHT, and the development of new land and water use systems as a means of encouraging major actions on private land, and strategic intervention to save high value public and private assets:

> Current programs that deliver neither assistance in the management of specific assets, nor research that delivers more effective management options, are not highly valued. This criticism, unfortunately, applies to a number of the core Commonwealth activities for salinity.[165]

2.146 The Australian Government was encouraged to adequately resource R&D to develop new land and water use systems. For example, the CRC PBMDS stated that the NAP:

> will not succeed in achieving salinity management on a substantial scale unless it is strongly supported by R&D that succeeds in

160 CRC PBMDS, *op. cit.*, p. 4.
161 WA SRDTC, *op. cit.*, p. 5.
162 *ibid.*, p. 6.
163 CSIRO, *op. cit.*, p. 9.
164 WA SRDTC, *op. cit.*, p. 5.
165 *ibid.*, pp. 3-4.

> developing profitable new technologies for salinity management.[166]

2.147 This key contention raises the issue of the adequacy of the salinity science base and the priorities for further salinity research, which the Committee addresses in chapter six.

2.148 Notwithstanding calls from most submitters that further salinity research be undertaken, CSIRO and the NDSP observed that the state of knowledge is sufficient to allow 'instant action to mitigate some problems' and that '[t]here is a considerable body of knowledge in existence that can already contribute to some positive landscape change.'[167]

Implications of region-based planning and delivery of NRM programs

2.149 The establishment of CMOs and regional planning is said to have assisted the integrated management of natural resource issues and, prior to their creation, much of the work that had been undertaken at a regional level was considered 'piecemeal and uncoordinated.'[168]

2.150 The Australian Spatial Information Business Association (ASIBA), observed:

> The catchment is a useful management size that you can work at … catchment management authorities seem to provide a good balance between focus and breadth … In their ability to draw different groups together they provide quite a valuable service. The way of dealing with a catchment based on a water catchment, which tends to lump all the processes together, is quite valuable. Where you have catchment authorities … they are starting to work well in bringing a level of focus and also providing a level of overview.[169]

2.151 However, devolution of planning and delivery of NRM to the regional level has prompted concern on two grounds relevant to the Committee's inquiry, as discussed below.

166 CRC PBMDS, *loc. cit.*

167 CSIRO, *op. cit.*, p. 4; NDSP, *op. cit.*, p. 8.

168 Eyre Peninsula Catchment Water Management Board, *Submission no. 75*, p. 4. Also see: Dr Richard Price (NDSP), *Transcript of Evidence*, 3 November 2003, p. 14.

169 Mr Greg Hoxley (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 14.

Increased complexity and fragmentation of the salinity research effort

2.152 Devolution of NRM to the regional level is said to have introduced additional complexity into the salinity research effort and will impede research into new salinity management systems and technologies.[170]

2.153 The South Australian Government submitted that CMOs, by their nature, are likely be focussed on regional issues and will direct funding towards immediate on-ground works to manage salinity. Accordingly, there will be a tendency to give investment in longer-term R&D a low priority.[171] This has serious implications for generic salinity research that would benefit multiple regions, or that should be undertaken at state and national levels.

2.154 While the potential exists for CMOs to pool funds for larger scale or more basic research, this will be at the expense of on-ground works and is therefore likely to face local resistance.[172] Coordinating research activities to address the needs of multiple CMOs 'has almost no chance of being funded.'[173] CSIRO has indeed found that coordinating regional groups to support strategic research is often difficult and costly.[174]

2.155 In this respect, the CRC PBMDS observed, 'except possibly in South Australia, there appears to be almost no coordination between [CMOs] in terms of research investment priorities.'[175] Again, the reason for this is that:

> The NAP has created community expectations that program funds will be spent exclusively on on-ground works, and [CMOs] are not willing or able to violate these expectations. Even if they were, the NRM regions are not the right scale to determine most funding priorities for salinity science.[176]

2.156 Furthermore, Associate Professor Richard Bell of Murdoch University noted that CMOs 'do not have sufficient funds to carry out … generic broad scale … research'.[177] Some regional bodies themselves have

170 CSIRO, *op. cit.*, p. 1; Natural Resource Intelligence Pty Ltd, *Submission no. 32*, p. 8; Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 55; Associate Professor David Pannell, *op. cit.*, p. 4.

171 Government of South Australia, *Submission no. 81*, p. 5.

172 *ibid.*; Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 18.

173 CRC PBMDS, *op. cit.*, p. 4.

174 CSIRO, *op. cit.*, p. 4.

175 CRC PBMDS, *loc. cit.*

176 *ibid.*, p. 5.

177 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 31.

acknowledged the need for a nationwide approach in coordination and sharing of salinity research.[178]

2.157 The CRC for Landscape Environments and Mineral Exploration (CRC LEME) argued 'the current model of devolution down to the CMAs is not working to best effect. We do not think this is the way to do good science in a timely or cost effective manner'.[179] While devolution to regions has 'some wonderful benefits in some regards … it seems to have stifled scientific cooperation, scientific progress, the generation of new science and … people are doing their own thing in an uncoordinated manner'.[180]

2.158 As an example of the consequences of the 'desire to see more on-ground actions rather than more science', CRC LEME pointed to:

> the profusion of drainage ditch schemes in WA, with the science struggling to keep up with the implications of on-ground actions. Essentially, while the concept of community-driven salinity actions is desirable, the lack of a strategic research capacity is leading to almost no new science at all, and certainly a lack of new science to underpin major public (and private) investments.[181]

2.159 Similarly, the NDSP argued:

> An unintended consequence of the [NAP] has been that it has focussed Australia's limited research resources into regional contexts, resulting in an increased amount of activity at the regional level whilst causing the focus at the national level to be fragmented.[182]

2.160 Professor Pannell concurred and explained that there are a number of 'key aspects of the science that would need to be coordinated and conducted on a state-wide or even national scale.'[183] These include the development of new farming systems that are commercially competitive with existing farming systems, mentioned in the preceding section:

> There will be substantial overlap between the regions in their needs for new systems and technologies … By constraining science to operate in this regional planning environment, we are effectively constraining the NAP investment in science to minimal levels, which is what we are seeing … It seems quite inappropriate

178 Murray Catchment Management Board, *Submission no. 10*, p. 1.

179 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 15.

180 Dr Dennis Gee (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 17.

181 CRC LEME, *op. cit*., p. 3.

182 NDSP, *op. cit*., p. 4.

183 Associate Professor David Pannell, *op. cit*., p. 4.

> that the setting of the level of investment in R&D in this area is left to chance—the actual level is whatever emerges out of funding sources and processes independent of the national salinity program.[184]

2.161 The Australian Conservation Foundation (ACF) submitted that while it believes that there is a role for CMOs to undertake R&D, 'at the moment we do not see that happening at anywhere near the scale at which it needs to happen'.[185]

2.162 Further discussion of salinity research coordination and the Committee's views on this matter are presented in chapter five.

Regional capacity and extension of salinity science

2.163 DAFF argued that the regional planning process, which is intended to be responsive to regional priorities, moves beyond 'older models of providing science to regions which had suppliers of science delivering information to unengaged communities.'[186] However, it was conceded that there are 'some real challenges in equipping regions to be able to manage science and to access science, and in ensuring that the best scientific expertise can work with regions.'[187]

2.164 In particular, evidence suggested that the shift to regional NRM has presented problems for the link between research providers and CMOs, and the transfer of salinity science.

2.165 Due to the large number of CMOs, national science agencies and brokers, CSIRO, LWA and CRC LEME have noted that it is very difficult to maintain a relationship with each CMO, without having research budgets consumed by communications costs. For example, LWA observed that 'it is very difficult for national science agencies to have a relationship with each of the 60-odd regional bodies in Australia.'[188] There is also potential for creating confusion among the CMOs if they are approached by several research providers.[189]

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184 *ibid*.

185 Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, p. 25.

186 Mr Ian Thompson (DAFF), *Transcript of Evidence*, 7 November 2003, p. 53.

187 *ibid*.

188 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26. See also: Dr Mirko Stauffacher, (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 88; CRC LEME, *Submission no. 64*, p. 4.

189 CSIRO, *op. cit*., p. 4.

2.166 For science providers to obtain funding under the NAP, it is necessary for them to invest considerable transaction costs in engaging with each individual region and endeavouring to have that science embedded in regional NRM plans. Professor Pannell argued that this is 'highly inappropriate and inefficient and will result in very patchy application of science across regions.'[190]

2.167 There is great variation across CMOs in terms of resources and their capacity to use and incorporate science into regional plans. Those CMOs that are well funded and have good management structures have formed effective partnerships with CSIRO, state agencies or consulting firms, but this has been done on a case by case basis and does not include CMOs that are less well advanced in their planning.[191] The contrast was drawn between the highly-advanced work of the Goulburn Broken CMA in the Shepparton region of Victoria, which the Committee inspected, and 'other [CMOs] across Australia that do not even have a single member of staff' and are poorly advised.[192]

2.168 CMOs also expressed frustration with the structures and processes to support dissemination of research findings. One NAP regional body made the following observation:

> The onus is on regional bodies to support their activities with sound scientific findings, but the means of accessing those findings is very much at the mercy of personal relationships developed between staff of regional bodies and individuals within research agencies … a more structured approach to the dissemination of information to, and communication with regional bodies will be a critically important element of both research programs and implementation programs.[193]

2.169 GRDC argued that there is, in many regions, a lack of capacity and skills to identify where land use change needs to take place and, specifically, that there is 'an enormous skill shortage of people who understand salt movement, water movement, agronomy and land use change to be able to integrate the processes that need to take place.'[194]

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190 Associate Professor David Pannell, *op. cit.*, p. 3.

191 CRC PBMDS, *op. cit.*, p. 5; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, p. 24.

192 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 7; Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 23.

193 Fitzroy Basin Association, *Submission no. 48*, p. 3.

194 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 71.

2.170 The MDBC suggested that the capacity to understand the science of salinity and its interdisciplinary nature may need to be developed in some CMOs.[195] However, it was observed that building the capacity of CMO staff will take both time and resources, and concerns have been raised that structures are not in place to ensure this will occur.[196]

2.171 Professor Pannell argued that, in developing their regional plans, CMOs are 'constrained from making adequate use of available science and data by the limitations of time and scientific resources that are put at their disposal.'[197] He noted that:

> it is currently easy [for CMOs] to get away with very superficial use of science in the planning process. Given tight timelines, limited resources and limited technical expertise in many cases, such a strategy becomes very attractive to them.[198]

2.172 Similarly, CSIRO found that 'very often the regions are not really in a position even to ask the right questions about what needs to be done and how it needs to be done.'[199] Murdoch University approved of regional devolution, but stated that 'we have significant concerns that these regional groups do not and will not have access to the best science'.[200]

2.173 Murray Irrigation also expressed concern at the paucity of science used in the development of some catchment blueprints and urged that standards be developed for substantiating science, prior to funds being given to catchment funding organisations.[201]

2.174 To address these issues, Professor Pannell recommended that the Australian Government provide:

> guidelines to the NRM bodies making them aware of the scientific realities … spelling out their implications for the broad types of investments that should and should not be undertaken, and enforcing the guidelines through the accreditation process for regional plans.[202]

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195 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 42.

196 See for example: Fitzroy Basin Association, *Submission no. 48*, p. 3; The Murray Catchment Management Board, *Submission no.* 10, p. 1; The Integrated Natural Resource Management Group for the South Australia Murray Darling Basin, *Submission no. 23,* p. 2.

197 Associate Professor David Pannell, *loc. cit*.

198 *ibid*.

199 Dr Mirko Stauffacher (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 84.

200 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 28.

201 Murray Irrigation Ltd, *op. cit.*, p. 3.

202 Associate Professor David Pannell, *loc. cit*.

2.175 He also suggested:

> any devolution to regional bodies of powers to plan public investments in such a complex and difficult issue as salinity would ideally be accompanied by well resourced systems to make the best science available to the NRM bodies, identify and prioritise knowledge gaps and set about filling them.[203]

2.176 Regional planning faces additional complexities in some highly heterogeneous catchments. For example, development of regional plans in Western Australia is made particularly difficult by the distinctiveness of the river systems in that State, as compared to those in the Murray-Darling Basin:

> our river systems really are very different … you can have a surface catchment defining a regional NAP catchment, a very large thing. But they do not flow from one end to the other continuously; they are often disconnected for very long periods of time. The communities in those locales may have very different visions or strategies on how to manage their subcatchment than another part of the same NAP region. In fact some of our NAP regions, including the one that Collie is in, are extremely heterogeneous: there are a number of very distinctive catchments, cultures, groupings of people, industries, within the same one. They do not all flow in and out from one to the other.
>
> This makes regional level decision-making and investment processes a little bit fraught.[204]

2.177 The Committee is concerned that all CMOs have access to, and the capacity to understand, the science of salinity and to incorporate validated research findings into their regional plans. To this end, the Committee believes that CMOs should be adequately supported to use the best available science, and that structured approaches for the dissemination of research findings should be developed. The Committee also considers that CMOs should be made aware of validated salinity research findings and their implications for appropriate regional investments.

2.178 The matters of regional capacity and support for the implementation of salinity programs are further addressed by the Committee in chapter eight of the report.

203 *ibid*.

204 Dr Tom Hatton (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 41.

Recommendation 1

2.179 **The Committee recommends that mechanisms be developed to ensure that validated salinity research findings are considered in regional planning processes, and specifically that Australian Government agencies in cooperation with state and territory governments:**

(a) develop systems to ensure that the best science is made available to state government agencies, catchment management organisations (CMOs) and land managers on an on-going basis;

(b) provide CMOs and land managers with adequate support and resources to use and incorporate science into their regional plans, investment strategies and on-ground works; and

(c) provide guidelines for CMOs and land managers, making them aware of pertinent salinity research findings, detailing their implications for the broad types of investments that may be undertaken, and enforcing the guidelines through the accreditation process for regional plans.

For implementation, this recommendation should be read in conjunction with recommendations 3 and 15.

2.180 The Committee notes that in 2002 the NRMMC agreed to commission annual reviews of the role that science plays in underpinning the NAP and NHT, with particular emphasis on:

- the scientific and technical robustness of NRM program strategies and plans during their implementation; and
- new or emerging scientific advances that may enhance the effectiveness of NRM program implementation.[205]

2.181 In April 2004, the NRMMC noted the first of these reports, prepared by the CSIRO and the Bureau of Meteorology (BOM). The Council agreed that the report's recommendations be considered by the NRM Standing

205 *Scientific Advice on Natural Resource Management: A Report to the Natural Resource Management Ministerial Council by the Commonwealth Scientific and Industrial Research Organisation and the Commonwealth Bureau of Meteorology*, report presented to the NRMMC, Adelaide, February 2004, p. 7. Also see: DAFF and DEH, *op. cit.*, p. 11; The Hon. Stephen Robertson MP (Minister for Natural Resources and Minister for Mines in the Queensland Government), Committee Correspondence, 27 October 2003; Dr John Williams (CSIRO), *Transcript of Evidence,* 7 November 2003, p. 87.

Committee, which will provide a report to the Ministerial Council in due course.[206] The Council noted that the report focuses on 'strengthening knowledge transfer so that the best available science is applied to improving natural resource management through the regional delivery model.'[207]

2.182 The Committee notes that the report's findings mirror many of the issues presented in evidence to the Committee. In particular, the report found that 'the capacity, capability and understanding of how to use scientific information to its best advantage was extremely variable across the catchment management agencies', and that this highlights the importance of strengthening 'knowledge-transfer programs in order to build capacity in the agencies implementing NAP strategies at the regional level.'[208] The report also noted issues associated with the:

- processes to monitor progress towards achieving NRM targets established under the NAP;
- importance of farm economics and profitability in natural resource planning and industry development;
- paucity of good data at the local and regional levels; and
- need for long-term investment in research and development for issues that transcend catchment boundaries.[209]

2.183 Among its other conclusions, the report recommended that the NRMMC task its Science and Information Working Group to review and report on the broader applicability of the recommendations contained in this report.[210]

Conclusions

Salinity programs and strategies

2.184 The Committee welcomes the commitment by the Australian and state governments to address salinity. The NAP involves a funding

206 NRMMC, *NRMMC 6*, Communiqué, Adelaide, 16 April 2004, viewed 17 April 2004, <www.affa.gov.au/ministers/truss/releases/04/nrmmc604.html>.

207 *ibid.*

208 *Scientific Advice on Natural Resource Management, op. cit.*, p. 3.

209 *ibid.*, pp. 3-4.

210 *ibid.*, p. 10.

commitment of $1.4 billion over seven years, which represents a significant increase in aggregate funding for works to address salinity. Along with the NHT, major components of the NAP have been designed around regional level planning and implementation.

2.185 The Committee notes that primary responsibility for NRM rests with the states and several state governments have developed salinity strategies, which are outcome focussed and incorporate salinity research findings. The Committee recognises that urban salinity is an emerging issue for residents in many locations and for local governments.

2.186 The Committee is aware that efforts to address salinity in the Murray-Darling Basin commenced in 1988 with the adoption of the Basin *Salinity and Drainage Strategy*. Over the decade following its adoption, the MDBC invested some $70 million in on-ground works and plans, which were successful in achieving salinity reduction targets. Following dire predictions made in the *Basin Salinity Audit* published in 1999, the Commission released a new *Basin Salinity Management Strategy* for the period to 2015.

2.187 Since 1990, the MDBC has generated a body of knowledge and salinity management tools through its Dryland Program and these have been synthesised into booklets to promote the sharing of information among Basin stakeholders. The Committee welcomes the efforts by the MDBC to fund investment in salinity knowledge generation. The MDBC also draws on the research of national science agencies, including CSIRO, NDSP, NLWRA and the CRC Program.

2.188 The Committee notes that under the BSMS, partner governments have committed to a range of actions, including research and development into new farming and forestry systems.

Responses to the salinity programs

Industry and state agency involvement

2.189 The Committee is concerned at the absence of formal industry involvement in the NAP and regrets tensions that have emerged between some states and national NRM agencies in relation to salinity management. The Committee believes that salinity poses too great a threat for difficulties of this nature to be allowed to persist. The Committee concludes that the NAP-related research activities of national agencies should be better coordinated with state and regional activities.

2.190 Given the apparent importance of land use change in addressing salinity, the formal involvement of primary producers would seem to be vital to the successes of salinity initiatives. The Committee urges that primary producer involvement in the NAP, particularly through the rural research and development corporations, be fostered.

Immediate on-ground works and the need for further research

2.191 The Committee supports the NAP's focus on immediate on-ground actions to address salinity, noting evidence suggesting there is sufficient knowledge to support some positive landscape change.

2.192 However, the Committee is also persuaded that a sufficient number of economically viable solutions to salinity are not yet available. Consequently, the Committee concludes there is a need to support further R&D if salinity is to be addressed at the scales required. The Committee is concerned that the NAP does not have a charter to fund salinity R&D, at least not beyond that required for regional-level implementation, and these matters are addressed further in chapters five and six.

Regional delivery of natural resource management programs

2.193 The Committee was informed that the establishment of CMOs has assisted the integrated management of natural resource degradation issues, ensuring that salinity is not addressed in isolation. The Committee is also aware that many CMOs are currently being established or have not been operating long. However, arrangements for CMOs (for example, their structure and legislative basis) vary considerably across the states. The Committee concludes that, to facilitate delivery of NRM programs, there may be value in establishing all CMOs on a consistent basis, perhaps through the Council of Australian Governments.

2.194 The Committee notes the risks attendant upon the devolution of NRM to regional bodies, particularly for the adequate use of science in regional plans, coordinated research activity and the extension of salinity science.

2.195 While the Committee supports regional-level investment, it notes that there is likely to be a focus on funding immediate on-ground works and a tendency to give investment in longer-term and generic research (that transcends regional boundaries) a low priority. Generic research may be beyond the resources, charter and scale of individual CMOs. Consequently, the Committee is concerned that the regional delivery focus under NRM programs not detract from coordinated research of a type that will benefit multiple regions, and that should properly be conducted at the state or national levels.

2.196 The Committee is concerned at evidence of considerable variation across regions in the uptake of science. The Committee urges that regional planning, investment strategies and on-ground works be informed by the best available science, and recommends that CMOs and land managers be adequately supported to use and incorporate science into their planning and investment activities. The Committee also urges that adequate scientific and technical support be given to those non-NAP regions that are also threatened by salinity. The matters of regional capacity and support for the implementation of salinity programs are addressed further in chapter eight.

2.197 The Committee acknowledges the value of the NRMMC receiving annual external appraisals of the quality of science underpinning the NAP and the status of science in regional planning and delivery.

3

The nature of the salinity problem

3.1 This chapter provides an overview of:

- the nature of the salinity problem (paragraphs 3.2–3.45); and
- alternative scientific perspectives presented in the evidence for the sources of salt, salinity processes, the extent of the salinity problem and the veracity of some public sector research and audits (paragraphs 3.46–3.80).

An overview of the nature of the salinity problem

3.2 The following section summarises the consensus explanation of the salinity problem—salinisation processes, the types of salinity, management options, and the extent, impacts and costs of salinisation. This account of the salinity problem underpins the programs to address salinity which were detailed in the previous chapter.

Salinisation processes, types of salinity and management options

3.3 Salts are naturally present in much of the Australian landscape. While these salts have a number of sources, it is generally held that the primary source comes from historic rainfall or 'cyclic salt'.[1] Salt (sodium chloride) has been carried inland from the sea by wind and deposited in rainfall over the millennia and then accumulated in the regolith, which is 'the soil,

1 Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), *Exhibit no. 128, Salination models*, p. 1. Glenelg Hopkins Catchment Management Authority, *Exhibit no. 20, Salinity Plan: Final Draft*, p. 7: 'Salt is carried inland from the sea by wind and deposited in rainfall. Some rain (containing salt) runs off the land surface, flowing into creeks and eventually back out to sea. For this reason it is often called cyclic salt.'

sediments, and weathered bedrock, that lie between fresh air and fresh bedrock.'[2] A proportion of the salt in the landscape has also resulted from mineral dissolution: that is, where salts present in rocks are released by weathering.

3.4 Salt is distributed widely across the arid and semi-arid landscapes of Australia and is known to be stored in patchy, complex patterns reflecting earlier geological events. Salt stores extend:

> in a huge arc from northern Australia, south by the Great Dividing Range, then broadening and sweeping south-west across the Murray-Darling Basin to take in the Riverina and Mallee regions of NSW, Victoria and South Australia. In Western Australia, massive amounts of salt are stored in an arc that sweeps south and east across the semi-arid and arid landscapes of south-western Australia.[3]

3.5 Naturally occurring salinity, such as coastal marine plains and salt lakes in central Australia, is referred to as *primary salinity* and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) estimates that there are approximately 29 million hectares of naturally saline land in Australia.[4]

3.6 As the continent is very flat, most rivers and groundwater systems are sluggish and have little capacity to drain the continent of salt. In addition, native vegetation has become effective at using Australia's low and highly variable rainfall, resulting in low amounts of runoff to rivers and deep drainage to groundwater.[5]

3.7 Consequently, enormous quantities of salt have accumulated in the Australian landscape over geological time. In Western Australia for example, 'a typical Wheatbelt hectare down to 40 metres contains between 170 and 950 tonnes of stored salt.'[6] Salt levels have been measured at up to 15 000 tonnes per hectare in Western Australia.[7]

3.8 Native vegetation, which in semi-arid areas is dominated by trees or woody shrubs, adapted to Australia's natural conditions. Perennial

2 CRC LEME, *Submission no. 64*, p. 1.

3 Land and Water Australia (LWA), *Exhibit no. 71, Australian Dryland Salinity Assessment 2000*, p. 44.

4 *ibid.*, p. xiv; CSIRO, *Exhibit no. 83, Groundwater Flow Systems Framework*, p. 1.

5 *ibid.* Groundwater is 'all the free water below the earth's surface' or, more precisely, the water in the saturated pores of soil or rock below the watertable.

6 CRC LEME, *Exhibit no. 128, loc. cit.*

7 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111, Salinity: A New Balance*, p. 22.

vegetation, with its relatively deep roots, uses most of the water entering the soil and the ‘leakage’ of water past the root zone into the deeper soil and groundwater is usually minimised. Over time, an equilibrium or balance is achieved where the amount of leakage beneath the root zone is approximately the same as the amount of water that drains or discharges from the landscape.[8]

3.9 Changes in land use since European settlement have significantly altered the hydrology of the Australian landscape. In particular, there has been large scale clearing of native vegetation which has been replaced with shallow-rooted annual crops and pastures. This has substantially increased the amount of water entering groundwater systems:

> These increased amounts of water now entering the groundwater [known as ‘recharge’] under current agricultural production systems greatly exceed the capacity of the groundwater systems to discharge the additional water to the rivers and streams. As the input to the groundwater exceeds the output, the water table [the top of the groundwater layer] must rise. As it rises, more water is discharged to the land surface as seepage surfaces (usually at lower positions in the landscape). Whenever this groundwater contains salt or intercepts salt stored in the landscape, salt is mobilised to these seepage faces, and hence to the lands surface, rivers and streams.[9]

3.10 As saline groundwater evaporates, salt is left, causing land salinisation. The salt can then increase surface water salinity when it is moved by rain into waterways and river systems. Water leaking beyond the root zone may also move laterally through soils and discharge into streams, rather than enter the groundwater.[10]

3.11 Salinity caused by changes to the groundwater balance induced by human activity is referred to as *secondary salinity*. Two main types of secondary salinisation are generally recognised in Australia. The clearing of native vegetation and its replacement with crops and pastures causes *dryland salinity*. In this type, the concentration of soluble salts near the soil surface of non-irrigated lands is sufficient to reduce plant growth and produce other deleterious effects. *Irrigation salinity* occurs when excess surface water is added to the land, thus raising groundwater levels. Irrigation

8 CSIRO, *Exhibit no. 80, Dryland Salinisation: A Challenge for Land and Water Management in the Australian Landscape*, p. 462.

9 CSIRO, *Exhibit no. 82, Effectiveness of Current Farming Systems in the Control of Dryland Salinity*, p. 3.

10 *ibid.*, p. 4.

salinity may also be caused where the irrigation water itself contains high levels of salt.[11]

3.12 The consensus position is that in both types of secondary salinity the fundamental hydrologic process is the same—changing land use (irrigation, land clearing and the replacement of perennial deep-rooted native vegetation with shallow-rooted annual crops and pastures used in agriculture) alters the water balance, allowing excess water to enter the groundwater, thereby mobilising salt, which then rises to the land surface.

3.13 The salinisation process described here is known to operate at a number of different scales in the landscape:

> Salinisation can occur in situations controlled by local processes such as shallow groundwater on a hill slope stretching over less than a kilometre, where seepage zones develop as the slope flattens near the stream. Or salinisation can occur in extensive situations where processes operate over large areas such as regional groundwater basins stretching hundreds of kilometres, where salt emerges on the lower parts of the basin and the floodplains.[12]

3.14 The original cause of the water entering the watertable may therefore be distant from where the effects of salinity appear. Salinity can occur on-site (farm scale), elsewhere in the catchment or outside the catchment (downstream). There may also be long response times in groundwater levels and time lags between the original cause of salinity and the appearance of its effects in the landscape—'often 100 years or more'.[13]

3.15 The original causes of salinisation and its expression in the landscape may therefore be both spatially and temporally distant from each other, which adds considerably to the complexity of the salinity problem, and means that 'salinity is likely to increase even with immediate, widespread action.'[14]

3.16 The National Land and Water Resources Audit's (NLWRA) *Australian Dryland Salinity Assessment 2000* maintains that there are four management options available in addressing salinity:

- prevention, or protecting regions at risk from salinity;

11 LWA, *Exhibit no. 71*, *op. cit.*, p. xiv. A third type of salinity, referred to as urban salinity, results from a combination of dryland salinity processes and over-watering of urban areas.

12 *ibid.*, pp. 45-46.

13 *ibid.*, p. vi.

14 *ibid.*

- treating the causes of salinity by managing the amount of recharge to prevent or reduce the rate of groundwater rise;
- ameliorating symptoms by intercepting and storing salt, and managing saline discharge, adapting to more saline land and water conditions; and
- adaptation, or learning to live with salt, by developing alternative uses of saline land and water resources.[15]

3.17 Due to regional variations in hydrogeology, soil characteristics and climate, the most appropriate salinity management response will vary depending on the landscape characteristics of the particular region. One or a combination of the approaches listed above may be deployed depending on the conditions of the particular region or catchment.

3.18 The most widely promoted management response to salinity is ‘to restore the original water balance (or best approximation) to ensure catchments are not leaking water in ways that mobilise salt’—that is, to reduce recharge into the groundwater.[16]

3.19 Options for the management of recharge include:

- retention of native vegetation;
- growing trees, which have the capacity to use large quantities of water, through evaporation of rainfall intercepted by the tree canopy and through extraction and transpiration of soil moisture (for example, blue gums and oil mallees);
- deep rooted perennial fodder crops, which use more water than annual pastures and lower watertables (for example, lucerne and tagasaste); and
- modified cropping, including raised bed, alley and phase cropping.[17]

3.20 Controlling salinity by reducing recharge is said to require a major shift towards the water balance which exists in native ecosystems. For Dr John Williams, Dr Glen Walker and Dr Tom Hatton from CSIRO:

> The cause of salinity can only be brought under control by the development of new industries and land uses based on deep-rooted perennial plants that are commercial, able to generate attractive farm incomes and control the leakage beneath the root

15 *ibid*., p. 48.

16 CSIRO, *Exhibit no. 80, op. cit*., p. 470.

17 Glenelg Hopkins Catchment Management Authority, *Exhibit no. 20,* op. cit., pp. 11-15.

> zone at levels similar to native vegetation. This is a most demanding task and will require a long-term, well-focused and funded strategy of research and development and on-farm innovation.[18]

3.21 The importance of engineering options as a means to mitigate salinisation is also emphasised by these authors:

> Given the immediacy of salinity risk and the impact of salinity on important built environments (eg. 80 towns) and natural assets (eg. key Ramsar wetlands), no solution involving recharge control will afford timely protection, and Australia will have to look to engineering approaches to protect these assets … large areas that are already affected, such as the regional valley systems in Western Australia, are in such an advanced state of salinisation that no form of recharge control is likely to maintain current farming enterprises.[19]

3.22 Engineering works intercept salt and redirect surface or groundwater. These options include surface, subsurface and deep open drains, and pumping of saline groundwater (for example, into evaporation basins) to lower watertables.[20]

3.23 Options to manage saline discharge, particularly saline land, include:

- saline agronomy, including salt tolerant pasture and fodder crops (for example, tall wheat grass, balansa clover, saltbush and bluebush);
- development of alternative industries, including commercial use of saline water in aquaculture, energy production, mineral harvesting and desalinisation; and
- use of trees around the margins of discharge zones, which can use the groundwater and lower saline watertables.[21]

3.24 It was suggested to the Committee that a 'triage' approach needs to be adopted towards salinity management, involving three overarching objectives of avoidance / prevention, mitigating the symptoms or adapting to live with salinity:

18 CSIRO, *Exhibit no. 80, op. cit.*, p. 470.

19 *ibid.*

20 Glenelg Hopkins Catchment Management Authority, *Exhibit no. 20, Salinity Plan: Final Draft*, pp. 11-15.

21 *ibid.*, p. 17. Also see: Grains Research and Development Corporation (GRDC), *Exhibit no. 79, Economic Evaluation of Salinity Management Options in Cropping Regions of Australia*, pp. 27-45.

> We tend to have introduced, within this ground water flow system concept, a thing called the triage approach. The triage approach … says that there are some places where farmers are going to be able to take action on the salinity problem that they already have and they might be able to fix that problem over a number of years, there are other places where they might be able to take some action now and head off an emerging problem, and there are other systems where the problem is so intractable and has so much momentum that it makes sense to actually live with that problem by finding more salt tolerant farming systems or new saline industries within them. So when it comes to individual farmers that have an emerging problem or an existing problem, it is that level of analysis that we have to go through: in the first instance, is this a problem that can be fixed or is this a problem that we are going to have to live with? That may well govern the decision about whether they go ultimately for a change from annual pastures to lucerne or perennial pastures or something else or whether their best option is to invest in saltbush or something like that.[22]

3.25 During its inspections the Committee observed several of the management options described here being deployed or trialled, either separately or in combination:

- In Western Australia, the Committee observed:
  - ⇒ engineering and vegetation solutions for salinity affecting water supplies in the East Collie catchment, including groundwater pumping at Maxon Farm (depicted in photograph 3.1);[23]
  - ⇒ surface water management, groundwater pumping and remnant vegetation protection at Lake Toolibin;[24]
  - ⇒ farmer-initiated vegetation projects in the Beaufort River flats, including raised-bed cropping and trials of new pastures species;[25]

22 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p.7. Also see: CSIRO, *Submission no. 42*, p. 1; Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, p. 2; Murray-Darling Basin Commission (MDBC), *Submission no. 51*, p. 7.

23 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 93, Collie Salinity Update – November 2003*; *Exhibit no. 95, A Fresh Future for Water: Salinity situation statement for the Collie River Catchment – a summary*, p. 3.

24 Mr Ken Wallace (Western Australian Department of Conservation and Land Management), *Exhibit no. 98, Water balance and salinity trend, Toolibin catchment, Western Australia*; *Exhibit no. 99, The Toolibin Lake Recovery Project*; *Exhibit no. 100, Recovering Lake Toolibin*.

25 Mr Jon Glauert (Western Australian Department of Agriculture), *Exhibit no. 92, NRM on Beaufort Flats, Woodanilling*, pp. 1, 2.

- ⇒ deep open drainage systems being evaluated in Dumbleyung (depicted in photograph 3.2);[26]
- ⇒ groundwater pumping to protect the town of Katanning;
- ⇒ a demonstration plant for the use of mallee eucalypts in the concurrent production of eucalyptus oil, activated carbon and electricity in Narrogin (depicted in photograph 6.1 in chapter six);[27] and
- ⇒ strategies, including surface water and groundwater management, for the protection of the Yenyening Lakes system.[28]

- In Victoria, the Committee observed the Muckatah surface water management system and engineering works to protect Kinnaird's Wetland.
- In New South Wales, the Committee inspected the Wagga Wagga Council's efforts to address urban salinity, including use of a bore field to pump groundwater and targeted revegetation. Outside the town, the Committee observed other works, funded under the NAP and supported by the New South Wales Southern Salt Action Team, in the Kyeamba Valley.[29]

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26 Mr Nick Cox (Western Australian Department of the Environment), *Exhibit no. 96, Dumbleyung Water Management Strategy: Benyon Road Deep Drainage*; Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 97, Dumbleyung Water Management Strategy*. Approximately 10 000 km of drains have been installed in the broad valleys of the Western Australian Wheat Belt over the past 25 years. The major risks of Wheat Belt drainage include: the downstream impacts of the effluent, including on biodiversity; increased acidity; and an increased risk in flood impacts. The Dumbleyung site has been partly funded under the NHT.

27 Mr John Bartle (Western Australian Department of Conservation and Land Management), *Exhibit no. 87, Development of mallee as a large-scale crop for the wheatbelt of WA*, p. 1.

28 Mr Peter Muirden (Western Australian Department of the Environment), *Exhibit no. 102, Yenyening Lakes Management Strategy: 2002 – 2012.*

29 Ms Deb Slinger (New South Wales Department of Agriculture), *Exhibit no. 110, Kyeamba Valley Targeted Salinity and Water Quality Control Program*.

Photograph 3.1 Chair of the Committee, Mr Gary Nairn MP (left), inspecting a groundwater pump at Maxon farm in the East Collie catchment, Western Australia

Photograph 3.2 Deep drainage systems being trialled at Dumbleyung, Western Australia

3.26 In terms of salinity management practices adopted by landholders, the Australian Bureau of Statistics (ABS) *Land Management and Salinity Survey*, conducted in May 2002, found that salinity management actions have been implemented on nearly 30 000 farms. The most common of these are:

- use of salt tolerant crops, pastures and fodder crops (including lucerne and other deep rooted perennial plants), over 3.2 million hectares (on 23 700 farms);
- earthworks (levees, banks, shallow and deep open drains, and subsurface drains) over 208 000 km (19 300 farms);
- trees on 776 000 hectares (11 000 farms); and
- fencing of 466 000 hectares (9 460 farms).

In addition, over 7 000 irrigated farms have made changes to irrigation practices for salinity management purposes.[30]

3.27 Salinity presents a highly complex problem to manage for reasons that include:

- the time it takes to implement the scale of land use changes necessary to alter the water balance;
- in some regions, farmers do not have practical and viable management options; and
- even where management options are implemented, there are time lags before groundwater systems show responses to change, which may be several decades or longer.[31]

The extent, impacts and costs of salinisation

3.28 The *Australian Dryland Salinity Assessment 2000* estimated that 'approximately 5.7 million hectares of Australia's agricultural and pastoral zone have a high potential for developing dryland salinity through shallow watertables' and that unless effective solutions are implemented, this area is predicted to increase to 17 million hectares by 2050.[32] Table 3.1 summarises the Assessment's estimates of dryland salinity potential for each state and territory.

30 ABS, *Salinity on Australian Farms*, cat. no. 4615.0, ABS, Canberra, 2002.

31 LWA, *Exhibit no. 71, op. cit.*, p. 46.

32 *ibid.*, p. 6.

Table 3.1: Areas, measured in hectares (ha), with a high potential to develop dryland salinity in Australia

State/Territory[33]	1998/2000	2050
NSW	181 000	1 300 000
Victoria	670 000	3 110 000
Queensland	not assessed	3 100 000
South Australia	390 000	600 000
Western Australia	4 363 000	8 800 000
Tasmania	54 000	90 000
Total	**5 658 000**	**17 000 000**

Source National Land and Water Resources Audit, *Australian Dryland Salinity Assessment 2000*, NLWRA, Canberra, 2001, p. 6.

3.29 Western Australia has by far the largest area of dryland salinity, with 1.8 million hectares already affected—amounting to over 70 per cent of the nation's currently affected land area of 2.5 million hectares.[34]

3.30 The Western Australian Salinity Research and Development Technical Committee (WA SRDTC) explained that the main reason salinity is such a large problem in Western Australia is that:

> We have large thicknesses of clay based regolith from the weathering of the granites that is able to absorb a lot of the salt coming in rainfall. We have very poor drainage or flushing out of the system, but we also have a very thick layer of clay which is able to accumulate very large quantities of salt.
>
> After clearing, it is that salt which is actually mobilised. One of the reasons why Western Australia has developed a salt problem far earlier than a lot of the other states is that our drainage has been so poor and we have had a long geological history where we could build up such a large, thick, weathered zone. Our environment was just teetering. Some of the valleys were already going saline progressively, when they went in and started clearing. The clearing released a lot of extra water into the system and we have had quite early onsets of salinity.[35]

33 The Northern Territory and the Australian Capital Territory were not included as the dryland salinity problem was considered to be minor.

34 Prime Minister's Science, Engineering and Innovation Council (PMSEIC), *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, Australian Government Department of Education, Science and Training (DEST), Canberra, 1999, p. 6, viewed 22 January 2004, <www.dest.gov.au/science/pmseic/documents/salinity.pdf>.

35 Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 48.

3.31 Increasingly in Western Australia inland forms of acid sulfate soils are occurring in agricultural areas. These acidic soils appear to be forming in response to rising watertables and land salinisation. Draining these soils could potentially cause significant environmental problems.[36] The Western Australian Farmers' Federation submitted:

> Once you start drainage, though, there are areas where you will start to bring in acid water, through iron sulfides in the soil. That is a far greater problem than salinity, but there are solutions ... I think this is where science can play a role.[37]

3.32 In other evidence of the extent of salinisation, the ABS' *Salinity on Australian Farms* report found that:

- 19 500 farms and two million hectares of agricultural land were reported by farmers as showing signs of salinity;
- of the agricultural land showing signs of salinity, 800 000 hectares cannot be used for agricultural production; and
- the state most affected by salinity is Western Australia, with 7 000 farms and 1.2 million hectares showing signs of salinity.[38]

3.33 The major impacts of salinisation include:

- declining river quality and salinisation of previously fresh rivers, which affect the quality of drinking and irrigation water, and damage the habitats of aquatic fauna in wetland, stream and riparian systems;
- the loss of productive land—when groundwaters are close enough to the surface to discharge or concentrate salts, total loss of crop and pasture production follows;
- damage to farm equipment, roads, buildings and other public infrastructure;
- damage to urban infrastructure;
- damage to conservation reserves, bio-biodiversity and remnant vegetation; and

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36 Government of Western Australia (Department of Environmental Protection), *Acid Sulfate Soils in Western Australia*, viewed 11 May 2004, <www.environ.wa.gov.au/article.asp?id=16&catid=69&pubid=2570>.

37 Mr Collin Nicholl (Western Australian Farmers' Federation), *Transcript of Evidence*, 13 November 2003, p. 3.

38 ABS, *op. cit.*, p. 2. The report's findings were based on a sample of 20 000 farm establishments and covered agricultural land only (460 million hectares), representing approximately 60 per cent of land use in Australia.

- increased flood risk.[39]

3.34 The magnitude of the predicted impacts is indicated by the following:

- dryland salinity potentially threatens production from 4.6 million hectares of agricultural land and this is expected to increase to 13.6 million hectares within 50 years;[40]
- some 80 rural towns are currently showing signs of salinity-induced damage;[41]
- approximately 80 important wetlands have been affected or are at risk of salinity across all states;[42]
- in Western Australia, salinity could cause the extinction of 450 species of native flora and reduce fauna species by 30 per cent in affected areas over the next 50 years;[43] and
- with predicted increases in salinity in the River Murray, within 20 years Adelaide's drinking water will fail World Health Organization salinity standards in two days out of five.[44]

3.35 Table 3.2 summarises the nation's assets in areas at high risk of shallow watertables or with a high salinity hazard.

Table 3.2 Summary of assets in areas at high risk from shallow watertables or with a high salinity hazard

Asset	2000	2020	2050
Agricultural land (ha)	4 650 000	6 371 000	13 660 000
Remnant and planted perennial vegetation (ha)	631 000	777 000	2 020 000
Length of streams and lake perimeter (km)	11 800	20 000	41 300
Rail (km)	1 600	2 060	5 100
Roads (km)	19 900	26 600	67 400
Towns (number)	68	125	219
Important wetlands (number)	80	81	130

Source National Land and Water Resources Audit, *Australian Dryland Salinity Assessment 2000*, NLWRA, Canberra, 2001, p. 8 (*Exhibit no. 71*, from *Land and Water Australia*).

39 LWA, *Exhibit no. 71*, *op. cit.*, pp. 8-13; PMSEIC, *op. cit.*, p. 7.
40 LWA, *Exhibit no. 71*, *op. cit.*, p. 11.
41 PMSEIC, *loc. cit.*
42 *ibid.*, p. 7.
43 LWA, *Exhibit no. 71*, *op. cit.*, pp. 13, 38.
44 Council of Australian Governments (COAG), *A National Action Plan for Salinity and Water Quality*, Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), Canberra, 2000, p. 5.

3.36 The Committee observed first-hand the impacts of salinity during its inspections in New South Wales and Victoria, but particularly in the Western Australian Wheat Belt. The Committee witnessed the devastation of former fresh water lakes and vast tracts of farming land.

3.37 The effect of salinity in urban areas was just as striking. The Committee observed saline groundwater filling the basement of a business in the centre of the Katanning township, despite groundwater pumping, and the destruction wreaked by salt on private dwellings and public infrastructure.

3.38 Innovative actions had been taken in an attempt to save Katanning's infrastructure, including raising the level of the town's oval and pumping saline groundwater away from key areas. The Committee heard about the efforts of CSIRO, in partnership with the Western Australian Department of Agriculture, to establish Katanning as a demonstration town for interventions to address rural town salinity. There are proposals to trial desalinisation technologies and, potentially, save the cost of having to pipe fresh water to Katanning and other Wheat Belt towns.

3.39 The Committee also observed clear evidence of the damage caused by rising saline groundwater to buildings in Wagga Wagga, including 'tide marks' from rising damp, salt efflorescence (white staining) and the breakdown of mortar and brickwork caused by the growth of salt crystals. These effects are illustrated in photograph 3.4.

Photograph 3.4 Members of the Committee inspecting urban salinity damage in Wagga Wagga

3.40 The costs attributable to salinity are difficult to estimate and to separate from costs attributable to other forms of natural resource degradation. Nonetheless, salinity costs are considered to be substantial. The Prime Minister's Science, Engineering and Innovation Council report, *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, estimated that the capital value of land lost to salinity is approximately $700 million, and the value of lost production is $130 million per year, and increasing.[45]

3.41 The Murray-Darling Basin Commission has estimated that the cost of dryland salinity in eight tributary valleys of the Basin is approximately $247 million per year and the cost to consumptive users of River Murray water totals $47 million per year.[46]

3.42 The NLWRA estimated that the total annual costs of dryland salinity in Western Australia is $664 million per year.[47] The loss in profits for the agricultural sector in Western Australia has been estimated at between $80 and $260 million per year.[48]

3.43 Significant costs are imposed on local governments and residents of affected towns. In Wagga Wagga, the Council reported that if nothing were done to address urban salinity, the damage to infrastructure in Wagga alone would be in the order of $180 million over 30 years, with some residents already spending '$10 000 to $20 000 on repair work' for their homes.[49]

3.44 Other evidence suggested while salinity is costly, it is not the most costly resource degradation issue confronting the nation.[50]

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45 PMSEIC, *op. cit.*, p. 5.

46 MDBC, *Exhibit no. 37*, *Basin Salinity Management Strategy 2001-2015*, p. 1.

47 LWA, *Exhibit no. 71*, p. 38.

48 Joint statement by the Western Australian Minister for the Environment, The Hon. Dr Judy Edwards MLA and the Western Australian Minister for Agriculture, Forestry and Fisheries, The Hon. Kim Chance MLC, 'Half a million dollars for Wheatbelt salinity options', issued 21 March 2004. Media statement available online, viewed 15 April 2004, <www.ministers.wa.gov.au / main.cfm?MinId=07&Section=0051>.

49 Mr Bryan Short (Wagga Wagga City Council), *Transcript of Evidence*, 30 October 2003, pp. 28, 23.

50 Mr John Ive, *Exhibit no. 124, Managing Dryland Salinity: From paddock to web*, p. 5. Citing a report prepared for the National Farmers' Federation and the Australian Conservation Foundation in 2000, Mr Ive stated that dryland salinity ranks fourth in terms of the relative costs of different forms of natural resource degradation. The cost of dryland salinity was estimated at $2250 per year for every agricultural holding in Australia, behind (1) environmental decline at $4800, (2) water quality at $3600 and (3) acid soils at $2400. However, the cost of irrigation salinity was ranked separately, in seventh place, at $520 per year for each agricultural holding in Australia. Combined, irrigation and dryland salinity would rank as the third most costly form of resource degradation by this estimate.

3.45 The explanation of the sources of salt (principally sodium chloride from historic rainfall—'cyclic salt') and the basic salinisation process (rising watertables due to water imbalance in a catchment) summarised above have been embraced in state and Australian government strategies to address salinity. For example, information associated with the NAP explains that the accumulation of salt has largely originated from oceanic salt deposited in rainfall, and that 'salinity increases are usually caused by a rise in the level of underground water-tables bringing naturally occurring salt to the surface.'[51]

Alternative scientific perspectives

3.46 The overview presented in the previous section summarises the conventional explanation of the salinity problem. Submitters stated that 'there is little dispute over the causes of dryland salinity', that 'our conceptual understanding of salinisation processes is good' and that 'we know enough about salinity's causes and effects to commence some action now.'[52] However, some evidence provided alternative perspectives on:

- the sources of salt in the landscape;
- salinisation processes; and
- the extent of the salinity problem and the veracity of some public science.

The sources of salt in the landscape

3.47 Associate Professor Robert Creelman and Dr Jerzy Jankowski submitted that there ought to be more comprehensive research into the sources of

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51 DAFF and DEH, *Australia's Salinity Problem*, Commonwealth of Australia, Canberra, 2001, p. 1, viewed 4 march 2004, <www.napswq.gov.au/publications/factsheets/salinity.html>; DAFF and DEH, *Putting Salinity on the Map*, Commonwealth of Australia, Canberra, 2001, p. 2, viewed 4 march 2004, <www.napswq.gov.au/publications/pubs/put-sal-map.pdf>.
Also see state strategies, for example:
New South Wales Department of Land and Water Conservation, *Taking on the Challenge: NSW Salinity Strategy*, Government of New South Wales, Sydney, 2000, p. 10, viewed 4 March 2004, <www.dlwc.nsw.gov.au/care/salinity/pdf/all_about_salinity.pdf>;
Western Australian State Salinity Council, *The Salinity Strategy*, Government of Western Australia, Perth, 2000, p. 14, viewed 28 January 2004, <www.salinity.org.au/management/pdfs/salinity-strategy.pdf>;
Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, Government of South Australia, Adelaide, 2001, p. 7, viewed 23 February 2004, <www.saltcontrolsa.com/pdfs/sadss_72.pdf>.

52 GRDC, *Submission no. 29*, p. 2; CSIRO, *Submission no. 42*, p. 1; WA SRDTC, *Submission no. 54*, p. 1. See also: Centre for Salinity Assessment and Management (CSAM), *Submission no. 19*, p. 3.

salt, the origins of salinity and the mechanisms responsible for the development of saline groundwaters.[53] It was argued that:

> The causes of salinity are complex, and although the rising water table model may be the answer in certain areas, and the source of the salt cyclical salts, these ideas are not universally applicable.[54]

3.48 In particular, Associate Professor Creelman suggested that the dominant model has neglected 'the role of rock weathering and the complexities of water-rock interaction—hydrogeochemistry'.[55] For example, it was argued that:

> the efflorescent salts seen on the ground surface in dryland salinity sites are not only sodium chloride (NaCl), but sodium-bicarbonate, magnesium-sulphate, calcium-sulphate and very complex salts … The undue emphasis and assumption that all white efflorescence is NaCl, and all saline groundwaters are sodium-chloride rich, is misleading. Cyclical salts cannot explain why some waters are magnesium rich, in fact magnesium dominated; this is the product of water-rock interaction and rock weathering.[56]

3.49 The contrary position was argued by the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), which maintained that while 'it is true that salt can have a number of primary sources … historic rainfall is the overwhelming contributor.'[57] However, Associate Professor Creelman conceded that the dominant model is appropriate in Western Australia, but stated that '[i]n south-eastern Australia is it is another story altogether.'[58]

3.50 Identifying the source of the salt is said to be important because misinterpreting the salt source could lead to the incorrect selection of management options:

> [T]he management options being applied … are simplistic. They are simplistic because there is an undue emphasis in Australia on the role of cyclical salts as the source of all salinity. This has

53 Associate Professor Robert Creelman and Dr Jerzy Jankowski, *Exhibit no. 19*, *Review of the Science of Salinity – It's Time*, p. 1.

54 Associate Professor Robert Creelman, *Submission no. 16*, p. 2.

55 *ibid*.

56 Associate Professor Robert Creelman and Dr Jerzy Jankowski, *Exhibit no. 19*, *op. cit.* pp. 3-4.

57 CRC LEME, *Exhibit no. 128*, *op. cit*., p. 3.

58 Associate Professor Robert Creelman, *Transcript of Evidence*, 29 October 2003, p. 28.

> probably come about because there are insufficient players in the scientific debate.[59]

A consequence of this perspective is said to be that, in some cases, 'salinity may not be related to water table changes'.[60]

3.51 Similarly, Dr Jerzy Jankowski argued that:

> If we understand the source [of the salt], we will also understand the origin of the salinity, and the solution to the problem and management of options will be much better.[61]

3.52 Moreover, Associate Professor Creelman asserted that the scientific community is now 'steadily entrenching itself in what are warring camps', essentially between '[t]hose who adhere to orthodox models of water table rises, aeolian [salt in dust carried by the wind] and other cyclic salts—the surficial camp' and '[t]hose who contend that salt has many inputs, including connate salt (salt in ancient sediments) and salt from rock weathering—the whole earth camp.'[62]

3.53 To address these issues, it was recommended that:

- academic debate be widened to incorporate the contributions of all relevant disciplines, particularly geology, geochemistry and hydrogeochemistry, and a proposal for a conference involving all fields of science was supported;[63]
- greater collaboration and sharing of information between scientists and between research organisations, including smaller research groups, be encouraged;[64]
- greater support be given to basic research into the source(s) of salt and the origins of salinity;[65] and
- funding for basic salinity science be broadened through the establishment of a specific Australian Salinity Research Program, modelled on the Australian Research Council, industry based granting

59 Associate Professor Robert Creelman and Dr Jerzy Jankowski, *Exhibit no. 19, op. cit.* pp. 1-2.

60 *ibid.*, p. 3.

61 Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, pp. 34-35; Dr Jerzy Jankowski, *Submission no. 60,* p. 2.

62 Associate Professor Robert Creelman, *Submission no. 16*, pp. 2-3.

63 *ibid.*, p. 2; Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, p. 37.

64 Dr Jerzy Jankowski, *Submission no. 60,* p. 3.

65 *ibid.*, pp. 2-3.

groups such as the Australian Coal Association Research Program, or a special Cooperative Research Centre.[66]

Salinisation processes

3.54 In contrast to the conventional explanation of the principle salinisation process (the hydrologic imbalance or 'rising groundwater' model), two submitters proposed an alternative mechanism based exclusively on increased lateral flows of water through the soil, caused by land use impacts that degrade soil structure.

3.55 Natural Resource Intelligence (NRI) disputed the conventional rising groundwater explanation of the salinisation process. Four reasons were posited for the alleged failure to identify the correct salinisation mechanism:

> One issue relates to the inability to directly measure the factor deemed responsible, namely the rate of recharge (percolation) to groundwater systems. Another relates to very limited knowledge of the functioning of natural systems and a third to the definition of groundwater. The fourth is the limited attention paid to the effects of land use impacts on soils and the consequences of these impacts for the hydrology of systems.[67]

3.56 As an alternative explanation of the cause of dryland salinity, NRI proposed that:

> salinity is generally associated with a decline in soil structure that is largely caused by a decline in soil organic matter. The decline in soil structure increases the near surface lateral flow of water in the soil, and also increases the salinity of the water moving through the soil. Adverse salinity arises where this water accumulates at lower parts of the landscape and is concentrated through evaporation.[68]

3.57 In this model, tree clearing may exacerbate salinity but it is not the cause. Rather, 'rising groundwater levels and adverse salinity are symptoms of land degradation', which may be caused by other land use impacts such as grazing.[69]

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66 Associate Professor Robert Creelman, *Submission no. 16*, p. 3; *Transcript of Evidence*, 29 October 2003, p. 32; and Dr Jerzy Jankowski, *Submission no. 60*, p. 2.

67 NRI, *Submission no. 32*, p. 4.

68 *ibid.*, p. 5; Mr Brian Tunstall, (NRI), E*xhibit no. 23, Scenario for Dryland Salinity*.

69 *ibid.*

3.58 Similarly, Orbtek submitted that the traditional 'groundwater rising model is fundamentally flawed, unscientific and inappropriate in developing land use management options.'[70] It was claimed that 'salinity is a minor symptom of a much larger land use and soil health issue' and asserted that salinity is 'clearly an outcome of increased lateral flows … due to land use impacts that degrade soil structure, eg. loss of organic matter in the case of dryland salinity.'[71]

3.59 Salinity is therefore said to be caused by soil degradation 'primarily due to unsustainable land use practices rather than from land clearing per se'.[72] As argued by NRI, the underlying salinisation mechanism is said to be a decline in soil structure:

> This change in soil health decreases deep percolation of water and increases lateral flows of water through preferred pathways of geological fractures and old / ancient prior stream systems.[73]

3.60 Using gamma-ray mapping technology, Orbtek found there was 'no evidence to support the groundwater rising model as it failed on all mapping applications and the only model that stood any test was a lateral flow model.'[74] Specifically, Orbtek claimed its mapping technology determined that, along salt pathways:

> Lateral flows can concentrate and saturate areas with salt and water and this process is often perceived as groundwater rising in these areas.[75]

3.61 The implications of these conclusions are said to be significant: 'The traditional solutions of treating salinity with groundwater management and engineering actions are fundamentally flawed.'[76]

3.62 Consequently, NRI recommended that programs be directed towards addressing the 'degradation of soil structure initially associated with a decline in organic matter', and hence at remediation of the soil structure.[77] Similarly, Orbtek concluded that salinity should be addressed, in part, by 'restoration of soil structure decline through the retention and recycling of

70 Orbtek Pty Ltd, *Submission no. 3*, p. 1.
71 *ibid.*, pp. 2, 8.
72 *ibid.*, p. 2.
73 *ibid.*
74 *ibid.*, p. 8.
75 *ibid.*, p. 2.
76 *ibid.*, p. 8.
77 NRI, *Submission no. 32*, p. 5.

organic matter in agricultural lands', and 'better understanding of the location, function and status of salt pathways.'[78]

3.63 More generally, NRI also recommended that salinity 'program structures should not be rigidly based on uncertain assumptions' and allow for 'independent assessment on the ground to develop approaches and methods that effectively address the specific local circumstances.'[79]

3.64 The Committee notes that debates on precisely this theme of alternative salinisation models have occurred on SALTLIST, an email-based forum hosted by the *National Dryland Salinity Program*, most recently during January and February 2004. The participants in this discussion included those proposing the lateral flow / soil processes model as an alternative to the commonly accepted model of rising groundwater. The debate underscored the complexity of salinisation processes, but some agreement was reached around the proposition that the rising groundwater model is not the only process that can lead to salinisation.[80] Nonetheless, CSIRO disputed the soils model as a salinisation process.[81]

3.65 While the Committee is not in a position to adjudicate between salinisation models, it notes that if alternative models of salinisation processes are valid, these may have implications for salinity management practices.

3.66 The Committee is concerned that those contributing to the scientific understanding of basic salinity processes have adequate opportunity for their perspectives to be presented and examined appropriately. Given the impacts and costs of salinisation, the nation cannot afford inter and intra disciplinary debates that degenerate into 'warring camps'. The Committee believes that further research must cover the differing views and techniques, and analyses should include a certain element of on-ground verification and testing.

3.67 The Committee acknowledges that a situation of perfect knowledge about underlying processes in all catchments is unlikely to ever be achieved, and therefore urges that salinity programs have a sensitivity to the regional variation in salinisation processes.

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78 Orbtek Pty Ltd, *Submission no. 3*, p. 8.

79 NRI, *Submission no. 32*, pp. 2, 6.

80 Mr Paul Raper (SALTLIST), email posting, 2 February 2004, <Bruce@clearconnections.com.au>.

81 Dr Mirko Stauffacher and Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, pp. 91-92.

The extent of the salinity problem and the veracity of some public sector research

3.68 Some submitters questioned the accuracy of research by some public sector research agencies and national audits relating to the current extent and predicted increases of salinity.[82]

3.69 The Institute of Public Affairs (IPA) disputed claims, said to have been made by CSIRO, that salinity is increasing in the Murray River. Drawing on data requested from the MDBC, the IPA found that average salinity levels in the Murray at Morgan have been dropping over the last 20 years and that water quality is improving. The MDBC concurred with these findings.[83]

3.70 It was also argued that the *Australian Dryland Salinity Assessment 2000* 'does not distinguish between current and predicted salinity problems' and does not give an indication of the current extent of salinity:

> When we are told water quality is deteriorating and dryland salinity is a worsening problem we should be provided with basic trend lines that give us a clear indication of the current and recent past situation. Indeed it is imperative that we have an indication of current trends. How else are we to understand whether or not our investment in salinity mitigation works over the last two decades have been effective?[84]

3.71 The IPA argued that the reason public sector science agencies misrepresent available information is to 'maintain the illusion of a crisis', notwithstanding evidence to the contrary, so that they can maintain their funding base and control the research agenda.[85]

3.72 Murray Irrigation also questioned the involvement of CSIRO in the Wentworth Group and urged that 'researchers need to maintain their

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82 The Committee notes that related issues were raised in the interim report of the House of Representatives Standing Committee on Agriculture, Fisheries and Forestry's inquiry into *Future Water Supplies for Australia's Rural Industries and Communities*. The report noted evidence which questioned the science underpinning the Living Murray initiative. It recommended that a comprehensive program of data collection and monitoring be completed and an audit of the Murray-Darling Basin's water resources be conducted, prior to authorisation for increased flows to the River Murray. The report is available at the Committee's web site, viewed 12 April 2004, <www.aph.gov.au/house/committee/primind/wateringq/interimrpt/wireport.pdf>.

83 IPA, *Submission no. 41*, pp. 4-5.

84 *ibid.*, pp. 1, 2.

85 *ibid.*, p. 1.

integrity by remaining apolitical' so that 'community confidence in the independence and professionalism of the organisation' is maintained.[86]

3.73 Similarly, Orbtek argued that:

> environmental decline predicted from some saline areas has never eventuated. For example, the Jemalong / Wyldes Plains area was predicted by CSIRO scientists in 1993 to have significant salinity degradation increases by 2020, but in 2003 there is little or no sign of further degradation. During the past 15 years salinity has been promoted as the worst environmental problem facing Australia, but this message has been a monumental beat-up by public scientists with a vested interest in access to public funds for research.[87]

3.74 In order to remove the alleged control over public funds for salinity research from 'public scientists and bureaucrats', Orbtek recommended encouraging greater industry involvement in salinity science. However, Orbtek also argued that new science in industry should not necessarily be subject to peer review by public scientists prior to application for participation in publicly funded programs.[88]

3.75 The IPA urged that public research agencies make basic information on the current extent and trends with respect to dryland and river salinity readily available, and recommended that there be greater reliance on measured statistics:

> [F]actual information needs to be based on measured statistics rather than computer generated predictions from simulation or decision support models. Information from models is useful, but must complement rather than replace measured statistics.[89]

3.76 The Chinchilla Shire Council also questioned the accuracy of salinity hazard maps, particularly of the Condamine Catchment in which the Shire is located. The Council argued that only small, localised outbreaks of salinity have been observed, contrary to the salinity maps which portray a high salinity hazard over much of the land. The Council concluded that:

> the research to date and the scientific knowledge being applied to the subject is not adequate to determine the significance of the

86 Murray Irrigation Ltd., *Submission no. 27*, p. 5.
87 Orbtek Pty Ltd, *Submission no. 3*, pp. 1-2.
88 *ibid.*, pp. 1, 13.
89 IPA, *op. cit.*, p. 2.

> salinity problem and/or is incorrectly being applied to promote solutions which do not have scientific backing.[90]

3.77 The Council insisted that the outbreaks in the Catchment require local solutions (such as planting lucerne or groundwater pumping), rather than the imposition of tree clearing limits.[91]

3.78 In a related argument, Mr Rex Wagner rejected the claim that salinisation may be driven by rising regional groundwater systems and argued that the projected spread of dryland salinity is not occurring. Instead, he argued that 'much past and current research supports' a localised model of salinisation:

> Salinisation is localised, restricted to particular soils and landforms, restricted in its spread, episodic in its development, and responsive to mitigation measures within its own local catchment or recharge area.[92]

3.79 CSIRO has readily conceded that small scale salinisation processes occur which do not fit easily into catchment-wide models.[93]

3.80 Again, the Committee does not propose to definitively adjudicate on these debates, but notes the concerns of submitters that statements by research agencies and audits of the extent and trends in salinisation be objective and as accurate as possible. There is a need to guard against fostering a sense of crisis where this is not warranted. This issue also points to the adequacy of the science base and the management of data, which are addressed in chapters six and seven respectively.

Conclusions

The nature of the salinity problem and alternative scientific perspectives

3.81 The Committee concludes that a consensus explanation of the salinity problem has developed which explains secondary, or human-induced, salinity as having resulted from changes to the hydrology of the Australian landscape caused by changed land use following European

90 Chinchilla Shire Council, *Submission no. 47*, p. 2.
91 *ibid.*, p. 8.
92 Mr Rex Wagner, *Submission no. 7*, p. 1.
93 Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 94.

settlement. In this model, land clearing and the use of shallow-rooted annual crops and pastures alters the water balance in catchments, allowing excess water to enter the groundwater, thereby mobilising salt, which then rises to the land surface.[94]

3.82 The Committee is profoundly concerned that while the precise extent of salinisation is unclear, 5.7 million hectares of agricultural and pastoral land are currently estimated to have a high potential for developing salinity. Landholders have observed that two million hectares of agricultural land are currently showing signs of salinity. More than 70 per cent of the nation's salinity problem occurs in one state—Western Australia.

3.83 The current and predicted impact of salinity on infrastructure, water quality, productive land, bio-diversity, remnant vegetation and conservation reserves is significant. The costs imposed on landholders, governments and residents of rural towns are considerable.

3.84 The Committee recognises that salinity presents a highly complex problem to address, and that its management may require a triage approach based on three overarching objectives of:

- avoidance / prevention;
- mitigating symptoms; and
- adapting to live with salinity.

3.85 The consensus explanation of the basic salinisation process and sources of salt (considered to be predominantly cyclic salt) have been criticised and alternative models proposed. Concerns have also been raised about the paucity of basic information on the current extent and trends with respect to salinity. The veracity of some statements issued by national science agencies and programs have been questioned.

3.86 Although the Committee does not wish to definitively adjudicate on these debates, it urges that all contributors to the scientific understanding of basic salinity processes and the sources of salt have adequate opportunity for their perspectives to be presented and examined, and that scientific disciplines addressing salinity not degenerate into 'warring camps'.

94 Dr Mirko Stauffacher (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 91.

4

The salinity science base

4.1 This chapter presents an overview of the agencies and programs whose research efforts constitute the 'science base and research data' to address salinity. The chapter also summarises key research findings and products of these initiatives presented in evidence to the Committee.

4.2 The chapter is comprised of three sections:

- the work of national research agencies and programs contributing to the salinity science base (paragraphs 4.3-4.91);
- the private sector contribution to salinity science and technologies (paragraphs 4.92-4.94); and
- the recommendation for an audit of the Australian Government investment in salinity research (paragraphs 4.95-4.98).

National research agencies and programs

4.3 Drawing primarily on the evidence presented to the Committee, the following section summarises the contribution to the salinity science base provided by national research agencies and programs. The overview is not exhaustive of the research that has been undertaken, but presents a number of principal research findings and products.

4.4 Commenting on the National Land and Water Resources Audit (NLWRA), the *National Dryland Salinity Program*, and the Cooperative Research Centre Program, the Murray-Darling Basin Commission (MDBC) argued:

> Each of these initiatives have contributed significantly to salinity management through broad ranging research across environmental, engineering, social and economic domains;

provision of data and information; and developing predictive modelling capacity.[1]

4.5 The Australian Government funded research agencies and initiatives which contribute to the science base for salinity management include the:

- Bureau of Rural Sciences and Australian Bureau of Agricultural and Resource Economics;
- national science agencies—Commonwealth Scientific and Industrial Research Organisation, and the Australian Nuclear Science and Technology Organisation, among others;
- Cooperative Research Centres Program;
- Research and Development Corporations;
- National Dryland Salinity Program;
- National Land and Water Resources Audit; and
- university research.

Bureau of Rural Sciences and the Australian Bureau of Agricultural and Resource Economics

4.6 The Bureau of Rural Sciences and the Australian Bureau of Agricultural and Resource Economics, agencies located within the Australian Government's Agriculture, Fisheries and Forestry portfolio, 'undertake biophysical, social and economic science assessments to inform the Australian Government with evidence to guide policy development.'[2]

Bureau of Rural Sciences

4.7 A substantial component of the work of the Bureau of Rural Sciences (BRS) involves developing and applying advanced techniques to map salt and hydrogeological assessments to translate salt distribution into an understanding of salinity risk at the landscape scale. The Bureau argued that the mapping makes it possible to consider the range of viable actions needed to address the causes of salinity problems. Issues associated with salinity mapping are addressed in chapter seven. The BRS also conducts

1 MDBC, *Submission no. 51*, p. 8.

2 Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), *Submission no. 72*, p. 6.

research into the factors that influence people to act and manage natural resources.[3]

4.8 The BRS conducts three programs which contribute to the science base for salinity:

- **Integrated Water Sciences Program**
  The Water Sciences Program provides scientific assessments of landscape processes, function and characteristics to inform investments of the *National Action Plan for Salinity and Water Quality* (NAP), *Natural Heritage Trust* (NHT) and the *National Landcare Program* (NLP). The Program has developed the application of airborne geophysics, integrated with hydrogeological assessments, field measurements and land use information, to map and predict salinity.

- **Landscape Sciences Program**
  The Landscape Sciences Program provides scientific advice on land use and land management issues. The Program produces spatial models of natural resource processes (eg. the impact of land clearing), applies advanced remote sensing (including satellite and radar imagery) to analyse agricultural landscapes and predicts the consequences of land use and management change.

  The Program coordinates continent-wide coverage with regional and catchment-scale digital land use data sets which provide a basis to develop cost-effective natural resource management (NRM) options. In cooperation with state agencies, the BRS has now achieved 80 per cent coverage of Australia with catchment-scale land use mapping. The Bureau anticipates that mapping of the entire continent will be completed by 2005–06.[4]

  The catchment scale land use maps are said to have wide ranging application because the data has been put together in a way that meets the requirements of national, state and regional users. For example, at the national level the maps help target investments and to monitor the effectiveness of programs such as the NHT and NAP. At the regional level, land use maps are used as an input to salinity modelling and planning. At the farm level, the maps assist landholders to understand how their farm is placed in a catchment context.

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3 *ibid.*

4 DAFF and DEH, *Exhibit no. 66, Land use mapping at catchment scale,* pp. 1-4. As examples of mapping scales, 1:25 000 means that 1cm on the map equals 250m on the ground; 1:250 000 scale means that 1cm equals 2.5km; and 1:2 500 000 scale means that 1cm equals 25km on the ground.

The BRS is the lead agency in the development of nationally consistent land use mapping. This includes a nationally agreed land use classification scheme, Australian Land Use and Management Classification, and other agreed procedures for dealing with coding and attribution, data structure, spatial referencing and accuracy.

BRS has produced a *Land Use Mapping at Catchment Scale* document to assist regional planners. A CD-ROM is also available to explain access to the land use data, with digital samples of the mapping, coverage and technical support information.[5]

- **Social Sciences Program**
  This Program involves work with regional catchment groups to assess landholder understanding and responses to dryland salinity. The Program uses surveys to provide information on landholder awareness of salinity and its processes, information about landholders' confidence in the science and practices currently recommended to address salinity, and data on their adoption of such practices. The BRS survey findings are provided to CMOs to assist them identify priority issues, particularly regarding effective communication with landholders.

Australian Bureau of Agricultural and Resource Economics

4.9 The Australian Bureau of Agricultural and Resource Economics (ABARE) provides information on economic aspects of NRM, including salinity control options, and this research is being used in the development of regional plans under the NAP.

4.10 In 2001–02, ABARE surveyed 75 per cent of broadacre and dairy farm businesses, which accounts for 98 per cent of Australia's agricultural production. The survey sought to investigate awareness of land degradation issues and the influences on management practices, including participation in national NRM programs. The survey found that landholders who participate in NRM initiatives were more likely than non-participants to have undertaken training, and more likely to have a farm plan which contained information about salinity management. Farmers identified a range of benefits from participation in national NRM programs including on-ground works, skills and information, improved community interaction and a better understanding of land degradation issues.[6]

5 DAFF and DEH, *Submission 72*, pp. 15-16.

6 *ibid.*, pp. 16-17.

4.11 ABARE has also developed a Salinity and Land Use Simulation Analysis (SALSA) model to integrate catchment scale hydrological and hydrogeological relationships with an economic model of land use. For example, SALSA was applied to analyse the implications of saline irrigation supplies in the Murray-Darling Basin for grape yields and producer returns in the viticulture industry.[7]

4.12 Support has been provided through the NAP for several projects aimed at developing tools and technologies to assist salinity management. These projects include:

- **A review of salinity mapping methods**
  In 2003 a project was endorsed by the NRM Standing Committee (NRMSC) to review salinity mapping methods in the Australian context. The review was prompted by the confusion created by salinity hazard and risk maps generated by different mapping methods to serve different purposes.

  The review has evaluated the range of methods available in Australia for mapping the extent and severity of salinity in Australian landscapes. It provides an assessment of the value and reliability of salinity mapping methods, so investors can be confident about their options and the products they purchase. The products of the review include a technical report and user guide aimed to assist landholders, sub-catchment groups and CMOs. These documents are available on the internet.[8] It is expected that not all sectors will necessarily accept all the findings of the review.

- **Guidelines for best practice in the public presentation of salinity data and mapping products**
  Through the Science and Information Working Group of the NRMSC, the Australian Government has developed nationally agreed *Guidelines for Best Practice in the Public Presentation of Salinity Data and Mapping Products*. The Guidelines aim to minimise the negative consequences from the public release of salinity and other NRM data and interpreted products.[9]

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7 *ibid.*, p. 17.

8 The Technical Report and User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, <www.ndsp.gov.au/80_airborne/airborne.htm>. Transcripts of the public forum convened by the Australian Academy of Science and the Academy of Technological Sciences and Engineering on 17 October 2003, to receive and critique the draft review products are available online, viewed 5 February 2004, <www.science.org.au/proceedings/salinity/index.htm>.

9 DAFF and DEH, *Submission 72*, pp. 18-19.

- **Stocktake of salinity tools and technologies**
  A national investment project of the NAP has collated information about each of the salinity models supported by government agencies and private industry into a single compendium, the Practical Index of Salinity Models (PRISM). PRISM provides information on over 90 tools, models and frameworks that can assist NRM planning at the regional scale. The resources of PRISM are presented in an Microsoft Access database or Excel spreadsheet format. The accompanying PRISM User's Guide describes the tools, models and frameworks and how these can be applied to assist the regional planning process. PRISM is provided on a CD-ROM and is available from Land and Water Australia.[10]

- **Review of desalination technologies**
  Reports have been produced which compile information about available desalination technologies and their potential to provide a cost-effective salinity and water quality management tool, particularly in NAP regions.[11]

National science agencies

Commonwealth Scientific and Industrial Research Organisation

4.13 Over the past 30 years the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has been involved in a wide range of salinity related research, including:

- catchment studies that provided a conceptual framework for understanding salinisation processes (these included studies in the Collie catchment of Western Australia; participation in *National Dryland Salinity Program* focus catchments of the Upper South East of South Australia, Liverpool Plains of New South Wales, Loddon Campaspe in Victoria, Kent River in Western Australia and Upper Burdekin in Queensland; and NLWRA case studies);
- measuring and estimating recharge across different landscapes and land uses to determine the effectiveness of current farming systems;
- development and application of remote mapping technologies (for example, Land Monitor in Western Australia) and geophysical techniques;
- understanding the impacts of plantations on hydrology;

10 *ibid.*, p. 19.
11 *ibid.*

- development and understanding of saline agriculture and forestry systems;
- development of tools to support decision-making for farming systems (for example, Agricultural Production Systems Simulator – APSIM), groundwater (for example, 'FLOWTUBE' model), catchment planning (for example, Floodplain Impacts Model), climate change and forecasting scenarios;
- improved tools for ecological understanding (eg. the salinisation of floodplains);
- improved social and economic tools;
- engineering support; and
- landscape characterisation (for example, Australian Collaborative Land Evaluation Program—ACLEP).[12]

4.14 CSIRO submitted that a number of key findings have emerged from this salinity research. These are summarised and listed here:

- The public and private investment required to shift to sustainable land and water management is massive, will require greater resources and will take some decades to achieve. The use of regional targets for natural resource outcomes and regional investment plans provides a framework for setting priorities. This allows instant action to mitigate some problems while allowing planning for other issues to commence.
- Currently, there is a limited range of robust profitable farming/biological systems that will reduce recharge to the extent required to make a major difference to the salinity problem. It is imperative that more innovative systems be developed and current systems modified to be appropriate for the Australian landscape. For example, developing tree-based systems that can also provide carbon sequestration, biodiversity and other benefits as well as salinity mitigation. It needs to be recognised that there may be significant time delays in developing these new systems, but there are some existing systems that can be adopted and these should be encouraged where it is appropriate to do so.
- The conceptual understanding of salinity processes is generally good, but to manage salinity effectively requires greater understanding of the spatial variability of these processes.

12 CSIRO, *Submission no. 42*, pp. 10-11.

- Climate variability has to be factored into understanding salinity processes and the development of salinity management options.
- There is a need for research investment to develop tools to assess the effect of paddock-scale management changes on end-of-valley salinity targets.
- Local information for monitoring land and water degradation is often deficient, abstract and catchment scale, rather than based on local information applicable at the farm level. Information needs to be provided at a finer scale, locally applicable and its impact assessed against a regional target.
- There is a need for a triage approach to salinity management for both public and private investment—based on identification of assets that can justify major interventions to protect them, areas which need to be managed to minimise adverse impacts, and remaining areas which require management that adapts to more saline conditions.
- Nationally, there is still scope to avoid further salinity outbreaks through maintenance of perennial cover and through use of planning regulations.
- Engineering will be required in the short to medium term to protect some assets. However, it needs to be recognised that such schemes must be part of an overall catchment plan which incorporates best management practice with respect to siting, design, disposal of saline water, water re-use, environmental impacts and so on.
- A much greater knowledge is required to understand impacts on biodiversity (terrestrial, floodplain and in-stream, and to manage land and water in a way appropriate to maintain important ecological assets and function.[13]

4.15 CSIRO is currently involved in partnerships and major programs that are delivering salinity research and development (R&D) for industry and community benefit, including:

- the *Heartlands Project* (with the MDBC), the objectives of which include developing new systems of land use that are more resource efficient than current practices and developing new production systems for agroforestry and agriculture;
- the *National Dryland Salinity Program*;

13 *ibid.*, pp. 4-7.

- the *Joint Venture Agroforestry Program* (with the Rural Industries, Land and Water Resources, and Forest and Wood Products Research and Development Corporations), which aims to integrate sustainable and productive agroforestry within Australian farming systems; and
- several Cooperative Research Centres, including the Centres for Catchment Hydrology, Plant-based Management of Dryland Salinity and Landscape Environments and Mineral Exploration.

4.16 CSIRO Land and Water has published numerous reports describing significant salinity research findings.[14] Three CSIRO salinity reports were drawn to the Committee's attention and their findings are briefly summarised here.

4.17 In 1999 CSIRO prepared a report for the MDBC entitled *Effectiveness of Current Farming Systems in the Control of Dryland Salinity*.[15] The report outlined the causes and extent of dryland salinity in the Murray-Darling Basin and found that, for much of the Basin, current farming systems would not be able to control salinity. It concluded that agricultural practices would have to be modified significantly if salinity is to be brought under control. Specifically, it called for an intensive focus on redesigning farming systems that will control the amount of water leaking into the groundwater system. It was stated that a high proportion of trees would need to be incorporated into the landscape in the higher rainfall parts of the Basin. However, the report concluded that even if suitable practices were to be found and adopted immediately:

> we cannot return to conditions identical to the natural system. In many cases, improvements in dryland salinity would occur very slowly, if at all. Although smaller, local scale catchments may respond to best management practice within several years, the larger regional and intermediate systems may take much longer.[16]

4.18 CSIRO published a companion report in 2000, entitled *A Revolution in Land Use: Systems for Managing Dryland Salinity*, which investigated the capability of various land use options to deal with salinity and the prospect for new solutions from research, development and innovation. The report rated ten land use options, which included saltland farming, phase farming, perennial pastures, high rainfall tree products and agroforestry, against four criteria: relevance to the Basin, effectiveness in terms of each option's ability to reduce leakage, robustness and

14 *ibid.*, publications listed at pp. 10-11.

15 CSIRO, *Exhibit no. 82*, *Effectiveness of Current Farming Systems in the Control of Dryland Salinity*.

16 *ibid.*, p. 15.

profitability relative to current land uses. While some options deployed in certain locations were found to meet the four criteria, it concluded that no single land use option will halt the spread of salinity across the Basin. It was also concluded that a suite of novel land uses, matched to the diverse climate, soils, and hydrological conditions of the Basin, would need to be developed and deployed.[17]

4.19 The report concluded that there needs to be radical changes to land use incorporating features that include commercially driven tree production systems, and new farming systems made up of novel mixes of the best current annual and perennial plants.[18]

4.20 In particular, the report identified the need for:

- a wider range of commercially viable, deep-rooted perennial plants, including trees, shrubs and herbaceous plants;
- refined land assessment techniques to pinpoint the best locations for agroforestry and high-value annuals;
- ways of rotating and mixing perennial plants with current crops and new agricultural plants; and
- tools for land managers to monitor leakage and change land use accordingly.[19]

4.21 In G*roundwater Flow Systems Framework: Essential Tools for Managing Salinity*, published in 2003, CSIRO described a new decision support tool—the Groundwater Flow Systems (GFS) framework—to assist CMOs develop regional plans and guide investment decisions for salinity management.

4.22 A GFS is a model developed by hydrogeologists to explain the behaviour of groundwater in response to recharge. 'Recharge', as described in the explanation of salinisation processes, is the component of rainfall that drains into the free water below the earth's surface, or groundwater. 'Discharge' is a flow of groundwater to the earth's surface. The responsiveness of a GFS to recharge is closely related to the length of the flow path (the distance between recharge and discharge areas) and the

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17 CSIRO, *Exhibit no. 81*, *A Revolution in Land Use: Emerging Land Use Systems for Managing Dryland Salinity*, p. 2.

18 *ibid*.

19 *ibid*., p. 23.

hydrogeological properties of the aquifer, which is the layer of soil or rock which holds water and allows water to move through it.[20]

4.23 In its National Classification of Catchments project, the NLWRA (described in a following section), defined three major groundwater flow system types:

- local flow systems extend only a few kilometres along the flow path, the aquifers fill relatively quickly and, land and river salinity appear within a few years of land clearing;
- intermediate flow systems extend five to 50 kilometres and take 50–100 years to develop land salinity, but perhaps less for river salinity; and
- regional flow systems, which typically have recharge and discharge areas separated by large distances greater than 50 kilometres.[21]

These three broad types have been further classified into 15 sub-systems—eight local, four intermediate and three regional. Conceptual models have been developed to describe each of the 15 flow systems, their different characteristics that influence the processes of recharge and discharge and their responsiveness to salinity control treatments.[22]

4.24 While the detailed processes of salt mobilisation and salinisation are thought to vary from one catchment to another and management options need to consider site-specific conditions, it is argued that similar groundwater flow systems in catchments with similar geologic and geomorphic characteristics should present common salinity issues. It is posited that these systems should therefore respond to similar management options.[23]

4.25 Given the impracticality of analysing each catchment and producing customised management options, the GFS framework allows knowledge from one catchment to be transferred to other similar catchments. With systematic classification of catchments and their groundwater flow systems, it may then be possible to design appropriate sets of generic management tools and extrapolate from these to other catchments.[24]

20 CSIRO, *Exhibit no. 83*, *Groundwater Flow Systems Framework: Essential Tools for Planning Salinity Management*, p. 5. Significant hydrogeological properties of an aquifer include its *permeability*, which is the capacity of the soil or rock to allow water to pass through it, and the *hydraulic gradient*, the slope on a watertable that results in hydraulic pressure.

21 LWA, *Exhibit no. 71*, *Australian Dryland Salinity Assessment 2000*, p. 51.

22 CSIRO, *Exhibit no. 83*, *op. cit*., p. 11.

23 CSIRO, *Exhibit no. 84*, *Groundwater Flow Systems Framework: Summary Report*, p. 1.

24 CSIRO, *Exhibit no. 83*, *op. cit*., p. 9.

4.26 Drawing on work in nine case study catchments representing a range of flow systems, the report demonstrated the effectiveness of the GFS framework in contributing to salinity management. The framework allows:

- landscapes to be partitioned into discrete areas so that planners (at regional, state and national levels) can prioritise catchments in terms of salinity risk and likely responsiveness to management;
- results from well understood catchments can be extrapolated to other catchments where a similar GFS operates; and
- the framework allows the aggregation of information across the landscape to meet targets.[25]

4.27 The framework is expected to assist catchment communities assess the risk of salinity, its likely responsiveness to land use or land management change and the extent of change needed to meet targets.

Australian Nuclear Science and Technology Organisation

4.28 The Australian Nuclear Science and Technology Organisation (ANSTO), which is a statutory body in the Australian Government's Education, Science and Training portfolio (as is the CSIRO), 'undertakes research to advance the understanding of nuclear science and applies resulting technologies and capabilities.'[26] ANSTO applies nuclear-based techniques to a range of problems in environmental systems, including salinity.

4.29 A central element of ANSTO's research is its use of radioactive tracers, which are chemical elements that emit radioactivity. ANSTO is able to use tracers to calculate the rates of water flow in aquifers and the age of water in a flow path.[27]

4.30 Among its current projects, ANSTO is conducting research into groundwater management to identify processes responsible for salt build-up, the source of the salt and the paths of water flow that transport the salt to the land surface. The intention with this research is to identify and quantify recharge or potential discharge areas, and to identify where appropriate remedial action could be implemented to lower the water table and prevent salt mobilisation. Examples of ANSTO's research include the following:

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25 *ibid.*, p. 24.

26 ANSTO, *Submission no. 22*, p. 2.

27 *ibid.*

- Electrokinetic sounding (EKS) mapping methods are used to map the flow of saline groundwaters and isotopic and geochemical techniques are employed to characterise salinisation processes. ANSTO is undertaking this work in several sites, including the Shepparton region of Victoria. EKS maps are said to be useful for defining the details of broad features identified by airborne geophysical mapping methods.
- Isotopic and geochemical methods are being used to characterise urban salinity and processes caused by urban development in Western Sydney. ANSTO maintains that this research could have implications for Australia's building codes.[28]

4.31 ANSTO conducts research in collaboration with other research institutions, including CSIRO, BRS, MDBC, Cooperative Research Centres, the Bureau of Meteorology, several universities and the New South Wales Department of Infrastructure, Planning and Natural Resources.

4.32 ANSTO and all other research and research funding bodies of the Australian Government will be expected to participate in implementing the *National Research Priorities*, to the extent that it is consistent with their mandates and missions. Announced by the Prime Minister in December 2002, the research priorities 'identify those areas that are of critical long-term importance to Australia and which require a whole of government approach.'[29] Salinity has been identified by the Australian Government as a priority goal for research under one of the four research priorities, 'An Environmentally Sustainable Australia'.[30]

Cooperative Research Centres Program

4.33 The Australian Government funds salinity research through the Cooperative Research Centres Program, which was launched in 1990 and aims to strengthen collaborative links between industry, research organisations, educational institutions and government agencies.[31]

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28 *ibid.*, pp. 2-3.

29 Australian Government Department of Education Science and Training (DEST), *Submission no. 69*, p. 1.

30 The two relevant priority goals are 'Overcoming soil loss, salinity and acidity' and 'Water – a critical resource': Dr Robin Batterham (Chief Scientist), *Transcript of Evidence*, 24 November 2003, p. 15. Information on the National Research Priorities is obtainable from the web site of the Australian Government Department of Education, Science and Training, viewed 15 December 2003, <www.detya.gov.au/priorities>.

31 DEST, *op. cit.*, p. 1. See also web site for the Program, viewed 25 April 2004, <www.crc.gov.au/>.

4.34 Of the 71 Cooperative Research Centres (CRCs) currently operating, several undertake salinity research. Two particularly significant CRCs are discussed below, but several others also conduct some salinity research to the extent that the issue affects their particular area of interest. These include the CRCs for Fresh Water Ecology, Cotton, Catchment Hydrology, Spatial Information, Viticulture, and Irrigation Futures.[32]

4.35 At least two CRCs have a significant focus on salinity research—the CRC for Plant-based Management of Dryland Salinity and the CRC for Landscape Environments and Mineral Exploration, both of which were established in 2001. The Australian Government will provide $27 million and $20.2 million over seven years respectively for each of these Centres.[33]

CRC for Plant-based Management of Dryland Salinity

4.36 The research focus of the CRC for Plant-based Management of Dryland Salinity (CRC PBMDS) is the management of dryland salinity through the use of profitable, perennial plant-based farming systems.[34] Two principles underpin the CRCs focus:

> firstly that farming systems should use perennial plants such that there is functional mimicry of the natural landscape; and secondly that perennial-based farming systems should be as profitable or more profitable than existing annual plant-based farming systems to encourage adoption of perennials on the scale necessary to impact on salinity.[35]

4.37 The Centre has eight objectives, which include:

- increasing the awareness of the need for change in dryland management practices and strengthening the will and capacity of rural communities to implement new land management systems;
- understanding the scientific basis for, and, through education, increasing the scientific capability to ensure effective development of plant-based solutions focused on coping with, arresting and/or reversing the impacts of dryland salinity;

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32 DEST, *Submission no. 69*, p. 2. See also: CRC for Fresh Water Ecology, *Submission no. 26*; and Australian Cotton CRC, *Submission no. 67*.

33 *ibid.*, p. 2.

34 DEST, *Exhibit no. 60, Information on the Cooperative Research Centres*.

35 CRC PBMDS, *Submission no. 8*, p. 2.

- selecting and breeding woody and herbaceous perennial and salt tolerant plants for new farming systems and industries, which increase water use and enhance profitability;
- developing, evaluating and promoting land use systems that are profitable, reduce recharge to ground water, tolerate waterlogging and salinity in discharge areas, and reduce adverse off-site effects;
- developing and demonstrating profitable and practical animal production systems using salt and waterlogging tolerant plants in discharge areas, and new and existing perennial plants in recharge areas;
- evaluating economic and hydrological performance of actual and potential CRC outputs and developing policy options recognising the socio-economic opportunities and constraints that lead to the adoption of new land use systems; and
- developing and promoting effective land uses for salinity management that protect and enhance biodiversity values in the agricultural landscapes of southern Australia.[36]

4.38 CRC PBMDS conducts seven research programs:

- education and communication, including educating existing and emerging scientists;
- understanding the way natural ecosystems function in recharge and discharge environments;
- selecting, breeding and evaluating plants (herbaceous and woody) for new perennial-based land use systems;
- developing and demonstrating more profitable and environmentally viable farming systems, including:
    - ⇒ perennial pastures for the high rainfall zone of the Murray-Darling Basin;
    - ⇒ perennial-based land use systems for recharge areas in the Wheat Belt (of Western Australia);
    - ⇒ land use systems that make productive use of saline and waterlogged land;
- economic and social assessment of actual or potential plant-based systems for the management of dryland salinity;

36 *ibid.*, pp. 8-9.

- developing and demonstrating profitable and practical animal production systems; and
- developing and promoting effective land uses and tools for salinity management that protect and enhance bio-diversity values in agricultural landscapes.[37]

4.39 CRC PBMDS involves 11 core partners in four states and links to stakeholder organisations and groups.[38] The Centre's total budget is $170 million over seven years and employs 93 research staff.[39]

4.40 Among the CRC's supporting partners is Landmark, the nation's largest supplier of inputs to farmers. Landmark claimed that it has direct communication with approximately 100 000 farmers nationwide and argued that it will be 'a vital partner in the extension and commercialisation of the CRC's research outcomes'.[40]

CRC for Landscape Environments and Mineral Exploration

4.41 The research focus of the CRC for Landscape Environments and Mineral Exploration (CRC LEME) is to provide breakthroughs in mineral exploration, with flow-ons of airborne geophysical methods and regolith knowledge to environmental studies, particularly addressing dryland salinity and other natural resource management issues.[41] CRC LEME involves eight partners.[42] The Centre's total budget is $118 million over seven years and it employs 72 research staff.[43]

4.42 CRC LEME conducts five research programs which include salinity mapping and hazard assessment, and environmental applications of

37 CRC PBMDS, *Exhibit no. 12, Restoring the Balance*, p. 3.

38 The core partners of the CRC PBMDS are: New South Wales Agriculture; Charles Sturt University; Department of Primary Industries, Victoria; Department of Sustainability and Environment, Victoria; Department of Primary Industries and Resources, South Australia; Department of Water, Land and Biodiversity Conservation, South Australia; the University of Adelaide; Department of Agriculture, Western Australia; Department of Conservation and Land Management, Western Australia; University of Western Australia; and CSIRO.

39 DEST, *Exhibit no. 60, loc. cit.*

40 Landmark, *Submission no. 30*, p. 2.

41 DEST, *Exhibit no. 60, loc cit.*

42 The partners of the CRC LEME are: the Australian National University; CSIRO divisions of Exploration and Mining, and Land and Water; Curtin University of Technology; Geoscience Australia; Minerals Council of Australia; New South Wales Department of Mineral Resources; Primary Industry and Resources South Australia; and the University of Adelaide.

43 DEST, *Exhibit no. 60, loc. cit.*

regolith geoscience (that is, geology, geophysics and geochemistry).[44] The CRC also engages in education and training.

4.43 CRC LEME aims to map where salt is present in the regolith and the mobilisation of salt by the movement of groundwaters through regolith materials. The regolith is defined as 'the soil, sediments, and weathered bedrock, that lies between fresh air and fresh bedrock' and represents the 'major salt store in the landscape'.[45]

4.44 CRC LEME has worked on nine priority action NAP projects in South Australia and Queensland. These projects involved evaluating the use of airborne geophysics in groundwater mapping and salinity management.

Research and Development Corporations

4.45 Salinity research is a major component of the programs conducted by several of the rural research and development corporations (RDCs) established under the *Primary Industries and Energy Research and Development Act 1989*.[46] The RDCs are jointly funded by the Australian Government and industry.

4.46 The main salinity-related RDC programs, which are operated principally through Land and Water Australia (LWA), Grains RDC (GRDC) and the Rural Industries RDC (RIRDC), include:

- *Grain and Graze* (jointly managed by LWA, GRDC and Meat and Livestock Australia). This aims to achieve widespread adoption (among some 6 800 farmers) of mixed farming systems to produce a 10 per cent increase in farm productivity and improved conditions for natural resources on mixed farms. This is to be achieved through, for example, a reduction in recharge by incorporating deep-rooted pastures. The Program includes establishing eight regional research sites corresponding to eight regions of the NAP where mixed farming could assist in attaining regional NRM targets.[47]
- *Sustainable Grazing on Saline Land* (SGSL) is a major sub-program of Land, Water and Wool (managed by LWA and Australian Wool

44 CRC LEME, *Exhibit no. 85*, p. 6.

45 CRC LEME, *Submission no. 64*, p. 2. Soil constitutes the top layer of the regolith, which can vary in depth down to approximately 200 metres. The regolith is 'all the unconsolidated material above basically hard rock'. Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 14.

46 DAFF and DEH, *Submission no. 72*, p, 6. There are fourteen rural research and development corporations, of which eight are statutory authorities and six are private companies.

47 LWA, *Exhibit no. 127, Land and Water Annual Report 2002-03*, p. 40.

Innovation), which is a national initiative focused on sustainable wool production. The *Sustainable Grazing* Program aims to achieve improved production and profitability from grazing saline lands and better environmental outcomes, by supporting the 41 per cent of wool growers nationally who have land already affected by dryland salinity. SGSL involves a producer network and demonstration sites.[48]

- *Joint Venture Agroforestry Program* (managed by RIRDC). Its aims include developing financially viable species for agroforestry systems and products, particularly for low to medium rainfall areas.[49]
- The *National Dryland Salinity Program* (managed by LWA). This is described in the following section.

4.47 Illustrating the importance of these and other salinity-related research programs conducted by RDCs, LWA argued that:

> In total, these programs involve major rural industries (including grains, meat, wool, dairy, sugar, cotton, horticulture and rural water authorities) in working collaboratively to support natural resource management science efforts. Further, they enable Land & Water Australia to straddle the critical issues of scale, from farming systems at a paddock scale and the industry-based extension programs needed to promote them; to work at catchment, regional, state and national scales with the full range of government, community and non-government organisations involved at those levels.[50]

Land and Water Australia

4.48 Land and Water Australia (LWA) submitted that it is responsible for ‘R&D aimed at the productive and sustainable management of the land, water and vegetation resources underpinning Australia’s primary industries and regional communities.’[51]

4.49 LWA explained that it has a charter to foster national collaboration in order to improve the effectiveness of the R&D effort and the majority of its

48 CSIRO, *Submission no. 42*, p. 8; Land Water and Wool, Sustainable Grazing on Saline Land, *Productive Solutions for Salinity Management*, Issue 1, Land and Water Australia, Canberra, 2003, viewed 12 February 2004, <www.lwa.gov.au / downloads / publications_pdf / PX030508.pdf>.

49 LWA, *Exhibit no. 127*, *op. cit.*, p. 46. Information on these programs and project products is available from the websites of the organisations involved, viewed 10 February 2004: LWA, <www.lwa.gov.au>; RIRDC, <www.rirdc.gov.au>; and GRDC, <www.grdc.com.au>.

50 LWA, *Submission no. 59*, p. 5.

51 *ibid.*, p. 1.

research investment occurs within national research programs and is conducted in partnership with other organisations. In 2002-3, LWA generated $23.3 million for its research investments.[52]

The Grains Research and Development Corporation

4.50 The Grains Research and Development Corporation (GRDC) invests in salinity research as part of the Corporation's broader mandate to 'identify, fund, manage and deliver the results of R&D that will improve the profitability and sustainability of the Australian grains industry.'[53]

4.51 The GRDC noted that of the 5.7 million hectares of land presently at risk or already affected by dryland salinity, some 2.6 million hectares are in grain-growing regions. Furthermore, the economic cost to the grains industry in lost farm profits due to salinity over the next 20 years has been estimated at $238 million.[54]

4.52 Recognising the threat posed by salinisation to cropping lands and the potential contribution of farming systems based on annual crops to increased recharge, the GRDC became an early partner and investor in the *National Dryland Salinity Program*, contributing $5 million to the Program over the last five years. More recently, the GRDC became a foundation industry and funding partner of the CRC for PBMDS.[55]

4.53 The GRDC also invests in salinity research through its own programs and has committed $11.5 million for salinity and water management projects for the period 2002–03 to 2007–08.[56]

4.54 The GRDC has targeted three areas for investment:

- water balance performance of crops – to better understand the significance of changes in land use and management on the processes that underlie salinisation;
- farming systems that use more available water—the development of profitable farming systems that use more moisture in the soil and thereby reduce recharge, including new plants and varieties; and
- grower group involvement in research, development and extension—to work with growers in all aspects of the salinity investment to ensure

52 LWA, *Exhibit no. 127, op. cit.*, p. 34.
53 GRDC, *Submission no. 29*, p. 3.
54 *ibid.*, p. 2.
55 *ibid.*, pp. 2-3.
56 *ibid.*, p. 2.

> that project outputs are practical, have grower support, and can be readily adopted by the industry.[57]

4.55 Rather than undertake generic research, the GRDC has focussed on work 'that would enable its industry to contribute to the national effort in salinity management, and on involving growers in the search for practical solutions.'[58] Consequently, the Corporation's investments in salinity management focus on:

> outcomes on the ground in terms of identifying where salinity is occurring, where land use change needs to take place, what profitable options are available and integrating solutions within the context of the whole farm.[59]

4.56 Examples of these four themes in the GRDCs research investments to address salinity include:

- targeting salinity at the farm scale using enhanced soil maps from airborne geophysics and stream surveys (with the BRS);
- increasing lucerne adoption in farming systems in south-eastern Australia (with the Department of Primary Industries, Victoria)[60];
- evaluating impacts of deep drains on crop productivity and the environment (with CSIRO Land and Water); and
- the *Grain and Graze* Program (with LWA and Meat and Livestock Australia).[61]

4.57 The GRDC stressed that it is committed to a participatory model of R&D in which 'researchers together with grain growers identify research priorities, develop hypotheses, carry out research, analyse and interpret the data and draw conclusions from the work.'[62] The Corporation also noted that several grower groups (such as Mingenew-Irwin, Mallee Sustainable Farming, and The Birchip Cropping Group) initiate research projects themselves and then contract researchers to investigate the issues, which often involve salinity management.[63]

57 *ibid.*, p. 4.
58 *ibid.*
59 *ibid.*, p. 5.
60 *ibid.*, p. 6: 'one of the few profitable options to reduce recharge in agricultural systems'.
61 *ibid.*, pp. 5-8.
62 *ibid.*, p. 8.
63 *ibid.*

4.58 Other RDCs have also conducted salinity research on behalf of their affected industries and extended the results to users. For example, the Grape and Wine RDC commissioned a recently published report entitled *The Potential Impact of Saline Irrigation Water on the Grape Industry in the Murray-Darling Basin*.[64] While noting that sodicity is regarded as a greater problem for the cotton industry, the Cotton RDC has also invested $1.2 million in mapping salinity risks in seven cotton-growing districts, covering 450 000 hectares.[65]

The National Dryland Salinity Program

4.59 The *National Dryland Salinity Program* (NDSP) is a 'collaborative research, development and extension program investigating the causes of, and solutions to, the problem of dryland salinity.'[66]

4.60 Established in 1993, the NDSP commenced in an environment where:

> there was no nationally coordinated dryland salinity research effort. Moreover, there was no national strategy for dealing with dryland salinity; few statewide strategies existed; experts argued about the size and cost of the emerging problem; catchment management was in its infancy; and Landcare and production interests were inadequately integrated.[67]

4.61 The NDSP was established in order to fund and coordinate dryland salinity R&D, and to promote the implementation of practices to combat salinity. The NDSP has sought to provide a national framework for stakeholders to invest collaboratively and efficiently in dryland salinity research:

> The NDSP has played a major management and coordinating role spanning ten years in the funding of new science, technical and engineering knowledge. In fulfilling this management and coordination role on behalf of its partners, the NDSP has funded

64 Grape and Wine Research and Development Corporation, *Submission no. 6*, p. 2.

65 Cotton Research and Development Corporation, *Submission no. 31*, p. 4. Sodicity is caused by the accumulation of sodium in soils. 'In sodic soils, much of the chlorine has been washed away, leaving behind sodium ions (sodium atoms with a positive charge) attached to tiny clay particles in the soil. As a result, these clay particles lose their tendency to stick together when wet—leading to unstable soils which may erode or become impermeable to both water and roots.' Sodicity is a more widespread form of land degradation than salinity, affecting 30 per cent of Australian soils and causing poor water infiltration, surface crusting, erosion and water logging. Australian Academy of Science, *Sodicity – a dirty word in Australia*, Canberra, 1999, viewed 11 March 2004, <www.science.org.au/nova/035/035key.htm>.

66 NDSP, *Submission no. 35*, p. 2.

67 *ibid.*, p. 1.

> numerous research projects aimed at answering the major questions in salinity management and in so doing, has produced a wealth of information currently being used in the management, coordination and implementation of salinity programs. Major research findings and outcomes which have been funded by the NDSP have had an enormous influence upon salinity programs and continue to be incorporated into the research and extension bases of these programs.[68]

4.62 For the Australian Government, the NDSP is ‘Australia’s major government-based salinity network and information resource ... the NDSP provides a major communication network for disseminating salinity science and information in Australia.’[69]

4.63 The NDSP was instigated and is still managed by LWA. The Program is funded by a consortium of industry and government agencies with an interest in salinity management, including: LWA, MDBC, DAFF, CSIRO, GRDC, RIRDC, Meat and Livestock Australia, and the six state governments of New South Wales, Victoria, South Australia, Western Australia, Queensland and Tasmania.

4.64 The Program has undergone two five-year phases and is now in its final year of operation. Over the period July 2003 to June 2004 the NDSP will conduct an Enhanced Communication Year, the objective of which is to synthesise and communicate all of the information produced over the life of the Program.

4.65 Phase one of the Program (1993 to 1998), which involved funding of $10 million, focused on understanding the causes and impacts of dryland salinity and establishing a national collaborative R&D effort. The NDSP stated that this phase:

> made significant headway in developing better research methods, coordinating research efforts and engaging rural communities in catchment management planning. It also helped break down the barriers between different disciplinary groups and government institutions and elevated awareness of salinity issues.[70]

4.66 Findings from the first phase also informed the conclusions of the Prime Minister’s Science, Engineering and Innovation Council (PMSEIC) report,

68 *ibid.*, p. 15.
69 DAFF and DEH, *Submission 72*, p. 12.
70 NDSP, *op. cit.*, p. 9.

Dryland Salinity and its Impacts on Rural Industries and the Landscape, and established that salinity is more just an agricultural problem.[71]

4.67 The second phase (1998 to 2003) of the Program encompassed a broader range of issues, which reflected a 'growing awareness of the wide-ranging impacts of salinity and the diversity of approaches that would be needed to address the problem.'[72] The second phase involved funding of $24 million and approximately 92 per cent of this was spent on R&D and project-related extension activities.[73]

4.68 The mission of the NDSP during this phase was to 'research, develop and extend practical approaches to effectively manage dryland salinity across Australia'.[74] Specifically, the second phase examined catchment processes, industry, engineering, policy, local government, environmental and regional dimensions of salinity, and set out to fulfil three tasks:

- improve the coordination of R&D and extension efforts;
- influence the direction of R&D by setting priorities and leading by example; and
- fill R&D gaps at the national level by funding a portfolio of projects.[75]

4.69 As the second phase of the Program evolved, the NDSP aimed to develop a place for itself as 'Australia's lead knowledge broker of R&D and extension efforts to combat dryland salinity.'[76]

4.70 In total, 43 projects were carried out during phase two and these were grouped into seven themes:

- Audit and monitoring. These projects examined the extent and rate of change in dryland salinity and its impacts at regional and national scales. Much of this research was undertaken in collaboration with the NLWRA.
- Policy and operating environment. These projects generated knowledge to support better policies, institutional structures and incentives for promoting appropriate management of dryland salinity.

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71 PMSEIC, *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, Australian Government Department of Education, Science and Training, Canberra, 1999, viewed 22 January 2004, <www.dest.gov.au/science/pmseic/documents/salinity.pdf>.

72 NDSP, *op. cit.*, pp. 9-10.

73 NDSP, *Exhibit no. 25, NDSP Achievements Report*, p. 8.

74 NDSP, *Submission no. 35*, p. 10.

75 *ibid.*, p. 12.

76 *ibid.*, p. 10.

- Industry solutions. This theme recognised that agricultural industries are expected to suffer losses due to salinity and are also needed to contribute to salinity management. The NDSP had a significant focus on the grains industry, as this sector is expected to be the most at risk from salinity, and involved collaborative research with the GRDC and Meat and Livestock Australia.
- Productive use of saline resources. This theme examined ways to 'live with salt' by viewing salinity as a new resource, for example, by developing new farming systems and industries which profitably use or rehabilitate saltland.
- Environmental protection and rehabilitation. These projects developed ways of measuring the environmental impacts of salinity and understanding how to control them.
- Infrastructure management. These projects examined engineering aspects of salinity and its impact on public and private infrastructure.
- Regional and community initiatives. The aim of this theme was to promote investment in the provision of a national network that would link different state, regional and community activities.[77]

4.71 These themes, designed to address all aspects of dryland salinity including institutional arrangements and technical treatments, addressed the specific concerns of stakeholders and aimed to provide a focus for partners to target their investments. Most of the projects were managed by LWA, which also contributed $6 million to the second phase.

4.72 Examples of the range of research and extension activities that the NDSP funded, coordinated or supported during the second phase include:

- development of the catchment management planning CD-ROM, Practical Index of Salinity Models, which provides catchment planners with information on the strengths and limitations of an array of catchment planning tools;
- development of the GFS framework which has 'radically changed how state governments and catchment management bodies across Australia devise salinity management strategies';[78]
- compilation of the NLWRA salinity theme results resulting in 'Australia's most comprehensive assessment of dryland salinity to date

77 *ibid.*, pp. 16-17.
78 *ibid.*, p. 5.

and which has formed the basis of resource allocation decisions by both Commonwealth and state governments';[79]

- development of decision support tools for designing environmentally sensitive engineering works and 'living with salt' options; and
- 'a vast array of reports, training packages, decision support tools, fact sheets et cetera that have successfully been incorporated into local government, industry, extension and policy materials.'[80]

4.73 The NDSP has documented how the research outcomes funded through these seven themes are currently being used in the management, coordination and implementation of salinity programs.[81]

4.74 As a key example, the NDSP argued that the outcomes of its Catchment Classification project which identified three different types of GFS, described in the information provided above on CSIRO, has had a profound effect on salinity management:

> The outcomes from this project in terms of the use of the data in managing, coordinating and implementing other salinity programs have been enormous. It has provided a low-cost means of understanding, at a broad level, the hydrological processes at work in a given catchment without having to collect detailed information. This has been achieved by transferring knowledge from well-documented catchments to other, less studied catchments. It has also provided a national map that classifies catchments according to the three types described above, which is a significant advance in guiding regional management strategies. More detailed assessments have been conducted in the Murray Darling Basin and Queensland. These assessments are assisting communities to identify priority areas for treatment.

4.75 The NDSP stated the GFS is now being incorporated into regional salinity management plans across Australia and argued that this example:

> Demonstrate[s] that when science is coordinated nationally, as it was with the GFS, then adoption can occur rapidly as a network of system developers operates to provide guidance and support to colleagues and others across agency and jurisdictional borders.[82]

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79 *ibid.*

80 *ibid.*

81 NDSP, *Exhibit no. 25, NDSP Achievements Report,* and *Exhibit no. 27, NDSP Communication Report 2003–03.*

82 *ibid.*, p. 15.

4.76 The NDSP argued that six key messages emerged from the ten years of the Program's research and research coordination efforts. These research findings are listed here and further detail is provided in appendix E to this report:

- salinity costs are significant and rising, resources are limited and hence protection 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 possible approach to deal with dryland salinity;
- vegetation management remains the key to managing water resources, although the benefit-cost of revegetating catchments requires careful analysis; and
- lack of capacity is an important, but secondary, constraint to managing salinity.[83]

The National Land and Water Resources Audit

4.77 The National Land and Water Resources Audit (NLWRA or 'the Audit') is a program of the NHT, initially established in 1997 to 'provide Australia-wide assessments of land, water and vegetation resources to facilitate improved decision-making on land and water management.'[84] The Audit, which is co-located with LWA, works with the Australian Government, state and territory agencies, regional NRM groups and community stakeholders through an Audit Advisory Council.

4.78 Among its objectives, the Audit seeks to facilitate improved decision making on land and water resource management issues by:

- providing a clear understanding of the status of, and changes, in the nation's land and water resources and implications for their sustainable use;
- providing an interpretation of the costs and benefits of land and water resource change and remedial actions;

83 NDSP, *Submission no. 35.1*, pp. 1-4.

84 LWA, *Exhibit no. 127, Land and Water Australia Annual Report 2002-3,* p. 53.

- developing a national system of compatible and readily accessible land and water data;
- producing national land and water (surface and groundwater) assessments as integrated components of the Audit;
- ensuring integration with, and collaboration between, other relevant initiatives; and
- providing a framework for monitoring Australia's land and water resources in an on-going and structured way.[85]

4.79 The Audit has undergone two phases. From 1997 to 2002, primary data and information related to Australia's natural resource management were collected and collated. The Audit prepared:

- assessments on the status and recent changes in Australia's land, vegetation and water resources;
- integrated reports on the economic, environmental and social dimensions of land and water resource management; and
- guidelines and protocols for assessing and monitoring the health of land, vegetation and water resources.[86]

4.80 Web-based access to the information prepared by the Audit has been made available through the Australian Natural Resources Atlas, which has interpretive products from Audit and NHT supported projects, and the Australian Natural Resources Data Library, which contains more than 170 data sets.[87]

4.81 One of the Audit's principal pieces of research was the *Australian Dryland Salinity Assessment 2000*, which provided information on the distribution and impacts of dryland salinity at a regional scale, and provided a context for consideration of dryland salinity management throughout Australia. DAFF and DEH stated that the Assessment remains 'the current and authoritative statement on salinity in Australia'.[88]

4.82 The Assessment included maps of the extent and future risks of salinity projected to 2050 and summarised the way forward in meeting the NRM challenges associated with dryland salinity, as follows:

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85 LWA, *Exhibit no. 71*, *Australian Dryland Salinity Assessment 2000*, inside cover.

86 *ibid*.

87 Access to the Australian Natural Resources Atlas and the Australian Natural Resources Data Library available online, viewed 10 February 2003, <http://audit.ea.gov.au/ANRA/atlas_home.cfm>.

88 DAFF and DEH, *Submission 72*, p. 8.

- recognise that although the rate of salinisation may be slowed or reversed in some areas, in other locations land and water resources will continue to salinise with major impacts on rural communities and terrestrial biodiversity. Consequently, engineering solutions are likely to be required to protect key community assets and infrastructure;
- implement a landscape function approach to the management of on-site and off-site impacts of dryland salinity;
- support the development and use of the GFS framework both within and across states to maximise exchange of knowledge and understanding of processes, scale and type of interventions required to manage dryland salinity;
- appreciate that any salinity targets set need to be based on an understanding of biophysical processes and the likelihood of their being achieved;
- maintain where possible natural water balance processes;
- design new farming and land use systems that manage the salt and water balance; and
- enhance existing monitoring systems to better support the assessment and evaluation of outcomes of dryland salinity management programs.[89]

4.83 In particular, the Assessment proposed the adoption of the GFS framework, which was described in the overviews of NDSP and CSIRO research efforts, as a basis for salinity planning, monitoring and evaluation of management responses. The Assessment also identified a number of significant information and methodological limitations that impede evaluation of the exact extent of the salinity problem and likely effectiveness of management interventions.

4.84 The Audit's dryland salinity activities were undertaken as a component of the NDSP and relied heavily on the processes and networks established through that Program.

4.85 The Audit commenced a second phase of operation in July 2002 (to June 2007), the outcomes of which are to include the collation of natural resource data and information (including data collected through investments of the NAP and NHT), and the coordination and quality

89 LWA, *Exhibit no. 71*, *op. cit.*, p. vii.

assurance of data management processes.[90] DAFF and DEH stated that during this phase the Audit will ensure that:

> salinity data and information is accessible and consistent, including support for the development and implementation of region-based monitoring and evaluation strategies for salinity. The Audit also promotes development of spatial information systems and metadata standards.[91]

University research

4.86 The Australian Research Council (ARC) is the key provider of support for university research and provides approximately half of all national competitive grant support.[92] The ARC funds basic research on a competitive basis for projects in all fields of research, except clinical medical and public health research. The *ARC Linkage* program requires interaction between researchers and the actual or potential users of research results.

4.87 Over the six years to 2003, the ARC invested a total of $16.5 million in 84 salinity related research projects.[93] For research projects whose funding is to commence in 2004 or later years, the selection criteria employed by the ARC will include Australia's *National Research Priorities*.[94]

4.88 Murdoch University and the Centre for Salinity Assessment and Management (CSAM) at the University of Sydney provided information to the Committee on their salinity research efforts.[95]

4.89 Murdoch University's research activities, which have been funded variously by ARC grants, RDCs or through the NDSP, include:

- the development of salt tolerant hybrid trees to add to the species available for planting in saline waterlogged areas and, in particular, the

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90 Information on the National Land and Water Resources Audit 2002–2007 available from the Audit's web site, viewed 10 February 2004, <www.nlwra.gov.au/about.htm>; and see DAFF and DEH, *Submission 72*, p. 5.

91 *ibid.*, p. 9.

92 House of Representatives Standing Committee on Science and Innovation, *Riding the Innovation Wave*, The Parliament of the Commonwealth of Australia, Canberra, 2003, p. 38, viewed 12 March 2004, <www.aph.gov.au/house/committee/scin/randd/report.htm>.

93 DEST, *op. cit.* p. 2; and see DEST, *Exhibit no. 61, Details of ARC funded projects.*

94 DEST, *Submission no. 69*, p. 1.

95 CSAM, *Submission no. 19*, p. 1 (information on CSAM and its activities is available from the Centre's web site, viewed 7 June 2004, <www.agric.usyd.edu.au/scam/index.html>); and Murdoch University, *Submission no. 24*, pp. 8-9.

breeding of trees to deliver commercial returns in lumber or wood chips from saline land (to be marketed Australia-wide by Saltgrow);

- development and application of desalination technologies to provide water to Western Australian Wheatbelt towns and protect infrastructure;
- studies of groundwater processes and hydrogeology, which inform catchment management plans;
- development of tools to judge the likely fate of remnant vegetation and the prospect of restoring damaged ecosystems; and
- an evaluation of the effectiveness and impacts of deep drains.[96]

4.90 Murdoch University stated that social research and economics must be considered as part of the salinity science base—not just the contributions of the biophysical sciences—and that salinity is best addressed through an integrated, multi-disciplinary approach.[97]

4.91 Both Murdoch and CSAM stressed the role of universities in training students, many of whom ‘will have carriage of management, coordination and implementation of salinity programs’, and urged that this role be adequately recognised and supported.[98]

The private sector contribution

4.92 In addition to the commitment of primary producers and rural industries to salinity related research through levies paid to RDCs, the Committee received evidence from private sector providers of salinity research and support services. Examples of the private sector contribution to the salinity science base and support for those managing salinity include the following:

- Murray Irrigation stated that it invests more than $300 000 per year in research and development projects as part of the Murray Land and Water Management Plans. R&D projects have included:
  - ⇒ an inland saline aquaculture trial;

96 *ibid.*, p. 9.

97 *ibid.*, pp. 1-3; Dr Susan Moore (Murdoch University), *Transcript of Evidence*, 13 November 2003, pp. 28-29.

98 *ibid.*, p. 4; CSAM, *op. cit.*, p. 3.

  - ⇒ optimisation of the Wakool Tullakool Sub-surface Drainage Scheme; and
  - ⇒ identifying and quantifying the contribution of physical processes and management practices on groundwater recharge under irrigated perennial pastures.[99]

  This research is conducted in partnership with state agencies, CSIRO and independent consultants. Murray Irrigation maintains a close relationship with CSIRO by accommodating CSIRO researchers with the Company's extension staff on its premises. This arrangement is said to have produced good research outcomes and has allowed the irrigators to develop a better understanding of the relevant science. The co-location has also allowed Murray Irrigation's perspectives to be considered in designing research projects.[100]

- GecOz have developed an airborne radar technology, known as 'SaltSAR', for salinity hazard mapping.[101]
- An Environmental Research and Information Consortium developed a technique of using gamma-ray data to map saline pathways, now patented by Natural Resource Intelligence.[102]
- Saltgrow is commercialising fast growing, salt tolerant eucalypt hybrids with commercial timber characteristics to provide profitable solutions for saline lands.[103] To date, Saltgrow has developed in excess of 1300 varieties, and conducted over 100 trials and a number of pilot scale commercial plantings across Australia.[104]
- Agrilink has developed a soil moisture, salinity and temperature sensor which can be integrated with geospatial technologies and used in salinity monitoring. The company has also developed a proprietary internet based software system, known as 'AgWISE', for the collection, management and distribution of agronomic data relating to the weather, irrigation, salinity and the environment.[105]

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99 Murray Irrigation Ltd, *Submission no. 27*, pp. 1-2.

100 Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 16.

101 GecOz Pty Ltd, *Submission no. 80*, p. 2.

102 Orbtek Pty Ltd, *Submission no. 3*, p. 1.

103 Saltgrow Pty Ltd, *Exhibit no. 109, Background to Saltgrow Products and the Xylonova Research and Development Program*, p.3.

104 Saltgrow Pty Ltd, *Exhibit no. 108, Salt Tolerant Eucalypts for Commercial Forestry: Progress and Promise*, p. 1.

105 Agrilink Holdings Pty Ltd, *Submission no. 25*, pp. 2-3, and see *Submission 25.1*.

- Consulting services in salinity and NRM are provided to CMOs, state agencies and landholders by firms that include Sinclair Knight Merz, Phil Dyson and Associates, and Webbnet Land Resource Services.[106]
- Landmark, a subsidiary of Australia's largest agribusiness, AWB, employs over 250 agronomists and directly communicates with some 100 000 farmers nation wide. Through its partnership with the CRCPBMDS, Landmark aims to extend and commercialise the CRCs research outcomes. Landmark has had its own staff participate in a series of workshops on the management of dryland salinity and will participate in a CRC project to increase the area of land sown to lucerne by farmers, as a tool for managing water levels and salinity. In total, Landmark's contribution of cash and in-kind support to the CRC amounts to $250 000 per year.[107]

4.93 The 'applied science' contributions of landholders in managing salinity outbreaks on their own properties was also brought to the attention of the Committee:

> What we do have in our favour are a number of landowners who have recognised the problem of salinity outbreaks on their properties and through being observant, innovative and committed to saving the land have instigated activities that have made a turn around. Their experience and endeavours need to be documented to assist others just as much as scientific research. This is applied science.[108]

4.94 The Committee witnessed farmer-initiated applied science in innovative salinity management practices during its inspections in New South Wales and Western Australia.

An audit of the Australian Government investment in salinity research

4.95 CSAM and the New South Wales Farmers' Association suggested that a national inventory of salinity research ought to be developed, 'to help funding agencies establish priorities and identify gaps'.[109] Similarly, the

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106 Sinclair Knight Merz, *Submission no. 28*, p. 9; Phil Dyson and Associates, *Submission no. 46*;

107 Landmark, *Submission no. 30*, pp. 1-2; Mr David Coombes (Landmark) *Transcript of Evidence*, 1 December 2003, p. 3.

108 Ms Margaret Thompson, *Submission no. 53*, p. 1.

109 CSAM, *op. cit.*, p. 2. The New South Wales Farmers' Association (*Submission no. 45*, p. 4) proposed that an audit occur at either state or national level and identify salinity research activities on a catchment by catchment basis.

NDSP proposed that an audit be conducted across the totality of Australian Government investment in salinity, including:

> the Commonwealth funds that move through CRCs … the Commonwealth money that goes into R&D corporations and the Commonwealth money that goes through these programs, plus through the agencies themselves … let us look at all that we have available to us in steering R&D forward and directing it in a new way according to the strategic direction we have now set.[110]

4.96 The Committee believes that an audit of the totality of the Australian Government's investment in salinity is needed to identify research gaps and to assist in enhancing research coordination across agencies and jurisdictions.

4.97 More specifically, the Committee believes that an audit may help to:

- map salinity research findings and tools that are currently available for use in salinity management;
- assist in identifying critical research gaps, identify any unnecessary duplication of effort and suggest directions for future salinity R&D; and
- bring coherence to the range of salinity related research activities that receive Australian Government support, and improve coordination with state and regional research efforts.

110 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 15.

Recommendation 2

4.98 **(a) The Committee recommends that the Australian Government, in cooperation with state government agencies, conduct an audit of the totality of salinity research and development activities undertaken by all agencies and programs in which the Australian Government invests, including:**

(i) national programs that address salinity, such as the *National Action Plan for Salinity and Water Quality* and the *Natural Heritage Trust*;

(ii) programs such as the *National Dryland Salinity Program* and the National Land and Water Resources Audit;

(iii) agencies within Australian Government departments, including the Bureau of Rural Sciences;

(iv) Cooperative Research Centres;

(v) Research and Development Corporations;

(vi) national science agencies, including the Commonwealth Scientific and Industrial Research Organisation;

(vii) universities; and

(viii) where possible, the private sector.

(b) The Committee further recommends that the audit:

(i) map the state of salinity research findings and the tools currently available for salinity management;

(ii) identify all critical research gaps;

(iii) suggest directions for future salinity research and development activities; and

(iv) identify steps that might be taken to bring greater coherence to salinity research efforts across all Australian Government funded agencies and programs, and to improve coordination with state and regional research activities.

Conclusions

National research agencies and programs

4.99 The Committee concludes that a wealth of salinity research has been undertaken by a range of Federally-funded agencies and programs, including: agencies within Australian Government departments, such as the BRS; numerous CRCs; RDCs; national science agencies, notably the CSIRO; universities, and programs that include the NDSP and NLWRA.

4.100 An array of research products and salinity management tools has been developed by these agencies. The efforts of state R&D programs and the MDBC, outlined in chapter two, also contribute to the salinity science base. The Committee welcomes the fact that 'despite the crowded market in salinity management, there is … the advantage that by having more players there is more funding going into research and extension effort.'[111]

4.101 However, the Committee concludes that a comprehensive audit of the Australian Government investment in salinity research may be timely. An audit will be able to map the salinity science base and management tools, and identify critical research gaps. An audit may also assist in bringing greater coherence to the range of science investments for salinity and potentially improve their effectiveness. The audit may also assist in improving coordination with state and regional research efforts.

Private sector contribution

4.102 The Committee notes the contribution made by the private sector, for example, in consulting services, development of salinity mapping technologies, commercialisation of salt tolerant plants, and in partnering with research organisations. The Committee is also pleased to acknowledge that many landholders are adopting innovative management practices based on what might be termed 'applied science', or are working in partnerships with researchers to do so.

4.103 Having presented an overview of the national programs to address salinity (chapter two), the consensus explanation for the salinity problem and alternative scientific perspectives (chapter three) and the science base that has developed to meet the salinity threat (chapter four), the following chapters present the Committee's evidence and views on:

- the coordination of the salinity research effort;

111 NDSP, *Submission no. 35*, p. 20.

- adequacy of the science base, research priorities and the funding of research;
- management of data and salinity mapping; and
- the extension of salinity science to those managing salinity, particularly CMOs and landholders.

5

The coordination of salinity research

[T]here would be resounding agreement across the board that we need a highly coordinated, sustained commitment to R&D, with nationally, regionally and basin directed R&D, depending on what the work is; it all has to come together. We have to keep our nerve for the long term.[1]

5.1 The chapter addresses six issues:

- the coordination of salinity research at the national level (paragraphs 5.3-5.16);
- research coordination at the state level (paragraphs 5.17-5.31);
- the need for and challenges in research coordination (paragraphs 5.32-5.62);
- institutional proposals for improved coordination (paragraphs 5.63-5.68);
- support for the continuation and expansion of the *National Dryland Salinity Program* (paragraphs 5.69-5.82); and
- functions that could be performed by a coordinating agency or program (paragraphs 5.83-5.85).

5.2 In considering the evidence in relation to salinity research coordination, the Committee notes the urgency of these matters given the imminent closure of the *National Dryland Salinity Program*. The evidence suggests

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1 Mr Kevin Goss (Murray-Darling Basin Commission), *Transcript of Evidence*, 7 November 2003, p. 35.

there is a need for an on-going national research coordination role, and a range of functions it could perform have been proposed to the Committee.

Salinity research coordination at the national level

5.3 The national coordination and communication of salinity science is supported primarily through committees and working groups under the Natural Resource Management Standing Committee (NRMSC), which in turn reports to the Natural Resource Management Ministerial Council (NRMMC).[2] Government involvement in these groups extends through the networks and project activities of agencies and programs outlined in the previous chapter.

5.4 The Programs Committee of the NRMSC is responsible for several working groups, including two with a direct role in coordinating aspects of salinity science:

- The Science and Information Working Group has identified national priorities for NRM research in five categories, all of which have some bearing on salinity research: sustainable agriculture and land use; biodiversity conservation; climate variability and change; natural resource management and indicators; and managing knowledge for change.[3]
- The Monitoring and Evaluation Working Group is developing indicators with data collection and management protocols to guide region-based monitoring and evaluation of the effectiveness of on-ground investment and action made through the regional NRM plans.[4]

5.5 The Land, Water and Biodiversity Committee of the NRMSC oversees discipline-based working groups such as the Working Group on Land Resource Assessment, and the Executive Steering Committees on Vegetation Information, and Land Use Mapping. These committees and working groups provide an advisory role on salinity issues, where relevant. The National Land and Water Resources Audit (NLWRA)

2 Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF), and the Environment and Heritage (DEH), *Submission no.72*, p. 10. Complementary support is provided through the Primary Industries Ministerial Council and Murray-Darling Basin Ministerial Council. Information on the work of the NRMSC and its three advisory committees is provided on the Ministerial Councils web site, viewed 26 April 2004, <www.mincos.gov.au/nrm_sc_committees.htm#programs>.

3 *ibid.*

4 *ibid.*

coordinates activities associated with indicator development and data collation.[5]

5.6 The Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF), and the Environment and Heritage (DEH), submitted that the operational arrangements made under the Ministerial Councils also ensure intergovernmental coordination of salinity research and development (R&D), including various networks and project activities. Examples of such arrangements include the following:

- The Commercial Environmental Forestry project is a three-year collaboration between the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Fisheries and Forestry Division of DAFF, the Murray-Darling Basin Commission (MDBC) and the National Association of Forest Industries. The project aims to develop a farm forestry investment framework to underpin sustainable land use change for commercial and environmental outcomes.[6]
- CSIRO and the Bureau of Meteorology (BOM) have been commissioned to prepare annual reviews of the scientific and technical robustness of NRM program strategies and plans during their implementation. The reports will also identify new or emerging scientific advances that may enhance the effectiveness of NRM program implementation.[7]
- The Australian Government also supports salinity science networks operated principally through the programs of the Research and Development Corporations (RDCs), notably Land and Water Australia (LWA) and the Rural Industries RDC (RIRDC), relevant Cooperative Research Centres (CRCs), and the conferences convened for the Productive Use and Rehabilitation of Saline lands (PUR$L).[8]

5.7 A summary of the roles performed by major agencies and national programs engaged in salinity management is provided in Table 5.1. The table indicates the extent to which the particular agency or program contributes to performing each role, including salinity R&D coordination.

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5 *ibid.*, p. 11.

6 *ibid.*

7 *ibid.*

8 *ibid.*, pp. 11-13.

Table 5.1 Major agencies and programs engaged in salinity management and their respective roles

Roles	*NDSP*	*NAP*	*CRCs*	*LWA*	*MDBC*	*NLWRA*	*RDC's*	*CSIRO*	*DAFF*	*DEH*	*State agencies*	*Regional management bodies*
National Coordination												
▪ R&D coordination	✓✓✓	✓	✓✓	✓✓✓	✓	✓✓	✓	✓				
▪ Communication coordination												
– Broad	✓✓✓	✓✓	✓✓	✓✓	✓		✓✓	✓	✓	✓		
– Project specific	✓✓✓	✓	✓✓	✓✓		✓✓		✓✓				
▪ Knowledge exchange coordination	✓✓	✓✓	✓✓	✓✓	✓		✓✓	✓✓	✓			
▪ Quality assurance coordination	✓✓	✓	✓					✓			✓	
Funder or provider of R&D												
▪ Generic principles	✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	✓✓✓	✓	✓	✓✓	
▪ Catchment specific	✓	✓	✓		✓✓	✓	✓✓	✓			✓✓	✓✓
Extension provider	✓✓	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓	✓	✓✓✓	✓✓
Funder of on-ground works												
▪ National level		✓✓						✓				
▪ State level		✓✓✓	✓				✓✓	✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
▪ Regional level		✓✓✓	✓		✓✓		✓✓		✓✓	✓✓	✓✓	✓✓✓
Public policy development												
▪ National level	✓✓	✓✓		✓	✓✓	✓	✓	✓✓	✓✓✓	✓✓✓	✓	
▪ State level	✓	✓✓	✓		✓✓	✓	✓	✓			✓✓✓	
▪ Regional level	✓	✓✓			✓✓						✓✓	✓✓✓

Source *National Dryland Salinity Program, Submission no. 35, p. 21.* Number of ✓ indicates degree of involvement.

5.8 The following abbreviations apply to the agencies and programs listed in Table 5.1:

NDSP	*National Dryland Salinity Program*
NAP	*National Action Plan for Salinity and Water Quality*
CRCs	Cooperative Research Centres
LWA	Land and Water Australia (Research and Development Corporation)
RDCs	Research and Development Corporations
MDBC	Murray-Darling Basin Commission
NLWRA	National Land and Water Resources Audit
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DEH	Australian Government Department of the Environment and Heritage

The National Dryland Salinity Program

5.9 The *National Dryland Salinity Program* (NDSP), which is described at length in the previous chapter, is a 'collaborative research, development and extension (R, D & E) program investigating the causes of, and solutions to, the problem of dryland salinity.'[9]

5.10 The Australian Government regards the NDSP as 'Australia's major government-based salinity network and information resource':[10]

> Over the past nine years of operation the NDSP has helped to raise awareness of salinity through regular newsletters and media articles (such as the "Silent Flood" series screened on ABC television), supported research and development into the causes of salinity, and … supports regular national forums to share information and insights into salinity and means for its management.[11]

5.11 Established in 1993, the NDSP commenced in an environment where:

> there was no national strategy for dealing with dryland salinity; few statewide strategies existed; experts argued about the size and cost of the emerging problem; catchment management was in its

9 NDSP, *Submission no. 35*, p. 11.

10 DAFF and DEH, *op. cit.*, p. 12.

11 *ibid.*

> infancy; and Landcare and production interests were inadequately integrated.
>
> The role for research in this institutional environment was seen as crucial, but was poorly directed and coordinated. There were few frameworks or set of priorities, except within the Murray-Darling Basin, to assist research funding agencies such as Land and Water Australia to invest rationally in dryland salinity R&D …
>
> Whilst there was no shortage of research effort, much of it was poorly conceived and misdirected, lacked rigour, duplicated efforts undertaken elsewhere, or was undertaken in isolation from other essential pieces of the puzzle or from those expected to implement the results.[12]

5.12 In this environment, the NDSP funded and coordinated dryland salinity R&D, and provided a national framework for stakeholders to invest collaboratively and efficiently in dryland salinity research. The NDSP argued that it made a 'critical contribution to the coordination of industry, Commonwealth and State government research and communication on dryland salinity throughout the 1990s', and that much has improved over the past decade as a result of the Program's efforts.[13]

5.13 The NDSP has undergone two five-year phases and is now in a final 'Enhanced Communication' year prior to its scheduled closure on 30 June 2004:

> Both phases of the NDSP attempted to enhance the national coordination of salinity science, establish national research priorities for efforts fundamental to underpinning state and regionally-based management responses, fund and manage research projects against these priorities, and create a network of knowledge exchange at both community and professional levels.[14]

A description of these phases and examples of the range of research products and extension activities they entailed are provided in the previous chapter.

5.14 The NDSP was instigated and is still managed by LWA, which has also been the principal financial contributor to the Program.[15] The Program is

12 NDSP, *op. cit.*, p. 1.

13 *ibid.*, p. 7. See also NDSP, *Exhibit no. 25, NDSP Achievements Report*, and *Exhibit no. 27, NDSP Communication Report 2002-03.*

14 NDSP, *Exhibit no. 134, National Priorities for Salinity Research and Development,* p. 3.

15 In 2002-03, LWA contributed $1.1 million of the Program's total income of $1.6 million. Other partners contributed $338 224. See NDSP, *Exhibit no. 26, NDSP Annual Report 2002-03,* p. 19.

funded by a consortium of industry and government agencies with an interest in salinity management, including: LWA, MDBC, DAFF, CSIRO, GRDC, RIRDC, Meat and Livestock Australia, and the six state governments of New South Wales, Victoria, South Australia, Western Australia, Queensland and Tasmania.[16]

5.15 The operational structure of the NDSP, depicted in Figure 5.1, is comprised of a Board of Management, an Operations Committee and a Communications Team.

- The Board is responsible for setting strategic directions for salinity R&D and then allocating Program funds towards priority research areas. The funds are derived from pooling partner (industry and government) commitments to the Program. As the Program's funding agencies are prominent in their respective state and industry-based salinity networks, the Board is well connected to national salinity efforts.[17]
- The Communications Team is comprised of a network of five state coordinators and a national leadership team. The Team, which is responsible for communicating key messages and research products, synthesises and shares NDSP-generated salinity knowledge as well as salinity knowledge in general. The NDSP argued that the Team is 'critical to the success of bridging both the coordination gap and in establishing effective links between the research outcomes and on-ground users.'[18] It was also argued that the Team is 'without a doubt, one of the most comprehensive and nationally connected communication teams dealing with any aspect of natural resource management existing in the country.'[19] The Committee further explores the communication and extension of salinity science in chapter eight.
- The Operations Committee, which is comprised of key salinity researchers and private consultants, selects projects, maintains technical quality and facilitates information exchange among the nation's salinity researchers:[20]

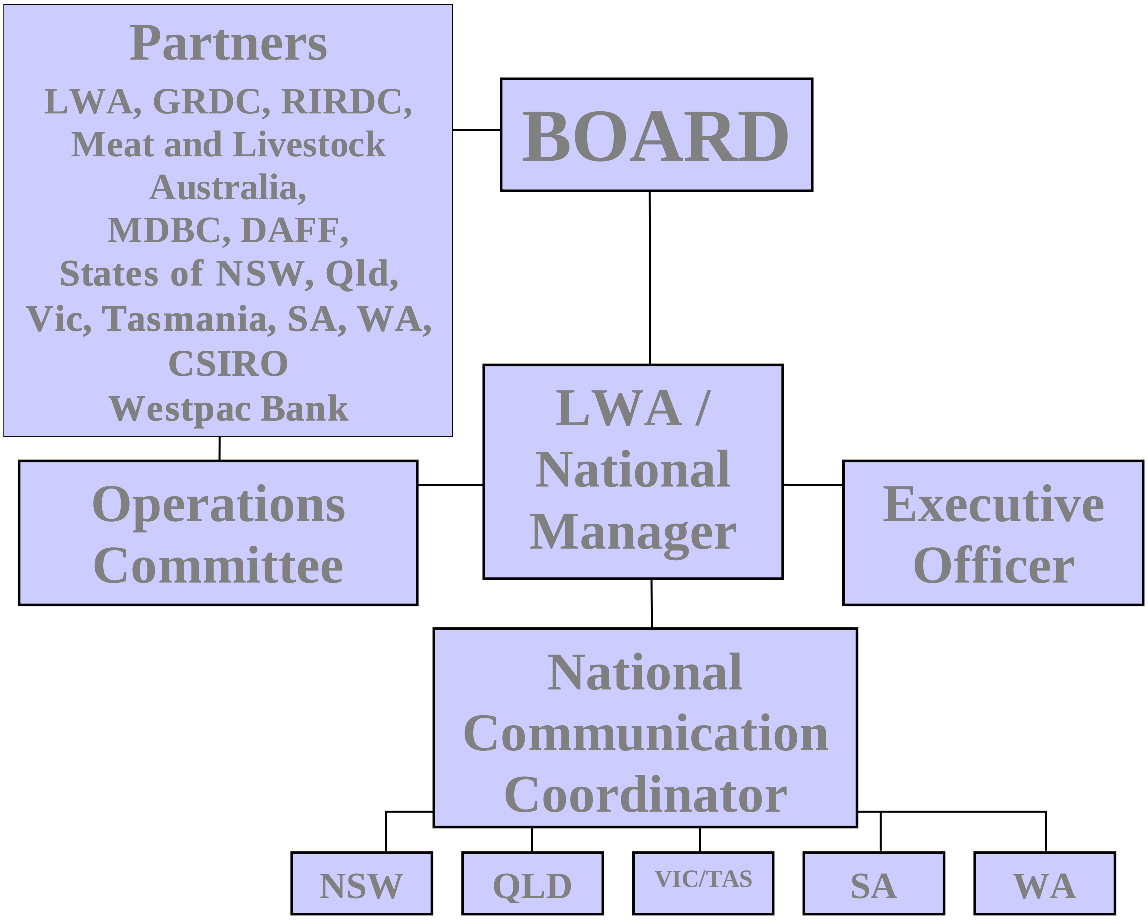
> This grouping allows for knowledge exchange and then the information is taken back and disseminated to those on-ground extension workers where necessary. By bringing together the

16 NDSP, *Submission no. 35*, p. 12.
17 *ibid.*, pp. 12-13.
18 *ibid.*, p. 23.
19 *ibid.*, p. 13.
20 NDSP, *Exhibit no. 25*, *op. cit.*, pp. 2-3.

> researchers and advisors from each partner it allows for the ability to tap into the shared knowledge base and improve.[21]

The Operations Committee provides for an independent analysis of the state of current salinity research.[22]

Figure 5.1 Structure of the National Dryland Salinity Program



Source National Dryland Salinity Program, Submission no. 35, p. 14.

5.16 LWA emphasised the value of the Operations Committee which 'remains the most important national forum for technical experts to consider salinity research issues on their technical merits, largely free from jurisdictional concerns.'[23] LWA described the importance of the Committee's separation from the NDSP Board:

21 NDSP, *Submission no. 35*, p. 23.
22 *ibid.*, p. 13.
23 LWA, *Submission no. 59*, p. 2.

> One of the critical things about the National Dryland Salinity Program that I think is under recognised is … the Operations Committee, which sits under the Board. The Operations Committee of the NDSP has had in it, throughout its entire history, Australia's main expertise on salinity—from the major science agencies and from some of the key private consultants … They have had some fierce and energetic exchanges over the years … and certainly they have not put all their eggs in one basket in terms of scientific theories, concepts or methodologies.
>
> I would argue that the real strength of the Program has been its ability to get the key players around the table in such a way that they are not wearing a state or territory hat, an agency hat or an organisational hat but just sitting around as experts, because we had a structure that had them separate from the Board. The Board was making the funding decisions and allocating resources but it took advice from the Operations Committee. We think that, in something like salinity, you need to separate the technical understanding from the allocation of money, particularly where it goes across jurisdictional boundaries. You need to be able to free up the scientists to talk about the science in as free flowing and energetic a way as is necessary.[24]

Research coordination at the state level

5.17 Several state governments have taken steps to coordinate salinity R&D efforts. The governments of New South Wales, South Australia and Western Australia made submissions to the Committee's inquiry and details of their state arrangements are summarised here. The efforts of the MDBC were detailed in chapter two.

New South Wales

5.18 A major recommendation of the New South Wales (NSW) Salinity Strategy was the formation of a Salinity Research and Development Coordinating Committee (SRDCC), comprised of representatives of state government agencies, CSIRO, MDBC, the Australian Government's Bureau of Rural Sciences (BRS), and DAFF. The SRDCC provides advice to

24 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, pp. 27-28.

the State Ministers for Agriculture and for Land and Water Conservation on research priorities and coordinates the State's salinity research efforts.[25]

5.19 The SRDCC has undertaken a process to identify and prioritise salinity research needs in NSW, which has involved:

- developing a strategic framework for salinity R&D, which identifies key questions that need to be answered for effective salinity management in NSW and criteria that can be used to evaluate the potential for research proposals to answer those research questions;
- compiling a register of current salinity research activities at the national and state levels, grouped according to their relevance to the key knowledge questions identified in the framework document;
- identifying and analysing knowledge gaps; and
- developing and prioritising research programs to address the knowledge gaps.[26]

5.20 The strategic framework and inventory of existing research was distributed to government and non-government agencies for their information and use. The SRDCC recommended that the framework be used in determining the R&D elements of investment strategies being developed by NSW CMOs, as well as investments by RDCs, universities and other R&D providers and purchasers. The strategic framework will also be used to assist investment decisions made under the NAP in NSW.[27]

Western Australia

5.21 The Western Australian Government has established a Salinity Research and Development Technical Committee (WA SRDTC). The WA SRDTC is a consortium of scientists from Western Australian State agencies, universities and CSIRO divisions involved in researching salinity problems within the State. The WA SRDTC is a committee of the Western Australian Natural Resource Management Council, which reports to the Minister for the Environment and the Cabinet Standing Committee on Environmental Policy.[28]

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25 NSW Government, *Exhibit no. 43, A Strategic Framework for Salinity Research and Development in NSW*, p. 2; NSW Government, *Submission no. 61*, p. 1.

26 NSW Department of Agriculture, *NSW Salinity R&D Portfolio*, Government of NSW, Sydney, 2003, p. 1, viewed 27 January 2004, <www.agric.nsw.gov.au/reader/13076>.

27 NSW Government, *Exhibit no. 43, op. cit.*, p. 30.

28 WA SRDTC, *Exhibit no. 86, Information on the Natural Resource Management Council of Western Australia*, p. 1.

5.22 The WA SRDTC has identified State salinity research priorities, carried out assessments of the State's Salinity Action Plan, convened conferences and provided technical reviews of solutions to salinity for the State's Salinity Council, the predecessor of the current State NRM Council.

South Australia

5.23 In South Australia, a Dryland Salinity Committee (SADSC) has been established to advise the State's Soil Conservation Council on the implementation, evaluation and review of the State's Dryland Salinity Strategy. The Committee is comprised of regional community representatives, representatives of key State Government agencies, the University of Adelaide and CSIRO.[29]

5.24 In addition to providing guidance to regional integrated natural management (INRM) groups in the development, evaluation and implementation of regional salinity management plans, the SADSC is also responsible for identifying salinity R&D priorities for the State and for communicating research findings. The Committee identifies and coordinates 'the science needed to underpin the implementation of salinity programs' and has 'initiated and developed a wide range of salinity R&D and extension projects.'[30]

5.25 The SADSC is supported by a Technical Advisory Group, comprised of representatives of key R&D organisations, including CSIRO, the NDSP, University of Adelaide, State Government agencies, extension officers and regional groups.[31]

5.26 The South Australian Government observed that the SADSC and its Technical Advisory Group have ensured that the salinity R&D effort in South Australia is highly collaborative and strongly linked to the needs of end users. The Government noted that research collaboration in the State has been strengthened through the co-location of researchers from the relevant state agencies, CSIRO Land and Water and the University of Adelaide at the University's Waite campus.[32]

5.27 In 2002, the South Australian Government also established a Centre for Natural Resource Management (CNRM), the aim of which is to:

29 Government of South Australia, *Submission no. 81*, p. 2. See also: Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, Government of South Australia, Adelaide, 2001, p. 34, viewed 23 February 2004, <www.saltcontrolsa.com/pdfs/sadss_72.pdf>.

30 *ibid.*

31 *ibid.*

32 *ibid.*

> create partnerships between regional INRM Groups and scientists so that integrated natural resource management across South Australia is based on world-class research and development.[33]

5.28 The Centre has established a Technical Working Group, comprised of representatives of peak scientific research agencies in South Australia, which has conducted meetings with regional INRM groups to discuss their information needs that could be met through scientific research:

> The outcome of these discussions has been a commitment from both the research agencies and the regional groups to continue building the relationship and to seek funding from a range of sources to address key issues identified through the process. Where more than one region has raised similar research needs, the Technical Working Group has sought to combine them into one multi-regional bid for funding. In one case, a project has been developed for the greater Lower Murray NAP region, which incorporates an area across South Australia, New South Wales and Victoria.[34]

5.29 A number of salinity projects have been identified through this process, including:

- identifying future trends in salinity and drivers of salinity across whole regions;
- better understanding hydrological systems in dryland and irrigated agriculture at threat of or that cause salinity;
- exploring options to better manage salinity (improved soil management practices, improved irrigation systems, new industries based on perennial vegetation); and
- protecting biodiversity assets from salinity (particularly wetland and floodplain ecosystems).[35]

5.30 CSIRO noted that the South Australian CNRM has:

> reviewed all current regional plans, held workshops with regional groups to discuss their knowledge gaps, prioritised research needs to underpin the regional investment and identified appropriate research providers.[36]

33 *ibid.*, p. 5.
34 *ibid.*
35 *ibid.*, pp. 5-6.
36 CSIRO, *Submission no. 42*, p. 7.

Victoria

5.31 Although the Victorian Government did not provide a submission to the inquiry, the Committee was informed of the NRM program of the Victorian Department of Primary Industries at Tatura, which delivers R&D services to the irrigation sector with a primary focus on sustainability. The Program includes 25 scientific staff and nine technical support staff. Among its four sub-programs, one relates to salinity and water quality and the projects currently supported include:

- groundwater management;
- farm salinity management;
- improved management of re-use dam water and dairy effluent as water sources on dairy farms;
- guidelines for sustainable irrigation with saline-sodic water;
- the effect of salinity and water logging on the productivity of forage species; and
- EM38 (hand-held electromagnetic induction surveying technique) soil salinity surveys.[37]

The need for and challenges in research coordination

5.32 The overview of salinity programs and research activities provided in the previous chapter demonstrates the veracity of the statement that there exists 'a complex landscape of research and science to support salinity management' in Australia.[38] While maintaining that the salinity research landscape is perhaps necessarily complex, CSIRO suggested that the current situation has led to a number of deficiencies:

- there are poor linkages between regional investment strategies and many of the research activities;
- there is a lack of cohesion between state and Australian Government activities;
- the coordination of research priorities from regional plans into state or national programs is currently weak (although state centres such as

37 Victorian Department of Primary Industries, Tatura, *Exhibit no. 59, Natural Resource Management: ISIA Project Summaries, May 2003,* pp. 23-35.

38 CSIRO, *op. cit.*, p. 9.

South Australia's CNRM are having a positive effect with respect to NAP funding);

- CRC programs do not cover all states, are often not well linked to regional bodies nor responsive to state issues;
- RDC's have been isolated from the regional planning processes and have historically been production-oriented—even when sustainability issues have been funded they have been poorly related to catchment-scale issues; and
- the direct BRS / Geoscience Australia (GA) funding for NAP-related activities has been poorly coordinated with state and regional activities and lacks a strategic framework as occurred through the NDSP.[39]

5.33 The WA SRDTC was critical of the lack of science coordination provided by core Australian Government agencies:

> Only the NDSP offers any consistency and coordination of responses … the level of coordination of scientific and technical services provided by the … Commonwealth agencies (DAFF, BRS, GA, MDBC) in the areas of dryland and irrigation salinity is discouragingly low and generally has little relevance outside the Murray-Darling Basin. Any national coordination that has occurred has been through the National Dryland Salinity Program and more recently though the CRC PBMDS (but only for a subset of the relevant agencies and issues).[40]

5.34 Another issue, identified by the Australian Nuclear Science and Technology Organisation (ANSTO), was that individual researchers find it difficult to identify a 'big picture' to which they should be contributing.[41] In this regard Professor James Macnae stated that despite:

> [t]he expressed interest in salinity of a great many federal, state and catchment authorities … there is no obvious single point of contact for a research scientists to make any direct approach to discuss problems and possible solutions.[42]

5.35 Some private sector companies called for improved coordination between the activities of national science agencies and the private sector.[43]

39 *ibid*.

40 WA SRDTC, *Submission no. 54*, pp. 4-5.

41 ANSTO, *Submission no. 22*, p. 4.

42 Professor James Macnae, *Submission no. 37*, p. 1.

43 Australian Spatial Information Business Association (ASIBA), *Submission no. 58*, p. 7.

5.36 The Committee provided an overview of the responses to the national NRM programs in chapter two. The evidence pertaining to research coordination is further developed in the sections which follow.

Implications of the National Action Plan and regional devolution

> *It is the fundamental issue of how far you take regionalism versus a generic way of approaching these kinds of coordination tasks.*[44]

5.37 Among the responses to the national NRM programs, outlined in chapter two, was the argument that the architecture of the NAP does not facilitate a nationally coordinated approach to salinity science.[45]

5.38 The NDSP noted that the devolution of NRM planning and delivery to the regional level has produced a 'major shift in the research supply-demand relationship'. While research priorities were previously determined by research and regulatory agencies, with the advent of the NAP 'it is now the community that has the purchasing power to determine research priorities specific to individual regions.' This regional approach was welcomed for the possibility that it might 'enhance the ownership of the results of purchased research and, in theory, increase the likelihood of adoption of the results.'[46]

5.39 However, the NDSP argued that the NAP has had deleterious consequences for science coordination that were hard to foresee. In particular, the NAP has:

> focussed Australia's limited research resources into regional contexts, resulting in an increased amount of activity at the regional level whilst causing the focus at the national level to fragment.[47]

5.40 One implication of the new funding arrangements has been institutional disruption for agencies at the national level. While this disruption has allowed a welcome and timely reassessment of roles and responsibilities for the major research agencies, it has caused confusion:

> For some institutions, such as CSIRO, whose research strengths lie in providing generic scientific underpinnings and frameworks critical across a number of regions, there exists a tension between having a national mandate with a knowledge-base that is

44 Dr Richard Price (NDSP), *Transcript of Evidence*, 3 November 2003, p. 14.

45 LWA, *op. cit.*, p. 3.

46 NDSP, *Exhibit no. 134, National Priorities for Salinity Research and Development*, p. 1.

47 NDSP, *Submission no. 42*, p. 7.

> extremely useful to regions and a lack of capacity to respond on a region-by-region basis. This tension is exacerbated under a funding regime that favours the regional approach, and where many regions are working to similar time schedules that result in the widespread and simultaneous demand for research assistance. Such institutions are currently facing a transitional period of internal adjustment that reflects a microcosm of the broader adjustments taking place across the institutional landscape of R&D providers.[48]

5.41 The CSIRO itself urged that there be a re-assessment of national salinity R&D coordination. CSIRO noted that the increased funding now available under the NAP, combined with the structural changes in NRM policy (notably, devolution of NRM to regional groups), have significantly changed the environment for application of salinity science:

> Additional resourcing and structural changes resulting from the NAP critically call for a re-assessment of national salinity research coordination needs, recognising the vital role the NDSP played since its inception … and its legacy of established networks.[49]

5.42 The shift to regional NRM has presented difficulties for national and state research providers, notably:

- the large number of CMOs has meant high transaction costs in communication for research providers;
- there is potential for creating confusion for the CMOs if approached by several research providers;
- there is a need to convince some CMOs to invest in technical information;
- it is not clear who is providing the balance between emerging technologies and existing technologies, and whether they have the capacity to make those decisions; and
- the difficulty of getting coordination between CMOs to support strategic research.[50]

5.43 At the regional level, CMOs purchasing research expressed frustration with the competition between research providers in what has effectively become an open-market, and the lack of coordination between providers.

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48 *ibid.*

49 CSIRO, *op. cit.*, p. 1.

50 *ibid.*, p. 4.

For example, the Murray Catchment Management Board (MCMB) noted the challenges of dealing with a number of messages about science and technologies:

> The task of deciding what is genuine or what is being promoted for self-interest, the quality of the science, how to deal with conflicting messages and the risks of ignoring this information are all issues the Board has had to contend with and would therefore welcome a coordinated nationwide, advisory source.[51]

5.44 The MCMB further stated it 'would welcome a nationwide approach in the coordination and sharing of ideas, research and information' and recommended that the Australian Government take a lead role in 'distilling the best science for addressing salinity'.[52]

5.45 Similarly, Mr Philip Dyson argued that:

> The catchment management authority model … has been a big step forward … The real problem we have … is that we seem to have put all our resources into regional catchment communities. I do not think we have the balance right in providing a level of central support for those kinds of organisations.[53]

5.46 The CRC for Landscape Environments and Mineral Exploration (CRC LEME) was emphatic that regional devolution under the NAP has 'stifled scientific cooperation, scientific progress, the generation of new science and … people are doing their own thing in an uncoordinated manner.'[54]

5.47 The NDSP argued that the dilemma faced by individual agencies with a national mandate, such as the CSIRO, has been shared by institutions at subsequent and cascading scales:

> While opportunities are enhanced for State-based provision of regional research, their over-stretched capacity makes it difficult to deal with important and emerging research gaps, especially if it comes at the expense of providing technical guidance to regions on implementing the limited range of options that presently exist to deal with salinity. This dilemma is highlighted further by recent findings that these options have limited adoption appeal in the cold hard light of economic reality.[55]

51 MCMB, *Submission no. 10*, p. 1.

52 *ibid*.

53 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 5.

54 Dr Dennis Gee (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 17.

55 NDSP, *Exhibit no. 134*, *op. cit.*, pp. 1-2.

5.48 The South Australian Government emphasised that the regional framework, reinforced in the funding arrangements for the NAP and other national NRM programs, may have implications for research activity that is beyond the boundaries and scope of individual regions:

> [T]here is a risk that the science needed to improve understanding of the biophysical processes or to develop alternative and innovative solutions (including policy and institutional mechanisms) to salinity problems will be beyond the resources, charter and scale of individual regions. By their nature the regional … [groups] will be focussed on local or regional issues and will endeavour to maximise the amount of funding directed towards immediate actions to manage salinity and other natural resource issues. Accordingly, there will be a tendency to give investment a low priority into longer-term and potentially more important research and development.
>
> While the option exists for individual regions to pool their funds for larger scale or more basic research and development, this would come at a cost to their on-ground actions and would meet with considerable local resistance. This would also be a fragmented approach as it would be subject to the decisions made by several regions, reflecting the differing priorities within each region.[56]

5.49 The CRC for Plant-based Management of Dryland Salinity (CRC PBMDS) also noted the difficulties of coordinating research activity under the regional approach:

> The way it stands at the moment is that a catchment management authority has to make a decision to support a research project in its catchment. Although $1.4 billion [the total budget for the NAP] sounds a lot of money, their resources at catchment level are fairly limited and there is a strong expectation that the money will be spent for on-ground works, so getting them to contribute to a significant statewide or national research effort is very difficult indeed.[57]

5.50 LWA pointed out the inefficiency of each individual CMO conducting generic salinity research:

> The National Land and Water Resources Audit salinity assessment illustrated that the salinity processes operating across many

56 Government of South Australia, *op. cit*., p. 5.

57 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, Perth, p. 18.

> regions, and in fact across state boundaries, are similar … While regionally specific information at a fine-grained resolution is critical for management purposes, it makes little sense to research the broader generic issues that should inform priority setting and resource allocation, in every region or even every State.[58]

5.51 More forcefully, the NDSP told the Committee that:

> investing through the regions and then assuming that regions have a capacity to drive the coordinated R&D agenda is aspirational. We do not see that the momentum is built yet for nationally coordinated R&D on the basis of that approach …[59]

5.52 State governments agreed with these assessments. The South Australian Government stated that 'there is a clear and ongoing need for a nationally coordinated and collaborative approach to dryland salinity research, development and communication', such as has been provided through the NDSP.[60]

5.53 Similarly, the WA SRDTC noted that, with the winding back of the NDSP's funding base from June 2004, the national salinity R&D coordination role is 'an urgent issue' and called on the Australian Government to:

> Invigorate the existing and well-respected leadership role in salinity funding, knowledge management and coordination by the NDSP … in the development of targeted programs of R&D.[61]

5.54 The Committee notes that the *Scientific Advice on Natural Resource Management* report (2004), prepared by CSIRO and BOM for the NRMMC, also expressed concern at the lack of science leadership and overview to support the regional implementation of the NAP and NHT:

> Given the size of the NAP/NHT and its significant objectives, there is a striking lack of full-time scientific leadership and overview. Far more attention should be focussed on this area to develop a sense of scientific cohesion and support for CMAs. Otherwise, there is a real probability that investment will be targeted on the wrong areas. The current structures at the state level focus more on administrative issues, project investment and compliance. Whilst each jurisdiction has clearly worked hard on

58 LWA, *op. cit.*, p. 3. See also Associate Professor David Pannell, *Submission no. 13*, p. 4.

59 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 3.

60 Government of South Australia, *op. cit.*, pp. 3, 7.

61 WA SRDTC, *op. cit.*, p. 5.

> trying to ensure that scientific robustness of the NAP/NHT programs is maintained, the lack of cross-jurisdiction coordination means that this is often done in relative isolation and/or the focus is often moved away from science to delivery.[62]

5.55 CSIRO maintained that, in the new NRM context, without effective science coordination at either state or national levels there is a real risk of:

- disconnection between science providers and NRM program implementation;
- a lack of investment in strategic research required to overcome knowledge gaps underpinning regional plans;
- lack of uptake of new technology;
- lack of coherence between different regional plans and monitoring;
- failure to learn from others' mistakes;
- lack of acceptance of lessons coming from science;
- greater influence of local interest groups; and
- the lack of a regulatory framework to ensure best management practice for engineering schemes.[63]

Increased research activity and complexity

5.56 While the NDSP commenced in an environment where there was no national strategy for dealing with dryland salinity, few statewide strategies existed and there was little agreement about the size and cost of the emerging problem:

> The 1990s saw a burgeoning in the number of organisations becoming involved in salinity research and extension. A nationally focussed Cooperative Research Centre was set up in 2001 to investigate plant-based solutions to salinity. At least three other CRCs have also conducted research into certain aspects of the problem.
>
> Furthermore, some of the member organisations of the NDSP have undertaken research activities independently of the NDSP …

62 *Scientific Advice on Natural Resource Management: A Report to the Natural Resource Management Ministerial Council by the Commonwealth Scientific and Industrial Research Organisation and the Commonwealth Bureau of Meteorology*, report presented to the NRMMC, Adelaide, February 2004, pp. 54-55.

63 CSIRO, *op. cit.*, p. 7.

> Industry R&D corporations and State government agencies have also ramped up their investments in salinity.[64]

5.57 Similarly, Mr Andrew Campbell of LWA observed that:

> I counted at one stage about 50 organisations at the national level that are involved in funding or doing natural resource management research. A large number of those would be involved in … salinity related work. Now that we have regional delivery of major national programs, there are 60 or 70 regional bodies that are charged with putting the information into effect on the ground. So the number of players has increased dramatically, and the difficulty of finding out what all of them are doing at any one point in time has increased accordingly.[65]

5.58 However, rather than detracting from the need for a coordination role, it was argued that the significantly increased number of organisations conducting salinity R&D and extension activities reinforces the need for effective coordination:

> We certainly do need to improve the coordination of science … to address salinity. This is not because there is a lack of activity but because there has been such a huge increase of activity in recent years and the number of players has increased enormously … The last thing we need in an already crowded sector is to create another institution …We need to look at the existing institutions and how they can work better together.[66]

5.59 The NDSP expressed similar views:

> As the political profile of salinity has risen so too has the number of government and industry initiatives for addressing salinity. There is now a degree of "crowding-out" among the various programs and initiatives. While the growth in research and extension effort is welcome, it does add complexity to the network of funding organisations, research providers and extension programs. In order to deal with the maze of information forthcoming from these networks, organisations and research providers it is imperative that there is some coordinated form of managing the science in relation to Australia's salinity programs. This coordination is essential not only to manage "crowding", but

64 NDSP, *Exhibit no. 25*, *op. cit*., p. 3.

65 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 3 November 2003, p. 6.

66 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 18.

> also to relieve the pressure placed upon existing research talent where expertise is still lacking or only just emerging.[67]

5.60 Similarly, the MDBC observed that:

> The key thing in terms of science and the way we move forward is that there is a wealth of information, there is a wealth of science, there is a wealth of activity going on within CRCs and organisations such as CSIRO and the work initiated through LWA and the NDSP. Yet we cannot bring all that information together … What I suggesting is that, over and above all, we need networks that share information—distributed networks.[68]

5.61 The South Australian Government expressed the 'major concern' that:

> without a national approach, salinity research and development would lose its momentum and resources for research and development would be withdrawn. This has occurred with other NRM issues … when the national approach has been removed.[69]

5.62 The NDSP summarised the value and importance of a coordination role for salinity science:

> Developing an effective coordinating group whether it is at a national or state level is paramount to the success of dealing with salinity. Such groups can help provide the necessary links between those undertaking the research and those utilising the research on-ground. A coordinating body enables information to be brought across the jurisdictions and the range of Commonwealth and State bodies involved in salinity research and finding a single way ahead. All agendas and needs are then discussed and the risks of duplication can be reduced. A coordinating body can also set in place information and consistent advice within state policies and strategies.[70]

67 NDSP, *Submission no. 35*, pp. 10-11.

68 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, pp. 37-38.

69 Government of South Australia, *op. cit.*, p. 4.

70 NDSP, *op. cit.*, p. 23.

Institutional proposals for improved coordination

5.63 The Committee was presented with a range of proposals to improve the national coordination of salinity research and development.[71] These included establishing new organisational structures such as:

- an Australian Centre for Salinity Research (or 'Centre of Excellence in Salinity'), with a mandate similar to the United States Salinity Laboratory, to substantially expand on the efforts of the CRC PBMDS;[72]
- an Australian Salinity Research Program to manage research grants, modelled on the Australian Research Council or industry based research granting groups;[73]
- a peak scientific panel to review and compare latest research findings for the benefit of CMOs;[74]
- a CRC for Dryland Salinity;[75]
- a 'national salinity action committee' established through the Council of Australian Governments;[76]
- an independent, national research coordinating body or council;[77]
- a statutory authority tasked to implement a 50 year strategic plan for salinity management and research;[78] and
- 'an independent community-based body' who could identify research priorities to government.[79]

5.64 It was suggested that coordination could be improved by tasking established entities with this responsibility, for example: the Science and

71 The Committee deals with aspects of research coordination, specifically improved data management, separately in chapter seven of this report.

72 Australian Society of Soil Science Inc (ASSSI), *Submission no. 68*, p. 4. In January 2000 the United States Salinity Laboratory was renamed the George E. Brown, Jr. Salinity Laboratory. Information on the Laboratory is available online, viewed 9 January 2004, <www.ussl.ars.usda.gov>. The Committee notes that the Department of Science, Education and Training (DEST) is providing $6.7 million seed funding for an International Centre of Excellence in Water Resource Management. DEST, *Submission no. 69*, p. 3.

73 Dr Robert Creelman, *Submission no. 16*, p. 3. Also see Associate Professor Richard Bell (Murdoch University), *Evidence of Transcript*, 13 November 2003, p. 32.

74 MCMB, *op. cit.*, p. 2.

75 Dr Jerzy Jankowski, *Evidence of Transcript*, 29 October 2003, p. 32.

76 Mr David Hocking (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 2.

77 Deakin University, *Submission no. 17*, p. 2.

78 Dr John Hails, *Submission no. 12*, pp. 2-3.

79 Australian Salinity Action Network (ASAN), *Submission no. 39*, p. 9.

Information Working Group under the NRMMC;[80] or a central science organisation, with strong industry links, such as CSIRO or LWA.[81]

5.65 Approaches to coordinate aspects of salinity research were also proposed, and these included using as possible models: the Joint Venture Agroforestry Program, aimed developing agroforestry systems for sustainable landscapes;[82] and the National Geoscience Agreement for data management.[83]

5.66 The South Australian Government submitted that:

> While there are advantages and disadvantages with each of these possible arrangements, the essential issue at this time is to ensure that a national approach to dryland salinity research and development and communication continues.[84]

5.67 The Committee also notes the recommendation contained in the *Scientific Advice on Natural Resource Management* report (the 'CSIRO/BOM report') for the NRMMC, that:

> The NRM lead agencies review the existing institutional arrangements for coordinating, integrating and disseminating NRM related science and consider the benefits of strengthening the NAP/NHT through the appointment of a science leader and coordinating body …[85]

5.68 Among its other functions, the CSIRO/BOM report suggested that an NRM science coordinating body, possibly under a chief scientist, could facilitate cross-jurisdiction science coordination, and implement the existing recommendations of the NRMMC Science and Information, and Monitoring and Evaluation Working Groups. It was proposed that the coordinating body could be staffed by full or part time secondments from each state. However, it was noted that the body would not need to be centrally located:

80 Government of South Australia, *op. cit*., p. 4.

81 Australian Academy of Technological Sciences and Engineering, *Submission no. 34,* p. 1; Cotton Research and Development Corporation, *Submission no. 31,* p. 1.

82 Dr John McGrath (Forest Products Commission of Western Australia), *Transcript of Evidence,* 12 November 2003, p. 8.

83 CRC LEME, *Submission no. 64,* p. 5. This agreement is discussed in chapter seven of this report.

84 Government of South Australia, *loc. cit.*

85 *Scientific Advice on Natural Resource Management: A Report to the Natural Resource Management Ministerial Council by the Commonwealth Scientific and Industrial Research Organisation and the Commonwealth Bureau of Meteorology*, report presented to the NRMMC, Adelaide, February 2004, p. 55.

> Indeed there would be an advantage in having the science staff located with the state-based NAP/NHT personnel. However, having individuals who could further assist with the brokerage of information between R&D providers and the [CMOs] as well as provide advice on how more effective methods of predictive modelling and monitoring and evaluation can be achieved would considerably strengthen NAP/NHT outcomes.[86]

Support for the continuation and expansion of the National Dryland Salinity Program

5.69 Among the institutional proposals for national salinity R&D coordination, the continuation and expansion of the NDSP received by far the greatest support, for example:[87]

- Webbnet Land Resource Services noted that:

> If the NDSP does not continue in its current form, there is likely to be a serious impact on information transfer across main stakeholder clients … It has provided a vital coordinating and networking process for the relatively few professionals involved in salinity management. The program has helped develop the capacity nationally in aspects such as salinity risk assessment, evaluation of management options and emphasised the need for social and economic factors to be incorporated into these activities … Very serious consideration should be given to retaining the National Dryland Salinity Program … [88]

- Engineers Australia recommended that the Australian Government:

> invigorate the existing leadership role in salinity funding, knowledge management and coordination by the NDSP to ensure the development of targeted programs of R&D in salinity.[89]

- The Government of South Australia recommended that the Australian Government:

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86 *ibid.*

87 See for example: Government of South Australia, *loc. cit.*; CRC PBMDS, *Submission no. 8*, p. 1; Webbnet Land Resource Services Pty Ltd, *Submission no. 40*, p. 5; Professor David Pannell, *Submission no. 13*, p. 5; Engineers Australia, *Submission no. 73*, p. 2; WA SRDTC, *op. cit.*, p. 5; Australian Conservation Foundation, *Submission no. 62*, p. 5; Murdoch University, *Submission no. 24*, p. 4; CSIRO, *op. cit.*, p. 1. Support for the NDSP was also expressed by: MDBC, *Submission no. 51*, p. 3; ASSSI, *op. cit.*, p. 5; Western Australian Farmers' Federation, *Submission no. 36*, pp. 1-2.

88 Webbnet Land Resource Services Pty Ltd, *op. cit.*, pp. 3, 5.

89 Engineers Australia, *op. cit.*, p. 2.

> Ensure that the leadership and coordination in salinity research and development previously provided through the National Dryland Salinity Program continues. There is a clear and ongoing need for a nationally coordinated and collaborative approach to dryland salinity research, development and communication:
>
> - to identify the research and development issues of national significance and to ensure they are adequately addressed
> - to tackle those issues that are beyond the resources or jurisdictions of individual states.[90]

5.70 Among those submitters calling for the continuation of the NDSP, the WA SRDTC urged that an invigorated NDSP be expanded to encompass irrigation as well as dryland salinity, and that it have a key role in coordinating and brokering R&D activity in these fields.[91] Similarly, Engineers Australia recommended that the NDSP be revitalised as the 'National Salinity Program for Research and Development' and that it be 'given much greater responsibility and resources to act as the agent for coordination of research for dryland and irrigation salinity.'[92] The WA SRDC also urged that to perform the national salinity R&D coordination role, the NDSP be given 'much greater funding than in the past, including funding from core Commonwealth programs.'[93]

5.71 However, CSIRO suggested that, as a result of the structural changes resulting from the NAP, some reworking of the NDSP model may be required:

> The additional level of complexity presented by the devolution of NRM to the regions suggests a need for a more region specific and targeted research coordination effort. This implies a partial reworking of the current NDSP model to address the NAPSWQ needs and other NHT initiatives.[94]

5.72 Similarly, LWA observed:

> The challenge for the future is to develop coordination arrangements that are flexible enough to cope with both the existing architecture of the NAPSWQ and NHT and the generic demands across regions and by industries. The most efficient means of coordination often requires an element of authority, yet we know from experience that various jurisdictions do not easily

90 Government of South Australia, *op. cit.*, p. 7.

91 WA SRDTC, *op. cit.*, p. 7.

92 Engineers Australia, *op. cit.*, p. 2.

93 WA SRDTC, *loc. cit.*

94 CSIRO, *op. cit.*, p. 1.

> relinquish authority to others. We need a management and reporting mechanism that makes transparent the range of salinity R&D investments, and consequently any duplication and gaps in effort, as the basis for collaborative decision-making and resource allocation.[95]

5.73 The NDSP itself conceded that while the NDSP is well known to traditional research providers and NRM agencies, it is less well known amongst the emerging regional bodies:

> [W]e have a track record … when it comes to key agencies across Australia, R&D corporations and people like Westpac Bank and the Murray-Darling Basin Commission, we do not have that with the new players, particularly catchment management bodies or regional bodies in natural resource management. I think that is a weakness now, and that is probably where a fair bit of the demand is coming from.[96]

5.74 In terms of supporting the CMOs, LWA proposed that the NDSP could perform an advisory service and act as a:

> first-stop shop … finding out where the information is—whom should I be talking to; whether any work has been done on this and, if so, where; where can I find more about it; who are the relevant bodies to be talking to about it.[97]

5.75 In the event of the NDSP's closure, successor agencies were nominated including the creation of a program modelled on the Australian Collaborative Land Evaluation Program for the development and transfer of standards in salinity assessment and management.[98] The Australian Conservation Foundation (ACF) suggested the continuation and expansion of the NDSP, but possibly modified as a new broad-based 'Landscape Changes Program', which could give the CRC PBMDS and LWA a leadership role.[99]

5.76 Despite the level for support for the NDSP, including from at least two state governments, LWA noted that some states have resisted nationally coordinated research efforts:

> As overall funding levels for salinity R&D have increased, the commitment of State agencies to the NDSP itself has declined,

95 LWA, *op. cit.*, p. 3.

96 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, pp. 5-6.

97 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 3 November 2003, p. 8.

98 Webbnet Land Resource Services Pty Ltd, *op. cit.*, p. 5.

99 ACF, *op. cit.*, p. 5.

> with larger states tending to 'do their own thing' rather than invest in salinity R&D through a coordinated national approach.[100]

5.77 Furthermore, in recognition of the increased investment in salinity activities by a range of agencies, the LWA Board decided in December 2002 that the Corporation would no longer be the major investor in salinity research after the current Enhanced Communication Year of the NDSP ends in June 2004. The Board believes it is appropriate for the Corporation to direct its research investments into other areas not yet recognised by mainstream research and policy.[101] However, LWA noted that:

> if resourced to do so, [LWA] is quite prepared, and very well placed to continue to play a coordination, brokering and knowledge management role in salinity R&D at the national level. Such a role would be consistent with the direction to [LWA] from Senator Troeth (Minister responsible for R&D Corporations) that [LWA] should "promote, integrate and coordinate" natural resource management R&D across the rural R&D corporations and related companies, recognising that this is a critical national research priority.[102]

5.78 LWA also emphasised that coordination of salinity science must be placed within broader contexts, and particularly that 'salinity R&D needs to be coordinated within the context of the full suite of natural resource management issues, not as an isolated phenomenon.'[103] In this respect, it was noted:

> This is where single issue-based programs such as the NDSP have their limitations. While focussing on single issues can draw the critical mass of attention needed to resolve them, it is difficult to focus both inwards and outwards at the same time.[104]

5.79 Consequently, LWA argued that:

> Institutional structures for coordinating salinity science must be well connected to other scientific programs, information delivery systems and policy and management frameworks.
>
> [LWA], as a coordinator of national research programs across a broad spectrum of natural resource management issues, and with

100 LWA, *op. cit.*, p. 3.
101 *ibid.*, p. 2.
102 *ibid.*
103 *ibid.*, p. 4.
104 *ibid.*

> a focus on integration and knowledge brokering, has the capacity to act with governments, industry and communities to deal with salinity science in its appropriate context.[105]

5.80 In other proposals relating to salinity research coordination, the WA SRDTC recommended that the Australian Government: reduce the number of salinity programs and agencies; reduce internal competition for resources; and ensure that programs focus on needs and operate in all states where salinity is present. It was also recommended that BRS salinity-related staff be moved into Geoscience Australia or CSIRO.[106]

5.81 Submitters also recommended that the Australian Government 'overtly remove any coordination of research and development activities from administrative programs (for example, the NAP and NHT) and coordinate them within management systems like that provided by the NDSP.'[107]

5.82 Likewise, Associate Professor David Pannell cautioned that there are some significant dangers if research coordination is not handled well:

> Relations between the Commonwealth and some states in relation to the science are already somewhat strained due to the Commonwealth's poor handling of science-related issues to date. Some of the state agencies are already investing in salinity science in a more balanced and realistic way and have been frustrated by Commonwealth resistance to proposals for better funding of science within the NAP. Among the states, confidence in the quality of thinking about salinity science in the core NRM Commonwealth Departments is at a low level. If a Commonwealth Department attempts to take a coordinating role in this environment, it may cause more problems than it solves. I suggest that if any national coordinating role is judged to be needed, then it should be managed somewhat at arms length from the Department of Agriculture, Fisheries and Forestry and the Department of Environment and Heritage. A possible vehicle for this already exists in the form of the National Dryland Salinity Program (NDSP), which is well established and well respected. It appears that the commitment of some states to the NDSP has reduced and that its continuation beyond the current financial year is in some doubt. A commitment of resources by the

105 *ibid.*

106 WA SRDTC, *op. cit.*, p. 6.

107 *ibid.*, p. 7. See also Engineers Australia, *op. cit.*, p. 2.

> Commonwealth to ensure its continuation would appear to be timely and appropriate.[108]

Functions that could be performed by a coordinating agency or program

5.83 In addition to those needs identified above, submitters noted specific functions that a national salinity program or agency could perform. Engineers Australia suggested that an expanded salinity program should undertake the following actions:

- ensure the development of targeted programs of R&D to address salinity;
- coordinate data and information management through a single entity, preferably the National Land and Water Resources Audit;
- ensure investment in national programs and their coordination is matched by the capacity of industry, state and regions to implement actions. This will require a much greater involvement of users and potential beneficiaries in the early stages of program development. The adoption of salinity management options is far more effective when communities and landholders are involved in the research and development; and
- coordinate research programs with state and territory salinity strategies to help avoid overlap of research between different levels of government.[109]

5.84 The Government of South Australia also argued that there is need for a nationally coordinated approach to salinity R&D and communication in order to:

- identify the R&D issues of national significance and to ensure they are adequately addressed. There is still a need for a national program to tackle those issues that are beyond the resources or responsibilities of individual states and regions;
- ensure maximum participation and involvement of all stakeholders, including industry, government and non-government research organisations, and community;
- ensure that the efforts of all those involved are coordinated and that partnerships and collaboration between researchers are maximised;

108 Associate Professor David Pannell, *op. cit.*, p. 5.
109 Engineers Australia, *op. cit.*, p. 2.

- ensure that solutions are integrated within a landscape / NRM approach;
- support continued R&D in those areas that require a concerted and nationally coordinated approach, recognising that there are many problems that remain to be solved or are inadequately understood;
- ensure that the momentum developed through the NDSP in both R&D and communication is maintained; and
- ensure research and development outcomes and approaches are widely shared and communicated to all stakeholders through a national communication program.[110]

5.85 Other functions that could be performed by a national coordinating agency or program include providing expert advice to CMOs on the latest research findings and technologies.[111] The Chief Scientist also supported proposals to 'have a clearing house and a forum for helping to focus on what the needs are, as a minimum.'[112]

Conclusions

5.86 The Committee concludes that a strong case has been made in the evidence for a national coordination function for salinity R&D. The reasons for this include:

- the structural changes ushered in with the NAP, notably the devolution of NRM responsibilities to regions and the fragmentation of efforts at the national level;
- the perhaps unavoidable complexity of salinity research efforts across a large number of agencies and programs, which need to be effectively coordinated—now more than ever;
- to link research providers and their products with CMOs, land managers and others undertaking on-ground works;
- to identify the R&D issues of national significance, ensure they are adequately addressed and avoid duplication;

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110 Government of South Australia, *op. cit.*, p. 4.

111 MCMB, *op. cit.*, p. 2. See also WA SRDTC, *op. cit.*, p. 8.

112 Dr Robin Batterham (Chief Scientist), *Transcript of Evidence*, 24 November 2003, p. 22.

- to maintain the momentum developed through the NDSP in R&D and communication; and
- to better coordinate research programs with state and territory salinity strategies, so as to avoid overlap between governments at different levels.

5.87 The Committee also notes evidence suggesting that without a national salinity research coordinator, there is potential to revert to many of the problems which existed prior to the establishment of the NDSP:

- approaches were different between states;
- science development was dependent on the strength of research providers in each state;
- because of the piecemeal nature of the research, it was difficult to provide a national picture of the extent of the problem and there was a lack of coherence in learning from the research programs;
- there was a significant divide between researchers at a national level and regional planning groups; and
- much of the activity at a local/regional level was taking place with only minor technical input.[113]

5.88 While the Committee agrees that there is a need for a national R&D coordination function, it is reluctant to recommend the creation of yet another agency in what is already a complex field of agencies and programs.

5.89 The Committee notes the range of evidence in support of the NDSP, which has effectively brokered R&D priorities at the national level since its establishment in 1993. The NDSP has served a unique function which would be missed if discontinued. The Committee is persuaded that the role of the NDSP ought to be continued and its functions expanded to address other relevant matters, including irrigation and urban salinity. The Program could be renamed the *National Salinity Program*, or similar.

5.90 With the withdrawal of LWA funding, the closure of the NDSP is imminent. The Committee concludes that the Australian and state governments should, as a matter of urgency, provide funding for the Program's continuation and expansion.

5.91 The Committee is persuaded that salinity ought to be addressed in the wider context of the range of NRM issues. Institutional structures for

113 CSIRO, *op. cit.*, p. 3.

salinity science should be integrated with other NRM science programs. In this way, the single issue focus may not overwhelm the importance of integrated responses to the range of NRM issues which CMOs and land managers must address. Therefore, continuing to situate a *National Salinity Program* within LWA, which has this broader mandate, seems appropriate. The Committee is pleased to note the willingness of LWA to maintain the Program, conditional on alternative sources of funding being provided.

5.92 The Committee notes the implications of the devolution of NRM responsibilities to CMOs and particularly the need for support and guidance at the regional level. The Committee recommends that the *National Salinity Program* be reconfigured to meet the requirements of the new NRM environment and, specifically, that its coordination and communication strategies evolve to meet the needs of the NAP. This may entail more region specific and targeted research coordination efforts.

5.93 A range of functions that could be performed, and needs that could be met, through a *National Salinity Program* were proposed in the evidence. For example, the Program could act as a conduit for research conducted by its partner agencies through to CMOs, thereby reducing the transaction and communication costs imposed on science agencies, aiding greater consistency of advice and reducing the potential for confusion among CMOs.

5.94 The Committee notes that the Operations Committee of the NDSP has acted as the 'engine room for national exchange of information' and 'one of technical quality assurance.'[114] The Committee also notes that some CMOs are calling for a single, nationwide advisory source to assist them in judging the validity of various science messages, and to provide guidance on salinity technologies. While the Committee recognises that CMOs and land managers obtain advice from a range of sources, which are further discussed in chapter eight, the Committee concludes that a reformed Operations Committee of salinity experts may be able to assist CMOs (and state technical committees) in this regard.

114 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 5.

Recommendation 3

5.95 **The Committee recommends that the Australian Government ensure the continuation of the *National Dryland Salinity Program* (NDSP) as a matter of urgency, and that:**

(a) the role of the NDSP be expanded to address irrigation and urban salinity, with the Program renamed the *National Salinity Program* (NSP) or similar;

(b) the NSP be managed within Land and Water Australia (LWA);

(c) the NSP adopt research, coordination and communication strategies that assist the regional delivery of natural resource management programs and the requirements of the *National Action Plan for Salinity and Water Quality* specifically;

(d) the functions of the NSP have regard for those identified in this report;

(e) the NSP/LWA be adequately resourced to perform its functions by the Australian and state governments;

(f) relevant Research and Development Corporations, Cooperative Research Centres, national science agencies, universities, state agencies and the private sector be strongly encouraged to partner the NSP; and

(g) there be a continuing role for an Operations Committee, or equivalent, in providing independent scientific advice with that advice coming from a broad cross-section of scientific personnel from both the government and non-government sectors.

This recommendation should be read in conjunction with recommendations 1 and 15.

6

The adequacy of the science base, research needs and funding

6.1 This chapter addresses three issues:

- the adequacy of the Australian Government's investments in salinity science and the need for further research (paragraphs 6.2-6.30);
- research needs and prioritisation (paragraphs 6.31-6.82); and
- funding for salinity research (paragraphs 6.83-6.128).

The need for further salinity research

6.2 The Committee concluded its overview of the salinity science base in chapter four with the observation that a wealth of salinity research has been undertaken by a wide range of nationally funded agencies and programs. An array of research products and salinity management tools have been developed. The first section of this chapter develops further the Committee's views on the adequacy of the salinity science base.

6.3 Given the volume of salinity research that has been undertaken to date, a few submitters questioned the necessity for significant additional research, and suggested that the immediate priorities are to fund on-ground works and address barriers to the adoption of existing research.

- The Australian Institute of Agricultural Science and Technology (AIAST) argued that:

> The production of "information" on the salinity problem is now such that dealing with this information is a problem in itself. The large array of leaflets, booklets, scientific papers, data bases and

> maps have now exceeded the capacity of most filing cabinets and arguably have long since overflowed into waste paper baskets. This is wasteful of resources and may be creating a 'switch-off' mentality among the target audience.
>
> It has been much easier to get funding to "do more research" on salinity than to actually deal with the problems of mitigation and rehabilitation. The result is a flood of researched "solutions" but almost no action on the ground.[1]

- The Central Queensland University (CQU) also suggested that there is 'a significant body of research already available and that the major challenge is in the need for a greater focus on real time change in practice and attitude'.[2] For CQU however, the central issue is the barriers to uptake of available research by CMOs and land managers. Many of the latter are said to be 'operating under a dependency and avoidance model, with the expectation that someone else or the Government should pay for, compensate or solve the problem.'[3]
- AgForce argued that 'existing research has identified a range of land management practices which can limit or cease the spread of salinity' and that adequate funding is being provided for salinity research.[4] Rather, the priority is 'implementation of site-specific land management practices' and greater assistance for landholders to manage salinity at the property level.[5]

6.4 Other submitters also suggested that '[t]here is a considerable body of knowledge in existence that can already contribute to some positive landscape change' and that the current level of salinity knowledge is sufficient 'to commence some action now.'[6]

6.5 Notwithstanding the knowledge and management tools that have been developed, a majority of submitters stressed the need for on-going salinity research and identified critical research gaps:

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1 AIAST, *Submission no. 76*, p. 1.

2 CQU, *Submission no. 57*, p. 1.

3 *ibid.*, p. 2.

4 AgForce, *Submission no. 70*, p. 1.

5 *ibid.*

6 National Dryland Salinity Program (NDSP), *Submission no. 35*, p. 8; Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, p. 1.

> The level of scientific knowledge is not adequate to address the salinity problem. A continued emphasis on R&D, especially in relation to profitable solutions to dryland salinity is required.[7]
>
> National reports have recognised that there are significant knowledge gaps in our understanding of salinity and its mitigation and remediation. It is recognised that if these knowledge gaps are not addressed now, they will reduce the effectiveness of the $1.4 billion investment in the National Action Plan for Salinity and Water Quality.[8]

Imbalance in national salinity science investments and research shortfall

6.6 As indicated in the overview provided in chapter two, several submitters argued that the Australian Government's investment in salinity science is imbalanced and neglects research into new salinity management methods and technologies.[9]

6.7 The Western Australian Salinity Research and Development Technical Committee (WA SRDTC) argued that the 'portfolio of Commonwealth science investment in salinity needs to be more balanced' and 'the Commonwealth's current investment is not matching the State needs for strategic intervention and developing new systems.'[10]

6.8 These conclusions followed the findings of the Western Australian Salinity Taskforce, that effective management of salinity in Western Australia requires large scale land use change and broadacre solutions. The Taskforce report, *Salinity: A New Balance* (2001), recommended that governments should invest in and support major actions on private land by developing new technologies and industries, in addition to supporting

7 Grains Research and Development Corporation (GRDC), *Submission no. 29*, pp. 1, 10. See also: CSIRO, *Submission no. 42*, p. 1; Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 40; Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 2; Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 71; Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PBMDS), *Submission no. 8*, pp. 3-4; Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), *Exhibit no. 128*, *Salination models*, p. 3.

8 CRC LEME, *Submission no. 64*, p. 2.

9 See for example: Associate Professor David Pannell, *Submission no. 13*, p. 4; CRC PBMDS, *op. cit*., pp. 3-5; CSIRO, *loc. cit.*

10 WA SRDTC, *Submission no. 54*, pp. 5, 3.

smaller on-ground works on private land and targeted interventions to protect high-value public assets.[11]

6.9 Specifically, the Taskforce urged the Australian Government to direct investment through the NAP towards targeted protection of public assets (for example, rural towns and threatened high-value conservation areas) and develop new technologies and industries for salinity management, particularly:

- profitable perennial vegetation for recharge areas (for salinity prevention);
- engineering works (for example, in discharge areas or where there is impending loss of high value infrastructure or natural resources);
- salt-tolerant plants to make use of saline land; and
- methods to utilise saline water economically.[12]

6.10 The need to develop options for productive use of salinised land and water follows the research finding that the off-site benefits of establishing perennials can often be long-delayed (by decades or centuries), 'since most of the salinity that has already occurred will not be reversed, and a significant proportion of the prospective salinity is not practically preventable.'[13]

6.11 Accordingly, the Taskforce recommended:

> a better balance be struck between capacity building (strongly supported in the NAP and NHT programs), strategic intervention to save public assets (for example, rural towns, biodiversity and water resources) and developing new land and water use systems (for example, woody and herbaceous perennials, adaptation to salinity, innovative engineering solutions).[14]

6.12 Differences in the geology and landscape characteristics between the east and west of the continent may require distinct salinity management approaches and dictate different research and development (R&D) priorities.

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11 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111, Salinity: A New Balance*, pp. 15-17.

12 *ibid*., p. 16. These research priorities were also identified by CRC PBMDS, *op. cit*., p. 3, and Associate Professor David Pannell, *loc. cit*.

13 Associate Professor David Pannell, *op. cit*., p. 3.

14 WA SRDTC, *op. cit*., p. 3.

6.13 The Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF), and the Environment and Heritage (DEH) argued that technological developments, particularly airborne electromagnetic (AEM) salinity mapping, combined with the heterogeneity of the geology and the localised nature of salt, mean that targeted interventions are likely to be successful in combating salinity in the east of the continent (that is, the Murray-Darling Basin). Mr Mike Lee of DAFF stated:

> particularly on the eastern side of the continent, the salt in the landscape is very spatially distinct … So interventions, firstly, need to be highly targeted and closely targeted, and the overall picture is much more optimistic than we thought.[15]

6.14 The Bureau of Rural Sciences (BRS) argued that the results of its mapping in ten catchments in eastern Australia demonstrated:

> Salt is much more localised in the landscape than previously thought and … specific management interventions can be tailored to individual situations, substantially reducing the cost of managing salinity and minimising potential disruption to agriculture.[16]

6.15 For example, the BRS predicted that land use change on only 17 per cent of the Billabung catchment will achieve a 50 per cent reduction in salt exported to the Murrumbidgee River.[17]

6.16 In contrast, with a far more homogenous geology and different landscape characteristics, it was argued that targeted interventions will not achieve significant and widespread improvements in salinisation in the west of the continent.[18] In Western Australia, management actions are said to be required on a large scale—and perhaps elsewhere in the country. The Western Australian Salinity Taskforce concluded:

> In recent years, we have lost earlier hopes that large-scale preventative impacts on salinity could be achieved by clever

15 Mr Mike Lee (DAFF), *Transcript of Evidence*, 7 November 2003, p. 57.

16 DAFF and DEH, *Submission no. 72.1*, p. 1

17 *ibid.*, p. 4.

18 Evidence of the distinctiveness of the geology and landscape characteristics of Western Australia was presented in chapter three. Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, pp. 47-48: 'the flow of the major drainage systems in the wheat belt is very poor. The gradient of them is often less than one in 1 000 and sometimes it is one in 1 500 … we also have a very thick layer of clay which is able to accumulate very large quantities of salt.'

> selection and placement of relatively small-scale treatments, or by changes to the management of traditional annual crops and pastures.
>
> The new scientific consensus is that large proportions of land in threatened catchments would need to be revegetated with deep–rooted perennial plants for at least part of the time.
>
> Even with massive changes in land use, the long-run potential to prevent salinity is believed to be limited in many catchments of Western Australia, particularly in low rainfall areas. This is because the catchments in low rainfall areas tend to be larger, flatter and less well drained than elsewhere.[19]

6.17 The *National Dryland Salinity Program* (NDSP) reached similar conclusions. While noting that some exceptions do exist, a key message from the Program's research efforts was that:

> The notion that salinity will be comprehensively fixed with targeted revegetation treatments … should be dispelled. There is no silver bullet. Hopes of finding a clever, low cost solution such as planting a relatively small part of the landscape with trees in strategic areas no longer hold credibility.[20]

6.18 The need for large scale actions explains the calls for profitable, plant-based management options that are available for widespread adoption, and for new industry development to ensure adoption on a large enough scale. However, a number of submitters suggested that there are currently very few profitable perennial systems:

- CSIRO Land and Water stated:

> there is a limited range of robust, profitable farming biological systems that will reduce recharge to the extent required to make a difference to the salinity problem, that are commercial and that will make sufficient income to generate a healthy rural community. What we need are solutions that address the cause of the problem in land uses that make money. We do not have very many and we do not have enough research directed towards finding them.[21]

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19 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111*, *op. cit*., p. 23.

20 NDSP, *Submission 35.1*, pp. 1-2.

21 Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, pp. 82-83.

- Similarly, the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PBMDS), told the Committee:

> there are no perennial pasture plants for the wheat belt that are sufficiently attractive for widespread adoption. Similarly, farming systems involving agroforestry are not well understood.[22]

- Presenting a landholder's perspective, the Western Australian Farmers' Federation stated:

> we do not have a big array yet of options … particularly in saltland pastures, to be able to make a big impact on the problem and turn around some of our saltland—which is of no commercial value to us—into something productive.[23]

6.19 However, the WA SRDTC asserted that CMOs are:

> currently being encouraged to deliver salinity outcomes that could not be attained without sending many landholders bankrupt due to the lack of feasible economic options which compete with currently profitable industries and landuses.[24]

6.20 Despite the lack of profitable solutions to salinity, it was submitted that the 'paucity of current profitable options reflects an absence of past research in this area, rather than fundamental barriers to success.'[25] It was also noted that '[t]here are a number of promising vegetation and engineering options' but these 'require long-term investment before they can be widely adopted.'[26]

6.21 Moreover, submitters argued that national salinity programs have not adequately supported this R&D activity. For example, the CRC PBMDS argued that 'research of this type has received minimal funding from the Commonwealth's NRM programs … and so far none at all from the NAP', and that this 'reflects poorly on the capacity of certain Commonwealth agencies to assess the real needs for salinity management.'[27]

6.22 A similar argument was advanced by the WA SRDTC:

22 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 15.
23 Mr Colin Nicholl (WAFF), *Transcript of Evidence*, 13 November 2003, p. 5.
24 WA SRDTC, *op. cit.*, p. 2.
25 CRC PBMDS, *op. cit.*, p. 4.
26 WA SRDTC, *loc. cit.*
27 CRC PBMDS, *op. cit.*, p. 4.

> The current Commonwealth provision of knowledge is focussed on mapping and monitoring groundwater systems and salinity hazards at the expense of … developing new technologies and systems, engineering systems and new industries for saline resources.[28]

6.23 Other submitters agreed. For example, Engineers Australia criticised current Federal directions in salinity research as 'dominated by a focus on mapping, monitoring, evaluation and capacity building'.[29] Associate Professor David Pannell argued that the emphasis in the NAP on airborne geophysics to assist with regional planning:

> reflected a failure to understand the real factors limiting large-scale land-use change. It is not lack of such information, but lack of profitable land-use options and systems that can be widely adopted by land managers to manage groundwater recharge. Airborne geophysics has an important role to play in some situations, but its application needs to be carefully considered and targeted.[30]

6.24 In the priority research areas identified by these submitters, several national agencies, such as BRS and Geoscience Australia, are said to be inactive.[31]

6.25 The CRC PBMDS recommended that, in addition to supporting salinity mapping, the Australian Government adequately resource salinity research focussed on developing new land and water use systems, such as those listed above. The Federal Government was also urged to encourage industry groups, notably the Research and Development Corporations, to take a leading role in supporting research activity of this type.[32]

6.26 Similarly, the Australian Conservation Foundation (ACF) argued that the Australian Government should maintain its support for quantifying processes, but also substantially upgrade its support for research 'focussed on developing technologies and tools for salinity prevention and

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28 WA SRDTC, *op. cit.*, p. 5.

29 Engineers Australia, *op. cit.*, p. 2.

30 Associate Professor David Pannell, *loc. cit*. Murray Irrigation Ltd (*Submission no. 27*, p. 3) expressed a similar view and urged that rather than continue to emphasise mapping techniques, 'salinity research needs to devote the majority of research effort into innovation that improves techniques to prevent or control salinity.'

31 WA SRDTC, *op. cit.*, p. 6.

32 CRC PBMDS, *op. cit.*, p. 4.

management'.[33] It was argued that 'the Commonwealth's investments in salinity management are unlikely to achieve more than small-scale impacts unless backed up by R&D for profitable new technologies for salinity management.'[34]

6.27 Notwithstanding the weight of evidence to the contrary, DAFF argued that, in many cases, the tools to address salinity are in fact well researched and that the key issue remains where to make targeted interventions in the landscape.[35] However, DAFF conceded that whereas in eastern Australia salt stores are localised, '[t]hat is very different from Western Australia … where there are much larger homogenous systems and landscape salt. But things are looking up for the eastern seaboard.'[36]

6.28 In essence, contrasting views emerged in the evidence: between the efficacy of targeted interventions (at least in eastern Australia) aided by the use of mapping technologies, versus calls for broadacre solutions supported by the development of new technologies and industries, and deployment of engineering works.

6.29 The Committee notes that at least 70 per cent of the nation's salinity problem occurs in Western Australia. Requests from this State, and a range of other submitters, are for a 'new balance' in the Australian Government's investment towards developing new land and water use systems, and strategic interventions to save key public assets such as rural towns. While welcoming the potential for targeted salinity management in some locations, assisted by mapping technologies, the Committee urges that these research priorities be given greater support in Australian Government funded salinity R&D programs and science investments. The Committee examines further the evidence in relation to mapping technologies in chapter seven.

Recommendation 4

6.30 **The Committee recommends that the Australian Government give greater emphasis through its investments in salinity science to develop new, economically viable land and water use systems.**

33 ACF, *Submission no. 62,* p. 4.

34 *ibid.*

35 Mr Mike Lee (DAFF), *Transcript of Evidence,* 7 November 2003, p. 62.

36 *ibid.*

Salinity research needs and prioritisation

> *The central R&D challenge is to develop farming systems that reduce recharge and maintain profits; as well as developing profitable farming systems that incorporate salt-affected land and water.*[37]

6.31 Although the Committee's inquiry was concerned with national salinity science coordination and the terms of reference did not seek comment on research priorities, approximately 70 submitters identified specific research needs. The array of salinity research needs included:[38]

- additional basic research, including into the sources of salt and salinisation processes;[39]
- improvements in groundwater mapping and monitoring methods that can be used and responded to by land managers and CMOs;[40]
- improvements in modelling techniques to provide more useful guidance on targeted responses, rather than widespread landscape change responses;[41]
- better understanding of the effectiveness of different engineering solutions for treating rising groundwater levels, and improving design

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37 GRDC, *Exhibit no. 79, Economic Evaluation of Salinity Management Options in Cropping Regions of Australia*, p. v.

38 NDSP, *Exhibit no. 134, National Priorities for Salinity Research and Development*, pp. 10-11. See also CSIRO, *op. cit*., p. 6: Drawing on its own research findings, which were summarised in chapter four, CSIRO have identified nine key science needs to address salinity, several of which are incorporated in the list provided.

39 See for example: Dr Jerzy Jankowski, *Submission no. 60*, pp. 2-3; Associate Professor Robert Creelman, *Submission no. 16*, pp. 1-2; Mr Kim Wright (Centre for Salinity Assessment and Management), *Transcript of Evidence*, 29 October 2003, p. 60; Dr Mike Dyall-Smith, *Submission no. 77*, p. 1.

40 See for example: AgForce, *Submission no. 70*, pp. 1-2; Mrs Margaret Thompson, *Submission no. 53*, p. 1; Dr Baden Williams, *Submission no. 1*, pp. 4-5; NSW Farmers' Association (NSW FA), *Submission no. 45*, p. 3; Institute of Public Affairs (IPA), *Submission no. 41*, p. 2; Australian Salinity Action Network (ASAN), *Submission no. 39*, p. 5; Agrilink Holdings Pty Ltd, *Submission no. 25*, pp. 6-9; The Pelham Group, *Submission no. 11*, pp. 3-4; Centre for Salinity Assessment and Management (CSAM), *Submission no. 19*, p. 1; Chinchilla Shire Council, *Submission no. 47*, p. 4; Fitzroy Basin Association, *Submission no. 48*, p. 2; CRC LEME, *Submission no. 64*, pp. 2, 6; Australian Society of Soil Science Inc., *Submission no. 68*, p. 3.

41 See for example: Lower Murray-Darling Catchment Management Board, *Submission no. 2*, p. 2; CSAM, *op. cit*., p. 3; NSW FA, *op. cit*., p. 2; Chinchilla Shire Council, *op. cit*., p. 4; Murray-Darling Basin Commission (MDBC), *Submission no. 51*, p. 10; Murrumbidgee Irrigation Ltd, *Submission no. 52*, p. 4.

of future engineering options (for example, to deal with saline effluent from groundwater pumping);[42]

- better understanding of the impact of salinity on freshwater environments, biodiversity and the relationship between landscape and waterscape processes;[43]
- intensification of urban salinity research, particularly pertaining to assessment and risk evaluation, options for treatment and management and development of appropriate building codes;[44]
- intensification of research into vegetative solutions, including perennial plant-based systems for recharge and discharge systems;[45]
- development of technologies for making productive use of salinised land and water resources, with specific emphasis on generating marketable products and industries;[46]
- combined systems research into multiple benefits from perennial vegetation, in particular biodiversity, carbon sequestration and aquatic systems;[47]

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42 See for example: Australian Institute of Agricultural Science and Technology (AIAST), *Submission no. 76*, p. 9; Associate Professor David Pannell, *op. cit.*, p. 4; Murdoch University, *Submission no. 24*, p. 9; CSIRO, *op. cit.*, p. 6; Grains Research and Development Corporation (GRDC), *Submission no. 29*, p. 1; Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 83; Mr Colin Nicholl (Western Australian Farmers Federation), *Transcript of Evidence*, 13 November 2003, p. 9.

43 See for example: Deakin University, *Submission no. 17*, pp. 1-2; Cooperative Research Centre for Freshwater Ecology, *Submission no. 26*, pp. 3-4; NDSP, *op. cit.*, p. 9; Dr Ben Kefford, *Submission no. 33*, p. 1-3; Australian Conservation Foundation (ACF), *Submission no. 62*, p. 3; Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 83; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, pp. 21-22.

44 See for example: New South Wales Government, *Submission no. 61*, p. 9; Western Sydney Regional Organisation of Councils (WSROC), *Submission no. 20*, p. 6; Hawkesbury-Nepean Catchment Management Board (HNCMB), *Submission no. 21*, p. 1; Mr Colin Kandan-Smith (WSROC), *Transcript of Evidence*, 29 October 2003, p. 15; Mr Bryan Short (Wagga Wagga City Council), *Transcript of Evidence*, 30 October 2003, p. 28; Mr Rex Edmondson (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, pp. 30-31.

45 See for example: Forest Products Commission of Western Australia (FPCWA), *Submission no. 63*, pp. 1, 6; Associate Professor David Pannell, *op. cit.*, p. 4; CRC PBMDS, *op. cit.*, p. 4; Murrumbidgee Irrigation Ltd, *op. cit.*, p. 1; Mr Clive Malcolm, *Submission no. 78*, p. 1; GRDC, *op. cit.*, p. 1; Chinchilla Shire Council, *op. cit.*, p. 8; Namoi Catchment Management Board, *Submission no. 65*, p. 1.

46 See for example: WA SRDTC, *op. cit.*, p. 4; AIAST, *op. cit.*, pp. 8-9; CSIRO, *op. cit.*, p. 6; NSW Government, *op. cit.*, p. 11.

47 See for example: FPCWA, *op. cit.*, p. 4; CSIRO, *op. cit.*, pp. 5-6.

- socio-economic analysis to improve resource allocation and better understand constraints to the widespread adoption of technologies;[48]
- developing innovative policy instruments to deal with the diversity of management regimes required to address salinity;[49] and
- encouraging the emergence of new industries and environmental management system frameworks for existing industries that will increase the adoption of salinity management technologies as they develop.[50]

6.32 The Committee notes that the Australian and state governments have made commitments under the NAP to fund projects which address some of the research needs identified above, such as market based instruments and engineering options:

- In December 2003 the Natural Resource Management Ministerial Council announced a $360 000 project for CSIRO to establish a pilot trading and offset scheme to address dryland salinity in Victoria's Avoca-Loddon-Campaspe region. The project is to be funded under the first round of a $5 million *National Market Based Instruments Pilots* Program.[51]
- In December 2003, Federal and Western Australian ministers announced the allocation of $2 million to identify the most effective engineering options for salinity management. The projects will be funded under the *Engineering Evaluation Initiative* (EEI) to be established

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48 See for example: CRC PBMDS, *op. cit.*, p. 6; Murdoch University, *op. cit.*, pp. 2-3; HNCMB, *op. cit.*, p. 2; ASAN, *op. cit.*, p. 8; Western Australian Farmers Federation, *Submission no. 36*, p. 2; Murrumbidgee Catchment Management Board, *Submission no. 43*, p. 2; Saltgrow Pty Ltd., *Submission no. 71*; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, p. 21.

49 See for example: CSIRO, *op. cit.*, p. 6; Grain Growers Association Ltd, *Submission no. 44*, pp. 1, 3; Murdoch University, *op. cit.*, p. 3; GRDC, *op. cit.*, p. 12; Murrumbidgee Irrigation Ltd, *op. cit.*, p. 3; AgForce, *op. cit.*, p. 2; Saltgrow, *op. cit.*, p. 1; Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 83.

50 See for example: Saltgrow Pty Ltd, *op. cit.*, p. 6; Associate Professor David Pannell, *op. cit.*, pp. 2-3; FPCWA, *loc. cit.*; Natural Resource Intelligence Pty Ltd, *Submission no. 32*, pp. 11-12; Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 42; Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, pp. 39-40.

51 Joint statement by the Australian Government Minister for Agriculture, Fisheries and Forestry, The Hon. Warren Truss MP and Australian Government Minister for the Environment, The Hon. Dr David Kemp MP, issued 8 December 2003. Media release available online, DAFF, Canberra, viewed 16 December 2003, <www.affa.gov.au/ministers/truss/releases/03/03363wtj.html>.

in the Western Australian Wheat Belt. The EEI is a priority project under the NAP.[52]

Research prioritisation

6.33 The Committee recognises that prioritising the array of research needs for future R&D investment is the responsibility of CMOs and technical committees at the state and national levels, such as the Science and Information Working Group of the Natural Resource Management Standing Committee, and others described in the previous chapter.[53]

6.34 The NDSP has conducted a detailed analysis of the research needs identified in the Committee's submissions and factored these into the development of an R&D priority set, which also synthesises the research priorities identified in state salinity strategies and other reviews.[54] However, the Committee also received some evidence relating to the process of establishing research priorities in the new NRM context.

6.35 The NDSP noted that the emphasis in the NAP for on-ground works investments through regional groups has marked a 'major shift in the research supply-demand relationship':[55]

> Until recent times research priorities for dealing with salinity were largely determined by research, management and regulatory agencies, not always in consultation with affected members of the community. Since the advent of the NAP, it is now the community that has the purchasing power to determine research priorities specific to individual regional circumstances … such an approach

52 Joint statement by the Australian Government Minister for Agriculture, Fisheries and Forestry, The Hon. Warren Truss MP, Australian Government Minister for the Environment, The Hon. Dr David Kemp MP, Western Australian Minister for Agriculture, Kim Chance, and Western Australian Minister for Environment, Dr Judy Edwards, issued 8 December 2003. Media release available online, DAFF, Canberra, viewed 16 December 2003, <www.affa.gov.au/ministers/truss/releases/03/03362wtj.html>.

53 See for example: Glenelg Hopkins Catchment Management Authority, *Exhibit no. 21, Future Directions for Integrated Catchment Research in South West Victoria*; NSW Government, *Exhibit no. 43, A Strategic Framework for Salinity Research and Development in NSW*, and *Exhibit no. 44, NSW Salinity R&D Investment Portfolio.*

54 NDSP, *Exhibit no. 134*, *op. cit.*, pp. 16-28. See also: NDSP, 'Salinity R&D priorities feature in House of Representatives Inquiry', *Focus on Salt*, issue 30, March 2004, pp. 1, 6. Available on the NDSP web site, viewed 12 April 2004, <www.ndsp.gov.au/15_publications/20_focus_on_salt/focus_on_salt.html>.

55 *ibid.*, p. 1.

> should enhance the ownership of the results of purchased research and, in theory, increase the likelihood of adoption of the results.[56]

6.36 Given the need for research activities to be directed and conducted at appropriate levels—catchment, state, Murray-Darling Basin and national—CSIRO proposed a two-stage process to identify research priorities and develop a salinity research portfolio, as follows.

- Bottom-up analyses of research needs:
  The investment strategy of each CMO requires some research and investigation to support the regional plan. There is a need at the state and national levels to provide a 'bottom-up' analysis of the research needs to support national program implementation. CSIRO emphasised that not all the answers are currently available. Some identified research needs are likely to involve an application of existing knowledge and techniques. Some research needs will be regionally specific, while others will have some generic similarities with other regions.

  Developing programs that are adequately regionally specific yet having broad similarities across state borders is likely to be a challenge. It was suggested that programs such as the *Sustainable Grazing Systems for Saline Land and Commercial Environmental Forestry* are good examples of the way forward in this regard.[57]

- Combining top-down with bottom-up analyses:
  CSIRO argued that merely aggregating from the regional plans will not necessarily allow new scientific knowledge or techniques to be incorporated into management practice, nor will it satisfy national objectives. Thus, in addition to the 'bottom-up' approach, there is a need for an additional process that canvasses new ideas or emerging technologies, and proceeds to phase in an appropriate implementation. There is also a need to incorporate lessons learnt from past studies and adopt a national perspective.[58]

6.37 CSIRO noted that it is not clear which agency or organisation could conduct this analysis. However, submitters suggested that 'science users' ought to be consulted or represented on research prioritisation

56 *ibid*.
57 CSIRO, *op. cit*., p. 12.
58 *ibid*., p. 13.

committees, to ensure an appropriate balance between basic research and the development of practical tools that can be used by land managers.[59]

6.38 A similar prioritisation process was proposed by Murrumbidgee Irrigation, which suggested that 'a top-down approach' be 'complemented by a bottom-up approach at local and regional levels.'[60] The Committee's recommendation, in chapter four, for an audit of existing salinity research may assist in the process of accurately identifying research gaps and establishing priorities at the appropriate levels.

6.39 Other than the matters identified in the first section of this chapter, the Committee does not wish to propose a detailed list of salinity R&D priorities. However, issues associated with new industry development, urban salinity and, more generally, the importance of multidisciplinary research are matters the Committee addresses in the sections which follow.

New industry development

6.40 Submitters who emphasised the need for substantial land use change and establishment of perennial vegetation on a large scale also urged that R&D into profitable salinity management methods:

> should be part of a strategy of industry development to complement the role of regional NRM bodies … There seems to be no prospect of adoption of perennials on anything approaching the desired scale without outstanding success from industry development efforts.[61]

6.41 The example held up to the Committee is the attempt at developing mallee eucalypts as a large-scale crop for the Wheat Belt in Western Australia:

> if you explore the process by which that experiment has been put together you will find … a case history, in how R&D, combined

59 FPCWA, *op. cit.*, pp. 2, 7; Lower Murray Darling Catchment Management Board, *Submission no. 2*, p. 3; Murray Irrigation Ltd, *Submission no. 27*, p. 4.

60 Murrumbidgee Irrigation, *Submission 52*, p. 1. The GRDC (*Exhibit no. 79, op. cit.*, p. xiii) proposes nine criteria for prioritising R&D for salinity management in cropping regions.

61 Associate Professor David Pannell, *op. cit.*, p. 3. See also: Dr Don McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, pp. 42-43; AIAST, *op. cit.*, pp. 8-9; CSIRO, *Exhibit no. 80, Dryland Salinisation: A Challenge for Land and Water Management in the Australian Lanscape*, p. 470.

> with very smart thinking around market driven industry development, is a blueprint to follow, regardless of the outcome.[62]

6.42 Efforts to develop tree crop industries in Western Australia have been underpinned by a recognition that while reforestation is an effective preventative treatment for salinity (that is, trees can effectively reduce groundwater recharge), these industries are most likely to succeed if the new forests or tree crops represent a commercially viable use of the land. A consistent finding of reports into salinity in Western Australia, including the Salinity Taskforce Report cited earlier in this chapter, has been that:

> the State must develop commercial perennial crops for agriculture to be able to moderate the salinity problem. These reports indicate that commercial perennial crops will be the only effective means to reduce groundwater recharge on the necessary scale.[63]

6.43 This understanding saw the successful development by the Western Australian Department of Conservation and Land Management (CALM) of a commercial bluegum industry in the higher rainfall (>600 mm / year) zone of the lower south west of Western Australia from the late 1980s.[64]

6.44 From the early 1990s, CALM began developing 'a commercially viable woody crop for the extensive low rainfall (<500 mm / year) wheatbelt region, where potential damage to natural resources and infrastructure from salinity is greatest.'[65] Having evaluated the potential of a range of low rainfall crops, CALM invested in the commercial development of mallee eucalypts. Since 1993, CALM has invested more than $6 million in mallee industry development, 'based on recognition that in the absence of any existing commercial wheatbelt crop a substantial effort was required to create one.'[66]

6.45 CALM involved all interested parties, notably farmer representatives who formed an incorporated industry association, the Oil Mallee Association, which then assumed control of industry development in 1997. The Association subsequently formed the Oil Mallee Company (OMC) to

62 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 35. See also: Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 19; Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 19.

63 Mr John Bartle (Western Australian Department of Conservation and Land Management), *Exhibit no. 87, Development of mallee as a large-scale crop for the wheatbelt of WA*, p. 3.

64 *ibid.*, p. 2.

65 *ibid.*

66 *ibid.*, p. 4.

facilitate development of commercial operations. The majority of investment (in excess of $10 million) has come from some 900 growers, who have now planted in excess of 21 million mallee trees.[67]

6.46 In 1998, the OMC attracted support from Western Power Corporation and the Rural Industries RDC to investigate the feasibility of new mallee processing technologies. A demonstration scale facility (20 000 tonnes of mallee biomass / year) has now been constructed to test the commercial viability of integrated processing for the concurrent production of eucalyptus oil (more precisely, cineole, which is a major constituent of eucalyptus oil), activated carbon and electricity. The feasibility study concluded that:

> the venture could sell products at prices that would open large market volume and strong revenues as well as pay growers a price for mallee feedstock competitive with other land-use options. Using cautious assumptions of market prospects it was estimated that some 9 full-scale plants (100 000 tonnes / year) could be constructed in the WA wheatbelt.[68]

6.47 The Committee inspected the demonstration facility at Narrogin (depicted in photograph 6.1), which was substantially complete but non-operational and in need of additional finance. Nonetheless, the CRC PBMDS expressed enthusiasm for the venture and argued that similar facilities would be applicable in eastern Australia:

> That sort of plant, multiplied 10 times in the Western Australian wheat belt, would make a very significant contribution to renewable energy, would have a significant effect on regional communities by providing employment and would address the salinity problem. Furthermore, I think that particular technology is more appropriate to eastern Australia where you have substantial regional communities than … here in Western Australia where most of our regional communities are pretty small and do not require that sort of decentralised generation of power in the same kind of way.[69]

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67 *ibid.*, pp. 3, 4.

68 *ibid.*, p. 1.

69 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, pp. 19-20.

Photograph 6.1 Use of mallee eucalypts as a preventative treatment for salinity, and for concurrent production of eucalyptus oil, activated carbon and electricity in a bioenergy (demonstration) plant constructed by Western Power Corporation, at Narrogin in Western Australia

6.48 Despite the work that is still necessary for the production systems to compete effectively in world markets (for the activated carbon and cineole), the MDBC stated that the oil mallee experiment ‘is a very good lesson in sustained R&D and industry development.’[70]

6.49 The MDBC conceded that supporting industry experiments of this sort ‘is inherently risky, and probably four out of five of these things might not get up. But one will, and that is an approach that we urge you to follow.’[71] Specifically, the MDBC urged the Australian Government to show leadership and innovation by encouraging investment driven forestry in the Basin, which needs to be ‘on a scale that a regional catchment authority really cannot deal with.’[72]

70 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 35.

71 *ibid*.

72 *ibid*., p. 39.

6.50 A similar argument was advanced by Saltgrow, a company engaged in commercialising salt-tolerant eucalypt hybrids. It was argued that land use change at the scale required to significantly impact on salinity and deliver new, sustainable land use industries will require a radical change from current land use practices. Notwithstanding the potential of commercially-driven tree production systems to enhance farm profitability, Saltgrow expressed concern at the 'failure of the catchment management planning process to embrace and seriously promote the adoption of commercially driven agroforestry despite extensive rhetoric of its benefits':[73]

> Without a dedicated industry development planning framework supported by adequate, long term funding to foster the establishment of such industries until they reach a critical mass to become self supporting and generate their own internal confidence, then the aim of commercially-driven driven tree production systems on the scale necessary to deliver real salinity impacts will remain rhetoric, and the goal of sustainability will remain unattainable.[74]

6.51 Saltgrow argued that to foster the adoption of new industries, involving substantial land use change from current practices, requires CMOs and national NRM agencies to introduce industry development planning into the NRM planning and funding prioritisation processes. To overcome the barriers to adoption of new land use practices at the regional level, Saltgrow specifically recommended that:

- CMOs introduce resource or industry development planning into their NRM planning and funding prioritisation processes; and
- CMOs be required to establish a framework for allocating expenditure between different categories of land use options in order to give new enterprises some level of funding scope and security, and thereby encourage investment in new, science-based land use industries.[75]

6.52 The Forest Products Commission of Western Australia (FPCWA) also noted that, in addition to selecting profitable tree species and developing new markets for wood products, such as bioenergy and industrial oils noted above:

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73 Saltgrow, *Submission no. 71*, p. 3.

74 *ibid.*, p. 5.

75 *ibid.*, p. 6.

> considerable effort is also required to develop environmental markets, such that payments are made for the collateral NRM benefits of reforestation such as improvements in land and water quality, carbon sequestration and biodiversity conservation.[76]

6.53 The FPCWA noted that processes to achieve this (including standardised methods for measuring changes in condition, monitoring the changes and reporting to investors), are relatively advanced for carbon, but less so for other environmental credits.[77]

6.54 In general, the FPCWA recommended that significant scientific investment be made to develop:

- new industries (for example, bioenergy) that will require large-scale use of products from forestation. This development will involve research that ranges from selection of the most productive species, low-cost establishment and harvesting systems, yield prediction and economic and social analyses; and
- methodologies that will allow the valuation of environmental benefits such as improvements of land and water quality and biodiversity, so that these can be sold to investors. This is analogous to the emergent carbon market and will involve steps such as the development of a unit of trade, prediction of likely delivery, measurement and reporting.[78]

6.55 AIAST also urged that greater support be given to emerging industries that make use of saline water resources (for example, aquaculture, energy production, mineral harvesting and desalinisation). AIAST supported the use of market-based instruments and 'friendly' investment capital as a means of encouraging private sector investment:

> the establishment of new industries to use saline groundwater will mean that future pumping programs can be funded privately instead of continuing to require a source of public revenue.[79]

6.56 CSIRO and DAFF noted that the Australian Government is currently supporting forestry initiatives, such as the joint CSIRO/DAFF Commercial Environmental Forestry (CEF) project funded by the NHT, and the Joint Venture Agroforestry Program.[80] DAFF stated that the CEF will include:

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76 FPCWA, *op. cit.*, p. 4.

77 *ibid.*

78 *ibid.*, p. 6.

79 AIAST, *op. cit.*, p. 8.

80 DAFF and DEH, *op. cit.*, p. 11; CSIRO, *op. cit.*, p. 8.

commercial outcomes for the low to medium (500-800 mm per year) rainfall zone based on species selection, location in the landscape, plantation management, product decisions and the assessment of environmental values. The project will also develop tools to predict the impact of farm forestry expansion on salt interception.[81]

6.57 The primary output of the CEF project will be a spatially based Scenario Planning and Investment Framework that will demonstrate the profitability of plantations at the property scale across regions.[82]

6.58 In the 2004 Budget, the Australian Government also announced two assistance programs for the Western Australian forest industry and dependent communities—a $12.5 million Forestry Assistance Program for Western Australia and a $2.5 million Grants for Forest Communities Program. These programs, which are to be funded over the next two financial years, will provide grants to businesses and community groups proposing developments in the forestry and forest products industries in Western Australia.[83]

6.59 The Committee notes the evidence that to arrest salinity requires substantial land use change and that this will only be achieved through the development of commercial crops and new industries. The Committee is pleased to note the considerable investment of growers in Western Australia, committed to the commercial development of mallee eucalypts. The Committee notes the calls for the Australian Government to encourage commercially-driven tree production systems, including the development of environmental markets, and to ensure that CMOs introduce industry development planning into their NRM planning and R&D funding prioritisation processes.

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81 DAFF and DEH, *loc. cit.*

82 Information obtained from the Commercial Environmental Forestry Brochure, viewed 26 April 2004, <www.ffp.csiro.au/cef/CEF_Brochure.pdf>.

83 The Hon. Warren Truss MP (Australian Government Minister for Agriculture, Fisheries and Forestry), Senator the Hon. Ian Macdonald (Australian Government Minister for Fisheries, Forestry and Conservation) and Senator the Hon. Judith Troeth (Parliamentary Secretary to the Minister for Agriculture, Fisheries and Forestry), *Rural and Regional Australia—Sustaining the Nation*, 2004-05 Budget Statement, pp. 12-13, viewed 12 May 2004, <www.budget.gov.au/2004-05/ministerial/download/agriculture_fisheries_forestry_mod.pdf>.

Recommendation 5

6.60 **The Committee recommends that the Australian Government encourage catchment management organisations to introduce industry development planning into their natural resource management planning and funding prioritisation process.**

Urban salinity

6.61 The effects of urban salinity are of particular concern to the Committee. As noted in chapter three, the Committee observed first-hand the destructive effects of urban salinity in Wagga Wagga and in the Western Australian Wheat Belt town of Katanning.

6.62 The Committee notes that the report, *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, to the Prime Minister’s Science, Engineering and Innovation Council, found that:

> while salinity is widely recognised as causing problems for agriculture it is less appreciated that dryland salinity causes serious damage … to regional and urban infrastructure due to damage to foundations from shallow, saline groundwater.[84]

6.63 Several submitters suggested that the need for research into the effects of urban salinity is not adequately recognised in national priorities.[85] The particular issues associated with urban salinity include: the interaction between urban development and salinity, potential impacts on major infrastructure, maintenance and threats to high value assets, and the potential impacts on agriculture located on the urban fringe.[86]

6.64 A range of R&D priorities to address urban salinity were outlined in the submissions. For example, the NSW Government suggested that the following matters be addressed at the national level:

- requesting the Australian Transport Council to consider a national roads project by Austroad to identify best practice in maintaining roads in saline conditions;

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84 Cited in Australian Government Department of Education, Science and Training, *Submission no. 69*, p. 4.

85 See for example: WSROC, *op. cit.*, p 4; HNCMB, *op. cit.*, p. 2; NSW Government, *op. cit.*, pp. 9-10; ACF, *op. cit.*, p. 4.

86 WSROC, *op. cit.*, pp. 6-7.

- expediting the work of the technical working party on salinity established by the Australian Building Code Board at its 2001 National Technical Summit, including enhancing the level of research and investigation into urban salinity;
- improving the technical and scientific input into the development of Australian standards, the Australian Building Code and construction specifications; and
- developing agreed national competencies and training packages to improve education in urban salinity, and developing National Guidelines on urban salinity.[87]

6.65 In addition, submitters advocated research into improved urban salinity assessment and risk evaluation, and options for treatment and management, including:

- measurement, mapping and modelling of salt stores and water flows in urban landscapes;[88]
- addressing the effects of salinity on building materials, roads and pavement, and implications for council asset management;[89]
- identifying the link between urban land use, planning and salinity;[90]
- identifying the relationship between stormwater and wastewater management and urban salinity;[91] and
- developing options for protecting infrastructure, conservation and cultural heritage assets.[92]

6.66 The Committee notes that for several years, the Wagga Wagga Council has implemented strategies to address urban salinity and carried out remediation work.[93]

6.67 During its inspections, the Committee was informed of proposals to develop and apply desalinisation technologies in Katanning (to use the groundwater currently pumped out from under the town) and a number

87 NSW Government, *op. cit.*, p. 9.

88 CSAM, *op. cit.*, p. 2.

89 Mr Colin Kandan-Smith (WSROC), *Transcript of Evidence*, 29 October 2003, p. 17; Mr Bryan Short (Wagga Wagga City Council), *Transcript of Evidence*, 30 October 2003, p. 28.

90 HNCMB, *op. cit.*, p. 4; WSROC, *op. cit.*, p. 7.

91 *ibid.*

92 ACF, *op. cit.*, p. 4; NDSP, *Exhibit no. 134*, p. 25.

93 Wagga Wagga City Council, *Submission no. 5*, p. 1.

of other Wheat Belt towns. This project is anticipated to have a range of benefits including saving the cost of piping freshwater from Perth to Katanning, promoting new industries, and establishing technologies with export potential.

6.68 The Committee is concerned at claims that the Western Australian Rural Towns Program, which addresses salinity in some 32 Wheat Belt towns, no longer receives Australian Government support.[94] However, the Committee is pleased to note the announcement by Western Australian and Federal Government Ministers in April 2004 of a $500 000 commitment under the NAP for a 'Rural Towns—Liquid Assets' initiative, to develop integrated town water management schemes for the Avon region of Western Australia.[95]

Recommendation 6

6.69 **The Committee recommends that the Australian Government emphasise, though its investments in salinity science, the development of technologies to address urban salinity, including:**

(a) salinity assessment and risk evaluation methods; and

(b) options for treatment and management.

94 Mr Rex Edmondson (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45.

95 Joint media release by the Australian Government Minister for Agriculture, Fisheries and Forestry, The Hon. Warren Truss MP, Australian Government Minister for the Environment, The Hon. Dr David Kemp MP, Western Australian Minister for Agriculture, Kim Chance, and Western Australian Minister for Environment, Dr Judy Edwards, and Mr Don Randall MP, Member for Canning, issued 7 April 2004. Media release available online, DEH, Canberra, viewed 4 May 2004, <www.deh.gov.au/minister/env/2004/mr07apr04.html>.

The need for multidisciplinary and interdisciplinary research

6.70 A range of submissions emphasised the importance of multidisciplinary salinity research activities:

> [t]he greatest hope for the future is being able to undertake multi-disciplinary research to provide integrated solutions to salinity as a multi-faceted problem.[96]

6.71 The complexity of agricultural systems is said to require multidisciplinary research, or the support of multidisciplinary teams:

> Many specialist discipline-based scientists have trouble understanding the complexity of agricultural systems. The interaction of the economic, social, environmental, political and cultural context of agricultural systems is complex and unless scientists work in multi-disciplinary teams, many pieces of technology are unlikely to deliver useful results.[97]

6.72 Similarly, Dr John Ive argued that land managers and scientists have strongly contrasting approaches to resource management issues. Traditionally, scientific research has been undertaken in single theme oriented groups or agencies which tend to form silos, thereby inhibiting the exchange of ideas between disciplines. In addition, scientists are generally rewarded on the basis of peer reviewed work, 'a process that engenders a need to specialise to meet the demanding standards of one's peers.'[98] It was argued that this specialisation clashes with the needs of landholders, who must manage a multitude of themes simultaneously and integrate knowledge across a range of disciplines. Consequently, Dr Ive argued that scientific input that has a single issue focus tends to miss the landholders' need for 'knowledge and tools to address the important interactions' between resource degradation issues.[99]

6.73 In this respect, CSIRO stated that it 'is in a unique position among research providers to assemble the multidisciplinary teams needed to address the complex NRM issues like salinity … CSIRO has in recent years developed extensive skill in those areas and can provide tailored advice to

96 Murdoch University, *op. cit.*, p. 3. See also: Dr Ben Kefford, *op. cit.*, p. 1; Murray Catchment Management Board, *Submission no. 10*, p. 2; CRC LEME, *op. cit.*, p. 4; NSW Government, *op. cit.*, p. 7.

97 CRC PBMDS, *op. cit.*, p. 7.

98 Dr John Ive, *Submission no. 74.1*, p. 1.

99 *ibid.*, pp. 2-3.

regions'.[100] The NSW Government also noted that links among the disciplines involved in salinity research are fostered by CRCs, the NDSP and state salinity R&D coordinating committees.[101]

6.74 Several submitters also emphasised that solutions to salinity require the input of the social sciences, in addition to the biological and physical sciences.[102] Five reasons were advanced for this:

- to meet Australia's obligations under international conventions for sustainability requires consideration of the triple bottom line—physical / biological, economic and social—each requiring and supported by a body of scientific research;
- to understand and develop economic and social conditions that will support adoption of findings from the biophysical sciences, for example:

  > no amount of research into new salt-tolerant agricultural crops is going to result in adoption if the economic drivers likely to support or impede such adoption are unknown and cannot be managed.[103]

- to determine the best way of designing institutional arrangements for NRM, such as the relationship between governments, regional bodies and non-government organisations;
- to develop and analyse policy options to encourage or require uptake of salinity measures; and
- to examine sustainable futures.[104]

6.75 Murdoch University noted that some effort has been made to integrate social and economic research in NRM, for example through the Social and Institutional Research Program of Land and Water Australia (LWA). However, it was recommended that the NDSP, or a successor agency, be adequately funded to conduct economic and social research as part of salinity management research activities.[105] The CRC PBMDS also

100 CSIRO, *op. cit*., p. 12.

101 NSW Government, *op. cit*., p. 7.

102 CSAM, *op. cit*., p. 2; Murdoch University, *op. cit*., pp. 2, 4; HNCMB, *op. cit*., p. 2; Australian Nuclear Science and Technology Organisation (ANSTO), *Submission no. 22*, p. 5.

103 Murdoch University, *op. cit*., p. 3.

104 Dr Susan Moore (Murdoch University), *Transcript of Evidence*, 13 November 2003, pp. 28-29.

105 Murdoch University, *op. cit*., pp. 3, 4.

recommended that NAP funds be used to increase understanding of the socio-economic constraints to adoption of relevant technologies.[106]

6.76 Proposals to foster greater cooperation amongst salinity scientists included an annual multidisciplinary salinity conference, research show-case or roundtable, and a dedicated salinity journal that brings together research findings from across the range of disciplines.[107] CSIRO also noted that, with the exception of the biennial Productive Use and Rehabilitation of Saline Land Conference, there are no regular national conferences that address salinity.[108]

6.77 Murdoch University recommended that the Australian Research Council (ARC) should be 'encouraged to support and preferentially fund multidisciplinary projects in the natural resource management area.'[109]

Recommendation 7

6.78 **The Committee recommends that the Australian Government:**

(a) foster greater cooperation amongst scientists addressing salinity and, specifically, sponsor an annual multidisciplinary salinity conference, research showcase or science roundtable; and

(b) examine ways to foster interdisciplinary research in natural resource management more generally.

The importance of adaptive management

6.79 Notwithstanding the need for further salinity research, the Committee was told that 'we cannot wait until we get the science perfectly right' and 'action should not be delayed until scientific proof is determined.'[110] Similarly, the Murray-Darling Basin Commission (MDBC) argued that:

106 CRC PBMDS, *op. cit.*, p. 6.

107 Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, p. 37; Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 63.

108 CSIRO, *op. cit.*, p. 13.

109 Murdoch University, *op. cit.*, p. 4.

110 Dr Michael Curll (Deputy Director-General, New South Wales Agriculture), *Transcript of Evidence*, 29 October 2003, p. 85; Lower Murray Darling Catchment Management Board, *Submission no. 2*, pp. 2-3.

> it is not realistic to wait for "perfect knowledge" … it is essential to act based on best available, "best bet" knowledge, managing risks and continually learning from the results.[111]

6.80 The importance of combining an adaptive management approach to addressing salinity, in which 'you review, you evaluate, you decide and you move forward', with traditional scientific research was emphasised.[112] For example, the FPCWA stated:

> The experience we have had, as an agency, in the last 10 or 15 years would suggest that both approaches are necessary. Trial and error—adaptive management—is necessary on an operational scale, but to back that up you need some good quality science and an understanding of the processes.[113]

6.81 Similarly, the Hawkesbury-Nepean Catchment Management Board suggested:

> Current knowledge and technical capacity is not perfect. Existing knowledge and skills need to be applied in an adaptive management context so that program monitoring and emerging knowledge gaps can be used to identify new research and technical needs.[114]

6.82 Moreover, the NSW Government observed that salinity solutions 'must be developed in a partnership / learning process with farmers, so that they know these new systems meet their needs, they are profitable, and that the new systems can be managed … without excessive risk.'[115]

Funding salinity research

6.83 In order to address the knowledge gaps identified in the evidence, several submitters made recommendations in relation to the funding of salinity research:

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111 MDBC, *Submission no. 51*, p. 7.

112 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 36. See also: Dr Ben Kefford, *Submission no. 33*, p. 1; Cooperative Research Centre for Freshwater Ecology, *op. cit.*, p. 2; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, p. 23; Phil Dyson and Associates, *Submission no. 46*, p. 3; NDSP, *op. cit.*, p. 15.

113 Dr John McGrath (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 3.

114 Mrs Mary Howard (HNCMB), *Transcript of Evidence*, 29 October 2003, p. 68.

115 NSW Government, *op. cit.*, p. 4.

- at the state and national levels;
- at the regional level; and
- for basic salinity science.

6.84 The Committee also received evidence in relation to the need for long-term funding of research, on-ground works and data collection, and measures to foster private sector investment in salinity R&D activities. These matters are addressed in the sections which follow.

Funding for nationally coordinated salinity research

6.85 The CRC PBMDS summarised a research funding dilemma for the Australian Government:

> There is a problem there … that the Commonwealth really needs to address if it firstly accepts that there is a need for research and then if it wants that research to be conducted without allocation of additional funds, other than the National Action Plan.[116]

6.86 To address this issue, the South Australian Government recommended that the NAP provide 'for a salinity research and development fund to finance research that is of statewide importance or of a size or scale that is beyond the scope of attention of an individual region'.[117] The CSIRO also supported a nationally coordinated research effort.[118]

6.87 Similarly, the FPCWA recommended a 'significant change in the quantum of science funding' and suggested that the increase in funding 'can be achieved by allocating a proportion (5%) of the funding already allocated to the NAP.'[119]

6.88 LWA suggested that the aggregate level of investment in salinity research is probably sufficient, but informed the Committee that in January 2003 it developed a proposal for pooled-funding to support a coordinated national approach to R&D under the NAP.[120] This proposal was developed for the Science and Information Working Group of the NRM Standing Committee, but it was not submitted to the Standing Committee 'because several jurisdictions argued that all NAP funds have already been

116 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 19.
117 Government of South Australia, *op. cit*., p. 7.
118 Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, pp. 86-87.
119 FPCWA, *Submission no. 63*, p. 7.
120 LWA, *Submission no. 59*, pp. 5, 2.

allocated through bilateral relationships between the Australian Government and each jurisdiction.'[121] LWA concluded:

> Extracting any funds from the "glass jar" of pooled funding for multilateral investment such as coordinated national approach to R&D has proven to be too difficult at this stage in the process.[122]

6.89 The CRC PBMDS also recommended that the Australian Government allocate significant levels of NAP funding to R&D priorities at the state level. Individual CMOs would be consulted but would not have the power to veto the allocation of research funds.[123]

6.90 The Committee notes that there has been an overall increase in salinity funding due to the NAP.[124] However, the Committee is concerned that the NAP does not have a charter to fund salinity R&D, at least not beyond that required for regional level implementation. Adequate funding should be available to support on-going salinity R&D, particularly into generic issues that are of nationwide significance or for research that is beyond the scope of individual CMOs. Research of this type was described in the first section of this chapter and includes the development of profitable land and water use systems.

6.91 The Committee also encourages state governments to continue to support a coordinated national approach to generic salinity R&D, particularly through contributions to initiatives such as the NDSP.

121 *ibid.*

122 *ibid.*, pp. 2-3.

123 CRC PBMDS, *op. cit.*, p. 5.

124 CSIRO, *op. cit.*, p. 1; LWA, *op. cit.*, p. 2.

Recommendation 8

6.92 **(a) The Committee recommends that the Australian and state governments make provision within the *National Action Plan for Salinity and Water Quality* for the establishment of a salinity research and development fund, to finance research that:**

(i) is of national or statewide significance, and beyond the scope of individual catchment management organisations (CMOs);

(ii) pertains to the development of new technologies and industries for salinity management; and

(iii) is otherwise of a long-term, strategic or generic nature.

(b) The Committee further recommends that the allocation of the pooled research funds:

(i) be as agreed between the Australian and state governments, but that CMOs be consulted for research needs; and

(ii) have regard for the research priorities identified in this report.

The role of Research and Development Corporations

6.93 The research investments of RDCs on behalf of rural industries was argued to be profoundly significant:

> These investments are as significant as those made by government; perhaps even more so, for they are closely tied to industry extension programs that engage a wider spectrum of producers than government programs, and are based on explicit levy-paying relationships that ensure more direct ownership by producers of these programs.[125]

6.94 The CRC PBMDS urged that RDCs, including Australian Wool Innovation (AWI), GRDC and Meat and Livestock Australia, be encouraged to take a leading role in supporting research for new technology development, such as those identified in the first section of this chapter.[126]

125 LWA, *Submission no. 59*, p. 4.

126 CRC PBMDS, *op. cit.*, p. 4.

6.95 The WA SRDTC strongly supported the work of those RDCs engaged in public good research to improve the sustainability of agriculture, but expressed concern that while 'some [RDCs] are beginning to accept their responsibilities in this area, others clearly are not.'[127] The Land, Water and Wool Program, managed by AWI, was held up as:

> an excellent model to follow. This Program funds nine sustainability initiatives including the Sustainable Grazing on Saline Lands (SGSL) initiative. SGSL is sponsoring Commonwealth-State Agency based research, the development of producer networks and major communication programs focused on the development of profitable uses for saline soils.[128]

6.96 The WA SRDTC recommended that the Australian Government insist that RDCs invest more substantially in researching sustainable land use systems.[129]

6.97 The CRC PBMDS also argued that the commodity based funding model, which has been dominant in research investment (for example, GRDC, Meat and Livestock Australia, Cotton RDC), has led to an emphasis on productivity at the expense of sustainability. It was argued that research funders struggle to put together research projects which recognise that 'farming systems in, for example, the Wheat Belt include several commodities.'[130] CRC PBMDS argued that the need to forge links between productivity and sustainability is a challenge for researchers and technologists.

6.98 While supporting the research activities of the RDCs, the MDBC and ACF also expressed concern that RDCs are not adequately supporting changed land use practice:

> We question whether they are sufficiently introducing the more challenging messages here. Just to emphasise a point, the R&D corporations have demonstrated their credentials by aligning increased productivity with marginal improvement in water use, and those two are moving on. Our issue is that increased marginal improvement in water use, in the absence of land use change, is not sufficient. Therefore, there is another line of work to be done,

127 WA SRDTC, *op. cit.*, p. 8.
128 *ibid.*
129 *ibid.*
130 CRC PBMDS, *op. cit.*, p. 7.

> and I do not think the relationship between what they are doing and farmers is good enough.[131]

6.99 The Committee concurs with these views.

Recommendation 9

6.100 **The Committee recommends that the Australian Government encourage Research and Development Corporations to:**

(a) invest more substantially in research for sustainable land use systems and in the development of new salinity technologies; and

(b) conduct projects that forge links across commodities in farming systems.

Funding research at the regional level

6.101 The South Australian Government noted that, at the regional level, a 'strong science base and a sound understanding of the biophysical processes is critical to develop management actions that will be successful, effective and provide value for money.' The South Australian Government recommended that CMOs be encouraged to continue to 'include research and development as part of their investment mix in their regional investment strategies'.[132]

6.102 The CRC PBMDS recommended that the Australian Government remove perceived or actual impediments to funding of R&D by individual CMOs under the NAP.[133] Similarly, the ACF argued that:

> [G]reater effort needs to be applied to ensure all catchment and regional bodies develop the wherewithal to do good R&D of most relevance to their needs. The Commonwealth should ensure that impediments to R&D investments by catchment and regional bodies are minimised, allocate significant NAP funds to R&D at

131 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 40; ACF, *Submission no. 62*, p. 4; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, p. 25.

132 Government of South Australia, *loc. cit.*

133 CRC PBMDS, *op. cit.*, p. 5.

> the catchment level and ensure that regional/catchment R&D investment meet both national and local priorities.[134]

6.103 CSIRO also argued that 'research below a generic level so as to be regionally-specific requires significantly more funding.'[135]

6.104 However, CRC LEME expressed concern with tendering processes at the regional level:

> There is a lack of separation between science advisors to CMAs from those benefiting directly or indirectly from the award of contracts. Often the same research groups or consultants are giving advice and benefiting from the contracts awarded.[136]

6.105 CRC LEME argued that research work contracted by CMOs is not peer reviewed and that there is a need for an independent body to:

> impartially assess science needs within a catchment, gaps in data, evaluation of tenders and contracts, and interpretation of results. All this needs to happen both at CMA level, and also at a more strategic level between Commonwealth and State organisations.[137]

6.106 Despite the need for generic research activities to be supported directly at state and national levels, the Committee concludes that individual CMOs ought to be encouraged and appropriately resourced to undertake salinity research, where this is relevant. The Committee also notes the difficulties presented by regional devolution for coordinated research activities and recommends that cooperation between regions to undertake strategic research and industry development be fostered.

134 ACF, *Submission no. 62*, p. 5.

135 CSIRO, *op. cit.*, p. 13; Murrumbidgee Irrigation, *op. cit.*, p. 1.

136 CRC LEME, *op. cit.*, p. 3.

137 *ibid.*, p. 4.

Recommendation 10

6.107 **The Committee recommends that, in cooperation with the states, the Australian Government:**

(a) identify and remove impediments for catchment management organisations (CMOs) to undertake or commission research, and encourage CMOs to support research activity as part of their investment strategies;

(b) provide incentives for greater collaboration between CMOs to support research of cross-catchment benefit; and

(c) provide an appropriate degree of support to evaluate tenders and contracts let at the regional level.

Funding of basic salinity science and multidisciplinary research

6.108 Some scientists, concerned with a lack of funding for basic salinity research, proposed the establishment of an 'Australian Salinity Research Program'.[138] The Program would act as a granting body, modelled on the competitive granting processes of the Australian Research Council (ARC) or industry based research granting groups such as the Australian Coal Association Research Program. Alternatively, the body could be established on a basis similar to CRCs.[139] It was emphasised that the Program would need to be independent of existing science agencies and should foster multidisciplinary salinity research.

6.109 The NSW Farmers' Association observed that 'it would be good to have one body doling out the research funds, as you do with the national research grants system.'[140]

6.110 It was also remarked that the ARC programs 'have the potential to look at some of [the] generic issues'.[141] The Committee notes that over the six

138 Associate Professor Robert Creelman, *Submission no. 16*, p. 3.

139 Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, pp. 29, 32; Associate Professor Robert Creelman, *Transcript of Evidence*, 29 October 2003, p. 32.

140 Mr Jonathan Streat (NSW Farmers Association), *Transcript of Evidence*, 29 October 2003, p. 49.

141 Associate Professor Robert Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 32.

years to 2003, the ARC invested a total of $16.5 million in 84 salinity related research projects.[142]

Need for long-term funding for research, on-ground works and monitoring

6.111 It was noted that there is a need to ensure long-term funding for some salinity R&D activities:

> We are dealing with a problem that has taken many decades to arise. It is not likely to be reversed or even stabilised in the short term … the funding has to reflect the long-term nature of some of the processes …[143]

6.112 It was also argued that there is a need for long-term funding to monitor the effects of salinity management actions. For instance, the NSW Government observed that 'to identify the effect of farming systems on hydrology, at least six years of data is required to cover variation in climate between seasons and for treatments to take effect.'[144] Furthermore, in the case of catchment studies involving forest management, the 'funding base for research projects' needs to recognise 'the decadal (at least 20-30 years) response times in hydrology and forestry experimentation.'[145]

6.113 However, the Committee was told that, in the case of some catchment studies in Western Australia, 'they are not [being] monitored right at the moment. The funding base for that has disappeared because of a lack of funding for the state agency that ran the system.'[146]

6.114 Similarly, Dr John Ive argued that funding for research and on-ground activities needs to reflect the realities of the underlying processes at work. The argument was made with reference to the example of a major dryland salinity project in the Yass Valley during the 1980s:

> Recharge areas were identified, tree planting undertaken, piezometers installed within the three-year life of the project. Any collection of information ceased early in the project and any

142 Department of Education, Science and Training, *Exhibit no. 61, Details of ARC funded projects.*

143 Dr John McGrath, (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 4; Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 24.

144 NSW Government, *op. cit*., p. 11.

145 FPCWA, *op. cit*., p. 2.

146 Dr John McGrath, (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 4.

> analysis was superficial. However, one landholder persisted with the result that there is now clear and substantive evidence of success in managing saline water tables, management of which has provided evidence of both production and environmental benefits. Ironically within the life of the project funding (3 years) no clear evidence was available of the benefits subsequently realised, rather it took a decade of detailed measurement before the evidence became convincing. Such time frames are not unusual for natural resource issues but a common term for project funding and prioritising issues convey an impression that results can be achieved within [three years] … thereby trivialising the issue and increasing the risk of today's solution becoming tomorrow's problem.[147]

6.115 CMOs also emphasised the importance of on-going monitoring and data collection.[148] The Namoi Catchment Management Board stated that many sub-catchments in the Namoi do not have piezometers and, of those that do, many lack on-going monitoring.[149] The Murray Catchment Management Board urged that governments resource and operate research and data collection programs 'over a longer time frame than the current 1-3 year funding cycles.'[150]

6.116 However, CRC LEME noted that it is possible for some salinity research to be tackled on a modular basis:

> with a series of short, sharp projects of a duration of six months or so … Sure, it has to go on for many years, but we can accommodate a series of short, sharp contractual arrangements. In fact, it is probably a good management mechanism because you then are judged on your deliveries.[151]

6.117 It was also recognised that the provision of funding for research and data collection over longer time frames is a difficult issue for governments to resolve. The FPCWA suggested that:

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147 Dr John Ive, *Submission no. 74.1*, p. 3.

148 Eyre Peninsula Catchment Water Management Board, *Submission no. 75*, p. 6; Wimmera Catchment Management Authority, *Submission no. 55*, p. 1. See also: Agrilink Holdings Pty Ltd, *Submission no. 25*, p. 5; Australian Society of Soil Science Inc., *Submission no. 68*, p. 4.

149 Namoi Catchment Management Board, *Submission no. 65*, p. 2.

150 Murray Catchment Management Board, *Submission no. 10*, p. 1.

151 Dr Dennis Gee (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 25.

> One of the key questions you have got to address in answering how you achieve this is to identify agencies or entities that have a long-term future or a long-term responsibility for an issue so they have a management role in the medium to long term so that they will exist.[152]

Encouraging private sector investment in salinity research

6.118 The ACF argued that, in addition to public investment in salinity R&D, the Australian Government should:

> augment its efforts by establishing an incentives framework that drives private sector investment in R&D for profitable and sustainable measures to arrest landscape decline, including new perennial land-uses.[153]

6.119 The report, *Repairing the Country: Leveraging Private Investment* (2000), found that in order to reach targets for sustainable natural resource use, an investment of some $65 billion over ten years would be required.[154] It was realised that funding of this size would be difficult to obtain from public sector budgets alone, but also that many activities could derive a commercial benefit and that these should be financed from private sector investment. The report outlined a framework to facilitate the establishment of investment vehicles capable of attracting such investment funds. The approach involves:

- improved access to private capital through tax-preferred investment vehicles (statutory investment companies);
- a Land Repair Fund to administer a range of programs and tax concessions;
- accreditation for commercial-environmental ventures to ensure project proposals yield public good benefits and are consistent with national and catchment-based policies and objectives;
- taxation measures—an integrated package of offsets and concessions tailored to make environmental investments more attractive; and

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152 Dr John McGrath, (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 8.

153 ACF, *Submission no. 62*, p. 4; Mr Michael Watts (ACF), *Transcript of Evidence*, 31 October 2003, pp. 23-24.

154 ACF, *Exhibit no. 48*, *Repairing the Country: Leveraging Private Investment*, p. 3. The report was prepared on behalf of ACF, CSIRO and the Business Leaders Roundtable comprising Macquarie Bank, Elders, Berri, ABN AMRO and Southcorp.

- seed funding for innovative commercial ventures that achieve environmental benefits.[155]

6.120 The Committee agrees that ways to encourage greater private sector investment in R&D for profitable and sustainable measures to address salinity ought to be examined.

Recommendation 11

6.121 **The Committee recommends that the Australian Government examine ways to encourage private sector investment in research and development for commercial measures to arrest salinity and other forms of natural resource degradation.**

Developing industry capacity

6.122 The Australian Spatial Information Business Association (ASIBA) and Natural Resource Intelligence (NRI) argued that program structures should not limit research funding solely to public science agencies. The Committee was told that '[t]he profit motive does not work as a detriment to good science, but rather adds a level of discipline that is not necessarily expected of government agencies.'[156] Moreover:

> Quality R&D is not restricted to government agencies. The private sector has been involved in salinity projects where new methodologies have been tested … By assuming that only National Science Agencies hold the answer to the salinity problem, government limits creative endeavour, extends the life of the problem and undermines the work of many private sector companies engaged in quality R&D programs.[157]

6.123 ASIBA and NRI recommended that steps be taken to develop industry capability and to involve the private sector in R&D. However, it was argued that:

> as long as government agencies are encouraged to mimic and compete openly with the private sector—performing work for other federal, state and local government agencies and even for

155 ACF, *Submission no. 62*, p. 5.

156 ASIBA, *Submission no. 58*, p. 4; NRI, *Submission no. 32*, p. 11.

157 ASIBA, *op. cit.*, p. 6.

> that small portion of private sector work placed to open tender—ASIBA and the companies it represents believes they will have a stranglehold on business opportunities and stifle economic growth.[158]

6.124 It was recommended that, in general, publicly funded agencies should not act as prime bidder for projects where that bid competes directly with the private sector, 'unless the work related to the project cannot be effected by an alternative bidder.'[159] ASIBA also recommended that all Australian companies ought to have equal access to the skills and experience of national science agencies as part of their own bids—'that is, CSIRO should not reserve its services exclusively for any one organisation over another.'[160] ASIBA also called for greater commercial exploitation of government held spatial information.

6.125 NRI also argued that that industry often has to compete with publicly funded organisations, such as state agencies, when tendering for contracts let by CMOs. It was argued that the '[t]he current situation provides opportunities for breaches of the Trade Practices Act and the Competitive Neutrality Regulations' and that this often occurs.[161]

6.126 To develop industry capacity, NRI recommended that:

- tender specifications provide opportunities for industry to compete for public research funds;
- existing policy and legislation be applied so that industry can compete effectively against publicly funded organisations;
- those specifying requirements in tenders be prevented from bidding for work; and
- all reviews of proposals be signed and made available to the proponent.[162]

6.127 The Committee acknowledges the contribution of the private sector to salinity R&D and wishes to see that capacity developed. In particular, the Committee urges that industry be given genuine opportunity to tender for public research funds, especially small to medium sized enterprises at the

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158 *ibid.*
159 *ibid.*, p. 5.
160 *ibid.*
161 NRI, *op. cit.*, p. 8.
162 *ibid.*, pp. 11-12.

regional level, and that tendering processes be transparent. The Committee addresses the private sector's role in the provision of technical and support services in chapter eight.

Recommendation 12

6.128 **The Committee recommends that the Australian Government, in cooperation with state governments, encourage development of industry capacity in salinity research and development, by adopting measures that include:**

(a) ensuring tender specifications provide genuine opportunities for industry to compete for public research funds, particularly for small to medium sized enterprises at the regional level; and

(b) ensuring tendering processes are transparent, so that industry can compete effectively against publicly funded organisations.

Conclusions

The need for further salinity research

6.129 Despite the knowledge and management tools developed to date, the Committee is persuaded that governments need to provide on-going support for salinity R&D.

6.130 The Committee notes evidence suggesting an imbalance in the Australian Government's salinity science investments towards mapping, at the expense of developing new technologies and systems, engineering systems and new industries for saline resources.

6.131 The Committee notes strongly divergent views in the evidence: between national NRM agencies which argued for the efficacy of highly targeted interventions (at least in eastern Australia) aided by mapping technologies, versus a range of submitters who argued that research findings point to the need for large scale land use changes and, hence, the need for profitable land use options that can be widely adopted by landholders.

6.132 The Committee notes that differences in geology and landscape characteristics between the east and west of the continent may have generated diverging perspectives on appropriate management interventions and R&D priorities. Nonetheless, the national NRM agencies conceded that while the prospects for targeted interventions in eastern Australia may be positive, the situation in Western Australia is characterised by much larger, homogenous systems and landscape salt.

6.133 The Committee welcomes the potential for targeted salinity management in some locations assisted by mapping technologies, but notes that 70 per cent of the nation's salinity problem occurs in Western Australia. Calls from this state and a range of other submitters are for new land and water use systems and strategic interventions to protect high value assets. Consequently, the Committee recommends that the Australian Government give greater emphasis through its science investments to the development of new land and water use systems.

Research priorities

6.134 Although the Committee's inquiry was concerned with national salinity science coordination and the terms of reference did not seek comment on research priorities, approximately 70 submitters identified specific research needs.

6.135 The Committee recognises that prioritising research needs for future R&D investment is properly the responsibility of CMOs and technical committees at state and national levels. However, the Committee recommends that, in addition to new land and water use systems, greater emphasis be given to:

- address urban salinity; and
- encourage CMOs to introduce industry development planning into their NRM planning and funding prioritisation process.

The Committee also urges that multidisciplinary research be encouraged.

6.136 The Committee recognises that the new NRM context has altered the research supply-demand relationship, with CMOs now having greater power to determine research priorities. While this situation is welcomed, the Committee urges that a 'bottom-up' approach to identification of research priorities be effectively combined with a 'top-down' analysis to ensure that national perspectives and new scientific knowledge or techniques are incorporated into regional management practice.

6.137 The Committee acknowledges the importance of combining on-going scientific research with an adaptive management approach: using the best available knowledge now and continuing research over the long term.

Funding for salinity research

6.138 Notwithstanding the overall increase in salinity funding, the Committee is concerned that the NAP does not have a charter to fund salinity R&D, at least not beyond that required for regional level implementation. The Committee is persuaded that adequate funding should be available to support salinity R&D, particularly into generic issues that are of nationwide significance or for research that is beyond the scope of individual CMOs. The Committee recommends that provision be made within the NAP for the establishment of a salinity R&D fund to finance research of this nature.

6.139 In view of the significance of their research investments and their relationship with primary producers, the role of RDCs is of particular importance. The Committee notes calls for RDCs to invest more substantially in researching sustainable land use systems, and in the development of new salinity technologies.

6.140 Although the Committee identifies the need for generic research activities to be supported at state and national levels, the Committee believes that individual CMOs ought to be encouraged to undertake or commission salinity R&D, where this is relevant.

6.141 The Committee wishes to encourage greater opportunity for small to medium sized enterprises to tender for research work, particularly at the regional level, and to encourage private sector investment in salinity research activities.

6.142 The Committee notes the need for long-term funding for data collection and to monitor the effects of salinity management actions at the regional level. The Committee urges government agencies to provide this on-going support. Other issues associated with the management data and salinity mapping are considered in the following chapter.

7

Data management and mapping technologies

7.1 This chapter reviews the evidence received on the management of data, and mapping technologies. The chapter develops issues addressed in chapters two and six.

7.2 This chapter first addresses issues relating to data collection, management and retrieval, as follows:

- an outline of submitters' concerns about the current data management arrangements (paragraphs 7.6-7.8);
- options for improving the coordination and retrieval of data (paragraphs 7.9-7.32); and
- the Australian Government initiatives aimed at reducing the problems associated with data management (paragraphs 7.33-7.46).

7.3 The second half of this chapter reviews the evidence received on salinity mapping technologies, in particular:

- a discussion on the place of mapping technologies, particularly airborne electromagnetics (AEM), in *A National Action Plan for Salinity and Water Quality* (NAP) (paragraphs 7.47-7.60); and
- an outline of submitters cautions and concerns about AEM (paragraphs 7.61-7.75).

The collection and management of data

The science to combat salinity is only as rigorous as the data that underpins it.[1]

7.4 By modelling and interpreting spatial and temporal data, scientists are able to refine their knowledge of salinity and its management, which in turn enables them to provide information for targeted policy making.[2] The emphasis in this section is on the management of fundamental datasets, not the extension of 'interpreted' data (which is discussed in chapter eight of this report).[3]

7.5 During the inquiry a range of issues relating to salinity data and its management were raised, including the adequacy of access, storage and maintenance of data, data standards and the availability of useable data.[4] In this section, the issues raised by submitters with regard to data management are explored. The Committee acknowledges that there were limitations in the evidence received on the governance structures for data management and salinity data specifically.[5]

Data and the concerns of submitters

7.6 At the time of writing *A Full Repairing Lease*, the Industry Commission heralded the proposed National Land and Water Resources Audit (NLWRA) and the Australian Spatial Data Infrastructure (ASDI)[6] as offering solutions to the problems associated with environmental datasets, such as poor access, the duplication of information, and incompatibility across jurisdictions.[7] Six years on, despite the commencement and successes of both the NLWRA and the ASDI initiatives, the Committee

1 Australian Society of Soil Science Inc. (ASSSI), *Submission no. 68*, p. 3.

2 Dr Richard Price (National Dryland Salinity Program), *Transcript of Evidence*, 3 November 2003, p. 18. Also see: Australian Government Departments of Agriculture, Fisheries and Forestry and the Environment and Heritage (DAFF and DEH), *Submission no. 72*, p. 5.

3 For a discussion on the differences between 'raw' and 'interpreted' data see Mr Greg Hoxley (Australian Spatial Information Business Association), *Transcript of Evidence*, 24 November 2003, p. 6.

4 Dr Martin Blumenthal (Grains Research and Development Corporation), *Transcript of Evidence*, 7 November 2003, p. 79.

5 The Committee did not receive direct evidence from the National Land and Water Resources Audit, the Australia New Zealand Land Information Council and Geoscience Australia (or the Office of Spatial Data Management).

6 The Australian Spatial Data Infrastructure is a network of fundamental spatial databases maintained by custodians and linked through the adoption of consistent standards, policies and administrative arrangements.

7 Industry Commission, *A Full Repairing Lease*, Report no. 60, 27 January 1998, pp. 185-186.

noted similar issues to those found by the Industry Commission during its inquiry.[8]

7.7 The concerns of submitters included:

- difficulties associated with accessing data held by individual researchers, research organisations and government agencies, and the need to increase access to datasets—related issues raised were:[9]
  - ⇒ the relatively high costs for consultants and other non-government users to purchase data;[10]
  - ⇒ data not being made publicly available because of the competitive nature of research, and issues relating to intellectual property rights;[11]
  - ⇒ the need for distribution guidelines, so that publicly accessible data does not negatively affect landholders (for example by decreasing property values) or breach intellectual property rights;[12]
  - ⇒ options for improving access, which included the development of a national database containing datasets, a meta-database describing the location and attributes of available datasets or interactive, flexible, web-based networks of information;[13]
- the need for nationally consistent data measurement and collection standards to ensure that datasets are fit for their purpose, and that there is commensurability and interoperability between datasets, across regions, states and other jurisdictional boundaries;[14]

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8 *ibid.*, pp.111-112, 181.

9 Centre for Salinity Assessment and Management (CSAM), University of Sydney, *Submission no. 19*, p. 3. Also see: Dr Inakwu Odeh (CSAM), *Transcript of Evidence*, 29 October 2003, p. 56; Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 9; Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), *Submission no. 64*, p. 5; Australian Nuclear Science and Technology Organisation (ANSTO), *Submission no. 22*, p. 5.

10 Mr Anthony Dawson (Murray Catchment Management Board), *Transcript of Evidence*, 30 October 2003, pp. 16-17.

11 Dr John Triantafilis (CSAM), *Transcript of Evidence*, 29 October 2003, p. 65. Also see: Sinclair Knight Merz, *Submission no. 28*, p. 3; Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 64.

12 The Hon. Dr Sharman Stone MP, *Transcript of Evidence*, 31 October 2003, p. 42.

13 Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, p. 33. Also see: Professor Les Copeland, *Transcript of Evidence*, 29 October 2003, pp. 56, 62; Mr David Hocking (Australian Spatial Information Business Association Ltd), *Transcript of Evidence*, 24 November 2003, p. 2; ANSO, *op. cit.*, p. 4.

14 The Pelham Group, *Submission no. 11*, pp. 1-4. Also see: Dr John Bradd (Australian Salinity Action Network), *Transcript of Evidence*, 29 October 2003, p. 3; Mr Andrew Huckle (NSW Farmers' Association), *Transcript of Evidence*, 29 October 2004, p. 47; Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 79; NSW Farmers' Association, *Submission no. 45*, p. 4; Australian Spatial Information Business Association, *Submission no. 58*, p. 1.

- the need to ensure data is maintained appropriately;[15]
- the lack of data upon which to make informed decisions, in particular:[16]
  - ⇒ data at catchment, sub-catchment and farm scale, combined with the need to increase support for catchment management organisations (CMOs), local governments and landholders, to use and access datasets;[17]
  - ⇒ to monitor project outcomes in the short, medium and long-term;[18] and
- long-term funding for the collection of salinity data.[19]

7.8 These concerns are discussed below, together with examples of the Australian Government initiatives aimed at addressing them.

Improving the coordination of data exchange

7.9 The weight of evidence indicated that the poor exchange of data and difficulties accessing datasets, between individual researchers, research organisations, industry groups and government agencies, was inhibiting the salinity research effort.[20] Despite improvements in data coordination resulting from the NLWRA, Mr Phil Dyson noted difficulties accessing data held by different states and government departments:

> We have multiple jurisdictions and multiple agencies that manage data and information … There are many projects that I have worked on where it does not matter whether it is Victoria, New South Wales, Queensland or wherever, data is something that is still very institutionalised. An awful lot of time is spent trying to secure access to information, particularly when you work on national projects or Murray-Darling Basin projects where you are

15 ASIBA, *ibid.*, p. 2; ASSSI, *loc. cit.*

16 Murray Catchment Management Board, *Submission no. 10*, p. 1; CSIRO, *Submission no. 42*, p. 14.

17 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 18. Also see: Mr Colin Kandan-Smith (Western Sydney Regional Organisation of Councils), *Transcript of Evidence*, 29 October 2003, p. 17; Orbtek Pty Ltd, *Submission no. 3*, p. 11; Mr Ian Thompson (DAFF and DEH), *Transcript of Evidence*, 7 November 2003, p. 53; Dr Philip Price (GRDC), *Transcript of Evidence*, 7 November 2003, p. 76; Mr Paul Farrell (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 12; Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, p.4; Webbnet Land Resource Services Pty Ltd, *Submission no. 40*, p. 4.

18 Agrilink, *Submission no. 25*, p. 6.

19 Murray Catchment Management Board, *loc. cit.*

20 See for example Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 37.

> trying to get information out of either a region or a state. It is as though you are dealing with a different country sometimes.[21]

7.10 While acknowledging the constraints imposed by intellectual property rights, the Centre for Salinity Assessment and Management (CSAM) submitted that increased access to databases held by different research organisations was needed.[22] CSAM suggested that:

> Some of the basic landscape data … should be made available to researchers free of charge, as occurs in the USA. The high cost of access to some of these data is a constraint on research, especially in earth sciences. At the very least, public good research programs should have free access to these data.[23]

A national repository of salinity data

7.11 A number of submitters recommended a national repository of data be established.[24] It was generally accepted that the Australian Government would be best placed to coordinate such an initiative.[25] In this regard the Australian Cotton Cooperative Research Centre recommended:

> Building and managing national and state databases containing publicly funded research data, rather than outcomes. The data should be recorded and reported in consistent (international standard) SI units. These databases should be accessible by other publicly funded research projects (possibly for a small fee to manage access).[26]

7.12 The Forest Products Commission of Western Australia (FPCWA) supported the establishment of a meta-database, which identifies the location of available data, rather than a database containing the actual datasets.[27] The Commission argued this arrangement could potentially assist in overcoming intellectual property right issues associated with data sharing.[28]

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21 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 9.

22 CSAM, *op. cit.*, p. 2.

23 *ibid.*

24 See for example Sinclair Knight Merz (SKM), *op. cit.*, p. 5; Murray Catchment Management Board, *op. cit.*, p. 2.

25 *ibid.*

26 Australian Cotton Cooperative Research Centre, *Submission no. 67*, p. 1.

27 Dr John McGrath (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 5.

28 *ibid.*

7.13 While noting weaknesses in the coordination of data, the Murray-Darling Basin Commission (MDBC) did not support the establishment of a repository and preferred 'networks' of information:

> I am not proposing to you that we should have a gigantic repository. What I am suggesting is that, over and above all, we need networks that share information—distributed networks. Yes, there is a technology component to that which can help, but it is a change of behaviour and a change in attitude in terms of information sharing, pricing policies and access to information. It is about coming to some agreed standards by which we can exchange and compare apples with apples, rather than having a mishmash of approaches when we are asking national scale questions.[29]

7.14 Land and Water Australia (LWA) endorsed the views of the MDBC, and suggested that a salinity data portal might be jointly managed by the Bureau of Rural Sciences (BRS), NLWRA and LWA.[30]

7.15 ASIBA submitted that the Australian Government's role in data management involves 'ensuring that data that is collected by disparate groups is not duplicated; and building on that knowledge base through an effective salinity data atlas':[31]

> No mechanism exists for aggregating salinity data and distributing it through an open system to stakeholders. Results of work carried out by the public and private sector are held in data silos without a single repository or metadata reference source. Failure to maintain a single salinity data infrastructure means duplication and conflicting results.[32]

7.16 ASIBA also noted the 'tendency' to consider a 'central repository' as the best way to coordinate data.[33] However, it argued that as long as there are clear standards and frameworks for data exchange a repository may not be necessary. ASIBA drew the Committee's attention to the arrangement developed by the Australian Greenhouse Office for managing data relating to the clearing of vegetation.[34]

29 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 37.

30 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 31.

31 Mr David Hocking (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 2.

32 ASIBA, *loc. cit.*

33 Mr Greg Hoxley (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 3.

34 Mr Paul Farrell (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 4.

7.17 The Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PBMDS) stated that it was developing networks to successfully distribute data:

> Within the CRC, of course, we are setting up systems so that can happen, because our projects generally speaking extend across institutions and state boundaries. We have systems where our scientists can enter their data into databases that are managed by the Internet. What I think is needed is something like this managed by an organisation something like the National Dryland Salinity Program, which is a body constituted by the states, the Commonwealth, and other interested people.[35]

7.18 Caveats on making salinity data publicly available were raised with the Committee. Despite supporting in principle the need to increase access to datasets, Sinclair Knight Merz (SKM) raised concerns about providing commercial information freely over the internet, and urged that consideration be given to the licensing control of topographic material.[36] The Hon. Dr Sharman Stone MP cautioned against putting salinity information into the public domain without adequately consulting the landholders on whose properties the data was gathered.[37] Dr Stone cited instances where farmers had been financially penalised, and felt stigmatised, by the publication of maps indicating that their properties exhibited signs of salinity.[38]

Data standards

7.19 In addition to supporting a single site for the storage of salinity data, the Grains Research and Development Cooperation (GRDC) submitted that the lack of data standards, and the resulting incommensurability of datasets, is an added hindrance to researchers working with multiple datasets:

> There are different state databases, information sources and ways of collecting information. There is very little standardisation. It is very difficult to compare across boundaries.[39]

35 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 23. Also see: Dr John McGrath (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 9.

36 SKM, *Transcript of Evidence*, 31 October 2003, p. 38.

37 The Hon. Dr Sharman Stone MP (Parliamentary Secretary to the Minister for the Environment and Heritage), *Transcript of Evidence*, 31 October 2003, p. 42.

38 *ibid*.

39 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 79.

7.20 ASIBA also noted that varying standards made it difficult to compare information, and a lack of standards could result in collected data being useless for its intended purpose.[40]

7.21 To address the concern that salinity data relating to geophysical surveys is not being consistently or efficiently collected, the Pelham Group presented clear recommendations:

> 1. The development and definition of standards for data collection and interpretation that will be applied for all NAP (and other) geophysical surveys for salinity; and
>
> 2. The development of a Quality Assurance process that ensures that the standards are attained.[41]

7.22 While acknowledging that 'minimal' collection standards are of value, Dr Brian Tunstall, from Natural Resource Intelligence (NRI), told the Committee: 'I hate standards. They are a bit like records: they are made to be broken. As soon as you set a standard, it is obsolete. They are too constraining.'[42]

7.23 While it is beyond the scope of the inquiry to provide a prescriptive recommendation regarding what standards should be applied nationally to salinity data, the Committee acknowledges that the adherence to clear standards reduces the risk of creating scientific and technical barriers to the exchange and use of data.

Maintaining data

7.24 ASIBA drew the Committee's attention to the need to ensure data is properly maintained:

> there is little recognition of the need to ensure that the data is properly maintained. Spatial information and its technologies are important tools in the management of the environment and its natural resources. It is also an infrastructure, just like a bridge or a road, and must be maintained. Without maintenance, the information with which organisations make important decisions, such as in salinity mitigation, will be corrupted, inferior and wasted.[43]

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40 Mr Greg Hoxley (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 3.

41 The Pelham Group, *op. cit.*, p. 4.

42 Dr Brian Tunstall (Natural Resource Intelligence), *Transcript of Evidence*, 7 November 2003, p. 16.

43 Mr David Hocking (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 2.

7.25 The Australian Society of Soil Science Incorporated (ASSSI) lamented the loss of historic databases, and argued that it had 'severely constrained' the NLWRA's ability to asses the current 'condition of our natural resources'.[44]

Scales of data for differing needs

7.26 To solve natural resource management (NRM) problems, data and information is required at a variety of levels. The amount of detail in the data should correlate with the scale of the issue it is aimed to address. As the MDBC stated:

> there are farm level decisions, catchment level decisions and, in our case, basin level decisions. The knowledge is best in the hands of the people who are closer to the decision front, because that is where you adapt it and refresh it and so on.[45]

7.27 The Committee heard that there is not sufficient data available at the farm, sub-catchment and catchment levels, which presents a problem for on-ground land managers implementing NRM programs.[46] In this regard Webbnet Land Resource Services submitted:

> The common constraint faced by regional groups and government agencies is the lack of appropriately scaled data on soil and landscape attributes, and DEM's. In many of the catchments where dryland salinity is an issue, more detailed datasets than the current ones are required for evaluating land use changes at the sub-catchment or property scale.[47]

Utilising pre-competitive and legacy datasets

7.28 The Committee received evidence that there is a need to improve access to datasets not collected specifically for salinity or NRM related projects, held by Geoscience Australia (GA) and the State Geological Surveys, including pre-competitive and legacy data.[48] On this issue, the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC

44 ASSSI, *loc. cit.*

45 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 39.

46 Dr Brian Tunstall (NRI), *Transcript of Evidence*, 7 November 2003, p. 9. Also see: Webbnet Land Resource Services Pty Ltd, *op. cit.*, p. 3.

47 Webbnet Land Resource Services Pty Ltd, *ibid.*

48 CRC LEME, *op. cit.*, p. 3. Pre-competitive data refers to geoscientific data collected and managed by government agencies, essentially Geoscience Australia and the states' geological surveys. Legacy data refers to technical data collected during exploration works by private companies. As a licensing requirement companies must periodically lodge this data with relevant state agencies, thereby making it public information.

LEME) was concerned that 'local NRM projects are not getting the benefit of datasets that already exist, often in the state geological surveys'.[49]

7.29 CRC LEME recommended the arrangements instituted under the National Geoscience Agreement (NGA), for the sharing of pre-competitive data, could be replicated to manage NRM data:

> The national Geoscience [Mapping] Accord [now the NGA], between GA and the State Surveys, has been very positive in providing basic geoscientific information to help mineral exploration. Similar knowledge sharing could greatly assist in applications to Natural Resource Management.[50]

7.30 In addition to encouraging data sharing, it was submitted that NGA avoids duplication in data collection, and promotes national data standards and objectives.[51]

7.31 The MDBC agreed that Geoscience Australia's experience, managing pre-competitive data, makes them well placed to assist with the management of NRM data:

> Geoscience Australia is a key custodian for some of the fundamental datasets in Australia. It has the capacity, linkages and discipline in the information sciences to provide a support role.[52]

7.32 Furthermore, the Western Australian Salinity Research and Development Technical Committee (WA SRDTC) recommended Geoscience Australia's standing orders be amended to encourage them to work in groundwater and natural resource management related areas.[53]

The Australian Government's role in the management of salinity data

7.33 According to the Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), the Australian Government has taken significant steps to standardise, collate and distribute salinity data.[54] In this regard, it was submitted that the departments were undertaking projects on:

> data standards and data management systems, mapping and mapping science, models and tools, communication and

49 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 18.

50 CRC LEME, *loc. cit.*

51 *ibid.*, p. 5.

52 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

53 WA SRDTC, *loc. cit.*

54 DAFF and DEH, *op. cit.*, p. 4. Also see: Dr Rhondda Dickson (DEH), *Transcript of Evidence*, 7 November 2003, p. 54.

> knowledge networks, and systems to access and disseminate salinity data and information.[55]

The National Land and Water Resources Audit

7.34 According to the National Dryland Salinity Program (NDSP), the NLWRA represents the first attempt to bring all the variable datasets on salinity together to produce salinity information at a national scale: 'It is the bible at the moment on the extent and cost of salinity'.[56] DAFF and DEH explained:

> At the national level, the National Land and Water Resources Audit (the Audit) works with DAFF and DEH to maintain a digital data library and an atlas of Australian natural resources. A key role of the Audit is to coordinate the science and data collected through investments of the NAP and NHT. The Audit also works with ANZLIC – the spatial information council, to ensure data standards are established and implemented consistently throughout the nation.[57]

7.35 In support of the efforts by NLWRA, LWA stated that:

> … the National Land and Water Resources Audit showed, when you can get the data out of the map drawers of the state agencies, get it into a consistent format and make it publicly available through a user-friendly system, then the community can start to access some often very useful information.[58]

7.36 According to the MDBC, the NLWRA highlighted that:

- there is not consistent data coverage of the Australian landscape;
- the wealth of information that does exist in institutions needs to be better linked;
- data standards need to be established to ensure datasets are commensurable.[59]

7.37 The NLWRA has been criticised for not providing data with sufficient detail to assist farmers,[60] however it is worth noting that the information generated out of the NLWRA was developed to promote broad scale

55 DAFF and DEH, *ibid.*

56 Dr Richard Price (NDSP), *Transcript of Evidence*, 3 November 2003, p. 13.

57 DAFF and DEH, *op. cit.*, p. 5.

58 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 2.

59 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 37. Also see: Dr Richard Price (LWA), *Transcript of Evidence*, 3 November 2003, p. 13.

60 Government of New South Wales, *Transcript of Evidence*, 29 October 2003, p. 80.

information on salinity and water issues, and to facilitate national policy decisions.[61]

7.38 ASSSI submitted: '[t]he Audit in relation to salinity was based upon incomplete, disjointed and partial sets of data, and so in many respects is not very useful'.[62] The NLWRA acknowledges limitations in the audit process resulting from variability in the 'methods, scale and reliability of data underpinning the state assessments', which made comparisons between states invalid.[63] The second phase of the audit aims to address these issues.[64]

7.39 To ensure data is collected in a consistent manner, DAFF and DEH submitted that the Bureau of Rural Sciences (BRS) will conduct a Salinity Data Infrastructure Project:

> The project will provide a specification for salinity data and information quality, which includes a set format (architecture) for salinity spatial data and data fields (attributes), including metadata (descriptions of datasets). The project will have input from all jurisdictions.[65]

Other national and state initiatives

7.40 DAFF and DEH submitted that BRS is the Australian Government's lead agency in the management of salinity related data and mapping technologies:

> As the lead agency in the development of nationally consistent catchment scale land use datasets, BRS is working with other Australian Government and State/Territory government agencies to establish agreed national land use mapping standards and specifications. This work includes ensuring land use information is available to support natural resource management and policy needs, including the NAP and NHT.[66]

7.41 The Australian Government, often in collaboration with state and territory governments, has taken steps to manage salinity related data through the

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61 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, pp. 40-41.

62 ASSSI, *loc. cit.*, p. 3.

63 National Land and Water Resources Audit, *Australian Dryland Salinity Assessment 2000 – Technical Overview*, viewed 22 March 2004, <audit.ea.gov.au/ANRA/land/docs/national/Salinity_Technical_Overview.html>

64 Dr Richard Price (LWA), *Transcript of Evidence*, 3 November 2003, p. 13.

65 DAFF and DEH, *op. cit.*, p. 9.

66 DAFF and DEH, *ibid.*, p. 15.

development of measurement and lodgement standards, the creation of retrieval systems and data sharing agreements. Initiatives include:

- improving accesses to data for decision makers at all levels, through:
  - ⇒ the Australian Natural Resources Data Library managed by the NLWRA in conjunction with DAFF and DEH;
  - ⇒ the Australian Spatial Data Directory[67] (an essential component of Australian Spatial Data Infrastructure) maintained by Geoscience Australia on behalf of ANZLIC;[68]
  - ⇒ Discovering Data on the Natural Resource Management website, which provides information on NAP and *Natural Heritage Trust* (NHT) initiatives;
  - ⇒ the proposed Australian Water Data Infrastructure Project, to be developed between 2003-06, with DAFF as the lead agency;
- policies on data costs and access:
  - ⇒ of note is the Australian Government Spatial Data Access and Pricing Policy developed by the Office of Spatial Data Management (hosted by Geoscience Australia);
  - ⇒ through the endorsement of the Spatial Information Industry Action Agenda (2001) which recommended that spatial data should be priced at 'a maximum of the cost of distribution, with minimal copying and royalty restrictions';[69]
- increasing data sharing through collaborative arrangements, such as exists between Geoscience Australia and CRC LEME;
- consistent data standards, for example:
  - ⇒ ANZLIC's Policy Statement on Spatial Data Management, DAFF's Australian Land Use and Management Classification, and other agreed procedures for producing land use maps, maintained and promoted under the ASDI;
- standards for the collection of salinity related data:

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67 The Australian Spatial Data Directory provides information about the availability, characteristics and quality of spatial data held by governments and the private sector and how that information may be obtained.

68 ANZLIC is the peak council for the coordination of spatial data management in Australia and New Zealand.

69 Department of Industry, Tourism and Resources, Spatial Information Industry Action Agenda, viewed 4 May 2004, <www.industry.gov.au/content/itrinternet/cmscontent.cfm?ObjectID=5BDDEA05-13C1-480C-BB4BB289E3976439>.

- ⇒ through collaborative policies developed between the NLWRA and ANZLIC and promoted by the ASDI;
- ⇒ via the Salinity Data Infrastructure Project being conducted by BRS;
- ⇒ by providing Guidelines for Best Practice in the Public Presentation of Salinity Data and Mapping Products, developed by the Science and Information Working Group of the Natural Resource Management Standing Committee (among other objectives these aim to ensure that researchers gain appropriate approval for data collection, identify data ownership, access rights and establish intellectual property);

- increasing support for CMOs:
  - ⇒ to access, visualise and manage their data through the development of the Natural Information Management Toolkit, prepared by NLWRA and ANZLIC;
  - ⇒ by the Monitoring and Evaluation Working Group, establishing the National Natural Resource Management Monitoring Framework and the National Framework for Natural Resource Management Standards and Targets.[70]

7.42 The Australian Government performs a vital role in the management of NRM data. The Committee is concerned that despite the Australian Government's substantial efforts to improve access to spatial and temporal datasets, and standardise measurement and lodgement procedures, problems persist.

Recommendation 13

7.43 **The Committee recommends that the Australian and state government agencies holding natural resource management datasets, accelerate the development of data collection, management and retrieval systems that are standardised, integrated and accessible.**

70 DAFF and DEH, *op. cit.*, pp. 2, 4, 5, 9, 36; Mr Ian Thompson (DAFF and DEH), *Transcript of Evidence*, 7 November 2003, p. 53; Australian Government, Geoscience Australia, *Australian Spatial Data Infrastructure [ASDI],* Canberra, viewed 4 April 2004, <www.ga.gov.au/nmd/asdi/>; National Land and Water Resources Audit Australia, *Audit data projects,* viewed 10 March 2004, <www.nlwra.gov.au/minimal/35_data/data.html>; Australian Spatial Data Infrastructure, Australian Spatial Data Directory (ASDD), viewed 4 April 2004, www.ga.gov.au/asdd/; ANZLIC, Policy Statement on Spatial Data Management, April 1999, viewed 6 April 2004, <www.anzlic.org.au/pubinfo/2358011750>; National Resource Management website, Discovering Data, viewed 19 April 2004, <www.nrm.gov.au/data/index.html>.

7.44 With the increased involvement of CMOs in data collection, the Committee is concerned that best practice standards for data management are developed and adopted by regional project managers. The Committee notes that in addition to supporting CMOs gain access and use salinity related information, there is an onus on the Australian Government to ensure that the spatial data collected becomes part of the national data resource base—available for multiple uses, across-jurisdictional boundaries—both now and in the future. The Committee notes the efforts of the NLWRA and other Australian Government initiatives in this regard. The Committee urges that these be adequately resourced to undertake the task of assisting CMOs into the future.

Recommendation 14

7.45 **The Committee recommends that ANZLIC – the Spatial Information Council, in collaboration with the National Land and Water Resources Audit, be resourced to support managers of regional projects to develop and implement best practice data management policies. Emphasis should be placed on developing:**

(a) consistent data collection, management and retrieval systems;

(b) mechanisms to encourage data sharing between catchment management organisations, research institutions, industry bodies and government agencies; and

(c) quality assurance processes to ensure standards are attained.

7.46 The Committee supports in principle the development, by the Australian Government, of an easily accessible web-based network to manage and disseminate salinity data. This proposal will be further developed in chapter eight. The Committee notes that any system to coordinate data should have the capacity to evolve as technological advances occur and understandings of salinity management and NRM develop.[71]

71 SKM, *op. cit.*, p. 4.

Mapping technologies

7.47 The range of techniques used to model the salinity processes and delineate surface expressions of salinity include ground-based and airborne electromagnetics (EM and AEM), air photo interpretation (API), satellite imagery, radar, soil surveys, borehole and stream monitoring and digital elevation models. The Committee received evidence on both airborne and ground-based mapping methods.[72]

7.48 In January 2004, a review of salinity mapping technologies was published on behalf of the Natural Resource Management Ministerial Council. The Salinity Mapping Methods User Guide and Technical Report were produced from this process.[73] The User Guide stressed that the appropriateness and efficacy of mapping and modelling techniques depends on a range of factors:

> The choice of mapping methods depends on scale, ground conditions, the problem at hand and the expertise of the user. To map the extent of areas affected by dryland salinity the most straightforward methods are API and satellite imaging combined with visual inspection, and ground EM38. To map the presence of salt at depth we recommend AEM constrained by borehole logging and point EC [electrical conductivity] sampling. To investigate hydrological factors affecting the transportation of salt by groundwater, aeromagnetics and AEM are the key techniques.[74]

7.49 Mapping is a central component of the NAP.[75] The NAP states the '[a]pplication of new scientific, technical and engineering knowledge requires … "ultrasound" salinity mapping and related technologies in priority catchments / regions'.[76]

7.50 The Committee notes that researchers have found geophysical mapping beneficial in assisting them to understand the processes of salinisation,

72 See for example: DAFF and DEH, *op. cit.*, pp. 20-21; *Exhibit no. 69, Technical aspects of salt mapping*; GecOz Pty Ltd, *Exhibit no. 131, GecOz Submission to the Review of Salinity Mapping Methods in the Australian Context.*

73 The Technical Report and User Friendly Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, <www.ndsp.gov.au / 80_airborne / airborne.htm>. Transcripts of the public forum convened by the Australian Academy of Science and the Academy of Technological Sciences and Engineering on 17 October 2003, to receive and critique the draft review products, are available online, viewed 5 February 2004, <www.science.org.au / proceedings / salinity / index.htm>.

74 The User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, p. 18, <www.ndsp.gov.au / 80_airborne / airborne.htm>.

75 Council of Australian Governments (COAG), *A National Action Plan for Salinity and Water Quality*, DAFF and DEH, Canberra, 2000, p. 5.

76 *ibid.*

and the development of management options. CRC LEME argued that mapping is one means of facilitating targeted salinity interventions:

> Airborne electromagnetics are an important tool—not everywhere, but in many of the environments we work in—to help us map salinity and work out solutions.[77]

7.51 Similarly, Professor Les Copeland of CSAM stated:

> I think the key to understanding the problem and addressing it is to map the salinity and to get good data or risk assessment on where the salinity problems are greatest and where the opportunities for management are greatest … What we lack is the mapping of the risk of salinity and where we can best invest to reverse it.[78]

7.52 As outlined in chapter six of this report, the Australian Government through the NAP has placed considerable emphasis on airborne geophysical mapping techniques.[79] The tension between the usage of AEM to aid targeted interventions (at least in eastern Australia) versus the calls for broadacre solutions was noted. Also, as Murray Irrigation highlighted, the emphasis on mapping technologies by researchers may be at variance to the needs of land managers:

> we are after new and improved methods on how to deal with salinity; and, to a large degree, our salinity researchers are more focused on mapping and where to find salinity.[80]

7.53 The Committee concluded in chapter six, that AEM has the potential to contribute to targeted salinity management, when used in combination with other techniques and adequately calibrated. However, it was posited that the Australian Government's support for this technology should not be at the expense of R&D investments in new land and water use systems.

77 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 16.
78 Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 59.
79 See DAFF and DEH, *op. cit.*, p. 20.
80 Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 16.

The Australian Government's involvement in salinity mapping

> *Investments made by the Australian Government have enabled innovative technologies such as airborne geophysics to be developed and applied. This technology provides a hitherto unattainable level of understanding of Australian landscapes in three and four dimensions (ie through space and time).*[81]

7.54 BRS and the Australian Bureau of Agricultural Resource Economics have developed the application of airborne geophysics, integrated with hydrogeological assessments, field measurements and land use information, to map and predict salinity.[82] A technical description of the geophysical mapping technologies employed by the BRS, which incorporates airborne electromagnetic, magnetic, radiometric and digital elevation techniques, is provided in Appendix F to this report.

7.55 DAFF and DEH outlined some of BRS achievements in the area of regional salinity mapping, these included:

- the *South Australian Salinity Mapping and Management Support Program*, which utilises airborne electromagnetic, radiometric and magnetic techniques to map five catchment regions within two of the NAP priority areas;[83]
- a guide for regional planners, *Five Steps to Tackling Salinity,* in its 'Science for Decision-makers' series, which explains where mapping fits in the planning process for salinity management;[84]
- establishing agreed national land use mapping standards and specifications, as previously mentioned;[85]
- synthesising the results of salinity mapping conducted in ten catchments in eastern Australia and in the process revealing that:
  - ⇒ salt is more localised in the landscape than previously thought and only represents a salinity risk if it is likely to be mobilised;

81 DAFF and DEH, *op. cit.*, p. 3.

82 DAFF and DEH, *ibid.*

83 Australian Government Department of Agriculture, Fisheries and Forestry, Bureau of Rural Sciences website, viewed 21 April 2003, <www.affa.gov.au/content/output.cfm?ObjectID=BB7F7EE7-38A9-4DD8-805FCFC19E763449>.

84 DAFF and DEH, *Exhibit no. 65, Five Steps to Tackling Salinity*, p. 1. In summary, the five steps are: consult with the community to specify salinity management objectives; map salt stores and identify areas likely to be at risk from salinity; consult with land users and professional agencies to identify feasible management options; work with the community to develop and implement an action plan; and monitor and review effectiveness, see *ibid* p. 3.

85 DAFF and DEH, *Submission no. 72*, p. 15.

⇒ AEM can be used in conjunction with other information to define the location and quantity of salt in the landscape and how it moves;

⇒ specific management interventions (which may include land use change or engineering solutions) can be tailored to individual situations, substantially reducing the cost of managing salinity and minimising potential disruption to agriculture; and

⇒ priority areas for AEM can be effectively established by compiling existing data and undertaking rapid community based stream surveys to identify sub-catchments contributing major salt loads.[86]

7.56 BRS has noted that, through the judicious use of mapping technologies, smaller land use change than previously thought is necessary to manage salinity in catchments:

> In the Billabung, land use change over 17 per cent of the catchment (tree planting over 6000 hectares in the highlands, and conversion of 10 000 hectares of crops and annual pastures to perennial pastures) is expected to achieve a 50 per cent reduction in salt export to the Murrumbidgee, with limited impact on agricultural productivity.[87]

7.57 In addition, BRS has concluded that it can substantially reduce the cost of the information needed to develop salinity management options. For example, the Bureau found that conducting airborne surveys in 10 per cent of the Billabung Catchment and 'combining this with previously collected landform, soils, regolith and groundwater data provided farm scale (1:25 000) management options … at 60 cents per hectare'.[88]

7.58 While noting that AEM is expensive,[89] CRC LEME argued that its studies demonstrate that the cost of conducting AEM surveys can be lowered, without necessarily reducing their effectiveness. This is achieved by increasing the distance between flight transects and identifying important landscape elements prior to surveying.[90] As a result of mapping undertaken at Honeysuckle Creek (Victoria) and the Lower Balonne (Queensland), DAFF concurred that there is the potential to double or

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86 DAFF and DEH, *Submission 72.1*, p. 1. It is worth noting that BRS has produced catchment scale land use maps for 80 per cent of Australia, with a further 15 per cent to be completed by 2005.

87 *ibid.*, p. 4.

88 *ibid.* p. 3. 1:25 000 means that 1cm on a map equals 250m on the ground.

89 According to CRC LEME AEM survey costs $60 to $80 per line kilometre.

90 CRC LEME, *Exhibit no. 116, Reducing the Acquisition Costs of Airborne Electromagnetics Surveys for Salinity and Groundwater Mapping*, p. 1.

triple the distance between line spaces, and thus reduce costs to less than $1 per hectare.[91]

7.59 The Committee received favourable feed-back from the Integrated Natural Resource Management Group for the South Australia Murray Darling Basin on the potential benefits of airborne mapping for regional planning:

> Although the airborne geophysics mapping in the region has not been completed, initial results indicate that the knowledge gained will be valuable in supporting prioritisation of on-ground works. This will ensure that future investment is well targeted and achieves the maximum return. The results are also expected to direct further research through the identification of knowledge gaps.[92]

7.60 Despite the Australian Government's enthusiasm for airborne geophysical surveying, particularly AEM, some submitters cautioned the Committee about the realities of its application. These concerns are outlined below.

Cautions against viewing Airborne Electromagnetics as the 'silver bullet' of salinity management

The appropriate usage of AEM technology

7.61 In his considered submission, Dr Andy Green provided a history of AEM and its present capabilities.[93] Dr Green acknowledged the 'over-enthusiastic endorsement of the technology in the National Action Plan'.[94] However, providing that the limits of the technology are understood and it is used appropriately within the broader NRM framework, he argued:

> we can now distinguish the situations were AEM … should be considered in salinity management.
>
> There must be:
>
> - Realistic, cost effective options for action
> - Genuine commitment to, and mechanisms for action
> - A need for hard geo-scientific information to enable successful action

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91 DAFF and DEH, *Exhibit no. 69*, p. 3. The current cost per hectare is between $2 and $10. These costs are based on flight-line costs of $50-$100 per line kilometre at a line spacing of 100-400 metres. Note mobilisation is expensive at $70 000 which limits practical survey areas to greater than 50 000 ha.

92 Integrated Natural Resource Management Group for the South Australia Murray Darling Basin, *Submission no. 23*, p. 1.

93 See Dr Andy Green, *Submission no. 38*, pp. 1-3.

94 *ibid.*, pp. 1, 4.

- Recognition that AEM is the most cost effective way of getting the information[95]

7.62 It is argued by Dr Green that current AEM technology has an important role in ameliorating the symptoms of salinity and protecting high value assets.[96] However, to date, AEM has not been successfully adopted to assist with treating the causes of salinity, and its role in broadacre recharge reduction strategies has been limited:

> My experience would suggest that current AEM technology is highly applicable for the protection and management of assets but application at the other end of the spectrum [that is, recharge reduction] awaits great clarity…[97]

7.63 Despite its limitations, Dr Green argued: 'AEM technology should not be ignored while clarity is achieved'.[98] In conclusion it was noted that: '[u]nless clear, attractive salinity management strategies are available there is little point in expending resources on activities that are unlikely to result in salinity management action'.[99]

7.64 Mr Phil Dyson explained that AEM provides another layer of information for researchers, which should not be interpreted in isolation from the existing salinity knowledge base.[100] Furthermore, Mr Dyson stated that geophysical surveying should be used more strategically in the future.[101]

7.65 As discussed in chapter six of this report, in Western Australia the benefits of AEM are limited due to the relative homogeneity in geology and the vast scale of the salinity problem.

7.66 WA SRDTC told the Committee that in Western Australia:

> They [AEM technologies] are quite good at predicting where discharges will occur [which] … can help you to fence out those areas before they become completely affected [by salinity]. We have used geophysics to do that, but it is not solving the problem … I have yet to see a highly effective geophysics technique that can identify small areas of landscape which you can treat and have a significant impact on salinity.[102]

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95 *ibid.*, p. 3.
96 *ibid.*, p. 4.
97 *ibid.*
98 *ibid.*
99 *ibid.*
100 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, pp. 8-9.
101 *ibid.*
102 Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, pp. 44-45.

7.67 Furthermore, WA SRDTC submitted that the politicisation of airborne geophysics by BRS had lead to unrealistic expectations about the technology's abilities. The recommendation was made:

> Prevent a repeat of the "Ultrasound era". Politicised processes that are related to such technologies create unrealistic expectations and cause distortion in the scientific process and integrity of information. Other sensible knowledge-based organisations become driven by political processes and rational science and justified expenditure is the victim (e.g. BRS and airborne geophysics).[103]

7.68 The South Australian Government noted that, as a result of its involvement in the NAP, airborne geophysics has been used to fill knowledge gaps surrounding both the causes and impacts of dryland salinity, and viable management actions.[104] However, it was stressed that: 'South Australia has been careful not to over-emphasise the ability of the technology to provide answers to all salinity issues'.[105]

7.69 In this regard the South Australian Government:

> Continue to use airborne geophysics in a highly targeted manner to fill critical knowledge gaps in our understanding of salinity processes and to assist in the development of management plans for high value assets, noting that the application and interpretation of the technology requires expert knowledge and the use of multi-disciplinary teams. [106]

AEM: one technology among many

7.70 The Committee was presented with evidence on a range of alternative salinity mapping and monitoring technologies.[107] For example GecOz's airborne imaging radar application and in particular SaltSAR—a surface soil salinity mapping technology.[108] Similarly, NRI has patented a process whereby gamma ray data is modelled to produce soil property maps.[109]

103 WA SRDTC, *op. cit.*, p. 5.

104 Government of South Australian, *Submission no. 81*, p. 6.

105 *ibid.*

106 *ibid.*, p. 7.

107 See for example: Agrilink, *Submission no. 25*, pp. 1-4.

108 SaltSAR was the recipient of the 2001 iAward for Innovation in IT Services, awarded the 2002 Asia Pacific ICT Award (APICTA) for Research and Development and represented Australia at the International 2003 APICTA. GecOz, *Exhibit no. 131, Submission Brief: Review of Salinity Mapping Methods in the Australian Context*, p. 1.

109 Orbek Pty Ltd, *Submission no. 3*, pp. 1-10.

Additional technologies used in salinity hazard mapping and risk assessments, include:

- at the surface (0-10 cm depth)—visual inspection, aerial photo interpretation, airborne multi-spectral imagery, gamma ray spectrometry, satellite multispectral and hyperspectral;
- at the shallow subsurface (<2m)—on-ground electro-magnetic conductivity mapping and ground probing radar;
- at the subsurface (>2m)—deep-probing electro-magnetic, nuclear magnetic resonance, gravity and airborne magnetics.[110]

7.71 GecOz submitted that the Australian Government has supported AEM technology at the expense of other equally useful mapping techniques.[111] It was argued that this has inhibited technological advances and unfairly disadvantaged small to medium sized enterprises.

7.72 Similarly, Natural Resource Intelligence submitted that the Australian Government's approach, in all areas of salinity management, is too prescriptive. This in turn has limited industry involvement in the provision of salinity services:

> One reason for the suppression industry providing technical services is the strong "top down" approach with the existing structure. We are told what causes dryland salinity, how it should be mapped, and how it should be remediated. There is limited scope for industry to deliver effective technical services when the problems and methods have been so rigidly defined.[112]

Appropriately scaled maps

7.73 As discussed in the previous section, farmers and CMOs have requested data and information that will help them make decisions at the paddock and sub-catchment scale.[113] It has been posited that airborne technologies may not provide as useful information at the local scale, as other mapping methods.[114]

110 For a more complete list, and explanations of, the available technologies see: The Technical Report and User Guide for The Review of Salinity Mapping Methods in the Australian Context, viewed 19 April 2004, <www.ndsp.gov.au/80_airborne/airborne.htm>.

111 GecOz, *Submission no. 80*, p. 1.

112 Natural Resource Intelligence Ltd Pty, *Submission no. 32*, p. 9.

113 See for example: New South Wales Farmers' Association, *op. cit.*, p. 5.

114 See for example: Dr Baden Williams, *Submission no. 1*, p. 3; Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45.

7.74 The Salinity Mapping Methods User Guide compared the efficacy of airborne and ground EM techniques over three areas of differing size. It was concluded that the correlation between AEM and EM31 was high over large areas but that EM31 provided more detailed data of small areas:

> At broader scales represented by the 5 and 50 km profiles, the AEM predictions correlate moderately well with the trends in the raw EM31 measurements. However, over profile lengths that are little more than the horizontal resolution of the AEM system (eg 1 km) … the broad averaging involved in the AEM measurements is unable to capture the local variability detected using an EM31 instrument. The AEM conductivity predictions and the raw EM31 apparent conductivity values would show very low correlation at this local scale.[115]

7.75 Dr Baden Williams submitted that airborne EM is 'a very useful product in describing the presence/absence of deep (>15-20m) stores of soluble salt but they have yet to provide any real information that a landholder could rationally devise land management options'.[116] WA SRDTC concurred with this view.[117]

Conclusions

Data management

7.76 The Committee acknowledges that a range of Australian and state government initiatives are in place to facilitate best practice data collection, management and retrieval. However, the Committee is concerned that problems in this area persist. With the increased involvement of CMOs in data collection, the Committee recommends that the Australian Government increase efforts to equip managers of regional projects with the requisite skills for data management. In chapter eight, the proposal for a national salinity database is further explored.

Mapping technologies

7.77 The Committee notes the importance accorded to mapping technologies, particularly airborne geophysical techniques, in the NAP. The Committee

115 The User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, p. 26, <www.ndsp.gov.au/80_airborne/airborne.htm>.

116 Dr Baden Williams, *loc. cit.*

117 See Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45.

contends that mapping technologies may perform an important role in salinity management, for example: surveying large areas of land (greater than 50 000 hectares); the prioritisation of on-ground works; and in protecting high value assets (such as towns).

7.78 The Committee notes the range of concerns about the use of airborne geophysical techniques and specifically the observation that AEM may have been 'over sold' by relevant Australian Government agencies. The Committee believes that the Government should take note of the concerns raised by submitters. Above all, the Committee concludes that while AEM is a useful enabling technology, the utilisation of the technology should not detract from efforts to develop new land and water use systems that can be adopted by land managers on-ground, particularly in Western Australia.

7.79 The Committee was disappointed to hear that some companies felt they were being discouraged from participating in salinity surveys. The Committee believes that the private sector has an important role in developing innovative technologies, and providing on-ground services to land managers. These issues are explored further in chapter eight.

8

Support for implementers: extending the science

> *The problem of diminishing extension services has come out very clearly in this inquiry. A gap is occurring in some areas regarding somebody being able to take the information through to the farmer on the ground.*[1]

8.1 This chapter reviews the adequacy of the technical and scientific support for land managers who implement salinity management options. The chapter is split broadly into two parts. First, general themes relating to extension and its purpose are addressed and second, current arrangements for extension provision are discussed.

8.2 The general themes covered include the role of extension services in community capacity building and the dissemination of technical and scientific knowledge relating to salinity management. This includes:

- a discussion of the information required by implementers (paragraphs 8.7–8.13);
- the methods of delivering extension services (paragraphs 8.14–8.30); and
- the necessary skill base of extension staff (paragraphs 8.31–8.32).

8.3 Subsequently, the effectiveness of current arrangements for the transfer of information about salinity management to land managers (particularly farmers and catchment management organisation (CMO) staff[2]) are reviewed. Covered in this section are the contributions of:

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1 Dr Robin Batterham (Chief Scientist), *Transcript of Evidence*, 24 November 2003, p. 18. Also see: Mr Kevin Goss (Murray-Darling Basin Commission), *Transcript of Evidence*, 3 November 2003, p. 8.

2 Under the *National Action Plan for Salinity and Water Quality*, farmers and CMOs are recognised as key implementers of natural resource management programs (Council of Australian

- state extension services (paragraphs 8.37–8.65);
- national extension initiatives and regionally delivered extension services (paragraphs 8.66–8.121);
- direct extension of research by scientists, and private sector involvement (paragraphs 8.122–8.146); and
- local governments (paragraphs 8.147–8.154).

Extension services: a means to disseminate knowledge

8.4 *A National Action Plan for Salinity and Water Quality* (the NAP), identified the promotion of scientific findings beyond universities and research organisations as vital to building the capacity of individuals and community groups, including CMOs, responsible for implementing and applying salinity management options.[3] Although the Committee recognises that the transfer of information alone will not solve the problem of salinity, it agrees with the Grains Research and Development Corporation's (GRDC) view that: 'ensuring that farmers have low-cost access to accurate information ... and access to interpretive advice, will facilitate their decision-making for salinity management'.[4]

8.5 The term 'extension' has come to refer, in the Australian vernacular, to the provision of agricultural advice to farmers by state agency staff: '*the department of agriculture offers an extension service to farmers*'.[5] According to the Australasia-Pacific Extension Network (APEN):

> Extension involves the use of communication and adult education processes to help people and communities identify potential improvements to their practices, and then provide them with the skills and resources to effect these improvements.[6]

8.6 For the purposes of this report, 'extension' refers to public and private sector community capacity building and knowledge dissemination activities, promoting the management of salinity and other natural

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Governments (COAG), *A National Action Plan for Salinity and Water Quality*, Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), Canberra, 2000).

3 *Ibid*., p. 6.

4 Grains Research and Development Coporation (GRDC), *Exhibit no. 79, Economic Evaluation of Salinity Management Options in Cropping Regions of Australia*, p.iv.

5 *The Macquarie Concise Dictionary*, The Macquarie Library, Adelaide, 1988, p. 332.

6 The Australasia-Pacific Extension Network website, viewed 26 February 2004, <www.apen.org.au/APEN/index.htm>.

resource issues. The aim of 'extension' is to assist land managers to practise sustainable natural resource management (NRM), by encouraging behavioural change and supporting the implementation of sustainable land-use practices.[7] Service delivery methods include field-days, seminars, on-farm trails, grower group meetings, publications, media reports, the internet and traditional style extension services. Professionals engaged in providing extension services to implementers are given a range of titles including extension officers, NRM facilitators, implementation officers, knowledge brokers, community service officers et cetera. Increasingly research scientists, agribusiness staff and NRM consultants are also involved in extension provision.[8]

Salinity management options that meet the needs of land managers

8.7 A key message from the *National Dryland Salinity Program* (NDSP), after a decade of salinity research, was that a '[l]ack of capacity is an important, but secondary constraint, to managing salinity'.[9] Indeed, the NDSP submitted that:

> The biggest constraints for moving forward lie in the lack of clarity of rights and responsibilities, nailing attribution between cause and effect and being able to clearly specify the benefits and costs of different courses of action.[10]

8.8 The Australian Institute of Agricultural Science and Technology (AIAST) expressed the view that:

> In general, action on salinity problems is not restricted by information – or communication of that information. Action is prevented by a lack of political will, misdirection of funding and the insurance crisis … the production of 'information' on the

7 During site inspections in New South Wales, Western Australia and Victoria the Committee witnessed the capacity of many land managers, particularly farmers, to understand, use and contribute to the NRM science base, and in turn to manage sustainably the natural resources in their custody.

8 For a broad discussion on the state of extension services also see: The Australasia-Pacific Extension Network, *Extending Extension: beyond traditional boundaries, methods and ways of thinking*, Hobart, viewed 26 February 2004, <www.regional.org.au/au/apen/2003/papers/>; Cullen P., Cottingham J.D., Doolan J., Edgar B., Ellis C., Fisher M., Flett D., Johnson D., Sealie L., Stocklmayer S., Vanclay F. and Whittington J., Cooperative Research Centre for Freshwater Ecology, *Knowledge Seeking Strategies of Natural Resource Professionals*, Canberra, viewed 26 February 2004, <http://freshwater.canberra.edu.au>.

9 *Focus on Salt: The Newsletter of Australia's National Dryland Salinity Program*, Issue no. 29, December 2003, p.1, viewed 18 March 2004, <www.ndsp.gov.au/15_pubications/publications.html>.

10 National Dryland Salinity Program (NDSP), *Submission no. 35*, p. 29.

> salinity problem is now such that dealing with this information is a problem in itself.[11]

8.9 The New South Wales Farmers' Association stated:

> If the farmers are talking to the scientists they want to be told the extent of the problem. But, most importantly … they need some options in terms of solutions. It is no good just taking a problem to the farmers without some feasible options.[12]

8.10 Similarly, Greening Australia submitted that:

> The worst outcome is to raise the willingness of a landholder to take action but then not be in a position to inform them on appropriate action. As one farmer recently commented at a salinity workshop:
>
> *You mean to tell me that you want to tell me how to manage my land, but when you get there you can't tell me what to do!*[13]

8.11 As discussed in previous chapters of this report, submitters have noted that if research outcomes are to be widely adopted they must meet the needs of land managers, by being:

- proven to manage salinity effectively;
- complementary to broader NRM efforts;
- economically viable;
- low risk and simple to implement;
- supported with the funding necessary for their implementation;
- at the scale required by the land manager.[14]

8.12 The New South Wales Government told the Committee that:

> A large amount of useful scientific information already exists that provides simple solutions to salinity problems, but these are often not implemented due to [a] lack of information relating to economics, potential impact or awareness. For local solutions to be

11 AIAST, *Submission no. 76*, p. 1.

12 Mr Andrew Huckel (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 46.

13 Greening Australia, *Submission no. 79*, p. 1.

14 New South Wales Farmers' Association, *Submission no. 45*, p. 3. Also see: Dr Donald McFarlane (Western Australian Salinity Research and Development Technical Committee), *Transcript of Evidence*, 12 November 2003, p. 35l; Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, pp. 2-3; Australian Salinity Action Network (ASAN), *Submission no.* 39, p. 8; GRDC, *Submission no. 29*, p. 11.

adopted, they need to be realistic, suitable and at least as profitable as current systems.[15]

8.13 The Prime Minister's Science, Engineering and Innovation Council (PMSEIC) concluded that science had failed to produce viable management options:

> Experiences with agricultural extension over the last 50 years has shown that for farmers to change, the change needs to be simple, divisible so they can try it in a limited area, and the results need to be obvious in economic terms. Salinity control measures fail on each of these elements. The challenge is to evaluate management options in situation-specific terms that give farmers the confidence to invest.[16]

Delivery methods

8.14 The Committee notes that scientific information on salinity and NRM issues is extended in a variety of forms, including:

- electronic distribution of material via the internet and databases, for example:
  - ⇒ the New South Wales Government's database Community Access to Natural Resources Information (CANRI);[17]
  - ⇒ at a national level, the National Land and Water Resources Audit works with the Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH) to maintain a digital data library and an atlas of Australian Natural Resources;[18]
  - ⇒ Land and Water Australia's (LWA) Practical Index of Salinity Models (PRISM) CD-ROM which contains information on over 90 different tools to assist CMOs manage salinity;[19]
  - ⇒ the 'Saltlist' email forum coordinated by the NDSP;[20]

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15 Government of New South Wales, *Submission no. 61*, p. 10.

16 PMSEIC, *Dryland Salinity and its Impacts on Rural Industries and the Landscape*, Commonwealth Department of Education, Science and Training, Canberra, 1998, p. 16, viewed 29 January 2004, <www.dest.gov.au/science/pmseic>.

17 Government of New South Wales, *Submission no. 61*, p. 4. The CANRI website is available at <www.canri.nsw.gov.au>, viewed 17 February 2004.

18 DAFF and DEH, *Submission no. 72*, p. 5.

19 See chapter four.

20 For information on Saltlist see the NDSP's website, viewed on 17 February 2004, <www.ndsp.gov.au/25_whats_on/SALTLIST_email_forum.html>.

- written information such as scientific journals, issue specific journals, pamphlets, newsletters and technical manuals, for example:[21]
  - ⇒ *Saltland Pastures in Australia: A Practical Guide* published by Land, Water & Wool Sustainable Grazing on Saline Lands Sub-program[22];
  - ⇒ *Focus on Salt* by the NDSP;[23]
  - ⇒ *Managing Dryland Salinity* booklets published by the Murray Darling Basin Commission (MDBC) synthesising knowledge generated by the Commission's Dryland Program;[24]
  - ⇒ *Landholder Guide to Land and Water Management* by the Kyeamba Landcare Group;[25]
  - ⇒ the proposed *Salinity Glove Box Guide* by the Southern Salt Action Team;[26]
- through the media, in particular the radio and television, for example:
  - ⇒ the *Silent Flood* series which was screened by the Australian Broadcasting Corporation;[27]
- a variety of face-to-face methods such as field days, conferences, on-farm trials, grower group meetings, grower workshops, and traditional style extension services, for example:
  - ⇒ state or CMO extension officers delivering face-to-face extension to land mangers;
  - ⇒ the Productive Use and Rehabilitation of Saline Lands group (PUR$L) bi-annual conferences for government, industry groups and farmers.[28]

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21 The Committee received 132 exhibits. Many were originally written to communicate information about, and advice on, salinity and its management.

22 Land and Water Australia (LWA), *Exhibit no. 70, Saltland Pastures in Australia: A Practical Guide.*

23 *Focus on Salt: The Newsletter of Australia's National Dryland Salinity Program,* viewed 18 March 2004 < http://www.ndsp.gov.au/15_publications/publications.html>.

24 Murray-Darling Basin Commission (MDBC), *Exhibit no. 41, Managing Dryland Salinity – Draft Report.*

25 Mr Sydney Clarke, *Exhibit no. 45, Landholder Guide to Land and Water Management.*

26 *Scientific Advice on Natural Resource Management: A Report to the Natural Resource Management Ministerial Council by the Commonwealth Scientific and Industrial Research Organisation and the Commonwealth Bureau of Meteorology,* report presented to the NRMMC, Adelaide, February 2004, p. 30.

27 DAFF and DEH, *Submission no.72,* p. 12.

28 *ibid.,* p.13.

Consolidating information: a national database or one-stop-shop

8.15 Despite the work of the NDSP, a number of submitters noted the need to bring salinity literature together, through a national database or a one-stop-shop.[29]

8.16 With regard to the establishment of a national database, Land and Water Australia (LWA) submitted:

> I am not aware of any jurisdiction that has the gold standard yet in making that information user-friendly and having it in every transaction centre, shire council and primary school. But the technology and machinery is such that we should not be very far away from that, and that is what we should be aspiring to. I can see a time where each agricultural adviser or farm consultant would just sit at the kitchen table, plug in their laptop and have a CD-ROM or log onto a web site to pull up that sort of information. It could be linked with farm-scale telemetry that is satellite-linked to have the catchment-scale data and the farm-scale data in the same system. That is where we should be headed, but we have not joined all the dots in any part of Australia…[30]

8.17 Similarly the GRDC stated:

> where the knowledge is available, those who need to get access cannot access it readily. There is no one database where you can get information about salinity management or information relevant to land use change.[31]

8.18 The GRDC recommended that a national database of salinity information be developed. It was suggested that it could be modelled on the New South Wales Government's Salinity Research and Development Coordinating Committee's meta-database for state salinity projects.[32]

8.19 The Committee is aware of NRM databases, or 'atlases', which contain some salinity research and general information, basic modelling tools, and metadata information. These include the Australian Government's Natural Resources Atlas, the New South Wales Government's CANRI, the Western Australian Land Information System (WALIS), and the South Australian Atlas.[33]

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29 GRDC, *Submission no. 29*, p. 11; New South Wales Farmers' Association, *Submission no. 45*, p. 5.

30 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 30.

31 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 70.

32 New South Wales Department of Agriculture website, viewed 7 April 2004, <www.agric.nsw.gov.au/reader/salinity-srdcc>.

33 These can be accessed on the Australian Government's NRM website, viewed 19 April 2004, <www.nrm.gov.au/data/ index.html>.

8.20 The Murray Catchment Management Board told the Committee that CANRI did not fulfil its needs:

> practitioners or the planners often do not have the time, the energy or even the ability to wade through a 3,000-page scientific document to decipher what it is all about. What we propose on this side is there should be some central repository where a lot of that scientific information is condensed down to layman's terms.[34]

8.21 The New South Wales Farmers' Association supported the idea of a 'one-stop-shop' for salinity management, which would incorporate a human interface to assist users to access collated material.[35] The Wagga Wagga City Council has made a proposal under the NAP funding guidelines to become a national coordinating body for education on urban salinity management: *The One Stop Shop for Managing Urban Salinity*.[36] However, the New South Wales Government cautioned that it had found one-stop-shops were an ineffective way of providing NRM advice, as implementers continued to contact the relevant state agencies for information.[37]

8.22 During the review of the *National Landcare Program* it was recommended that 'A Landcare Information Storehouse' be established. It was argued that an electronic database containing the outcomes, successes and failures of Landcare projects would assist Landcare groups and networks, landholders and industry gain access to and share information.[38] The Committee sees the merit of this proposal. Such a project could be a major contributor in a national salinity database for both interpreted and raw data.

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34 Mr Anthony Dawson (Murray Catchment Management Board), *Transcript of Evidence*, 30 October 2003, p. 16.

35 New South Wales Farmers' Association, *Submission no. 45*, p. 5.

36 Wagga Wagga City Council, *Exhibit no. 7, The One Stop Shop for Managing Urban Salinity*.

37 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, 29 October 2003, pp. 85-86. Also see: Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 28.

38 Review of the National Landcare Program, DAFF, Canberra, October 2003, p. 50, viewed 19 April 2004, <www.daff.gov.au/corporate_docs/publications/pdf/nrm/landcare/nlp_review_report_final.pdf>.

Recommendation 15

8.23 **The Committee recommends that the Australian Government in cooperation with the states and territories build on existing initiatives to establish a database of interpretive material, scientific research and data, related to salinity and its management. The three levels of the database should be:**

(a) a ready reference salinity component, containing concise, integrated, accurate, and easy to understand information to assist land managers, particular farmers, catchment management organisation staff and natural resource management extension officers;

(b) links to salinity related research papers endorsed by the *National Dryland Salinity Program* or its successor body;

(c) a meta-data component identifying the location of available salinity data and, where possible, the capacity for a storage and retrieval system for salinity related data particularly that collected for the *National Action Plan for Salinity and Water Quality*.

For implementation, this recommendation should be read in conjunction with recommendations 1 and 3.

Face-to-face extension

8.24 It was submitted that face-to-face contact with qualified, competent and trusted extension staff or facilitators was an effective method of providing information and transferring skills to land managers.[39] Extension officers can act as conduits between scientists, the knowledge base of NRM, and implementers: collecting, interpreting, filtering, translating and promoting scientific information.[40]

8.25 The Committee heard from the Western Australian Farmers' Federation that the 'human factor … is not given enough credibility in this debate':

> there are some farmers who are quite happy to use the Internet and get all the information they need off that, but there are those who still prefer the face-to-face across the kitchen table approach.

39 Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 15.

40 For the purposes of this report professionals engaged in providing scientific and technical support and information to implementers will be referred to generically as 'extension staff'.

> As old-fashioned as it might sound, it is the most effective way of doing things.[41]

8.26 Similarly, the New South Wales Farmers' Association told the Committee that:

> When it comes down to it, a lot of farmers communicate orally – by word of mouth. They like the advisor to come out and talk to them … They need an explanation of a problem and a solution and most importantly that needs to be achieved through a relationship of trust; that is how they communicate.[42]

8.27 The Commonwealth Scientific and Industrial Research Organisation (CSIRO) noted that to translate science into action on the ground 'you need somebody … to come and explain to the locals or the CMAs'.[43] Similarly, Mr Philip Dyson considered that alternative modes of transferring information such as the internet and publications, are of limited value for local Landcare coordinators:

> At the end of the day, after working a long day, coming in and trying to look up information on a computer or read the fantastic reports that we produce is something that they would all like to do. But, having worked with them throughout eastern Australia, I know they are very limited in their capacity to take on information in a written form and in web form.[44]

8.28 The New South Wales Farmers' Association advised that only 30 per cent of its members had internet access.[45]

8.29 According to Murdoch University, extension staff are able 'to do some of the running around' for land managers, who often have neither the time, nor requisite skills, to extract the information they require.[46] In addition to collecting information, competent extension staff can interpret, filter,

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41 Mr Andrew McMillan (Western Australian Farmers Federation), *Transcript of Evidence*, 13 November 2003, p. 12. Also see: Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 15.

42 Mr Jonathan Streat (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 46. Similar views were expressed by Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 3.

43 Dr Mirko Stauffacher (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 88.

44 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 3. Also see: Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 6.

45 Mr Andrew Huckel (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 47.

46 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 29.

translate, integrate and promote scientific information which meets the needs of their target audience.[47]

8.30 Rather than being a purely top-down transfer of information, the delivery of extension is becoming responsive to the need of land managers, who are requesting the information they require and providing scientists with new ideas and innovations.[48] The Western Sydney Regional Organisation of Councils (WSROC) stated:

> Two-way communication and feedback that is timely and constructive is critical in linking research and those who need to implement solutions. Communication from researchers and technologists must be able to distil complex technical and theoretical concepts into a user friendly format for land managers, policy makers and decision makers. Constructive feedback from users to researchers and technologists is essential to allow refining of assumptions, systems and tools to improve their application and effectiveness in real world situations.[49]

The necessary skill base of extension staff

8.31 The Committee heard that good extension staff need a range of skills and attributes, which include:

- a multi-disciplinary knowledge of NRM issues, and practical knowledge of farming systems and salinity management options;
- good research and analytical skills;
- the ability to translate and communicate complex information, and isolate and collate information relevant to their audience;
- flexibility and skills to deal with, and present information to, a diverse range of people;
- credibility with, and trust of, their audience.[50]

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47 *ibid.*

48 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 29. Also see: Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p.6; Dr Mirko Stauffacker (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 89.

49 WSROC, *Submission no. 20*, p. 6.

50 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 71. Also see: Dr Baden Williams, *Submission no. 1*, p. 4; Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 7; Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 9. The Hon. Dr Sharman Stone MP, *Transcript of Evidence*, 31 October 2003, p. 44.

8.32 The Committee acknowledges that the success of salinity management depends on the commitment and actions of individuals and community groups, in particular CMOs. Therefore it is vital that research findings for salinity management are extended effectively to meet their needs. The weight of evidence indicates that face-to-face extension is an effective delivery method for farmers and community organisations. The Committee concludes that good face-to-face extension with experienced and trusted extension staff can lead to a more rapid and widespread adoption of new technologies and management options. The Committee also recognises that the extent to which extension staff can induce wide-scale changes may be limited by the effectiveness, economic viability, scale and complexity of the management options presented.[51]

Recommendation 16

8.33 **The Committee urges relevant Australian, state and territory government agencies and industry groups to enhance their support for face-to-face extension services by ensuring that there are adequate numbers of qualified extension staff available to assist land managers, particularly farmers.**

Recommendation 17

8.34 **The Committee recommends that the Australian Government, in partnership with the relevant state government agencies, compile and publish a state by state manual of viable salinity management options, to assist extension staff and land managers. This manual should be updated regularly, and survey current best practice approaches to salinity management. It should also be available free of charge in both hard copy and on the internet to extension staff and land managers dealing with salinity problems.**

51 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111, Salinity: A New Balance*, p. 46.

The provision of extension services

8.35 The extension of NRM information to landholders has traditionally been the responsibility of state and territory governments.[52] Recently, in addition to state extension officers, extension is being provided via alternative sources, for example;

- CMO facilitators;[53]
- landholders and community organisations sharing information between individuals and through Landcare activities with the aid of Landcare facilitators;[54]
- private industry promoting science as it sells products to landholders (eg. Landmark),[55] and consultants providing extension services on a fee-for-service basis;[56]
- scientists and research organisations extending their research directly to land managers;[57] and
- local governments which employ dedicated extension staff.[58]

8.36 The Committee heard that CMOs and landholders consult a range of sources depending on their perceptions of a source's credibility; the type and scale of the information they require; and the relative ease of accessing a source:

> depending on who the farmers are, it could be a Wesfarmers Landmark agent, it could be a scientist from CSIRO, it could be a government agency extension officer or it could be through a Landcare group. A whole range of people get involved here … none of them gets above 30 or 40 per cent, even the industries. So it is how you support all of that in its diversity, because that is what it is.[59]

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52 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, 29 October 2003, p. 89.

53 Mr Andrew Huckel (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 50. Also see: Mrs Mary Howard (Hawkesbury-Nepean Catchment Management Board), *Transcript of Evidenc*e, 29 October 2003, p. 67.

54 Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 5.

55 Landmark, *Submission no. 30*, pp. 1-3.

56 For example, Phil Dyson and Associates Pty Ltd (*Submission no. 46)* and Sinclair Knight Merz (*Submission no. 28*) were two consulting companies who submitted to the inquiry.

57 Dr Thomas Hatton (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36.

58 Wagga Wagga City Council, *Submission no. 5*, p. 2.

59 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 3 November 2003, p. 18.

Traditional extension: state and territory government extension services

8.37 As outlined in chapter two, most state and territory governments have developed salinity strategies, and are involved in providing extension services for NRM. The Committee received evidence from the Governments of New South Wales, Western Australia and South Australia on their extension services. It is beyond the scope of this report to catalogue all the NRM or salinity extension programs undertaken by the states and territories.[60] Salient examples of positive state extension initiatives were brought to the Committee's attention during the course of the inquiry, and evidence on the general status of state/territory extension services was received.[61]

8.38 State and territory government agencies have traditionally been the main providers of NRM extension services.[62] Evidence was presented that state extension officers were a crucial and effective means of 'bridging the gap' between scientists and landholders. Indeed, the Australian Nuclear Science and Technology Organisation (ANSTO) submitted that 'State agencies provide the most effective way for scientists and on-ground managers to communicate'.[63]

8.39 The New South Wales Government submitted that the current processes for delivering extension were working well in New South Wales,[64] and information was being transferred through a range of activities:

> In the case of state agencies, the knowledge that we generate is usually transferred to farmers, rural communities and industry groups through a range of processes, including formal and informal extension education programs—in particular, what we

60 For example, in the South Australian Government's Dryland Salinity Strategy there is a strong emphasis on supporting CMOs and other land managers. The types of extension 'actions' undertaken in South Australia, with regard to dryland salinity include: long-term catchment support teams based in the regions; a key interdisciplinary service provider hub for dryland salinity management, linked to regional service providers; the provision of targeted and sound information for land managers. See: Primary Industries and Resources SA and the Soil Conservation Council of South Australia, *South Australian Dryland Salinity Strategy*, Adelaide, 2001, pp. 24-26, viewed 23 February 2004, <www.saltcontrolsa.com/pdfs/sadss_72.pdf>. For further information on extension arrangements see the 'salinity strategies' relevant to each state and territory (as outlined in chapter two of this report).

61 See for example: Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41; Mr Philip Dyson (Phil Dyson and Associates Pty Ltd*), Transcript of Evidence*, 31 October 2003, p. 4.

62 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, 29 October 2003, p. 89.

63 Australian Nuclear Science and Technology Organisation (ANSTO), *Submission no. 22,* p. 4.

64 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, *ibid.*

> call experiential learning activities, publications, field days and demonstrations.[65]

8.40 These ‘activities’ were facilitated by the state’s ‘frontline extension advisory officers’.[66] The Department of Infrastructure, Planning and Natural Resources (DIPNR) and New South Wales Agriculture employ the State’s NRM extension staff. In the New South Wales Government’s submission it was stated that in excess of 400 extension staff are employed between the departments. However, other evidence from the New South Wales Government indicated this figure was only 200.[67]

8.41 For specialist information on salinity, extension officers refer questions to one of the State’s six Salt Action Teams, also staffed by the two departments.[68] As a key initiative of the *NSW Salinity Strategy (2000*), the Salt Action Teams have a four year budget allocation of $9.4 million.[69]

8.42 The role of the Salt Action Teams, according to the New South Wales Government, ‘is to facilitate the adoption of on-ground change and to facilitate the transfer of technology, skills and knowledge from agencies’ technical staff to catchment and landscape level’.[70] To access the expertise of the Salt Action Teams, landholders must first contact extension officers from DIPNR, New South Wales Agriculture and, when they are set up, the State’s Catchment Management Authorities (CMAs).[71]

8.43 The Salt Action Teams were described to the Committee as:

> teams of agency specialists, scattered strategically across the state. One focuses on urban matters and five focus mostly on rural matters ... They get out there, they channel the best science into CMA thinking and they channel the best science into private sector provider activities. We do a lot of work in training private sector providers so that the Elders and the CRCs of this world are up to speed with the science and the best available options.[72]

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65 *ibid.*, p. 77.

66 *ibid.*

67 Government of New South Wales, *op. cit*., p. 6. Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, 29 October 2003, p. 85.

68 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, *ibid.* Also see: Government of New South Wales, *Submission no. 61*, p. 5.

69 Government of New South Wales, *Submission no. 61*, p. 5. Also see: New South Wales Department of Land and Water Conservation, *Taking on the Challenge: NSW Salinity Strategy – Update;: Premier’s Annual Report 2000/01*, Government of New South Wales, Sydney, 2000, viewed 27 January 2004, <www.dlwc.nsw.gov.au/care/salinity/pdf/salinity_strategy_update.pdf>.

70 Government of New South Wales, *Submission no. 61*, p. 5.

71 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, *ibid.*

72 *ibid.*, p. 89.

8.44 The Murrumbidgee Catchment Management Board noted:

> [t]he establishment of the Salt Teams as brokers for research and extension has certainly improved the situation … However, we still find that utilisation of these Salt Teams is not optimal and intend to address this in the future.[73]

8.45 To 'keep abreast of major research outcomes', the Salt Action Teams gather scientific information on salinity from an a range of sources 'including the DIPNR Centre for Natural Resources, New South Wales Agriculture, relevant Cooperative Research Centres, CSIRO, and the Bureau of Rural Sciences'.[74]

8.46 In light of the expertise held in state agencies, state extension staff have an important role in training and linking with industry and non-government agencies that deliver land management advice. Landmark agronomy staff in New South Wales, Western Australia and Victoria have undertaken salinity training with state government specialist salt advisors, to ensure they are able to provide 'the best advice to clients'.[75]

8.47 During the course of the inquiry the Committee observed first-hand the work of departmental officers performing extension roles in New South Wales and Western Australia. The professionalism of staff from the Western Australian Departments of Agriculture and Environment, and the New South Wales Southern Salt Action Team, and the extent to which they work in partnership with community groups, such as Landcare and individual landholders, is commendable. The Committee also notes the credibility these officers have with land managers.[76]

8.48 The Committee concludes that state extension services have many strengths which it would be difficult for other organisations to replicate, including: their long and sustained relationship with the farming community; their capacity to make sustainable NRM decisions based on the best scientific information available (independent of commercial imperatives); and their ability to plan works across farm, and even catchment, boundaries to achieve broad scale environmental outcomes.

73 Murrumbidgee Catchment Management Board, *Submission no. 43*, p. 2.

74 Government of New South Wales, *loc. cit.*

75 Westfarmers Landmark, *Westfarmers Landmark National Salt Smart Strategy*, viewed 26 February 2003, <www.wesfarmerslandmark.com.au>.

76 Mr Andrew McMillan (Western Australian Farmers' Federation), *Transcript of Evidence*, 13 November 2003, p. 2. Also see: Mr Rex Edmondson (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 35.

Problems with state extension services

8.49 The diminishing and de-skilling of state and territory extension services was an issue raised by a number of submitters.[77] This trend has been identified as an issue of concern in a range of public policy documents.[78]

8.50 The Western Australian Farmers' Federation told the Committee:

> Over the years in Western Australia the Department of Agriculture, particularly, has had its extension service eroded from a very effective interface between farming and government to virtually nothing. [79]

8.51 Similarly, Mr Philip Dyson noted:

> It would be fair to say that the farmers around here do have a pretty good relationship with their extension officers, although there are very few of those people around any more—compared to what I would have called extension officers 10 or 15 years ago. A lot of the people you are talking about are now landcare coordinators and those kinds of people.[80]

8.52 A related trend has been the de-skilling of extension staff. The GRDC stated that '[t]here is an enormous skill shortage of people who understand salt movement, water movement, agronomy and land use change to be able to integrate the processes that need to take place'.[81]

8.53 According to the Australian Society of Soil Science Incorporated (ASSSI) the de-skilling of state extension staff has meant that they lack the capacity to assist the newly forming CMOs.[82] This view was countered by the Lower Murray Darling Catchment Management Board which was satisfied with the technical and scientific support provided by DIPNR.[83]

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77 See for example: Dr Thomas Hatton (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36. Also see: CSIRO, *Submission no. 42,* p. 14; Mr Kevin Goss (MDBC), *Transcript of Evidence*, 3 November 2003, p. 8; Dr John McGrath (Forest Products Commission of Western Australia), *Transcript of Evidence*, 12 November 2003, p. 13.

78 See for example: Industry Commission, *A Full Repairing Lease: An Inquiry into Ecologically Sustainable Land Management*, Canberra, April 1999, p. 10, viewed 2 October 2003, <www.pc.gov.au/ic/inquiry/finalreport/index.html>; House of Representatives Standing Committee on Environment and Heritage, *Co-ordinating Catchment Management*, Canberra, December 2000, p. 119, viewed 17 March 2004, <www.aph.gov.au/house/committee/environ/reports.htm>.

79 Mr Andrew McMillan (Western Australian Farmers' Federation), *Transcript of Evidence*, 13 November 2003, p. 2.

80 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 4.

81 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 71. Also see: Dr Baden Williams, *Submission no. 1*, p. 4.

82 Australian Society of Soil Science Incorporated (ASSSI), *Submission no. 68,* p. 2.

83 Lower Murray Darling Catchment Management Board, *Submission no. 2*, p. 2.

8.54 It was submitted to the Committee that state extension services are not attracting and retaining adequately skilled staff because there are no clear career pathways for them to follow, salaries are generally low and they are usually employed on short term contracts.[84] The New South Wales Farmers' Association stated:

> the extension officer role is that area of natural resource management that has been neglected through funding arrangements and structures—three-year terms and such approaches. It does not allow an option for an extension officer to settle in an area. He or she has uncertainty of tenure, which means that they do not build a relationship with the land-holder and a relationship with the scientist.[85]

8.55 Similarly, ASSSI noted the problems associated with short-term funding cycles and the departure of extension staff:

> It is typical of State-government agencies to re-allocate staff to (often disjointed) projects receiving external funds, which last for only between 2 and 5 years. As an example, many of the salinity extension-staff in New South Wales are funded only until the end of 2003. Similarly, the Queensland Department of Natural Resources & Mines has gradually cut its salinity staff to the point where there remain only a handful of scientists for the whole of Queensland. Funding cuts, re-allocation and departure of staff invariably deplete the critical mass of valuable experience and knowledge gained during periods of short-term funding.[86]

8.56 Murdoch University noted that state extension had become a training ground for university graduates, and once they gained experience there was a tendency for them to move into more stable and lucrative employment in the public sector.[87] In this regard the Western Australian Salinity Research and Development Technical Committee (WA SRDTC) told the Committee:

> On the economics side, we really do need people to have skills we are not currently giving them in the field. They tend to be people who are in a state agency—say the Department of Agriculture—and they understand the industries and pick up those skills and

84 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 30.

85 Mr Jonathan Streat (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 46.

86 ASSSI, *Submission no. 68*, p. 2.

87 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 30.

> become very valuable over five, six or eight years. But to take new graduates out of universities and put them into regional areas and expect them to sell a very complicated message like salinity to people who are managing multimillion dollar businesses, is a big ask.
>
> One of our pleas is to invest a lot more in those people and give them time to develop, give them careers and give them the access to the skills so that they can provide an information brokering role between the scientists and the land managers particularly.[88]

8.57 According to the New South Wales Farmers' Association, the turnover of extension staff results in land managers being 'presented with a continuous rotation of ideas and personalities'.[89] Similarly, the Western Australian Farmers' Federation told the Committee that state extension services should be reinvigorated.[90]

8.58 LWA considered the withdrawal of extension was an issue worthy of review:

> From my perspective, Australia needs to be having a hard look at the way in which we deliver extension services using modern technology, using industry, using non-government organisations. I am not saying for a moment that we should have fleets of public servants in government cars in a return to the 1950s or 1960s. The private sector can deliver a lot of this, but we need to recognise that for problems across farm boundaries with a strong public good dimension it is just unrealistic to expect that the private sector is going to pick that up. We actually need skilled people who can work at a landscape scale on these public good issues, but who are literate in the farming systems that are needed to solve the problem at the end of the day.[91]

8.59 Sinclair Knight Merz (SKM) submitted that good staff could be retained 'as long as career structures exist and salinity is seen as an area where people can work for the long term'.[92] However, SKM concluded that state agencies could no longer hold all the necessary knowledge on salinity 'in house', and that private sector providers now had a necessary and

88 Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36.

89 Mr Jonathan Streat (New South Wales Farmers' Association), *Transcript of Evidence*, 29 November, p. 46.

90 Mr Andrew McMillan (Western Australian Farmers' Federation), *Transcript of Evidence*, 13 November 2003, p. 2.

91 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, pp. 25-26.

92 Sinclair Knight Merz (SKM), *Submission no. 28*, p. 6.

established role in the delivery of extension services.[93] Professor Philip Cocks, from the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PBMDS), told the Committee:

> I think we still have to use the conventional methods—the state government extension agencies—but I would reiterate what I believe is the importance of this partnership with private industry. It need not be just Landmark; there are a number of other private companies. They have the capacity to have face-to-face relationships with virtually every farmer in Australia. That is certainly not true of the state agencies.[94]

8.60 The withdrawal of state extension services has been accompanied by an increase in the involvement of private industry, the Australian and local governments, CMOs and scientists.

8.61 Mr Kevin Goss, in his capacity as Deputy Chief Executive of the MDBC, summarised the current state of extension services:

> There is a long-term trend with public agencies of withdrawing from servicing farmers with free-to-farm services. That is well advanced and almost complete, I suppose, in straight commercial advice. There has been a substitution for that with funding positions with Landcare and NHT now taking over, particularly in the catchment management framework. But there is a mature commercial consulting industry around natural resource management and around salinity now, and it can contribute an enormous amount.[95]

8.62 The Committee notes the trend of state and territory governments withdrawing from the provision of extension services in their traditional form. Nevertheless, the weight of evidence indicates that these services are of tremendous value to landholders. The Committee urges state and territory governments to review this issue, with particular regard to the employment conditions of extension officers; their potential career pathways; and the adequacy of the training provided for officers to ensure their knowledge of technical, scientific and policy issues, relating to NRM and in particular salinity, is current and comprehensive.

8.63 The Committee notes that there is a tension between the need for generalist and specialist extension staff in NRM. Indeed, while not diluting a focus on salinity, technical and scientific support for salinity management should be integrated within broader NRM objectives. The

93 *ibid.*

94 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 18.

95 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

use of specialist salt teams to assist generalist extension staff is an effective compromise. The Committee commends the New South Wales Government on the establishment of the Salt Action Teams, and sees this as a positive step in the provision of expert advice on the complex issue of salinity. Other state governments are urged to consider the Salt Action Teams as a potential model for providing on-ground salinity expertise to assist NRM extension officers around the country.

8.64 The Committee is also aware that several states are addressing the issue of extension in partnership with the Australian Government and industry groups through national and regional NRM programs. The following section discusses national and collaborative approaches to the delivery of extension services.

Recommendation 18

8.65 **The Committee recommends that the relevant Australian Government agencies in consultation with state and territory governments review the issue of diminishing state extension services, with a particular focus on:**

(a) the employment conditions of extension staff;

(b) the potential career pathways of extension staff; and

(c) the adequacy of the training provided for extension staff to ensure their knowledge of technical, scientific and policy issues, relating to natural resource management and in particular salinity, is both current and comprehensive.

Support from national NRM programs for extension

8.66 LWA submitted that the task of assessing the adequacy of the Australian Government's role in the provision of salinity extension is complicated by a lack of comprehensive data:

> As a national science funding agency we cannot even get a list of the facilitators and coordinators being funded by the Australian government.[96]

96 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26.

Recommendation 19

8.67 **The Committee recommends that the Australian Government, in cooperation with the states, undertake an audit of the national, state and regional extension services available for salinity management, and natural resource management more generally.**

The National Landcare Program and Landcare Australia

8.68 In its submission, Landcare Australia claimed that many Australian farmers 'get their information on reversing land degradation from the landcare group network'.[97] Landcare has established 4 000 voluntary Landcare groups and 40 per cent of practising farmers are members.[98]

8.69 The activities undertaken by Landcare groups are an excellent example of experiential learning where farmers learn-by-doing. To support activities, and in turn the regional delivery of information, the *National Landcare Program* (NLP) funds facilitators and coordinators to assist community Landcare groups:

> The National Landcare Program also provides complementary functions to regional planning. For example, the NLP fosters the landcare 'movement' which has been growing for more than a decade, it provides landcare facilitators and coordinators to connect communities to information sources and services, and it supports Landcare groups and landcare-minded individuals to implement on ground actions for natural resource management. Landcare is also supported by the NHT through which it operates with other well-established groups, Bushcare, Rivercare and Coastcare.[99]

8.70 Mr Sydney Clarke, a farmer from the Wagga region (New South Wales), shared his views on Landcare and the importance of NLP facilitators:

> One of the major issues which comes up is getting the science from the knowledge base to the farmer through some sort of activity. That activity has to be Landcare … Certainly, we need a coordinator to transport the science from the science block, so to speak, to the farmers through the medium of Landcare activities in

97 Landcare Australia Ltd, *Submission no. 49,* p. 3.

98 *ibid.*

99 DAFF and DEH, *Submission no. 72*, p. 8.

> a Landcare group. So it is imperative that we keep coordinators to assist in getting the science to the farmer.[100]

8.71 Mr Philip Dyson told the Committee that Landcare coordinators were able to get communities involved in regional projects, and thus it was vital they be supported:

> The big issue is that it is very hard to get to catchment communities unless you have the landcare coordinators, the salinity coordinators and the information providers in each of the regions tuned up to deliver the information. It is at that level that we need to provide knowledge, information and, above all, mentorship to look after those people. A lot of them are very isolated.[101]

8.72 As members of the local farming community, it was suggested that Landcare coordinators could best be supported through face-to-face extension with salinity and NRM experts, and not inundated with written or web-based information.[102]

8.73 In its report *Salinity: A New Balance*, the Western Australian Salinity Taskforce stated that the Landcare program had 'been successful in raising awareness of resource conservation issues among farmers, and in some cases this awareness has lead to changes in farming practices'.[103] However, the Taskforce had reservations about the Program's ability to facilitate sufficient land-use changes to prevent resource degradation caused by dryland salinity:

> To be fair, the land-use changes required to prevent salinity effectively are now known to be very much more substantial than was believed when the Landcare program was conceived.[104]

8.74 The Australian Government recognises that Landcare has 'undergone significant changes' with the shift to the regional delivery of NRM services, and that the support arrangements at regional and local levels are 'insufficient for the effective engagement of community landcare in regional planning and plan implementation'.[105] As a result, in October

100 Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 8.

101 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 3.

102 *ibid.*

103 Mr Tim Sparks (Western Australian Department of the Environment), *Exhibit no. 111, op. cit.*, p. 52.

104 *ibid.*

105 DAFF, *National Resource Management: State Landcare Coordinators*, DAFF, Canberra, viewed 21 February 2004, <www.affa.gov.au/content/output.cfm?&OBJECTID=1F8F9C07-6A88-4256-BB5C5B76507A127E>.

2003, regional and state facilitators were recruited by the NLP. Funds were provided in the Australian Government's 2004 Budget for 70 Landcare facilitators.[106] Facilitators will work in conjunction with NAP facilitators to support regional planning initiatives. It is anticipated that state level facilitators will:

> support and communicate Australian Government policies, programs, and priorities, in particular, in relation to the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality, engage relevant government, industry and community stakeholders in relation to one of the four broad NRM themes [land, river, bush and coast] and coordinate the facilitator and coordinator network effort overall.[107]

8.75 The role of regional level facilitators will be to assist CMOs to develop and implement their regional plans, by collating and translating government policies, information and resources within each region. Furthermore facilitators will focus on encouraging industry participation in regional NRM initiatives.[108]

8.76 The Committee concludes that Landcare activities are vital to the transfer of information on salinity and its management. While acknowledging reservations about Landcare's ability to facilitate sufficient land use change in its current form, the Committee does not believe this detracts from Landcare's role in the communication and dissemination of information about salinity. Indeed, it further highlights the need for better management options to be developed by researchers, and the strengthening of the mechanism by which information is transferred from researchers to extension providers.

8.77 Although in its infancy, the effectiveness of NLP facilitators in the design and implementation of regional plans will need to be assessed, and their roles clearly delineated to avoid duplication with other extension services.

Recommendation 20

8.78 **The Committee recommends that the Australian Government review the effectiveness of the *National Landcare Program's* state and regional**

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106 The Hon. Dr David Kemp MP (Australian Government Minister for the Environment and Heritage), *A Sustainability Strategy for the Australian Continent: Environment Budget Statement 2004-05*, p. 28, viewed 12 May 2004, <www.budget.gov.au/2004-05/ministerial/download/environment.pdf>.

107 *ibid.*

108 *ibid.*

natural resource management facilitators, with a particular focus on ensuring that:

(a) their roles and responsibilities are delineated clearly to avoid duplication with other extension services and are consistent with other national programs designed to address salinity issues; and

(b) they receive the training and access to current information, necessary to perform their duties.

The National Action Plan and the Natural Heritage Trust

8.79 The Australian Government recognises that NRM facilitators and coordinators are vital to achieving successful outcomes from regional investments under the NAP and the *Natural Heritage Trust* (NHT).[109] Community capacity building is a central element of the NAP model.[110] Facilitators have been employed to support community and stakeholder engagement in the development and implementation of the catchment blueprints. Facilitators will address NRM issues at national/state and regional/local levels. Facilitators employed to date include:

- at a local level, approximately 650 facilitators funded under the NAP and NHT;
- at a state level, 30 Australian Government NRM Facilitators, 13 Indigenous Land Management Facilitators and eight Local Government NRM Facilitators funded directly by the NHT;
- at a regional level, 58 Regional NRM Facilitators, jointly funded by the Australian and state governments.[111]

8.80 ASAN submitted that the NAP 'provides a comprehensive system for implementing the science'. However, it was argued that insufficient time

109 Australian Government response to the House of Representatives Standing Committee on Environment and Heritage's Report on the *Inquiry into Catchment Management: Coordinating Catchment Management*, 2003, p. 21, viewed 17 March 2004, <www.aph.gov.au/house/committee/environ/reports.htm>.

110 For details see: DAFF, National Capacity Building Team for the National Action Plan for Salinity and Water Quality, *National Natural Resource Management Capacity Building Framework,* Canberra, 2002, viewed 22 February 2004, <www.affa.gov.au/corporate_docs/publications/word/nrm/landcare/capacity-building-framework.doc>.

111 Ms Kate Gowland (Director, Capacity Building Section, NRM Team, DAFF), *Natural Resource Management Facilitators and Coordinators,* Committee Correspondence, 23 January 2004; The Hon. Dr David Kemp MP (Australian Government Minister for the Environment and Heritage), *A Sustainability Strategy for the Australian Continent: Environment Budget Statement 2004-05*, p. 28, viewed 12 May 2004, <www.budget.gov.au/2004-05/ministerial/download/environment.pdf>.

had elapsed since the Program's commencement to review the approach.[112]

8.81 In contrast, the WA SRDTC advised the Committee that many of the facilitators and coordinators employed through the NAP and NHT 'do not have adequate technical skills or experience to take complicated land management issues and fit them into an industry basis'.[113] It was recommended that investment in extension staff increase and that they be given:

- 'time to develop';
- stable career paths; and
- 'access to the skills so that they can provide an information brokering role between the scientists and the land managers'.[114]

8.82 The WA SRDTC also recommended:

> Progressive skilling and employment of Commonwealth-funded community support officers to allow them to provide appropriate technical advice and not just administration and policy support.

8.83 Funding provided under the NAP and NHT initiatives will boost extension services nationally and represents a significant step in the regional delivery of NRM extension services. The Committee welcomes the steps taken to build community capacity and facilitate the regional delivery of NRM programs, and believes that insufficient time has elapsed to review the process.

112 ASAN, *Submission no. 39*, pp. 3, 9.

113 Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36.

114 *ibid.*

Recommendation 21

8.84 **The Committee recommends that the extension services provided by the Australian Government, and participating states and territories, through the *National Action Plan for Salinity and Water Quality* and the *Natural Heritage Trust* be reviewed in due course, with a particular focus on:**

(a) the employment conditions of extension staff;

(b) the potential career pathways of extension staff; and

(c) the adequacy of the training provided for extension staff to ensure their knowledge of technical, scientific and policy issues, relating to natural resource management and in particular salinity, is both current and comprehensive.

The role of regional management bodies

> *In the fight against salinity, communication is a powerful tool and the sharing of information paramount if we are to make an impact on salinity.*[115]

8.85 Under the regional delivery arrangements of the NAP, CMOs will increase their role in the provision of extension services.[116] Some CMOs have submitted that they have the capacity and are well positioned to provide extension services.[117] The Hawkesbury-Nepean Catchment Management Board (HNCMB) presented the Committee with a picture of how scientific research on salinity should be extended:

> Existing scientific knowledge needs to be implemented through regional and local strategies and action plans by the responsible body using experienced extension officers. The advisory staff need to possess multi-disciplinary skills and be able to engage local communities in the development and implementation of local NRM plans. Although the roles of these staff members needs to be separated from extension agencies promoting economic outcomes (eg. agronomists, livestock advisers), the specialist NRM facilitator needs the ability to engage these staff in the development of

115 Glenelg Hopkins Catchment Management Authority, *Submission no.18*, p. 1.

116 Mr Andrew Huckel (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 50. Also see: Mrs Mary Howard (Hawkesbury-Nepean Catchment Management Board), *Transcript of Evidence*, 29 October 2003, p. 67.

117 Integrated Natural Resource Management Group for the South Australian Murray Darling Basin Inc., *Submission no. 23*, p. 1.

sustainable management systems that reflect community socioeconomic expectations.[118]

8.86 The Murray Catchment Management Board (MCMB) told the Committee that, once it is established as a Catchment Management Authority, ‘implementation officers’ will be employed with a broad knowledge of NRM issues, and they will be supported by technical salinity officers.[119] To ensure that staff have the requisite skills and community acceptance, the MCMB told the Committee it aims to employ ex-Landcare coordinators and similarly skilled people.[120]

8.87 It was put to the Committee that there are limitations in the capacity of some CMOs to understand the scientific research they are expected to extend. The MDBC stated:

> Catchment management organisations with a locally appropriate rigour are an emerging enterprise as well, and they have done an excellent job in understanding the problems and also in coordinating activity at the local scale. But they are still learning to appreciate the application of science, particularly its interdisciplinary application.[121]

8.88 ASSSI has cautioned that the capacity problems encountered with state extension services may be repeated with the regional delivery of extension:

> The development of regional bodies under the *National Action Plan for Salinity and Water Quality (NAPSWQ)* has done little to resolve this problem, particularly because many of the staff employed by regional bodies are extension officers rather than scientists. Because they are employed on short-term contracts (typically < 2 years) they are often inexperienced and must be trained in the broad range of natural resource systems (often across large geographic regions). For this reason, they are often unable to contribute much before their positions are terminated.[122]

8.89 The Integrated Natural Resource Management Group for the South Australia Murray Darling Basin acknowledged that the:

> adequacy of technical and scientific support in applying salinity management options is variable and it is recognised that there will always be a need for more knowledge and expertise … There will

118 Hawkesbury-Nepean Catchment Management Board, *Submission no. 21*, p. 3.

119 Mr Anthony Dawson (MCMB), *Transcript of Evidence*, 30 October 2003, pp. 18-19.

120 *ibid.*, p. 19.

121 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 42.

122 ASSSI, *Submission no.* 68, p. 2.

> be an ongoing need for technical and scientific support in the region and the INIRM Group will seek to identify the support needs required and ensure that appropriate investment is sought to meet these needs.[123]

8.90 The CRC PBMDS told the Committee that CMOs need support to access the information available in national and state agencies.[124] Similarly, the Murray Catchment Management Board submitted that, although it had enough scientific information to put together 'The Murray Catchment Blueprint', there were gaps in the processes that link new research and technologies developed outside the region.[125]

8.91 The Fitzroy Basin Association raised concerns about the informal and 'fragile' nature of the links between CMOs and researchers:

> In these early days of regional bodies, much of the dissemination occurs through the development of personal relationships between the regional bodies' science coordinator (if they have one) and researchers. This leaves that body, and resource managers, open to a gap in sourcing relevant information, should the science coordinator leave, or if insufficient funds are available to maintain the position … In other words, this arrangement is not supported by structure or process to the degree that it could be.[126]

8.92 National science providers and brokers, including CSIRO, LWA and the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), noted that it is difficult for them to have a relationship with all the CMOs in Australia.[127]

8.93 The Committee was told of a range of options to increase CMOs' access to, and understanding of, relevant scientific research:

- MCMB recommended that 'Salinity Knowledge Brokers' be employed to support CMOs.[128] The brokers would be nationally linked, and their role would be to validate, synthesise and extend the latest research and technologies relating to NRM.[129] Similarly, to target salinity

123 The Integrated Natural Resource Management Group for the South Australia Murray Darling Basin, *Submission no. 23*, p. 2.

124 CRC PBMDS, *Submission no.8*, p. 6.

125 MCMB, *Submission no.* 10, p. 10.

126 Fitzroy Basin Association, *Submission no. 48*, p. 3.

127 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26. Also see: Dr Mirko Stauffacher, (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 88; CRC LEME, *Submission no. 64*, p. 4.

128 Murray Catchment Management Board, *Submission no. 10*, p. 3.

129 *ibid.*

management, Greening Australia recommended that a dedicated team of 10 to 15 'knowledge brokers' be established.[130]

- Phil Dyson and Associates suggested a national team of salinity experts could provide mobile extension services to CMOs (modelled on the NDSP's Tools Project).[131]
- GRDC noted that catchment staff need a range of expert skills to understand the science behind salinity management. It was suggested that this could achieved through 'significant on-job or post graduate training'.[132]
- LWA recommended 'a first-stop shop—which all the regional bodies, any extension officers or farm consultants can go to and say, "Who is doing work on this? What is useful," or, "I'm after a CD-ROM," or, "I'm after a decision support tool," or, "I need to know if anyone has done this sort of mapping that we propose to be doing. Who can I talk to?".'[133] It was proposed this could be linked to the National Land and Water Resources Audit.[134]
- ASSSI recommended that the Australian and state governments 'consider setting up a group of 'Salinity Specialists' capable of offering advice to regional groups as required. These specialists could be supported through the current CRC PBMDS or through the proposed Australian Centre for Salinity Research'.[135]
- HNCMB suggested that each CMO develop a science subcommittee to provide expert advice on salinity and NRM issues. [136]
- WA SRDTC urged that there needs to be a 'focused source of information' for CMOs and farmers 'with linkages to the various initiatives such as NDSP and RIRFs [Rural Industry Research Funds]'.[137]

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130 Greening Australia, *Submission no. 79*, p. 5.

131 Phil Dyson and Associates, *Submission no. 46*, p. 2.

132 GRDC, *Submission no. 29*, p. 9.

133 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 28.

134 Review of the National Landcare Program, DAFF, Canberra, October 2003, p. 50, viewed 19 April 2004, <www.daff.gov.au/corporate_docs/publications/pdf/nrm/landcare/nlp_review_report_final.pdf>.

135 ASSSI, *Submission no. 68*, p. 6.

136 Mrs Mary Howard (Hawkesbury-Nepean Catchment Management Board), *Transcript of Evidence*, 29 October 2003, p. 68.

137 WA SRDTC, *Submission no. 54*, p. 6.

- DAFF advocated ‘strong working relationships’ between research organisations and CMOs, as have been developed between CSIRO, James Cook University and the Burdekin Dry Tropics Board.[138]
- Murray Irrigation recommended that support for extension providers could be improved by billeting research scientists in the offices of extension providers (as Murray Irrigation has done with CSIRO researchers).[139]

8.94 The Committee is aware that the Australian Government is committed to ensuring that CMOs have the capacity to provide on-ground extension.[140] However, the Committee notes serious concerns about the capacity of CMOs to adequately extend salinity research and other relevant NRM information, and the ability of research agencies to communicate and assist each CMO. The Committee acknowledges the range of proposals submitted to address these issues. The mechanisms in place through the NAP and NHT go some way to ensuring that there is a coordinated, consistent national approach to the delivery of scientific information to catchment management organisations. However, the Committee believes additional support may be necessary.

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138 Mr Mike Lee (DAFF), *Transcript of Evidence*, 7 November 2003, p. 55.

139 Murray Irrigation Ltd, *Submission no. 27*, p. 5.

140 COAG, *A National Action Plan for Salinity and Water Quality*, DAFF and DEH, Canberra, 2000; House of Representatives Standing Committee on Environment and Heritage, *Co-ordinating Catchment Management*, Canberra, December 2000, p. 119, viewed 17 March 2004, <www.aph.gov.au/house/committee/environ/reports.htm>.

Recommendation 22

8.95 **The Committee recommends that the Australian, state and territory governments increase their support of catchment management organisations by:**

(a) undertaking a review to assess the effectiveness of providing groups of mobile knowledge brokers, directed to advise on national natural resource management policies and provide integrated, current and relevant scientific and technical support on salinity issues to individuals and organisations managing salinity;

(b) providing funding for the operations of any such groups as are recommended to be formed;

(c) enabling the secondment of such knowledge brokers from relevant research agencies, such as the *National Dryland Salinity Program*, the Cooperative Research Centre for Plant-Based Management of Dryland Salinity and the Commonwealth Scientific and Industrial Research Organisation's Land and Water Division.

Support provided by national and collaborative research agencies

8.96 In addition to NAP and NHT funding, the Australian Government, in collaboration with industry, state/territory governments and other partners, funds a range of agencies and programs which undertake and commission research on salinity, and provide extension services for salinity management. Significant players include:[141]

- Research and Development Corporations (RDCs), in particular LWA and the GRDC;
- NDSP;
- MDBC;
- CSIRO; and
- CRCs.

141 For details see chapter four of this report.

8.97 Evidence was presented that, increasingly, research agencies have to directly extend research to land managers, or find alternative mechanisms through which to provide extension services.[142]

8.98 As illustrated below, the Committee was told that the decrease in state extension services had resulted in research agencies directly extending their findings, and working in collaboration with industry and other stakeholders to promote their research. The Committee was told that the costs and difficulties for research and technical providers, associated with delivering their finding to end users, were likely to increase with the regional delivery of NRM services.[143]

8.99 Dr Tom Hatton told the Committee that in Western Australia extension was being undertaken by scientists, as they worked in collaboration with industry groups, CMOs and farmers on research projects; not ‘second hand’ via state extension officers.[144] Although costly, the process ensures the needs of end users are fed into research priorities. However, CSIRO also told the Committee that it was difficult to have links with all the CMOs:

> The shift to regional NRM management has presented a number of difficulties for Commonwealth and state technical providers who continue to support NRM science:
>
> - The sheer number of NRM groups has meant high transaction costs in communication;
> - There is potential for creating confusion for the NRM groups if approached by several research providers;
> - There is a need to convince NRM groups to invest in technical information;
> - It is not clear who is providing the balance between emerging technologies and existing technologies and whether they have the capacity to make those decisions;
> - Getting the coordination between groups to support strategic research.[145]

8.100 Furthermore, CSIRO concluded that the de-skilling of state agencies and the reduction of state extension services has led to a situation where

142 Dr Mirko Stauffacher, (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 88. Also see: CRC LEME, *Submission no. 6*4, p. 4; Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26.

143 CSIRO, *Submission no. 42*, p. 42.

144 Dr Thomas Hatton (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36.

145 CSIRO, *loc. cit.* Also see: Dr Mirko Stauffacher (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 88.

information is not being adequately communicated to implementers 'in terms of the magnitude of the problem we face'.[146]

8.101 LWA told the Committee:

> it is very difficult for national agencies like ourselves, the CSIRO, BRS or whatever to have a relationship with each of the 60-odd regional bodies in Australia. We can do it through a web interface or whatever, but it is very difficult for us to have direct face-to-face relationships with 64 different agencies. The transaction costs would eat up all our budget.[147]

8.102 LWA questioned the efficiency of having to pay research funds to state agency staff to extend the program *Land, Water and Wool* (of which *Sustainable Grazing on Saline Lands* is a major component):

> It is groups of farmers doing trials on their own farms that are literally getting this one-on-one interface through the coordinators that we fund. To be fair, some of that is being done in partnership with the relevant state government agencies. We are contracting them to do the work, but the point is that we are actually spending research dollars to pay state agencies to provide extension services. From a public policy point of view, I do not believe it is the optimum allocation of resources.[148]

Research and Development Corporations

8.103 Both the GRDC and the Cotton Research and Development Corporation (CRDC) submitted that RDCs are fundamental to national salinity initiatives as '[t]hey have links to growers who ultimately make the land use change on the ground'.[149] The GRDC has contributed $5 million to the NDSP over the last five years, and committed $11.5 million for salinity and water management projects through its own programs between 2002–08.[150]

8.104 With regard to building the capacity of CMOs, the GRDC submitted:

> given that the science of predicting and managing salinity has run well ahead of practice, perhaps it is time to shift some of the emphasis away from regional capacity building and place greater

146 Dr John Williams (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 82.

147 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26.

148 *ibid.*, p. 25.

149 GRDC, *Submission no. 29*, p. 1. Also see: Cotton Research and Development Corporation, *Submission no. 3*1, p. 1; Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 71.

150 *ibid.*, p. 2. The GRDC submission, at pp. 14-21, provides an extensive list of (a) salinity projects which it has been involved in, and (b) how these have been linked to land managers.

> emphasis on supporting adoption. This is an area where the GRDC can offer the greatest support and advice to catchment bodies, given the Corporation's experience with grower-group networks and in the development and extension of more sustainable farming practices.

8.105 Other issues raised by the GRDC in regards to communication and extension included the need for:

- profitable salinity solutions; and
- the establishment of a freely accessible, national database of salinity management options.[151]

8.106 GRDC concluded that '[p]erhaps the simplest action the Commonwealth could take to encourage landholders to apply scientifically proven salinity management options would be to pay landholders directly or via the tax systems'.[152]

The National Dryland Salinity Program: principal communicators

8.107 Submitters widely recognised the NDSP as the principal, national communicator of information on dryland salinity.[153] Through its Communication Team, the NDSP has worked to bridge the 'communication gap' between salinity researchers and implementers at a national, state and regional level.[154]

8.108 The NDSP submitted that it aspires to be 'Australia's lead knowledge broker of R&D and extension efforts to combat dryland salinity'.[155] During 2003–04, the NDSP will undertake an 'Enhanced Communication Year' in which research conducted over the past decade will be synthesised and communicated. With support from the CRC PBMDS, the NDSP aims to promote 'practical, "best-bet" and integrated systems to manage the salinity risk'.[156] The target audience will be farmers, communities and governments. To get its message into the public domain, the NDSP has created communication networks with CMOs, all levels of government,

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151 *ibid.*, pp. 1-2.

152 *ibid.*, p. 12.

153 For example see ASSSI, *Submission no. 68*, p. 5; WA SRDTC, *Submission no. 54*, p. 5.

154 NDSP, *Submission no. 35*, p. 25. Also see: NDSP, *Exhibit no. 27*, *Appendix C: NDSP Communication Report 2000-03.*

155 *ibid.*, p. 19.

156 *Focus on Salt: The Newsletter of Australia's National Dryland Salinity Program*, Issue no. 28, October 2003, pp. 8-9, viewed 4 February 2004, <www.ndsp.gov.au/15_publications/20_focus_on_salt/focus_28/focus_028.htm>

implementers such as Landcare groups and contractors, industry and research organisations.[157] DAFF and DEH submitted that:

> The NDSP provides a major communication network for disseminating salinity science and information in Australia.
>
> Over the past nine years of operation the NDSP has helped to raise awareness of salinity through regular newsletters and media articles (such as the "Silent Flood" series screened on ABC television), supported research and development into the causes of salinity, and along with others, supports regular national forums to share information and insights into salinity and means for its management. The substantial salinity science and information resource products of the NDSP are maintained and made accessible through its web site at www.ndsp.gov.au.[158]

8.109 Examples of the communication tools and products produced by the NDSP include a *Focus on Salt* newsletter and *SALT* magazine. In 2002–03, *SALT* magazine was distributed to 65 000 primary producers and *Focus on Salt* was distributed to approximately 5 000 catchment managers, researchers and agency personnel.[159] The NDSP also facilitates 'Saltlist', an email forum for those with an interest in salinity research and management issues.

8.110 In addition, the NDSP employs knowledge brokers (either consultants or staff from state agencies) to work directly with communities:

> They do work with the communities to explore what their issues are, listen to them and provide them with feedback as to what the National Dryland Salinity Program has to offer them as well as what other researchers have to offer them.[160]

The NDSP's 'Tools' for the improved management of dryland salinity project

8.111 The Tools Project, managed by the NDSP, was presented to the Committee as a successful example of the extension of scientific research on dryland salinity.[161] The aim of the Tools Project was to make sure that the

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157 *Focus on Salt*: *The Newsletter of Australia's National Dryland Salinity Program*, Issue no. 28, October 2003, pp. 8-9, viewed 4 February 2004, <www.ndsp.gov.au/15_publications/20_focus_on_salt/focus_28/focus_028.htm>.

158 DAFF and DEH, *Submission no. 72*, p. 12.

159 LWA, *Exhibit no. 127, Land and Water Annual Report 2002-03,* p. 39.

160 Dr Richard Price (NDSP), *Transcript of Evidence*, 3 November 2003, p. 10.

161 The project was supported by a range of partners including the MDBC, the Cooperative Research Centres, DEH, National Land and Water Resources Audit Program, Research and Development Corporations, and state land and water management agencies' research and development programs throughout Australia.

knowledge acquired from research programs was distilled, interpreted and made available to the CMOs of the Murray-Darling Basin for incorporation into local salinity planning activities.[162]

8.112 Mr Phil Dyson, a community consultant during the project, told the Committee that:

> the Tools project provided us with the vehicle to put information together and to take that information out to the regional communities, and the catchment classification process allowed us to go to each of those regions and to talk about what they could do. More than that, we actually used a workshopping process over a three to five day period to break those catchments up into their component parts, using the local people's knowledge. That is the key to a lot of what we are trying to do, I think—to take the national research out into the regions where it has some relevance and then use the catchment planning tool and that understanding to take that down to the community level.[163]

8.113 According to CSIRO it was a 'very neat process' but expensive: 'As you can imagine, you have to have the resources to be able to do it. That was, I would say, a too rare one-off.'[164]

The future of the NDSP

8.114 As discussed in chapter five, the Committee notes that the forecast cessation of the NDSP was lamented by many submitters, and its continuation was widely supported.[165] Webbnet Land Resource Services submitted that:

> The current communication thrust by the NDSP is an excellent example of the sorts of packaging, and delivery of information to the various industry, regional, technical and local government groups managing dryland salinity nationally … If the NDSP does not continue in its current form, there is likely to be a serious impact on information transfer across the main stakeholder clients.

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162 Dr Mirko Stauffacker (CSIRO), *Transcript of Evidence*, 7 November 2003, p. 89. Also see: Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 3; Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 6.

163 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 3. Also see: Mr Sydney Clarke, *Transcript of Evidence*, 30 October 2003, p. 6.

164 Dr Mirko Stauffacker (CSIRO), *Transcript of Evidence*, *ibid.*

165 See for example: CSIRO, *Submission no. 42*, p. 4; CRC PBMDS, *Submission no.* 8, p. 1; South Australian Government, *Submission no. 81*, p. 4.

> State programs have not filled this role, and no other program seems likely to pick it up.[166]

8.115 The Committee believes that there is an ongoing role for the NDSP, and in particular the Communications Team, in the distillation and communication of salinity research. The Committee has recommended the retention and expansion of the NDSP.[167]

8.116 However, in the event the NDSP is discontinued, it has been suggested that the Australian Government fund an alternative organisation to provide its research and extension functions. Proposals for successor organisations are discussed in chapter five.[168]

Cooperative Research Centres

8.117 The Department of Education, Science and Training (DEST) submitted that: '[t]he transfer of research results to the users is one of the major objectives of the [CRC] programme'.[169]

8.118 To ensure research is 'available in easily interpreted formats for both the scientific and non-scientific community' the CRC for Freshwater Ecology (CRCFE) has a 'dedicated knowledge exchange program':

> The aims of knowledge exchange are 1) to distil the key findings from a range of scientific research projects, 2) to deliver them to resource managers or the community in a useable format, and 3) to provide feedback to researchers about the needs of managers and community groups. In the CRCFE, knowledge exchange activities are carried out by a team of "knowledge brokers", in conjunction with researchers.[170]

8.119 CRC LEME questioned the capacity of CRCs to deliver information under the new regional arrangements to the CMOs:

> There is a capacity issue – with so many new CMAs to service, how can individual CRC and research agencies be expected to service such a diverse client base?[171]

8.120 CRC PBMDS told the Committee that, with the decline in state extension services, it has become necessary to use alternative avenues to extend

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166 Webbnet Land Resources Services, *Submission no. 40*, p. 3.

167 See chapter five of this report.

168 CRC PBMDS, *Submission no. 8*, p. 1. Also see: Australian Society of Soil Science Inc., *Submission no. 68*, pp. 5-6.

169 DEST, *Submission no. 69*, p. 2.

170 Cooperative Research Centre for Freshwater Ecology, *Submission no. 26*, p. 3.

171 CRC LEME, *Submission no. 64*, p. 4.

research information.[172] Both Landmark and CRC PBMDS advocated that their partnership represented a useful model for linking the science base for salinity management to land managers.[173] With access to over 100 000 farmers, 430 service locations throughout Australia and 250 agronomists on staff, Landmark submitted that they have become ‘a vital partner in the extension and commercialisation of the CRC’s research outcome’.[174] Currently, CRC PBMDS and Landmark, in conjunction with state government agricultural agencies and other CRCs, are undertaking a two part education program on dryland salinity and its management through the use of lucerne.[175] To date, over 450 farmers, Landmark staff and government agency staff have participated.

8.121 As a result of its successful partnership with Landmark, CRC PBMDS has recommended:

> That the Commonwealth put in place strategies to encourage strategic partnerships between agribusiness, State agencies and CMAs to enhance face-to-face extension of the results of research. This CRC has a partnership with Landmark, which may serve as a model.[176]

Direct extension by research scientists

8.122 Research scientists involved in salinity research are increasingly called upon to extend their findings to land managers. The Australian Research Council (ARC) explicitly encourages research scientists to extend their findings. In this regard, DEST informed the Committee that:

> ARC programmes emphasise, where appropriate, the need for collaboration between researchers and, in the case of ARC Linkage, require interaction with the actual or potential users of the research results.[177]

8.123 The Centre for Salinity Assessment and Management (CSAM) at the University of Sydney aims to extend information on salinity and its management to a broad spectrum of the community: from school children to landholders to industry.[178] To extend its research CSAM intends:

- ‘To develop interactive programs with community groups’; and

172 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 24.
173 Mr David Coombes (Landmark), *Transcript of Evidence,* 1 December 2003, p. 2.
174 Landmark, *Submission no. 30,* p. 2.
175 *ibid.*
176 CRC PBMDS, *Submission no. 8,* p 1.
177 DEST, *Submission no. 69,* p. 2.
178 Professor Les Copeland (CSAM), *Submission no.* 19, p. 1.

- ‘To organise symposia involving government agencies, community groups and research scientists to promote salinity education, research and management’.[179]

8.124 To encourage academic staff to undertake extension, CSAM suggested that scientists could have an extension component written into their university employment contracts, as occurs at some American universities:

> Extension has never been part of the university scene in Australia … But in the United States the evolution of the land grant system has served that community very well. There would be people who have an appointment where they do normal academic activities for 50 per cent of their time and spend the other 50 per cent of their time actually in the community with farmers.[180]

8.125 The Committee heard from Professor James Macnae, a research scientist and recipient of ARC funds, that he had difficulty communicating the findings of his research on salinity to, and getting feedback from, land managers:

> The expressed interest in salinity of a great many federal, state and catchment authorities further means that there is no obvious single point of contact for a research scientist to make any direct approach to discuss problems and possible solutions … there is no existing linkage mechanism that allows me to communicate results of active research to those responsible for management and implementation of salinity mapping or salinity solutions. In addition, other than through the scientific literature, popular press and web searches, there is no obvious way by which problems identified by the myriad governments and agencies can be directly and rapidly communicated to the University research community.[181]

8.126 The Committee received evidence that research scientists were not necessarily the ideal people to provide NRM extension. For example, Murdoch University conceded ‘that while researchers are good at research they are not necessarily the best people to be delivering that information to the community’.[182] Similarly, NDSP told the Committee that:

> the last people whom I want interpreting science are scientists. I would rather see science interpreted by those who are close to the

179 *ibid.*

180 Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 59.

181 Professor James Macnae, *Submission no. 37*, p. 1.

182 Associate Professor Richard Bell (Murdoch University), *Transcript of Evidence*, 13 November 2003, p. 34.

> ground. There has been a gap between our science speakers and our science listeners, unfortunately. So there is definitely a capacity issue that does need to be addressed and potentially within a coordinated way. We are not just dealing with the coordination of R&D but talking about potentially coordination of information dissemination.[183]

8.127 LWA stated that:

> To direct all the opprobrium at the researchers is a bit rich. I do not want to have to try to turn each researcher into a David Bellamy or a David Suzuki or a David Attenborough. Some of them are good at it, but most of them are better at doing the research.[184]

8.128 WA SRDTC acknowledged that the direct engagement of scientists in extension was not necessarily the best use of resources, as Dr Tom Hatton stated: '[y]ou would probably get best value out of scientists if they were just doing science and somebody else was left to take it out to the community'.[185]

8.129 Apart from the issue of communicating the science, submitters noted a mismatch between the needs of end users and the aims of scientists. For example, Dr John Ive submitted that scientific research tended to be narrowly focussed on a single theme or issue. This results from the delineation of scientific disciplines and an emphasis on scientific specialisation: 'this need for scientists to specialise is at odds with the needs of the landholder or manager who has to manager [sic] for a multitude of themes simultaneously'.[186] Indeed, Cullen et. al. have posited that land managers do not want the results of individual projects, rather they require 'concise overviews of the current understanding of a particular area'.[187]

8.130 The Committee concludes that involving scientists in the direct extension of their research findings has the dual function of ensuring (a) findings are correctly interpreted; and (b) the priorities of land managers are relayed back to researchers. The Committee supports efforts, where feasible, to co-locate researchers with implementers, as demonstrated by CSIRO and Murray Irrigation.

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183 Dr Richard Price (LWA), *Transcript of Evidence*, 3 November 2003, p. 6.

184 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 25.

185 Dr Thomas Hatton (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 36.

186 Dr John Ive, *Submission no. 74*, p. 1.

187 Cullen P., Cottingham J.D., Doolan J., Edgar B., Ellis C., Fisher M., Flett D., Johnson D., Sealie L., Stocklmayer S., Vanclay F. and Whittington J., Cooperative Research Centre for Freshwater Ecology, *Knowledge Seeking Strategies of Natural Resource Professionals*, 2001, p. 13, Canberra, viewed 26 February 2004, <http://freshwater.canberra.edu.au>.

8.131 The Committee acknowledges that scientists are being increasingly relied upon to promote their research findings. The Committee is aware of conferences dealing with salinity issues; including the 'Productive Use and Rehabilitation of Saline Land (PUR$L)' conference, the 'Salinity Solutions: Working with Science and Society' conference (sponsored by the CRC PBMDS, GRDC, NDSP and others), and the inaugural 'Engineering Salinity Solutions' conference to be held in November 2004.[188] The Committee sees merit in the establishment of an annual national forum to promote salinity education, research and management particularly in relation to the NAP, involving government agencies, land managers and research scientists.

8.132 The option of including an extension component in the contracts of research scientists is worthy of consideration; however, the Committee believes that the provision of extension should not be at the expense of research activities. Indeed, the Committee acknowledges that the direct extension of research by scientists may not be the best allocation of resources, nor facilitate the dissemination of the information required by land managers.

Recommendation 23

8.133 **The Committee recommends that the Australian Government support the establishment of a national annual forum on salinity policy, research and management, associated with the *National Action Plan for Salinity and Water Quality*, for government agency staff, catchment management organisations, private consultants, farmers, and other land managers.**

Private sector involvement in the provision of extension services

8.134 The agricultural industry and NRM consultants have submitted that they are well positioned and have the capacity to increase their role in the provision of extension services. This shift was viewed as inevitable and necessary by many research organisations and government agencies.[189]

188 Mr Bruce Munday (Saltlist), email, 25 February 2004, <Bruce@clearconnections.com.au>; Salinity Solutions: Working with Science and Society, Bendigo, viewed 13 May 2004, <www.cdesign.com.au/salinity2004/>.

189 Dr Michael Curll (Government of New South Wales, Department of Agriculture), *Transcript of Evidence*, 29 October 2003, p. 89. Also see: Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

8.135 With regard to agribusinesses involvement in extension, Natural Resource Intelligence (NRI) told the Committee that '[o]ver the last 20 years, the agriculture industry has developed a very good technical service provision'.[190]

8.136 As previously discussed, the Committee heard evidence about successful partnership arrangements whereby industry groups are delivering research findings to land managers, such as CRC PBMDS and Landmark, and CSIRO and Murray Irrigation.[191] The advantages claimed for involving agribusinesses in extension were that they:

- have the capacity to have a face-to-face relationship with every farmer in Australia;
- can provide integrated information which factors in social and economic constraints;
- provide a mechanism for industry concerns to be fed back to scientists;
- emphasise providing practical solutions to salinity;
- reduce the drain on public funds (particularly in light of the perception that salinity and NRM projects can lead to private gain for land managers); and, in addition
- reduce the need for individual land managers to pay for services.[192]

8.137 The Committee heard that consulting companies providing NRM services on a fee-for-service basis tended to be hired with public funds, and not by individual landholders.[193] According to SKM, consulting rates range between $50 and $100 an hour, making extension provision a very expensive, but necessary, undertaking:

> Spending $50,000 or $100,000 on a project just talking to people does not seem to be delivering outcomes—whereas, in fact, we would suggest that is probably the best way to deliver outcomes in many cases.[194]

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190 Dr Brian Tunstall (NRI), *Transcript of Evidence*, 7 November 2003, p. 3.

191 CRC PBMDS, *Submission no. 8*, p. 1. Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 16.

192 ASAN, *Submission no. 39*, p. 7. Also see: Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41; Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 15; Orbtek Pty Ltd, *Submission no. 3*, p. 13.

193 Mr Greg Hoxley (SKM), *Transcript of Evidence*, 31 October 2003, p. 37. Also see: Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

194 *ibid.*

8.138 To promote industry involvement in the implementation of salinity management and extension, NRI recommended a range of policy and administrative changes which include:

- Providing opportunities for industry to compete for public research funds.
- Ensuring industry can compete effectively with publicly funded organisations (full application of policy and legislation such as the Trade Practices Act and Competitive Neutrality legislation).
- Preventing those specifying requirements from bidding for the work (full accountability and transparency).
- Ensuring all reviews of proposals are signed and made available to the proponent.[195]

8.139 Orbtek made two recommendations to foster the involvement of private enterprise in R&D and extension:

- Increase the funding opportunities for private companies that provide R&D, innovation and delivery support services in sustainability that support both national and regional initiatives.
- Require all public science initiatives on sustainability to be undertaken collaboratively with industry (including specific knowledge companies) and local governments.[196]

8.140 While the benefits of private sector involvement in extension were acknowledged, concerns were raised regarding the quality and objectivity of the advice on offer, and whether issues such as resource sustainability and conservation were adequately incorporated in advice.[197]

8.141 The MDBC noted that there was a need to ensure that the qualifications and skills of consultants were adequate:[198]

> Whilst there are some really excellent people, there are also some snake oil salesmen. A coordinating role that could be assisted would be to try and get some sort of quality assurance process into that.[199]

8.142 To ensure that consultants were able to offer best practice salinity management options to land managers, SKM and the New South Wales Farmers' Association supported the formal accreditation of salinity

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195 NRI, *Submission no. 32*, p. 12.

196 Orbtek Pty Ltd, *Submission no.* 3, p. 14.

197 See for example: Mr Robert Newman (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41; Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26.

198 Mr Robert Newman (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

199 *ibid*.

advisors.[200] AIAST submitted that its advisors undertake an internal accreditation course which requires they complete 50 hours of relevant training per year.[201]

8.143 LWA noted that there were limits on the extent to which private sector agronomists should be relied upon to extend information on public good issues, such as salinity management, as they are primarily driven by profit, and not environmental imperatives. LWA informed the Committee that:

> Those people [agronomists with agribusinesses such as Elders], though, have a private job to do for a company that has to work for its shareholders. We can get them to take this information where it fits in with their business. We cannot turn them into catchment planners.[202]

8.144 The New South Wales Farmers' Association told the Committee that it was unclear if industry involvement was the panacea to problems in extension: 'I see those cost recovery principles going against the idea of having consistent, steady, reliable, long-term extension and research programs'.[203]

8.145 The Committee acknowledges that there is an important 'public good' aspect to the extension of salinity research which may not be profitable. In addition, it is conceded that governments and government agencies, not industry, are predominantly best positioned to make integrated policy decisions about environmental issues affecting broad landscapes. However, despite these caveats, the Committee concludes that there are many advantages to increasing the involvement of agribusinesses and private consulting companies in the extension of salinity research, particularly in collaboration with public organisations involved in funding and undertaking salinity research. The Committee supports measures to foster private industry involvement in technical and support services for environmental management. In addition, the Committee recommends the formal accreditation of private sector salinity advisers, to ensure salinity advice and implementation services meet best practice standards.

200 SKM, *Submission no. 28*, p. 6. Also see: Mr Jonathan Streat (New South Wales Farmers' Association), *Transcript of Evidence*, 29 October 2003, p. 52.

201 AIAST, Submission no. 76, p. 5.

202 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 26.

203 Mr Jonathan Streat (New South Wales Farmers' Association), *Transcript of Evidence, ibid.*

Recommendation 24

8.146 **The Committee recommends the Australian Government:**

(a) examine and remove any impediments to the further development of an industry in technical and support services for environmental management; and

(b) establish and coordinate, with the cooperation of the states and territories, a national accreditation process for private sector salinity advisors to ensure that salinity advice and implementation services meet best practice standards.

The contributions of local governments

8.147 The Council of Australian Governments (COAG) has noted the importance of local government involvement in regional planning processes.[204] In particular, as recognised by the NAP arrangements, local governments are important conduits for delivering information on salinity management options at the local level.[205]

8.148 ASAN submitted that despite being important players in salinity management, local governments were often not supported by other tiers of government:

> This sector has potentially one of the greatest mechanisms to influence change on the land through its planning instruments at the local scale required. Often councils lack the funds and are not briefed sufficiently on matters of salinity within their jurisdiction. This issue needs to be addressed. Local government perhaps is a more effective instrument of bringing about change than Catchment Management Authorities.[206]

8.149 Similarly, Orbtek recommended that local governments, in collaboration with industry, need to be funded to undertake regional NRM planning and implementation:

> Restore the integrity of regional and local governance in sustainability by directly funding consortia of local governments

204 Government response to the House of Representatives Standing Committee on Environment and Heritage's Report on the *Inquiry into Catchment Management: Coordinating Catchment Management*, 2003, p. 17, viewed 17 March 2004, <www.aph.gov.au/house/committee/environ/reports.htm>.

205 DAFF and DEH, *Exhibit no. 64, Overview of the NAP, NHT and NLP*, p. 27.

206 ASAN, *Submission no. 39*, pp. 9-10.

> and industry bodies to lead regional (or economic zone) activities in sustainability planning, decision support, monitoring and reporting.[207]

8.150 The Western Sydney Regional Organisation of Councils (WSROC) advised that information on the science of salinity was not flowing through to councils and as a result only half the councils in the Western Sydney area were actively engaged in the management of salinity:

> There may be research happening and, if there is, that is great, but local government is not aware of it … There is a feeling out there that we would really love some more information about this so that we can make some concrete decisions about what we are going to do in managing and developing this area, because it is going to affect our councils and our ratepayers.[208]

8.151 To support local councils, the New South Wales Government (through DIPNR) has produced a number of booklets covering the following themes:

- 'Indicators of Urban Salinity', which contains photographs of a range of salinity indicators and explains what might be the cause of salinity;
- 'Broad Scale Resources for Urban Salinity', which discusses some of the resources available to determine if salinity is, or is likely to be, an issue in a particular region;
- 'Site Investigations for Urban Salinity', which provides a methodology for assessing the impact of salinity on a proposed urban development and the impact that development may have on water and salt processes;
- 'Roads and Salinity', which reviews how salt and water processes can affect road structure and decrease lifespan, and strategies to prevent or minimise salinity damage to roads; and
- 'Building in a Saline Environment', which presents ideas on how to build structures less susceptible to salt damage.[209]

8.152 Currently the Murray Darling Association is conducting an investigation into the level of local government involvement in dryland salinity management.[210]

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207 Orbtek Pty Ltd, *Submission no. 3*, p. 14.

208 Mr Colin Kandan-Smith (Western Sydney Regional Organisation of Councils), *Transcript of Evidence*, 29 October 2003, p. 23.

209 Hawkesbury-Nepean Catchment Management Board, *Exhibit no. 42, Salinity Potential in Western Sydney*.

210 Murray Darling Association Inc., *Submission no. 14*, p. 1.

8.153 The Wagga Wagga City Council has taken a lead role in extending information on urban salinity to residents.[211] During the course of the inquiry the Committee undertook an urban salinity tour with the Wagga Wagga City Council. The Council has employed staff to explain and translate ‘salinity science’ to the residents of the Wagga region. The types of activities undertaken by the Council include:

- issuing media releases on salinity management;
- mounting ‘Salt Expos’ at events like the annual Leisure and Garden Show;
- funding staff to present at salinity conferences around Australia;
- making publications about salinity freely available;
- conducting ‘Urban Salinity Tours’ for interested groups;
- liaising with the Local Government Salinity Initiative team;
- supporting Landcare Groups in their salinity management projects; and
- making salinity information available on a website.[212]

8.154 The Committee recognises that local governments have an important role to play in the transfer and dissemination of information on salinity, in particular with regard to urban salinity.

Conclusions

8.155 The Committee believes that effective extension officers can act as conduits between scientists and implementers: collecting, interpreting, filtering, translating and promoting scientific and technical information. However, it is conceded that extension services can only be effective with the development and promotion of economically viable salinity management options.

8.156 The Committee concludes that the adequacy of extension services, providing technical and scientific support for salinity management and NRM issues more generally, to land managers is ‘variable across the nation’.[213] The withdrawal and de-skilling of state/territory extension

211 Mr Colin Kandan-Smith (Western Sydney Regional Organisation of Councils), *Transcript of Evidence*, *ibid*.

212 Wagga Wagga City Council, *Submission no. 5*, p. 2.

213 CSIRO, *Submission no. 42*, pp. 2, 14. Also see: Integrated National Resource Management Group for the South Australian Murray Darling Basin Inc., *Submission no. 23*, p. 2.

services continues to be a matter of concern. However, the Committee notes that this issue is being addressed by some states in their state salinity strategies (for example the New South Wales Salt Action Teams), and via involvement in national programs (for example the NAP facilitators). In addition, the Committee notes the contemporaneous increase in the involvement of researchers, industry groups, private consultants, and the Australian and local governments, in the provision of extension services.

8.157 The Committee commends governments at all levels which have entered into partnership arrangements to support the regional delivery of NRM services. However, the Committee identifies the shift and the resulting increase in CMOs' involvement in extension provision, as a major challenge for policy makers and the research community dealing with salinity management issues. The future task will be to ensure that the capacity of CMOs is sufficient to undertake their responsibilities with regard to the provision of extension services. The Committee views the increasing involvement by agribusiness and non-government extension providers as offering a promising avenue to consolidate efforts in this regard.

Gary Nairn MP
Chair
May 2004

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Appendix A – List of submissions

Number	From
1	Dr Baden Williams
2	Lower Murray Darling Catchment Management Board
3	Orbtek Pty Ltd
4	Mr Bill Henty
5	Wagga Wagga City Council
6	Grape and Wine Research and Development Corporation
7	Mr Rex Wagner
8	CRC for Plant-based Management of Dryland Salinity
9	Mr Paul Raiter
10	Murray Catchment Management Board
11	The Pelham Group
12	Dr John Hails
13	Professor David Pannell
14	Murray Darling Association Inc
15	CONFIDENTIAL
16	Associate Professor Robert Creelman and Dr Jerzy Jankowski
17	Deakin University
18	Glenelg Hopkins Catchment Management Authority

19	Centre for Salinity Assessment and Management, University of Sydney
20	Western Sydney Regional Organisation of Councils Ltd
21	Hawkesbury-Nepean Catchment Management Board
22	Australian Nuclear Science and Technology Organisation
23	Integrated Natural Resources Management Group for the South Australian Murray Darling Basin Inc
24	Murdoch University
25	Agrilink Holdings Pty Ltd
25.1	Agrilink Holdings Pty Ltd (supplementary to submission no. 25)
26	Cooperative Research Centre for Freshwater Ecology
27	Murray Irrigation Limited
28	Sinclair Knight Merz
29	Grains Research and Development Corporation
30	Landmark
31	Cotton Research and Development Corporation
32	Natural Resource Intelligence Pty Ltd
33	Dr Ben Kefford
34	Australian Academy of Technological Sciences and Engineering
35	National Dryland Salinity Program
35.1	National Dryland Salinity Program (supplementary to submission no. 35)
36	The Western Australian Farmers Federation Inc
37	Professor James Macnae
38	Mr Andy Green
39	Australian Salinity Action Network
40	Webbnet Land Resource Services Pty Ltd
41	Institute of Public Affairs
42	Commonwealth Scientific and Industrial Research Organisation

43	Murrumbidgee Catchment Management Board
44	Grain Growers Association Ltd
45	NSW Farmers’ Association
46	Phil Dyson & Associates Pty Ltd
47	Chinchilla Shire Council
48	Fitzroy Basin Association
49	Landcare Australia Ltd
50	ACT Government
51	Murray-Darling Basin Commission
52	Murrumbidgee Irrigation Limited
53	Ms Margaret Thompson
54	Western Australian Salinity Research and Development Technical Committee
55	Wimmera Catchment Management Authority
56	Dairy Australia
57	Central Queensland University
58	Australian Spatial Information Business Association Ltd
59	Land and Water Australia
60	Dr Jerzy Jankowski
61	NSW Government
62	Australian Conservation Foundation
63	Forest Products Commission of Western Australia
64	Cooperative Research Centre for Landscape Environments and Mineral Exploration
65	Namoi Catchment Management Board
66	Ricegrowers’ Association of Australia Inc
67	Australian Cotton Cooperative Research Centre
68	Australian Society of Soil Science Inc

69	Australian Government Department of Education, Science and Training
70	AgForce
71	Saltgrow Pty Ltd
72	Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage
72.1	Bureau of Rural Sciences (supplementary to submission no. 72)
72.2	Bureau of Rural Sciences (supplementary to submission no. 72)
73	Engineers Australia
74	Mr John Ive
74.1	Mr John Ive (supplementary to submission no. 74)
75	Eyre Peninsula Natural Resource Management Group and Eyre Peninsula Catchment Water Management Board
76	Australian Institute of Agricultural Science and Technology
77	Dr Mike Dyall-Smith
78	Mr Clive Malcolm
79	Greening Australia
80	GecOz Pty Ltd
81	Government of South Australia

B

Appendix B – List of exhibits

Number	From
1	**Dr Ross Kingwell**
	Economic evaluation of salinity management options in cropping regions of Australia
2	**Mr David Allen**
	A floating geoelectric array for groundwater imaging
3	**Lower Murray Darling Catchment Management Board**
	Salinity Targets Discussion Paper (related to submission no. 2)
4	**Lower Murray Darling Catchment Management Board**
	Salinity section of Monitoring and Audit Provisions (related to submission no. 2)
5	**Mr Bill Henty**
	The Wentworth View: Reform lost in red tape (related to submission no. 4)
6	**Mr Bill Henty**
	Extract from joint media release on Multi-Regional Projects, funded under the National Action Plan, 9 July 2003 (related to submission no. 4)

7 **Wagga Wagga City Council**

The One Stop Shop for Managing Urban Salinity (related to submission no. 5)

8 **Mr Colin Dunstan**

Correspondence

9 **Mr Rex Wagner**

Referee's report on the Examination of the MSc Thesis of Rex Wagner entitled *Dryland Salinity in the South East Region of New South Wales* (related to submission no. 7)

10 **Mr Rex Wagner**

Dryland salinity in south-eastern Australia (related to submission no. 7)

11 **Mr Raul Raiter**

Correspondence (related to submission no. 9)

12 **Professor Philip Cocks**

Restoring the balance, publication by the CRC for Plant-Based Management of Dryland Salinity (related to submission no. 8)

13 **Mr Robert Vincin**

Correspondence

14 **Mr Robert Vincin**

Correspondence

15 **Mr Robert Vincin**

Correspondence

16 **Mr Robert Vincin**

Correspondence

17 **Mr Robert Vincin**

Correspondence

18 **Mr Robert Vincin**

The Missing Sink? It is in the Soil! Paper authored by Robert Vincin and R. W. Condon

19 **Associate Professor Robert Creelman and Dr Jerzy Jankowski**

Review of the Science of Salinity – Its Time, paper authored by Associate Professor Robert Creelman and Dr Jerzy Jankowski (related to submission no. 16)

20 **Glenelg Hopkins Catchment Management Authority**

Glenelg Hopkins Salinity Plan Final Draft: Protecting our Future-Naturally (related to submission no. 18)

21 **Glenelg Hopkins Catchment Management Authority**

Future Directions for Integrated Catchment Research in South West Victoria, report and recommendations to Glenelg Hopkins Catchment Management Authority. Authored by Greg Wearne, Sally Muston, Samantha Greiner and Jonathan Wearne (related to submission no. 18)

22 **Glenelg Hopkins Catchment Management Authority**

Glenelg Hopkins: Regional Catchment Strategy 2003-2007 (related to submission no. 18)

23 **Mr Brian Tunstall - Natural Resource Intelligence Pty Ltd**

Scenario for Dryland Salinity (related to submission no. 32)

24 **Mr Brain Tunstall – Natural Resource Intelligence Pty Ltd**

Dryland Salinity: Providing Solutions (related to submission no. 32)

25 **National Dryland Salinity Program – Mr Kevin Goss**

Appendix A: NDSP Achievements Report, paper prepared in part by the Centre for International Economics (related to submission no. 35)

26 **National Dryland Salinity Program – Mr Kevin Goss**

Appendix B: NDSP Annual Report 2002-03 (related to submission no. 35)

27 **National Dryland Salinity Program – Mr Kevin Goss**

Appendix C: NDSP Communication Report 2002-03 (related to submission no. 35)

28	**Cotton Research and Development Corporation**
	Salinity survey of growers and researchers at the CRDC Farming Systems Forum on Salinity, Sodicity and Hard-setting Soils, December 20002 (related to submission no. 31)
29	**Australian Salinity Action Network (ASAN)**
	Profile of ASAN's Steering Committee
30	**Australian Salinity Action Network**
	An outline of typical projects conducted by the Australian Government through the Bureau of Rural Sciences in collaboration with other organisations (related to submission no. 39)
31	**Australian Salinity Action Network**
	Windows of opportunity/moving a strategy forward-The Salinity Issue, paper by Dr John Bradd (related to submission no. 39)
32	**Dr Phillip Macumber**
	Abstract of paper from Dr Macumber titled '*Ecology and Management of Australia's Water Resources in the Next Two Decades: 2020 Vision or Blind Faith*?
33	**Mr Ian Mott**
	Correspondence from the Landholders Institute Inc
34	**Murray-Darling Basin Commission**
	Salinity Update 2003 (related to submission no. 51)
35	**Murray-Darling Basin Commission**
	Basin Salinity Management Strategy Implementation Working Group-Terms of Reference (related to submission no. 51)
36	**Murray-Darling Basin Commission**
	Salinity and Drainage Strategy-Ten Years On, 1999 (related to submission no. 51)
37	**Murray-Darling Basin Commission**
	Basin Salinity Management Strategy 2001-2015 (related to submission no. 51)

38 **Murray-Darling Basin Commission**

Murray-Darling Basin Agreement-Schedule C (related to submission no. 51)

39 **Murray-Darling Basin Commission**

Basin Salinity Management Strategy-Operational Protocols (related to submission no. 51)

40 **Murray-Darling Basin Commission**

Murray-Darling Basin Commission Review of Salinity Science (related to submission no. 51)

41 **Murray-Darling Basin Commission**

Managing Dryland Salinity-Draft Report (related to submission no. 51)

42 **Hawkesbury-Nepean Catchment Management Board**

Salinity Potential in Western Sydney, kit of documents published by the NSW Department of Infrastructure, Planning and Natural Resources (related to submission no. 21)

43 **NSW Government**

A Strategic Framework for Salinity Research and Development in NSW, document published by NSW Agriculture (related to submission no. 61)

44 **NSW Government**

NSW Salinity R&D Investment Portfolio, paper by the NSW Salinity Research and Development Coordinating Committee (related to submission no. 61)

45 **Mr Sydney Clarke**

Landholder Guide to Land and Water Management, document by the Kyeamba Landcare Group

46 **Australian Conservation Foundation**

Salt: Nature in the balance, community information brochure published by the Australian Conservation Foundation (related to submission no. 62)

47 **Australian Conservation Foundation**

Salt: Nature in the balance, community information kit published by the Australian Conservation Foundation (related to submission no. 62)

48 **Australian Conservation Foundation**

Repairing the Country: Leveraging Private Investment, document prepared for the Business Leaders Roundtable by the Allen Consulting Group (related to submission no. 62)

49 **Wagga Wagga City Council**

Halt the salt in our homes, buildings and farms (related to submission no. 5)

50 **Wagga Wagga City Council**

Wagga Wagga: Salinity and the Urban Salinity Tour (related to submission no. 5)

51 **Wagga Wagga City Council**

Water Wise and Salt Tolerant Plans (related to submission no. 5)

52 **Environment Business Australia**

Reserve Bank for Water: National Water Reform, Sustainability and Micro-economic Reform, paper by Philip Frost

53 **Murrumbidgee Catchment Management Board**

Murrumbidgee Catchment Blueprint, document published by the NSW Department of Land and Water Conservation

54 **Murrumbidgee Catchment Management Board**

Technical Addendum: Technical supporting information for the Murrumbidgee Catchment Blueprint, published by the NSW Department of Land and Water Conservation

55 **Australian Cotton Cooperative Research Centre**

Proposed Research Program for Better Catchment Planning and Water Resources Management, prepared by Clive Lyle and Associates and Aquatech Consulting (related to submission no. 67)

56	**Goulburn Broken Catchment Management Authority**
	Goulburn Broken Draft Regional Catchment Strategy, September 2002
57	**Goulburn Broken Catchment Management Authority**
	Goulburn Broken Catchment Management Authority Annual Report 2002/2003
58	**Victorian Department of Primary Industries**
	Coordination of Salinity Research at Primary Industries Research Victoria, Tatura, paper prepared by Mr Mike Morris, DPI Tatura
59	**Victorian Department of Primary Industries**
	Natural Resource Management: ISIA Project Summaries, May 2003, Victorian Department of Primary Industries
60	**Australian Government Department of Education, Science and Training**
	Information on cooperative research centres (related to submission no. 69)
61	**Australian Government Department of Education, Science and Training**
	Details of ARC funded projects (related to submission no. 69)
62	CONFIDENTIAL
63	**Saltgrow Pty Ltd**
	Hybrid and clonal eucalypts for saline land: current progress and where to from here? Paper by Dr Glenn Dale (related to submission no. 71)
64	**Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**
	Overview of the NAP, NHT and NLP (related to submission no. 72)
65	**Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**
	Five Steps to Tackling Salinity, document published by the Bureau of Rural Sciences (related to submission no. 72)

66 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Land Use Mapping at Catchment Scale, document published by the Bureau of Rural Sciences (related to submission no. 72)

67 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Terms of Reference for the National Review of Salinity Mapping Methods (related to submission no. 72)

68 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Guidelines for Best Practice in the Public Presentation of Salinity Data and Mapping Products (related to submission no. 72)

69 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Technical aspects of salt mapping (related to submission no. 72)

70 **Land and Water Australia**

Saltland Pastures in Australia: A Practical Guide, publication authored by E. G. Barrett-Lennard (related to submission no. 59)

71 **Land and Water Australia**

Australian Dryland Salinity Assessment 2002, document published by the National Land and Water Resources Audit (related to submission no. 59)

72 **Murray-Darling Basin Commission**

The Effect of Salinity Management in the Murray-Darling Basin: Daily Salinity Levels – Jan 2002 to July 2003 (related to submission no. 51)

73 **Murray-Darling Basin Commission**

Increasing Costs of Salt Interception Schemes (related to submission no. 51)

74 **Murray-Darling Basin Commission**

Where to Plant Trees for Salinity Outcomes (related to submission no. 51)

75 **Murray-Darling Basin Commission**

Keeping salt out of the Murray (related to submission no. 51)

76 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

How do we know where to address the salinity problem? Billabong Creek example, notes prepared by the Bureau of Rural Sciences (related to submission no. 72)

77 **Grains Research and Development Corporation**

Productive Solutions to Dryland Salinity (related to submission no. 29)

78 **Grains Research and Development Corporation**

Farming Systems Groups (related to submission no. 29)

79 **Grains Research and Development Corporation**

Economic Evaluation of Salinity Management Options in Cropping Regions of Australia (related to submission no. 29)

80 **Commonwealth Scientific and Industrial Research Organisation (CSIRO)**

Dryland Salinization: A Challenge for Land and Water Management in the Australian Landscape, paper by John Williams, Glen R. Walker and Tom J. Hatton (related to submission no. 42)

81 **CSIRO**

A Revolution in Land Use: Emerging Land Use Systems for Managing Dryland Salinity, publication by R. Stirzaker, T. Lefroy, B. Keating and J. Williams (related to submission no. 42)

82 **CSIRO**

Effectiveness of Current Farming Systems in the Control of Dryland Salinity, publication by Glen Walker, Mat Gilfeder and John Williams (related to submission no. 42)

83 **CSIRO**

Groundwater Flow Systems Framework: Essential Tools for Planning Salinity Management, publication by the Murray-Darling Basin Commission and CSIRO (related to submission no. 42)

84 **CSIRO**

Groundwater Flow Systems Framework: Essential Tools for Planning Salinity Management – Summary Report, publication by Murray-Darling Basin Commission and CSIRO (related to submission no. 42)

85 **Cooperative Research Centre for Landscape Environments and Mineral Exploration**

CRC LEME Annual Report 2002-2003 (related to submission no. 64)

86 **Western Australian Salinity Research and Development Technical Committee**

Information on the NRM Council of WA (related to submission no. 65)

87 **WA Department of Conservation and Land Management**

Development of mallee as a large-scale crop for the wheatbelt of WA, paper by J. R. Bartle and S. Shea

88 **WA Department of the Environment**

WA Field Trip: House of Representatives Inquiry Salinity Research and Development, inspection route map presented to the Committee by Mr Tim Sparks, WA Department of the Environment

89 **WA Department of the Environment**

Land Monitor Salinity Mapping, map presented to the Committee by Mr Tim Sparks, WA Department of the Environment

90 **WA Department of Agriculture**

Perennial vegetation, bores and areas of consistently low productivity over shaded digital elevation model-Kojonup Zone 4, map presented to Committee by Mr Jon Glauert, WA Department of Agriculture

91 **WA Department of Agriculture**

Low lying areas with the potential for shallow watertables – Kojonup Zone 4, map presented to Committee by Mr Jon Glauert, WA Department of Agriculture

92 **WA Department of Agriculture**

NRM on Beaufort Flats, Woodanilling, paper by Sally Thomson, Wagin / Woodanilling Community Landcare Coordinator

93 **WA Department of the Environment**

Collie Salinity Update, November 2003, paper by the WA Water and Rivers Commission and the Collie Recovery Team

94 **Harvey Water**

The Harvey Water Irrigation Area

95 **WA Department of the Environment**

A Fresh Future for Water: Salinity situation statement for the Collie River Catchment-a summary, paper by the WA Water and Rivers Commission

96 **WA Department of the Environment**

Dumbleyung Water Management Strategy, Benyon Road Deep Drainage Demonstration Site, by Dumbleyung Zone Committee, Water and Rivers Commission and the WA Department of Agriculture

97 **WA Department of the Environment**

Dumbleyung Water Management Strategy, paper by the Dumbleyung Zone Committee, Water and Rivers Commission and the WA Department of Agriculture, February 2001

98 **WA Department of Conversation and Land Management**

Water balance and salinity trends, Toolibin catchment, Western Australia

99 **WA Department of Conversation and Land Management**

The Toolibin Lake Recovery Project

100 **WA Department of Conversation and Land Management**

Recovering Lake Toolibin

101 **WA Department of the Environment**

Salinity-a story of water and salt

102 **WA Department of the Environment**

Yenyening Lakes: Management Strategy 2002-2012, publication by the WA Water and Rivers Commission and the WA Department of Conservation and Land Management

103 **WA Department of the Environment**

Review of Engineering and Safe Disposal Options, publication by WA Water and Rivers Commission

104 **WA Department of the Environment**

Salinity Investment Framework Interim Report-Phase I, publication by the WA Department of the Environment

105 **WA Department of the Environment**

State Salinity Action Plan 1996: Review of the Department of Conservation and Land Management's programs, January 1997 to June 2000

106 **Western Power Corporation**

25 years of innovation…, publication by Western Power Corporation

107 **Saltgrow Pty Ltd**

Pictorial of Saltgrow trials across a range of landscape conditions related to salinity abatement, paper presented by Dr Glenn Dale to Dubbo Farm Forestry Conference, 2001 (related to submission no. 71)

108 **Saltgrow Pty Ltd**

Salt tolerant eucalypts for commercial forestry: progress and promise (related to submission no. 71)

109 **Saltgrow Pty Ltd**

Background to Saltgrow Products and the Xylonova Research and Development Program (related to submission no. 71)

110 **NSW Department of Agriculture**

Notes to accompany the Science and Innovation Committee's inspections in Wagga Wagga, 30 October 2003, information provided by Ms Deb Slinger, Salinity Team Leader

111 **WA Department of the Environment**

Salinity: A New Balance, the report of the Salinity Taskforce established to review salinity management in Western Australia (September 2001), report provided by Mr Tim Sparks

112 CONFIDENTIAL

113 CONFIDENTIAL

114 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Science for Decision Makers: Five Steps to Tackling Salinity (related to supplementary submission 72.1)

115 **Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage**

Mid Macquarie Case Study, notes prepared by the Bureau of Rural Sciences (related to supplementary submission 72.1)

116 **Cooperative Research Centre for Landscape Environments and Mineral Exploration**

Reducing the Acquisition Costs of Airborne Electromagnetics Surveys for Salinity and Groundwater Mapping, paper by K. Lawrie, M. Gray, A. Fitzpatrick, P. Wilkes and R. Lane (related to submission no. 64)

117 **Eyre Peninsula Catchment Water Management Board and the Eyre Peninsula Natural Resource Management Group**

Eyre Peninsula Salinity Strategy, CD ROM prepared by the Eyre Peninsula Natural Resource Management Group (related to submission no. 75)

118 **The Leucaena Network Association**

A code of practice for the sustainable use of leucaena-based pasture in Queensland, paper by Mr Keith McLaughlin, Executive Officer

119 **The Leucaena Network Association**

Leucaena-Dilemma, paper by Mr Keith McLaughlin, Executive Officer

120 **The Leucaena Network Association**

A Module for salinity and water Quality Control in the Fitzroy Catchment, paper by Mr Keith McLaughlin, Executive Officer

121 **Hawkesbury-Nepean Catchment Management Board**

Guidelines for the map of salinity potential in Western Sydney 2002, publication by the NSW Department of Infrastructure, Planning and Natural Resources (related to submission no. 21)

122 **Hawkesbury-Nepean Catchment Management Board**

Preliminary Draft Hawkesbury Nepean 2003/04 NHT Transition Investment Strategy to $2.0 million (related to submission no. 21)

123 **Hawkesbury-Nepean Catchment Management Board**

DIPNR Staff Newsletter: 16 October 2003 (related to submission no. 21)

124 **Mr John Ive**

Managing Dryland Salinity: form paddock to web, CD ROM by Mr John Ive of a presentation given to the Science in the Paddock, forum convened by Land and Water Australia, 12 December 2003 (related to submission no. 74)

125 **Mr John Ive**

Talaheni, brochure by Mr John Ive (related to submission no. 74)

126 **Land and Water Australia**

Land and Water Fundamentals (related to submission no. 59)

127 **Land and Water Australia**

Land and Water Australia Annual Report 2002-03 (related to submission no. 59)

128 **Cooperative Research Centre for Landscape Environments and Mineral Exploration**

Salination models

129 **Mr Rex Wagner**

Salinity in the Murray River, paper by Mr Rex Wagner (related to submission no. 7)

130 **GecOz Pty Ltd**

SaltSAR Technical Veracity Report, by Dr Keith Morrison, November 2003 (related to submission no. 80)

131 **GecOz Pty Ltd**

GecOz Submission to the Review of Salinity Mapping Methods in the Australian Context (related to submission no. 80)

132 **Dr Dugald Black (NSW Department of Infrastructure, Planning and Natural Resources)**

Information relating to the cost of digital elevation data in NSW

133 **Western Sydney Regional Organisation of Councils Ltd**

Amounts spent on salinity projects by WSROC

134 **National Dryland Salinity Program**

National Priorities for Salinity Research and Development (related to submission no. 35)

C

Appendix C – Public hearings and witnesses

Organisations and persons are listed in alphabetical order and under each public hearing day.

Wednesday, 29 October 2003 - Sydney

Australian Salinity Action Network

Dr John Bradd (Founder and National Coordinator)

Centre for Salinity Assessment and Management (Sydney University)

Professor Les Copeland (Director, and Dean, Faculty of Agriculture, Food and Natural Resources, University of Sydney)

Dr Inakwu Odeh (Senior Research Fellow)

Dr John Triantafilis (Senior Research Fellow)

Mr Kim Wright (General Manager, Earth Resources Foundation, University of Sydney)

Hawkesbury-Nepean Catchment Management Board

Mrs Mary Howard (Deputy Chair)

Mr Stephen Nichols (Senior Natural Resources Officer, Department of Infrastructure, Planning and Natural Resources)

New South Wales Farmers' Association

Mr Andrew Huckel (Senior Analyst)

Mr Jonathan Streat (Policy Manager, Conservation and Resource Management)

NSW Government

Dr Dugald Black (Manager, Resources Processes Branch, Centre for Natural Resources, Department of Infrastructure, Planning and Natural Resources)

Dr Michael Curll (Deputy Director-General, New South Wales Department of Agriculture)

Private Capacity

Dr Robert Creelman (Project Manager, Nanotechnology Project, University of Western Sydney)

Dr Jerzy Jankowski (Senior Lecturer, University of NSW)

Western Sydney Regional Organisation of Councils

Mr Colin Kandan-Smith (Senior Project Officer, Environment)

Thursday, 30 October 2003 - Wagga Wagga

Murray Catchment Management Board

Mr Anthony Dawson (Landscape Manager)

Private Capacity

Mr Sydney Clarke

Wagga Wagga City Council

Mr Bryan Short (Director, Asset Management)

Councillor Kevin Wales (Mayor)

Mrs Kay Hull MP (Member for Riverina)

Friday, 31 October 2003 - Shepparton

Australian Conservation Foundation

Mr Michael Watts (Sustainable Rural Landscapes Campaigner)

Murray Irrigation Ltd

Mr Alex Marshall (Manager, Environment)

Phil Dyson and Associates Pty Ltd

Mr Philip Dyson (Director)

Sinclair Knight Merz

Mr Greg Hoxley (Principal Hydrogeologist and National Salinity Coordinator)

Private Capacity

The Hon. Dr Sharman Stone (Federal Member for Murray)

Monday, 3 November 2003 - Canberra

National Dryland Salinity Program

Mr Andrew Campbell (Executive Director, Land and Water Australia)

Dr Richard Price (National Manager, National Dryland Salinity Program)

Mr Kevin Goss (Chair, National Dryland Salinity Program)

Friday, 7 November 2003 - Canberra

Australian Government Departments of Agriculture, Fisheries and Forestry; and the Environment and Heritage

Mr Peter Baker (Program Leader, Integrated Water Sciences Program, Bureau of Rural Sciences)

Dr Rhondda Dickson (Acting First Assistant Secretary, Land, Water and Coasts Division—Department of the Environment and Heritage)

Dr Colin Grant (Deputy Executive Director, Bureau of Rural Sciences)

Mr Mike Lee (General Manager, Commonwealth Regional Natural Resource Management—Department of Agriculture, Fisheries and Forestry)

Mr Ian Thompson (Executive Manager, Natural Resource Management—Department of Agriculture, Fisheries and Forestry)

Mr Simon Veitch (Manager, Industry Involvement in Natural Resource Management—Department of Agriculture, Fisheries and Forestry

Commonwealth Scientific and Industrial Research Organisation

Dr Mirko Stauffaker (Research Director, Salinity Directorate, Land and Water Division)

Dr John Williams (Chief, Land and Water Division)

Grains Research and Development Corporation

Dr Martin Blumenthal (Program Manager, Sustainable Farming Systems)

Dr Philip Price (External Consultant, Sustainable Farming Systems Program)

Land and Water Australia

Mr Andrew Campbell (Executive Director)

Murray-Darling Basin Commission

Dr Michele Akeroyd (Salinity Program Officer)

Mr Kevin Goss (Deputy Chief Executive)

Mr Warwick McDonald, (Director, Integrated Catchment Management Business)

Mr Robert Newman (Part-Time Coordinator for Salinity Management)

Natural Resource Intelligence Pty Ltd

Dr Brian Tunstall (Research Development Manager and Acting General Manager)

Wednesday, 12 November 2003 - Perth

Cooperative Research Centre for Landscape Environments and Mineral Exploration

Dr Dennis Gee (Chief Executive Officer)

Mr Paul Wilkes (Deputy Chief Executive Officer)

Forest Products Commission of Western Australia

Dr John McGrath (Manager, Technical Services Branch)

Western Australian Salinity Research and Development Technical Committee

Mr Rex Edmondson (Chairman, Natural Resource Management Council of Western Australia)

Dr Thomas Hatton (Member)

Dr Donald McFarlane (Chairman)

Thursday, 13 November 2003 - Perth

Cooperative Research Centre for Plant-Based Management of Dryland Salinity

Professor Philip Cocks (Chief Executive Officer)

Murdoch University

Associate Professor Richard Bell (Associate Professor, School of Environmental Science)

Dr Susan Moore (Senior Lecturer, School of Environmental Science)

Western Australian Farmers Federation

Mr Andrew McMillan (Director of Policy)

Mr Colin Nicholl (President)

Monday, 24 November 2003 - Canberra

Australian Spatial Information Business Association

Mr Paul Farrell (Director)

Mr David Hocking (Chief Executive Officer)

Mr Greg Hoxley (Member)

Mr James Moody (Director)

Private Capacity

Dr Robin Batterham (Chief Scientist)

Monday, 1 December 2003 - Canberra

Landmark

Mr David Coombes (General Manager, Marketing)

D

Appendix D – Composition of submissions

Submissions by State and Territory of origin

State or Territory	
Australian Capital Territory / National	**15**
New South Wales	**27**
Queensland	**6**
South Australia	**7**
Victoria	**16**
Western Australia	**9**
Northern Territory	**1**
TOTAL	**81**

Submissions by submitter type

Submitter type	
Governments:	
Australian (Commonwealth) (including departments and programs)	**4**
State	**5**
Local	**3**
Intergovernmental	**1**
(TOTAL GOVERNMENTS)	**(13)**
Regional / Catchment Management Organisations	**11**
National Science Agencies	**2**
Universities / Academic Institutes	**4**
Individuals (including academics)	**11**
Cooperative Research Centres	**4**
Research and Development Corporations	**5**
Industry Associations	**5**
Professional Associations	**3**
Landholders	**2**
Businesses	**12**
Other associations (including state farmers' associations)	**9**
TOTAL	**81**

E

Appendix E – Key lessons from the National Dryland Salinity Program

This appendix provides further detail on the six key messages to have emerged from a decade of the research and research coordination activities of the National Dryland Salinity Program:[1]

- Salinity costs are significant and rising, resources are limited and hence protection must be strategic:
  - ⇨ Current costs of dryland salinity are significant and are projected to increase by 60 to 70 per cent over the next 20 years.
  - ⇨ The best that can be hoped for from recharge control treatments is a slowing down of the rate of future salinisation. Rehabilitation of existing salinity damage is generally not economically viable, owing to the sluggish response of watertables to recharge reductions.
  - ⇨ The focus of policy should be on preventing future damage to high value assets, carefully prioritising on-ground investment so as not to waste money.
  - ⇨ Close attention will need to be paid to the cost-benefit of protecting public versus private assets. In some situations direct investment in public works to protect public assets may be more efficient than efforts to protect agricultural land.
  - ⇨ Engineering works will be an important and inevitable part of protecting high value assets.

1 This appendix reproduces National Dryland Salinity Program, *Submission 35.1*, pp. 1-4.

- Profitable options for reversing the trend are lacking (but under development):
  - ⇒ Salinity will not be fixed comprehensively with targeted revegetation treatments or discharge management. The hope of finding a low cost solution, such as planting a relatively small proportion of the landscape with trees in strategic areas, is no longer tenable. However, some exceptions do exist where targeted treatment may work.
  - ⇒ However, the NDSP has confirmed that because the hydrogeology of the Australian landscape is so complex, there will be parts of the landscape (principally overlying local aquifers) where treatments could yield a net benefit.
  - ⇒ To make significant progress in extensive treatments to prevent further salinisation, it will be important to develop solutions that are profitable for those managing the great majority of land—farmers and graziers. Improved farming options that increase perennial vegetation will remain the most likely means of attaining salinity management responses at the scale needed. Research in this area will be critical.
  - ⇒ Living with salt will become inevitable if profitable plant-based solutions are not to hand. Some saltland pastures have already proven viable, as well as profitable, but these need refinement and their use requires a mindset change among many farmers.
- There is no one salinity problem—it challenges us to look beyond traditional policy instruments:
  - ⇒ Results from GFS modelling confirm that the many forms of salinity expression require a corresponding diversity in response (including no response). The NDSP has advocated strategic responses based on prevention, recovery and adaptation (which may have to take into account engineering approaches and living with salt strategies).
  - ⇒ The NDSP has developed a range of strategies from analysing responses using the GFS and Flowtube, a rapid catchment appraisal model able to assess the impact of recharge control strategies on water tables. These strategies take into account perennial farming systems, engineering works and productive uses of saline lands.
  - ⇒ The externality concept, whereby the actions of some people impose a net cost on others, may not always be valid for dryland salinity. Hence encouraging land mangers to internalise off-farm ‘costs’ by creating markets in recharge credits and debits may not be appropriate for all areas. For example, ‘leaky’ farming systems in

cleared catchments can cause salinity but they can also provide twice as much water for consumptive use compared with the amount of water available pre-clearing, and can provide significantly more water than low-recharge farming systems. Socio-economic benefits generated from the 'excess' water, and from the 'leaky' farming systems themselves, may outweigh salinity impact costs or the net benefits of recharge control.

⇒ Even for regional and intermediate aquifers, where discharge sites are more remote from recharge areas, the externalities principle does not always hold. This is because in these aquifers the lateral movement of groundwater tends to be very slow (up to thousands of years), meaning that benefits of recharge control are usually localised — at least in the short term. Again, the gains from internalising off-site costs by defining salinity credits (or recharge rights) and allowing trade between farmers appear to be smaller than previously thought.

- Integrated catchment management must be seen as only one possible approach to deal with dryland salinity:

  ⇒ New information on groundwater systems highlights the need to develop institutional options other than integrated catchment management in some parts of Australia. In some regions, groundwater flow systems (for example, some regional and intermediate systems) transcend surface catchment boundaries, requiring cross-catchment action to achieve co-ordinated surface and groundwater outcomes. In other regions, salinised land is a higher priority issue than salinised water resources. In these areas, planning and management on a more localised 'community of common concern' basis may be more appropriate.

  ⇒ Tools exist at regional and catchment levels that can help target specific interventions and predict their likely responses. In particular, modelling can support better vegetation management decisions.

- Vegetation management remains the key to managing water resources, although the benefit-cost of revegetating catchments requires careful analysis:
  - ⇒ Salt carried by surface water run-off and saline groundwater discharge into waterways imposes costs on downstream users. In water supply catchments, revegetating cleared land can reduce water yield and increase stream salinity due to less dilution.
  - ⇒ Benefit-cost analysis is needed before revegetation policies are implemented to protect water resources. Where water is scarce, desalination may be more cost-effective (given the problem here is more likely to be a groundwater than surface water problem).
  - ⇒ There is a significant difference in water use between trees (or woody perennials) and grasses (perennial or otherwise). In some parts of the landscape, only trees (or woody perennials) may reduce leakage to required levels. These trees are best placed where leakage contributes significantly to groundwater recharge. In much of the remaining landscape there may be a need to provide high volumes of clean water. Managing native grasses as low input systems may provide high volumes of clean water and biodiversity benefits as well. These systems need to be explored as much as the more popular perennial-based pasture systems such as lucerne.
- Lack of capacity is an important, but secondary constraint, to managing salinity:
  - ⇒ NDSP findings indicate that lack of skills, management expertise, poor access to information and financial difficulties are by no means the most significant factors in constraining land use change. In the absence of commercially attractive treatment options, it is unrealistic to expect farmers to change their current annual farming systems in favour of perennials or agroforestry. Under these circumstances no amount of capacity building or training will facilitate change.
  - ⇒ Other constraints for moving forward lie in the lack of clarity of rights and responsibilities, ascribing cause and effect and clearly specifying the benefits and costs of different courses of action.

F

Appendix F – Technical aspects of salt mapping

Introduction

This appendix reproduces a paper contained in the submission from the Commonwealth Departments of Agriculture, Fisheries and Forestry, and the Environment and Heritage.[1]

The appendix provides technical descriptions of some salinity mapping techniques, including airborne electromagnetic surveys used by the Bureau of Rural Sciences.

This overview is not exhaustive of the range of mapping techniques currently available and employed by private consulting firms. It is also acknowledged that there are other interpretations of the effectiveness and use of the technologies detailed by the Departments in this paper.

Electromagnetic surveys

In general, ground or water that contains much salt conducts electricity better than when there is little salt. This effect is used to measure and map the conductivity of the ground and groundwater together, the 'bulk conductivity'. Generally, high

1 Commonwealth Departments of Agriculture, Fisheries and Forestry, and the Environment and Heritage, *Exhibit no. 69, Technical aspects of salt mapping*.

bulk conductivity corresponds to high electrical conductivity in fluids in the ground but low bulk conductivity can be generated by ground with low porosity, ground with low conductivity fluids, or a combination of both.

Bulk conductivity is measured in the field with hand-held or vehicle-mounted electromagnetic induction instruments (EM31 and EM34). Surveys are conducted along traverses or a grid. EM31 provides a profile of the bulk conductivity to depths of five to six metres; EM34 has the capacity to explore to a depth of 50 – 60 metres depending on the configuration of the equipment and other factors. The benefit of an airborne electromagnetic (AEM) survey is that it offers rapid, accurate coverage of large areas with locations of salt stores and conduits for possible transport of salt, to depths greater than 100 metres below ground surface.

Both ground-based and airborne EM surveys need to be verified against down-hole EM39 induction conductivity logs, which give an absolute field value to compare against modelled bulk conductivity from the electromagnetic survey. This process is known as calibration.

Boreholes need to be drilled specifically to calibrate the survey over the full range of conductivities obtained in the survey. These can be converted later to groundwater monitoring bores to assess the performance of salinity amelioration treatments in the catchment.

It is important to note that ground-based and airborne EM surveys map bulk conductivity, which is proportional to both electrical conductivity (EC) of pore fluids or groundwater *and* porosity of the formation. The internationally accepted unit of measure for EC is milliSiemens per metre (mS / m). Conversion of bulk conductivity to EC therefore requires a good knowledge of the porosities of the soils and rocks in the saturated zone and volumetric water content (the ratio of the amount of water stored in a material to its total volume) in the unsaturated zone.

In practice, porosity and volumetric water content are generally poorly known, so a well-calibrated EM survey should be done against measurements of the pore fluids in the unsaturated zone, groundwater ECs in the saturated zone and porosities, in addition to the down-hole EM39 logs.

Assessment of salt stores and groundwater conduits from EM surveys requires expert hydrogeological interpretation in order to advise on the best options for management intervention—that is, the maps by themselves are no good to lay users and carry an inherent danger of being misinterpreted. Also, EM surveys do not differentiate primary salinity (naturally occurring in soils and rocks) from secondary salinity (salinity resulting from human activities), whereas mapping of new salinity outbreaks is a measure of secondary salinity.

Airborne electromagnetic (AEM) surveys

AEM induces an electromagnetic pulse from a transmitter towed from a low flying aircraft, generally about 120 metres above the ground. The survey can be flown by either fixed-wing aircraft or helicopter, flying sequences of parallel survey lines, generally at 200 m or more line spacing. The transmitted pulse induces a secondary electromagnetic response in the ground that gives a pseudo three-dimensional image of the ground's bulk conductivity structure.

Airborne electromagnetics systems such as those flown at Billabung Creek and Bland Creek (NSW), Honeysuckle Creek (Vic), and the Lower Balonne Catchment (Qld), transmit and measure electromagnetic signals that vary as a function of time. The signal received and 'mapped' by the system is sensitive to variations in the electrical conductivity of the ground, but the raw data itself in not a direct measure of the ground's conductivity.

Converting the data captured by the survey into an approximation of the bulk conductivity of the ground is done using various software-based processing or imaging methods, such as Layered Earth Inversion (LEI) or Conductivity Depth Imaging (CDI). Retrospective research in the lower Balonne and Honeysuckle Creek surveys showed that very little information was lost had the line spacing been increased by up to three times, raising the possibility of tripling the survey area for the same cost.

Salt mapping using AEM requires some initial understanding of the subsurface characteristics. Airborne electromagnetics is not always the most suitable technology for salt-mapping in the landscape. As a rule, AEM is most applicable for salt mapping where one or more of the following conditions hold:

- Where the terrain is relatively flat. Converting the raw data captured in the survey into an estimate of the Earth's conductivity requires certain assumptions to be made during the processing. AEM modelling processes are based on a 'layer cake' stratigraphy model—they assume that the Earth's material in the study area is made up of flat layers of material, laid down one on top of the other. Where this is not the case, for example, where there is extensive folding or faulting, the 'layer cake' assumption does not hold.

- In areas where the salinity target being mapped is relatively simple (that is, a single conductive unit rather than multiple salt-bearing units). It is difficult to convert the raw data into an approximation of the Earth's conductivity when there are several very conductive (potentially salty) materials at different depths; one layer of conductive material tends to hide another. The mathematical algorithms and modelling processes are continually improving – however, current imaging methods work best with relatively simple conductivity targets, which is the dominant situation over most of Australia’s extensive agricultural areas.

- Where the salinity target is easily defined (that is, where the unit being mapped is definable and significantly different from the background materials). Again, this relates mainly to shortcomings with the techniques used to transform the raw electromagnetic data into estimates of the Earth’s bulk conductivity. Does this mean that the unit is too obvious and is therefore smoothed or smeared?
- Where there is a high value asset to be protected. Flying airborne electromagnetic surveys costs between $2 and $10 per hectare. These costs are based on flight-line costs of $50-$100 per line kilometre at a line spacing of 100-400 metres. Mobilization is expensive (around $70 000) so economies of scale are important—limiting practical survey areas to greater than 50,000 ha. It is important to note however, that these economies of scale do make large airborne electromagnetic surveys very cost efficient, producing salt mapping at an overall cost of around $2-3 per hectare.

There is potential to double or triple the flight line spacing with insignificant loss of information, so survey costs could be reduced to less than $1 per hectare. In high-value irrigation lands, the AEM survey costs represent significantly less than 1 per cent of the value of applied water annually.

Airborne radiometrics

Radiometric surveys measure the natural radioactivity of soils. It measures gamma emissions from Uranium (U), Potassium (K) and Thorium (Th). Different soil types generate different ratios of U, K and Th, which allow the radiometric signature to map soils by their different mineral compositions. Because not all soil types give a unique gamma-ray signature, it is important that field investigation is always incorporated into any radiometrics survey.

Airborne gamma-ray spectroscopy surveys are commonly used to map soils, and are really only applicable for surface and near-surface investigations—to a maximum depth of 30cm. The distribution and shape of the different soil materials can indicate where they have come from and where they might move. In some situations, near surface conditions are indicative of deeper materials and radiometrics can be used to infer deeper geological characteristics. However, this relationship cannot always be assumed and field verification is always necessary.

Unlike AEM, radiometrics cannot generate a 3D salinity map, except by inference based on expert interpretation. Soils higher in clay content are more likely to store salt in the landscape. Note however that this does not mean a clayey soil is by definition likely to be a salt store.

Airborne magnetics

The primary magnetic field of the Earth induces smaller magnetic fields around magnetically susceptible (receptive) minerals—most commonly iron-rich minerals such as magnetite (George et al 1998).

A magnetics survey will not map salt but it can map sub-surface structures that can influence salt movement. The principle use of airborne magnetics surveys in salinity mapping is in conjunction with AEM, where it may give insights into the geology of the area where salt is being mapped. For example, because of the comparative heaviness of iron-rich minerals, they commonly occur as sedimentary lag deposits in ancient stream channels that are buried under later-deposited sediment. Aeromagnetics can measure these iron-rich deposits, which may define present conduits for groundwater movement and provide information on how the groundwater may influence salt deposition, accumulation and its potential for movement.

Aerial photographs and satellite imagery

The expansion or contraction of salt-affected areas in the landscape can be recorded by plotting visibly affected land on successive air photos (Coram et al. 2001). Air photos are also useful in mapping variations of catchment vegetation over time and photogrammetry with control points can provide elevation data for salinity outbreaks.

Satellite imagery using several bandwidths and wavelengths can be combined with other spatial information to map salinity outbreaks but the satellite record is much shorter than that for air photos. Interpretation of satellite imagery requires extensive experience in reading the images produced by remote sensing.

Soil surveys

Soil samples are taken from salt-affected areas and adjacent land or along surveyed traverses. Soil salinity measurements are interpreted on the basis of 1:5 soil:water EC extracts and moisture contents measured on the samples. Soil EC is generally reported in deciSiemens per metre (dS/m). Repeat soil surveys have the potential to map salinity change but these are point measurements only and cannot provide the spatial variability information of on-the-ground GPS mapping or aerial surveys. Soil surveys also provide little information on the impact of treatments on salinity since most groundwater flow systems are strongly buffered against change and long delays are expected between treatments and the amelioration of soil salinity (Coram et al. 2001).

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